Adaptive governance of utilities: case of the water sector in an emerging market context

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‘I, Corina Shika Kwami, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.'

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List of Abbreviations and Acronyms

Alternative Service Delivery (ASD)

Área Metropolitana del Valle de Aburrá (AMVA)

Empresas Publicas de Medellin (epm)

Environmental Agency (EA)

Habilitacion Viviendas (HV)

Juntas Accion Comunal (JACS)

New public management (NPM)

The Office of Water Services (OFWAT)

Organization of Economic Cooperation and Development (OECD)

Planes Territorio de Ordenamiento (POT)

Public Private Partnership (PPP)

Mejorimiento de Barrios (MB)

United Nations (UN)

World Bank (WB)

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Abstract

Adequate, equitable provision of essential resources requires governance that can adapt to the needs of a complex resource regime. Insufficient coordination and cooperation are barriers to governance of a resource system that is characterised by human and social interaction. This thesis explores how the application of governance frameworks for complex resource regimes, adaptive governance and social contracts that enable a diversity of perspectives on governance to inform understanding of cooperation in the provision of essential resources. Utilising an in-depth case study of water and sanitation provision in Medellin, Colombia, the thesis identifies insights from adaptive governance for the provision of essential resources through data-driven and theory-driven analytical approaches to: 1) test whether the system of water governance in Medellin is adaptive 2) describe the regime characteristics in comparison with existing theory on adaptive governance and assess alternative governing arrangements and 3) assess the social contracts within these governance arrangements.

The results of semi-structured interviews with 30+ representatives from 6 stakeholder groups (utility provider, metropolitan authority, municipal authority, universities, community-based organisations and water user associations) indicate that the system of water governance in Medellin has: 1) adaptive governance in the policy domain and mechanisms for multi-stakeholder participation, 2) Strong features of polycentric governance associated with 'bridging actors', 3) Strong forms of monocentric governance among environmental and municipal authorities and 4) top-down, mixed and bottom-up social contract arrangements. These findings suggest a form of governance that is consistent with "malleable" governance the capacity of actors within a system to demonstrate different types of arrangements that evolve in relation to needs within the system. Contributions include a multi-disciplinary approach for navigating complex resource regimes and findings that provide a case study narrative of governance that moves towards malleability.

Thesis Overview

The thesis includes three parts. Part 1 frames adaptive governance in the context of governance for complex resource systems in Chapter 1: Governance and adaptive governance for the provision of essential resources. The chapter establishes the epistemological lens for the thesis and concludes with an overarching question for the thesis. Chapter 2 provides a contextualisation of governance and adaptive governance for complex resource regimes in the wider context of governance literature and concludes with 3 sub-questions that frame the thesis. Chapter 3 introduces the case study and describes the approach to investigating the research question (adaptive governance, regime characteristics and societal arrangements).

Part II presents the results of analysing evidence of adaptive governance, regime characteristics and societal arrangements in Medellin, Colombia in:

Chapter 4: Adaptive governance of a complex social ecological system, a form of complex resource regime

Chapter 5: Governing arrangements of an adaptive system – a description of polycentric governance in the water sector in Medellin, Colombia

Chapter 6: Governing arrangements of an adaptive system – monocentric governance and other forms of nested governance within a polycentric system in the water sector in Medellin, Colombia.

Chapter 7: Social contracts within an adaptive governance system

Part III discusses the results of chapters 4-7 in Chapter 8: Towards an adaptive approach to constructing governance. Part III concludes with Chapter 9: Design and construction of a narrative for adaptive governance, questions for water governance and beyond. It also includes an impact statement, appendices and references.

Part I

Chapter 1 Governance and adaptive governance for the provision of essential resources

1.1 State of Affairs – the critical role of governance in the provision of essential resources

As societies evolve and develop, the provision of natural resources such as water that are essential for human and planetary survival and well-being remain a constant and acute feature of meeting societies' demands for the future. These essential resources are embedded in what Pahl-Wostl describes as resource governance, which takes into account the different actors and networks that help formulate and implement environmental policy and/or policy instruments for the provision of resources (Pahl-Wostl 2009). While the governance aspects will be described in more detail in Chapter 2, this introduction intends to situate and describe this area of governance study within the context of complex resource governance regimes. Resource governance regimes are complex as they "embrace the full complexity of regulatory process and their interaction"(Pahl-Wostl 2009). To view the complexity of governance regimes systematically, Pahl-Wostl includes the following properties of a complex resource governance regime: institutions and the relationship and relative importance of formal and informal institutions; actor networks with emphasis on the role and interactions of state and non-state actors; multi-level interactions across administrative boundaries and vertical integration; governance modes which refers to bureaucratic hierarchies, markets and networks.

These properties indicate that a complex resource governance regime is comprised of systems in society and ecosystems that interact. These properties also suggest that these regimes are characterised by human involvement (intentional and unintentional) and social interaction that tends to dominate the management of the system (Walker et al. 2004; Folke et al. 2010; Walker et al. 2006). Human involvement in and social interaction within ecosystems comprise what is understood as a complex social-ecological system. While the complex resource governance regime will be characterised and explored further, the next section will describe it as a type of a social-ecological system and where this perspective has informed understanding of how social-ecological systems, including complex resource governance regimes, operate and adapt.

Elinor Ostrom describes “all humanly used resources as embedded in complex, social-ecological systems (SESs) which are composed of multiple subsystems and internal variables within these subsystems at multiple levels” (Elinor Ostrom 2009). In a complex SES, “subsystems such as a resource system and governance systems are relatively separable but interact to produce outcomes at the SES level, which in turn feedback to affect these subsystems and their components, as well as other larger or small SES” (Elinor Ostrom 2009). Understanding complexity within SES requires understanding specific aspects such as resource systems, resource units and governance systems and the relationships among multiple levels and the different scales. Within the literature on complex social-ecological systems, there is a view of complexity of living systems of people and nature as emerging from a smaller number of controlling processes that create and maintain self-organisation (Holling 2000; Gunderson and Holling, 2001). Self-organisation, is what Ostrom describes as a term that characterises the development of complex adaptive systems (Elinor Ostrom 2009).

A problem facing the management of these social-ecological systems is that cooperation within the system across these different aspects critical to the management of the resource can be a challenge related to the complexity of the governance system and the manner in which cooperation occurs. A consequence of insufficient cooperation is that effective and equitable distribution of essential resources is placed in jeopardy. This would seemingly suggest that a framework for approaching the complexity of the system, and a means for understanding the interconnectedness of the systems and sub-systems within, may provide insight on how complexity is managed within an SES manages, how it is shaped and shapes a system’s capacity to manage complexity (Folke 2006).

Social-ecological systems that can manage complexity are considered to have features of adaptability at the societal level (L. Gunderson & Holling 2002). Because human actors dominate the system, adaptability is a feature that is reflective of a society’s capacity to manage complexity within the system (Walker et al. 2004; Cote & Nightingale 2012; Folke et al. 2003). Social actors in systems are also considered to have the capacity to adapt, to

manage resilience and/or transform in the wake of change (Walker et al. 2004).[1] When considering how to distribute resources effectively and equitably, governance of an essential resource and the arrangements between members of society who consume them, is of major importance. Before describing in more detail why governance is critical, this introduction will now discuss why arrangements of groups in society within a system are critical for providing the essential resources, identify a problem of coordination and highlight the vital role the arrangement of groups within a system plays in adaptation. The following section will discuss the challenge at a general scope and then specifically in reference to a resource that is critical to the functioning of all human life, societies and the activities that connect them. The general scope is intended to highlight challenges that emerge from studies of complex resource regimes (as a type of social-ecological system) that serves to inform an examination of a specific resource.

1.2 Challenge – barriers to cooperation within a complex resource regime

A challenge for a complex resource regime is that cooperation within may not always occur for a variety of reasons. Firstly, the complexity of the different actors and their interactions are a feature that may be in a state of change (Folke et al. 2003; Holling 2001). Complexity within a system refers to the arrangement of different groups within a system and how they relate to one another. For example, a centralised system may offer benefits of simplifying authority; however, during times of change and flux, the centralised design may preclude different actors or groups from accessing multiple sources of information (Bodin et al. 2006). Contrastingly, systems that are highly decentralised yet without the capacity to manage the interactions within the system in an adaptive way may not capture the benefits of decentralised and dense systems (associated with trust and the tendency to form groups (Bodin et al. 2006; Andersson & Ostrom 2008). In both of these examples, scale is also a factor

[1] Attributes such as adaptability (the capacity of actors to manage resilience) and transformability (the capacity to create a new system) are associated with systems that are able to adapt. For the purpose of understanding how complex social-ecological systems can be adaptive, references to adaptability and resilience are to be considered with how the social actors shape and are shaped by the system's dynamics. This is adapted from previous work on adaptability and resilience that calls for attention to the attributes that govern the system's dynamics (Walker et al. 2004; Walker et al. 2006). Part of ensuring access to these essential resources requires adaptability, resilience and transformability of the social, human actors as well as the system as a whole.

in consideration challenges related to cooperation within a complex system (Cash et al. 2006; Cumming et al. 2006; Berkes 2006).

Secondly, different and sometimes competing interests, incentives and different appetites for risk of different actors within a system may be associated with different levels of participation (Ostrom & Cox 2010; Susskind et al. 2012). Thirdly, arrangements in place (policies and plans) may not be conducive to cooperation. As a result, channels for sharing knowledge are not optimised which may have implications for the system's overall adaptability, resilience and transformability (Folke et al. 2010). Continuous testing, learning and developing knowledge and understanding is critical (Olsson et al. 2004). However, without cooperation, change and uncertainty cannot be navigated cohesively. To promote more fluid cooperation, there is some evidence to suggest the importance of social capital and the role of institutions in facilitating cooperation (Brondizio et al. 2009; Folke et al. 2005). In a review of 15 case studies of complex social-ecological systems exploring how learning and knowledge sharing is integrated, the findings conclude that top-down approaches, from a policy and management perspective are less likely to be equipped to meet the cooperation needs of complex resource systems (Walker et al. 2016).

What each of these factors (complexity, different interests and structural arrangements) have in common is their association with a social-ecological system's capacity to cooperate. Chapter 2 will describe how these factors emerge from disciplines exploring system's resilience, and capacity to adapt and transform. At this stage, these factors are introduced a reflection of human involvement and societal interactions, as this thesis draw upon thinking from disciplines exploring the human and social involvement within social-ecological systems to inform understanding of how the governance system operates and adapts. This approach is from the perspective of constructivist epistemological position which will be described further in Chapter 3 as it correlates to the choice of method for data collection and analysis.

1.3 Example of this challenge in the water sector

Essential resources, and the adaptability of systems to provide them, are core components of different and interconnected ecological, industrial, social and environmental systems (Pahl-Wostl 2009). As an example of an essential resource, water has been identified as a cross-cutting resource whose security is also related to other systems such as energy, waste and

food (OECD 2016; Parkes et al. 2010). As described for essential resources at a general scope (See Section 1.2), a barrier to an efficient and equitable provision is the challenge of cooperation which is unsurprisingly, a challenge in the water sector. Cooperation barriers are most acutely described as the foundation of a "governance crisis" (OECD 2015a). While this thesis is not ignoring that there are several technical challenges related to the provision of water, these challenges are highly likely to be connected to broader governance challenges (OECD 2015a).

Solving a challenge of governance will be critical to serving the 2.1 billion people of the global population that lack access to secure water and the 4.5 billion who lack access to sanitation services (OECD 2015a; Zurich Insurance Group Ltd 2017; Pahl-Wostl & Knieper 2014). With a broad acknowledgement that water is essential for all human life and part of the functioning of all social-ecological systems, this thesis aims to develop an understanding of an essential resource system where the change is most acute. Most imminently, acute and rapid change is occurring in urban areas, and more specifically, in secondary cities where populations are growing at a faster rate compared to other cities. The implications of this growth are that there is an even more acute stress on available resources (Roberts 2014).

While the justification for water will be discussed further in Chapter 2, in summary it is selected as the complex resource regime for investigation for to several reasons: its connection with other systems such as food-energy-water and food-energy-waste nexus (OECD 2016; Gandy 2004; Akhmouch 2012), its role as an essential resource for human planetary life (Bakker 2007; Castro 2007; Eric Swyngedouw 2002) and its connection to the functioning of other systems (Zurich Insurance Group Ltd 2017). Beginning with the literature and theoretical frameworks for adaptive governance of essential resources more broadly, an adaptive lens can frame an investigation of a specific resource regime (water). The findings contribute to a discussion of possible connections and lessons learned for other complex resource regimes.

1.3 Macro research question and outline of the thesis

This thesis explores what an adaptive lens can offer for understanding governance from a societal perspective. The adaptive lens draws upon previous research that has examined the relationship between cooperation in the provision of an essential resource and adaptive governance. The guiding macro-question: *What can an adaptive governance lens offer for*

tackling a governance challenge related to cooperation in a complex resource regime? frames a review of the literature in Chapter 2 with an overarching question and precedes three research questions to guide the thesis. The review situates resource governance and adaptive governance (for complex resource regime and social-ecological system) within the wider multi-disciplinary perspectives on governance. The literature review identifies features consistent with adaptive governance and calls for more research in the literature that situate opportunities for further investigation. As the case study is related to the water sector, the review of resource governance also explores to what extent these features have been investigated in the literature on water governance. The lens for governance frameworks, however, is from the perspective of complex resource governance regimes. This is done with the intention of discussing the results and wider implications of adaptive governance for resource governance regimes more broadly. With an understanding of adaptive governance for complex resource regimes and governance for the water sector, the chapter will now discuss the research questions that emerge and the hypotheses to frame the investigation.

(OECD 2016; Gandy 2004; Akhmouch 2012)(Bakker 2007; Castro 2007; Eric Swyngedouw 2002)(Zurich Insurance Group Ltd 2017)

Chapter 3 includes two sections. The first section introduces why a case study approach was selected and introduce the case study. Section 2 describes the methods for investigating the research questions and justifications for the chosen methods.

Chapter 4 provides results to the first research question which demonstrates to what extent the case study is consistent with the definition of adaptive governance by comparing data for the case study with a definition and features of adaptive governance in the literature.

With an understanding of the context of adaptive governance in the case study, Chapters 5 and 6 explore to what extent the case study includes regime characteristics established as arrangements of an adaptive system in the literature. These chapters demonstrate where to what extent there is consistency and where there is a departure from theory.

Chapter 7 presents the findings related to the societal arrangements within those regime characteristics, taking into account the findings from Chapters 5 and 6 to summarising the results.

Chapter 8 discusses findings in the context of the broader question of what an adaptive lens offers for tackling challenges related to coordination and governance, implications of findings for understanding adaptive governance in within the water sector and more broadly and contributions to interpretations and studies of governance.

Chapter 9 concludes with a summary of the discussion, recommendations, strengths and opportunities for future research. Following this chapter of concluding remarks, an impact statement describes the contribution to the field.

Chapter 2 Governance for complex resource regimes: an overview of governance and adaptive governance across disciplines

2.1 Governance – as an explanation for arrangements of actors in a system

Governance is a critical factor to consider in a complex resource regime for the provision of essential resources. To examine how an adaptive governance lens can tackle the challenge of cooperation in complex resource regimes, the review of literature contextualises governance and cooperation for complex resource regimes within the wider governance literature and describes the research questions that emerge. The chapter begins with a definition of governance for resource regimes and a definition from the water sector, contextualisation within the wider governance literature and perspectives for understanding cooperation within the governance for complex resource regimes, as social-ecological systems, more broadly. The chapter then discusses what the lens of adaptive governance offers for understanding cooperation within the complex resource regime, presenting features commonly associated with adaptive systems, characteristics of the adaptive governance design and theory for understanding the nature of cooperation within a complex resource regime (as a social-ecological system). Lastly, the chapter presents literature related to theoretical frameworks for exploring the interactions between actors within a system.

The perspective of governance for this thesis is informed by a broader understanding of governance as the 'rules in use' as described by Ostrom which refers to "the specific combination of formal and informal institutions that a group of people determine what to decide, how to decide, and who shall decide" (Ostrom, 1999). This perspective of governance is consistent with a sector specific understanding of governance in the water sector where water governance can be understood as the "relationships between governments and societies, including laws, regulations, institutions, and formal and informal interactions which affect the ways in which governance systems function" (Tortajada 2010). Tortajada also emphasises that governance and government are not the same. Governance includes decision-making from public institutions, private sector, civil society and society in general and stresses the importance of involving more voices, responsibilities, transparency and accountability of formal and informal organizations associated in any process (Tortajada

2010). Karen Bakker, a leading scholar in the field of water governance, defines water governance "as a practice of coordination and decision-making between actors, which is invariably inflected with political culture and power" (Bakker 2010). Applied from a perspective of water governance as a type of resource governance regime, these understandings highlight the importance of context which can include for example a society's culture and power relations (hierarchy) embedded within, which is consistent with a constructivist perspective. A context-specific view of governance also may refer to governance "as a process of decision-making that is structured by institutions (laws, rules, norms and customs) and shaped by ideological preferences"(Bakker 2010) of that society.[2] This definition of water governance is consistent with Tortajada's perspective of water governance as "comprising all social, political, economic and administrative organizations and institutions, as well as their relationships to water resources development and management" (Tortajada, 2010). This governance definition and perspective of governance in the water sector is utilised as an perspective for governance of a specific type of resource regimes. Governance is situated within a wider, extensive field covering disciplines across the political, social and natural sciences (ecology, engineering and environmental science). The following sections introduce the diversity of perspectives on governance across disciplines, summarise governance within several different disciplines, how these perspectives emerge and conclude where the perspective of governance of a resource regime (water) is situated within the broader literature.

If governance is understood as "the rules-in-use" in collective decision-making at a general level and applied to a specific governance regime like water, it is critical to highlight the different disciplinary perspectives that have contributed to this understanding and offer an opportunity for a richer discussion of findings related to resource governance regime. To study governance is a cross-disciplinary endeavour and develops as a multi-disciplinary activity (source). Governance has emerged in response to different forces of change such as globalisation, rising democratisation and the spread of economic and social links. These forces of change have presented disciplines with unique opportunities to respond using disciplinary

[22] When this literature review was revised on 16.02.2017, there were 84,500 titles in Google Scholar (with library links to UCL, LSE), for water governance definition and 118,000 titles for "urban water governance definition."

tools and acknowledge the core epistemological positions within and between disciplines. These following (2) sections will summarise the literature from two disciplinary camps – that of social-political science and the natural sciences, acknowledge core principles and perspectives and conclude with an overview of commonalities and where resource governance is positioned.

2.1.1 Governance perspectives from social-political sciences

Under the umbrella of governance in social-political science, governance includes perspectives from several fields. This section will highlight disciplines and key contributions. This include new institutional economics (Williamson, North, Ostrom), International relations (Rosenau, Smouts and Murphy), Development Studies (World Bank, Hyden), Social-Legal governance (Moore, Cochrane, Benda-Beckman), Corporate Governance (Shleifer and Vishny, Keynes, Hart), Participatory Governance (Ostrom, Heller, Ackeman) and Environmental Governance (Pahl-Wostl, Rijke, Folke). This list is meant to provide a broad overview and acknowledges that there may be other connections to governance. These selections are included as they aid in situating resource governance in a wider context.

New Institutional Economics

The field of New Institutional Economics is described as emerging from an interest in the development of transparent systems and institutional arrangements as well as reasons behind market failure and thus the perspective of governance is focused on the nature of transactions, managing uncertainty in economic decision-making and the allocation of common-pool resources. Thinkers such as North assume that institutions are formed to reduce uncertainty in human exchange and that human exchange is reflective of culture which is produced through the 'intergenerational transfer of knowledge, values and norms', and in part acquired through experience which is 'local' to a particular environment" (North 1995). This interpretation is consistent with Ostrom's "rule-in-use" which suggests that the role of governance for North is to reduce uncertainty in human exchange (Ostrom 1999). Williamson explores these exchanges within a system of governance further in transaction cost economics and their implications for law, economics and organisational mechanisms to facilitate exchange. Exchanges within transaction studies are made more complex with regards to common-pool resources. Ostrom tackles common-pool resources as public goods which will be revisited again in relation to participatory governance (Ostrom 1986). In the

field of New Institutional Economics, the contribution to thinking around common-pool resources and how they are allocated includes the perspectives presented here for understanding the formation of self-governing institutions, the existence of nested rules at different levels and the importance of the external political regime on the operational rules and at the level of the community (Ostrom, quoted in Chhotray & Stoker 2010).

International Relations

Governance in international relations is concerned with key debates on the role of the state and the relationship between globalisation and global governance (Chhotray & Stoker 2010). Unsurprisingly, this field expanded in the 1990s in response to globalisation as a driving force behind complex societal dynamics and pressures for change. The role of globalisation includes shifting roles and authority as global orders are rearranged through integration, centralisation, decentralisation and localisation (Chhotray & Stoker 2010). Scholars such as Rosenau explore this in relation to changing regulation mechanisms for resources that are not necessarily endowed by a formal authority (Rosenau 1992). While globalisation involves large scale governance (state, inter-state levels), scholars such Rosenau as well as McGinnis and Mann also explore drivers, needs and power dynamics at local, individual scale that influence how coordination is enacted in a system of governance. For McGinnis this approach is informed by assumptions of human needs such as physical security which is directly and indirectly linked to access to resources (McGinnis 1999). For Mann, this begins with an understanding and assumptions regarding power relationships (Mann 1997). For resource governance, these perspectives offer the potential for situating discussions around water and other essential resource governance within the broader international affairs landscape.

Development Studies

Development studies is presented separately from new institutional economics and international relations although it shares commonalities with these two disciplines as it grew in response to a need for understanding the unequal nature of relationships between and within the developed and developing world (Chhotray & Stoker 2010). This is not exclusive to access to resources, however debates related to inequality do include issues related to climate change, resource governance and transboundary governance. A development studies response also emerges in the wake of development partners and institutions raising questions of how governance is implemented by donors and how governance can facilitate aid policy

outcomes and has been described by as a movement away from New Political Economy towards 'Good Governance' (Chhotray & Stoker 2010). Scholars such as Hyden contributed notable understandings of governance with an emphasis on stewardship of rules that regulate the public realm and a focus on how economic and societal actors interact (Hyden et al. 2004). Development studies is included here as it is a link between the academic work related to new institutional economics and international relations and the policy and planning work of development partners.

Social-Legal Studies

Governance in the realm of social-legal studies presents shifts in thinking within the law profession from one examining the power of the state to shape law (1960s), towards exploring the limits of the capacity of law to transform social life (1970s), further towards understanding relationships between state law and context (1980s) and with an emphasis on understanding the position of the individual in relation to the law (Chhotray & Stoker 2010). These shifts suggest a view of governance that is not synonymous with government and that the state is not the only source of legitimacy (Benda-Beckmann 1994). Law is where governance is practiced yet is shaped by various other factors such as custom and social behaviour, which may not always be within the conscious control of individuals (Diamond 1973). These features from a social-legal perspectives of governance is consistent with understandings of complexity, power and good governance, which are in dialogue with views raised in earlier discussions of new institutional economics, international relations and development studies. Moore's exploration into complexity says that more complex societies require more intricate questions around supposedly binary understandings of issues such as domination vs autonomy (Moore 1978). This dialogue around binary understandings will be discussed as it applies within water governance and a call for exploring the role of actors within systems with an alternative service delivery model (where the shift is away from a binary understanding). See Furlong 2016. This emphasis on complexity in the social-legal realm is in contrast to international relations studies where the emphasis is on changing roles across scales due to trends such as globalisation. Social-legal understandings view legitimacy as widened beyond the state and that law is informed by culture (Chhotray & Stoker 2010). This perspectives is consistent with views raised by North related to rules and norms. Where a view from the social-legal tradition departs from perspectives presented here is in relation

to the good governance agenda which aims for an approach to rule of law and an optimal division between government, market and civil society (Benda-Beckmann 1994). This is in contrast to the "rules-in-use" perspective (Ostrom 1999), which would suggest the "complex and multi-faceted social processes...which can be official and unofficial, intended and unintended, visible and invisible, together mediate social behaviour and conduct" (Chhotray & Stoker 2010). The social-legal perspective is included because it is where the application of governance and practice can be studied from the perspectives of law and culture.

Corporate governance

The previous disciplinary views emphasise perspectives relevant to governance from a societal and state level perspective. Corporate governance is included as well as its insights on the governance of firms and private companies, the role of stakeholders and the interface between public policy and regulatory frameworks have contributed an understanding of governance informed understandings of human behaviour at a micro and macro level. This includes view of governance as how organizational resources will be managed and conflicts are to be resolved (Daily, C., D. Dalton and A. Cannella, 2003). There are some commonalities with New Institutional Economics that explore transaction cost theories to understand the nature of exchange as well as behavioural economics which focus on how learning occurs within organisations (Smyth, R., and Lo 2000). While not the emphasis of this study (at the level of the firm), corporate governance offers an opportunity for discussion of the behavioural and micro level interactions in how organisations and institutions can be governed.

Participatory governance

Participatory governance emerges alongside trends such as globalisation referenced by the disciplines here and is attributed as a response to formal state inadequacy to deal with growing social complexities and actors from different sectors (Chhotray & Stoker 2010). Complexity from a participatory governance perspective arises in relation to several changes including the proliferation of different political actors such as civil society organisations and the unequal and asymmetric relations of power. Civil society is understood as a site for governance especially in environmental politics and community development (Fischer 2004). As in social-legal studies, context and local understanding are central to governance from a participatory governance perspective as 'local knowledge and understanding' are a basis for

'local action', and on 'direct forms of participation through the development project cycle' (Gaventa n.d.). This manifests in studies examining various attempts to govern from a communitarian, pluralist democratic, populist or neoliberal views to name a few. Participatory governance is fundamentally about transformative power and is concerned with the opening up of decision-making processes conventionally dominated by hierarchical and top-down state structures to new social actors (Chhotray & Stoker 2010). In order to do this, scholars such as Ackerman say that for participatory governance to thrive, "institutionalism must avoid bureaucratisation and preserve social dynamics through integrating participatory mechanisms into strategic plans of government agencies, creating agencies to assure societal participation and inscribing of participatory mechanisms into law" (Ackerman 2004).

This overview of governance from perspectives related to political science emerges for different global trends such as market failure (new institutional economics), globalisation (international relations), growing inequality (development economics), changing legal and corporate paradigms (social-legal and corporate governance) and a perceived inadequacy of the state to deal with growing complexity (participatory governance). While each of these areas of study include different epistemological points of reference, there are some common understandings that have been presented in these summaries: governance and government should be distinguished, governance and social context should be considered together and that governance is complex and should account for the role of different stakeholders, different levels and scales of governance, the interaction between social and economic context. The fields of new institutional economics and participatory governance take these commonalities into account with respect to the governance of common-pool resources, which can be positioned in the realm of environmental governance, which draws from social-political science and natural science. The next section provides a summary of the disciplinary contributions from natural science fields such as ecology and some applications of engineering that have been taken into account for understanding governance of common-pool resources beginning with water.

This summary will describe concepts such as adaptive capacity and resilience from engineering, ecology and environmental science which inform the governance perspective and underpin an understanding of adaptive governance which is discussed in more detail in 2.2. The section will introduce these concepts as background for adaptive governance which

will be developed further in (cross-reference). The section will conclude with a summary of environmental governance that contextualises governance of complex resource governance regimes with the acknowledgement of the social-political and natural science perspectives outlined in these sections.

Water governance emerging from multiple disciplines

Water governance emerges from disciplines such as geography and development studies and is also informed by studies and concepts from ecology, environmental science and engineering. This link is particularly acute as the successful application of technical solutions in water, as in other complex resource regimes, often requires capacity to coordinate at a technical and social level within a wider society. In addition to Bakker, there are other scholars in water governance such as Kathryn Furlong, Eric Swyngedouw and Rogers that contribute to a societal perspective that is inclusive of "the range of political, social, economic, and administrative systems that are in place to allocate, develop and manage water resources and the delivery of water services for a society" (Rogersa et al. 2002). Scholars with a management perspective contribute to a view of water governance that acknowledges the variety of systems that should be taken into account, suggesting that systems' theory accounts for processes that include a range of actors (Nelson 2011). Given the range of actors from a system's approach, scholars differentiate water governance from "water management" which refers more acutely to the administration, implementation and the functioning of water infrastructure (Sutherland et al. 2015) and seems to suggest a focus from within water utilities and actors with a direct link. Contributions from other disciplines such as ecology and environmental science examining water governance, identify the link between the social and ecological aspects of water systems, which will be discussed further in relation to coordination between the different actors within a mapped system of water governance (Pahl-Wostl et al. 2012).

2.1.2 Concepts in governance of social-ecological systems that emerge from ecology, environmental sciences and engineering

Literature from ecology, engineering and environmental science provide the concepts of resilience, adaptive capacity and social-ecological systems, which position an interpretation of governance at the intersection of social and ecological (natural systems). This next

discussion will highlight linkages between these concepts, in context of the disciplinary contributions to governance of complex resource regimes at this disciplinary intersection.

Resilience

Resilience has several disciplinary underpinnings of which there is a link to adaptive capacity as a characteristic of resilience, a distinct concept unto itself, related to adaptability. The use of resilience theory for analysing complex systems in environmental science features in literature on adaptive resource and environmental management beginning with an application of ecological resilience to social-ecological systems (Gunderson, 2000). Carl Folke provides an in-depth summary of several authors who apply ecological principles of resilience (Carpenter & Gunderson 2001; Berkes et al. 2003; Martin F 2003; Walker et al. 2016) in the environmental management arena. The application of ecological resilience is expanded further in work that looks at "renewal, regeneration and re-organization" within a system that demonstrates resilience (Bellwood, 2004). From the ecological perspective, this tends to view resilience as how a system develops in the face of change. This seems to suggest an emphasis on how to innovate and transform towards new more desirable configurations, described as "transformability" (Folke et al. 2003).

An understanding of resilience from an environmental science approach provides an interpretation that emphasises a capacity to change which differs from what may be emphasised in conventional interpretations of resilience in engineering which examine how a system returns to equilibrium in light of change (Pike et al. 2010). Methods and applications of engineering practice seem to have linked interpretations in engineering as well as to systems' applications of resilience which focus on behaviour near a stable equilibrium and the rate at which a system approaches a steady state following a change or disturbance (Folke 2006). Ludwig addresses the difference between engineering resilience and ecosystem resilience mathematically, demonstrating to what extent a system can maintain efficiency of function, constancy of the system and a predictable world (Ludwig, D., Walker, B.H., Holling 1997). While there is evidence to suggest that different disciplines within engineering may have perspectives not represented in this description, Folk highlights early understandings of resilience that emphasise the capacity to persist and sustain a domain in light of change (Berkes, Colding, & Folke, 2003; Ludwig et al., 1997, Pimm 1991). There is a debate within

engineering that seems to suggest a reconsideration of this form of thinking. Young argues for a view of resilience free of the "return to equilibrium" assumption and a refocus on the ability to handle stress in an adaptive manner in institutions and regimes (Young et al. 2006 quoted by Duit et al. 2010).

The contributions on resilience from ecology and engineering to environmental science, provide a foundation for dialogue on governance of complex resource systems. Adaptive capacity draws similarly from disciplines of ecology, engineering and the environment and can inform governance of complex resource systems. Capacity to adapt has been increasingly described as a characteristic of social-ecological resilience which accounts for social and societal factors that interact in a given ecological system (Berkes et al. 2003). Some scholars suggest that resilience gives rise to adaptive capacity (Smit & Wandel 2006). While these definitions are inter-related, adaptive capacity emphasises an aspect of the resilience definition that is more specific to a system's capacity to change, adapt and transform. Adaptive capacity is closely associated with resilience theory, developed in the discipline of ecology. Gunderson and Holling as well as contemporaries have been attributed with describing resilience as the capacity to persist within such a domain in the face of change (L. H. Gunderson & Holling 2002). Embedded in Holling's definition, which originates from an ecological context, is the capacity of an organism or a system to withstand change and/or to persist in the face of change. These interpretations from disciplines such as engineering, environmental management and systems' theory show that there is evidence for a link between resilience theory and its application for analysis of complex systems.

Adaptive capacity and social ecological systems.

As the previous discussion makes reference to adaptive capacity, there is a need to highlight the evidence from different disciplines to support analysis of social-ecological systems from a perspective of adaptive capacity which includes evidence that governance from this perspective is used in order to understand how co-evolving societies and natural systems can cope with and develop from disturbance and change (Duit et al. 2010). This link between adaptive capacity and social-ecological systems seems to be made with an emphasis on the complexity of systems which are an aggregate of social and natural actors, processes and functions in different levels of interaction (horizontal, vertical). There is a description of

adaptability as the capacity of actors in a social-ecological system to manage resilience in the face of uncertainty and surprise vs. transformability, which is the capacity to create a fundamentally new system (Folke et al. 2010). These nuanced interpretations inform an application of adaptive capacity as a characteristic of resilience takes its perspective from "complex systems and resilience theory, complexity theory and resilience thinking – in the natural and social sciences" (Duit et al. 2010) . This approach draws on Ostrom's work in 1990 and 2005-2007, where the investigation of polycentric systems is derived from a shift from local level analysis to emphasis on cross-system interactions and dynamic social-ecological systems (Duit et al. 2010). Further, with this approach to social-ecological systems,

> *"the focus is placed on processes of change and surprises….how governance arrangements try to cope with and adapt to a dynamic and changing environment"* (Duit et al. 2010).

This emphasis on change within a system seems to challenge analysis that would approach the complexity of a particular outcome, rather than a focus on which components are social and/or ecological. This approach would seem to suggest:

> *"A view of human-made governance systems consisting of institutions, networks, bureaucracies, and policies as examples of complex systems in which adaptive agents respond to external and internal impulses"* (Duit et al. 2010).

The link between adaptive capacity and social-ecological systems is made strongly by Folke, who identifies factors for dealing with social-ecological dynamics during periods of rapid change and reorganization which include:

- Learning to live with change and uncertainty
- Combining different types of knowledge for learning
- Creating opportunity for self-organization toward social-ecological resilience
- Nurturing sources of resilience for renewal and reorganization

  (Folke et al. 2005)

Contributions of concepts such as adaptive capacity and resilience in social-ecological systems from ecology, engineering and environmental science provide an understanding of how environmental systems and complex resource systems such as water operate. While water governance is predominantly positioned in the fields of geography and development studies, the contributions from fields closely associated with the natural sciences entertain an interdisciplinary dialogue with social and political science perspectives of common-pool resources. Scholars such as Ostrom, who contributed extensively to thinking on common-pool resources and participatory governance, can serve as a bridge between these disciplinary perspectives, in particular, within the interdisciplinary field of environmental governance wherein complex resource regimes is situated. By acknowledging the nature of the environment and its governance as a global issue, Ostrom's work on common-pool resources focuses environmental governance as a "collective action problem eliciting institutional responses from states, markets and communities" (Chhotray & Stoker 2010). In acknowledging the different areas of emphasis for the scope of governance, this last section will summarise and situate governance of resource regimes as a sub-set of environmental governance and discuss how social interaction is accounted for within these regimes.

Resource governance as a sub-set of environmental governance

As environmental governance relates to a collective action problem and there is growing recognition of the role of society and social actors, theories of human cooperation are utilised to understand the governance of common-pool resources. To understand human cooperation, scholars in this domain argue for:

> *"Identifying the conditions under which 'appropriators' are expected to cooperate to devise governing arrangements. In this tradition, great emphasis has been placed on the institutions that are most likely, and able, to facilitate cooperative behaviour to promote desired values such as sustainability of growth and development and conserve the earth's environmental resources (Chhotray & Stoker 2010).*

In exploring the conditions and governing arrangements that enable cooperation, within environmental governance, 'resource regimes' signifies thousands of resource using institutions which function at varying geographical and social scales, and are not only 'material', but also 'ideational' involving collective cognition, ideas and explanations" (Chhotray & Stoker 2010). Ostrom's work informs the theoretical perspective on common-pool resources and participatory governance.

Social interaction within resource governance regimes

Because social-ecological systems are characterised as having a high degree of social and human involvement, social contract theory is applied as it captures the nature of human cooperation at a micro as well as a macro, societal scale. Nonetheless, Ostrom's work on common-pool resources informs the perspective, particularly in how human cooperation relates to the wider governance literature. For examining a resource such as water at a micro and societal level, keeping this perspective in mind is also useful in looking at the management and supply of water and challenges such as over-use or exploitation of the resource, different models of governance (state regulation, privatisation, user base) because it allows for a mix of mechanisms (Jessop, 2003). This perspective will be used for understanding complex resource regimes.

Ensuring that societies have essential resources is closely related to how they are governed within a system, notably as it establishes that governance failures are at the origin of many resource management problems (Pahl-Wostl 2009). The complexity of politics in most countries along with the challenges of power, resource and responsibility distributions, can be barriers to cooperation within an environmental system (Leck & Simon 2012). In addition to understanding governance as the management and supply of water, mapping the governance regime includes the actors (state and non-state) arrangements between actors within the society, the interactions within the system (hierarchies, networks and markets) and the processes that guide these interactions. These interactions can be informal or formal; facilitated by the application of principles, rules, norms and enabling institutions that guide public and private institutions as posited by Pahl-Wostl in Figure 1 (2009).

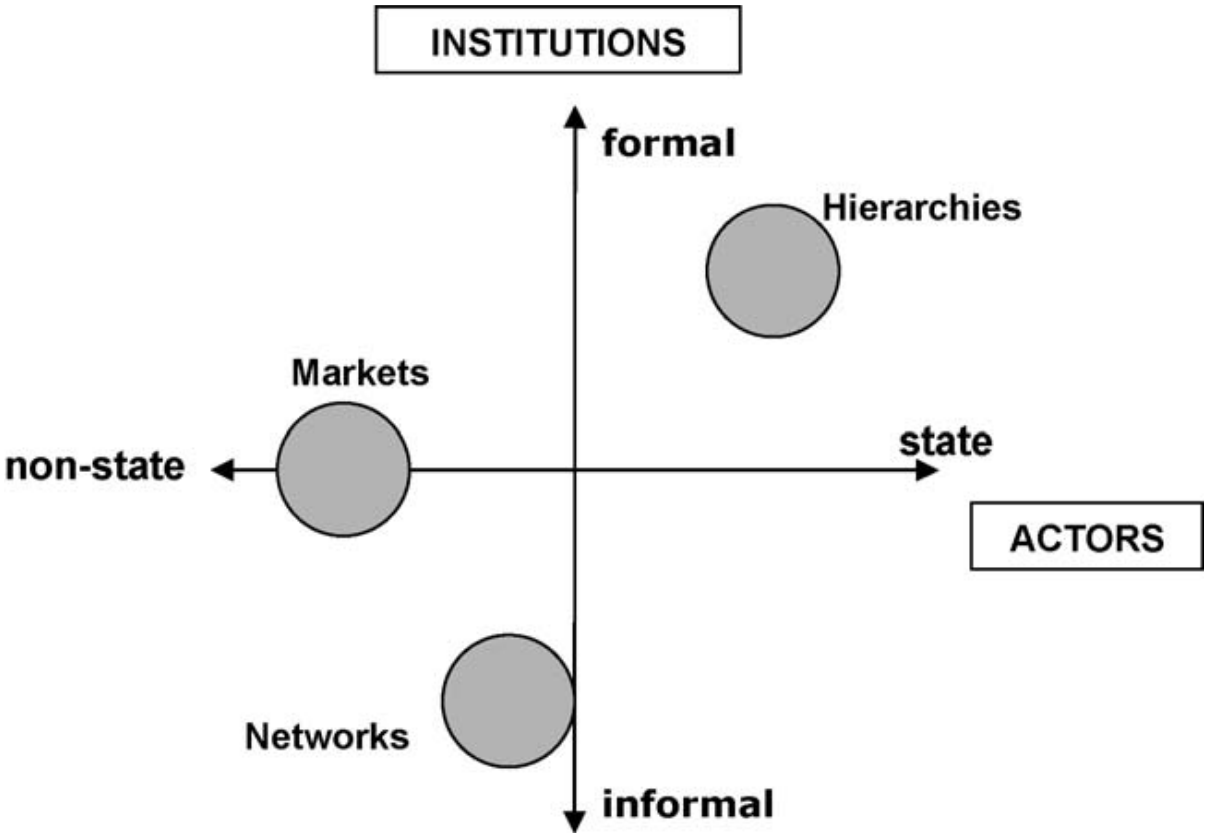


Figure 1 Mapping governance regimes (Pahl-Wostl-2009)

A governance perspective on the arrangements of different actors within a system and how they interact emerges from the literature that discusses how the social and ecological aspects of a system interact. To join the systems' and social-ecological context in which water governance regimes are placed, the following figure derived by Ostrom and Cox, provides an overview (Ostrom & Cox 2010). Figures 2 and 3 show the range of contextual factors (social, economic and political) that may have associations with the governance system and the range of contexts that could be taken into consideration. This framework is used in the analysis of complex social-ecological systems and how they sustain themselves

in light of change and sudden shocks (Ostrom & Cox 2010).

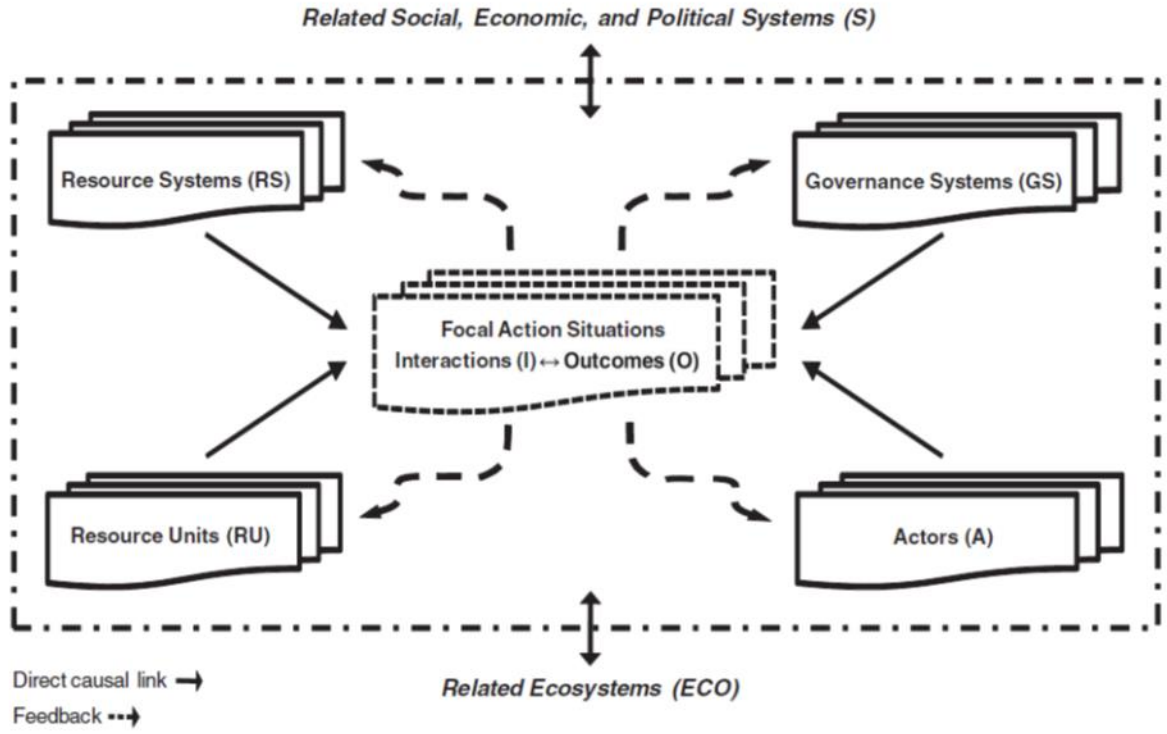


Figure 2 Revised SES Framework combining the IAD and SES frameworks (Ostrom and Cox, 2010 citing McGinnis 2010)

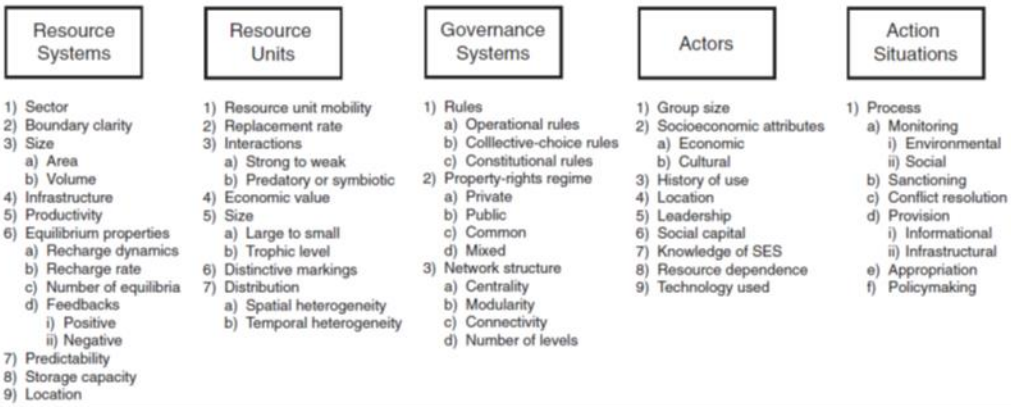


Figure 3 Review of theoretical frameworks for mapping the water governance regime (Ostrom and Cox, 2010)

While social contract frameworks are applied for understanding human cooperation over Ostrom's, this framework has also been consulted to understand a perspective on the composite parts within the governance system (rules, property-rights regime and network structure) and where the actors are situated in relation to the other composite parts. Taking these different disciplinary viewpoints on governance into account and situating complex resource governance within the broader literature on environmental governance (informed

by ecology, engineering and environmental science), the next section will discuss governance in the water sector will discuss adaptive governance as a means for exploring human and social cooperation.

2.2 Adaptive governance – as an explanation of features of societal groups in a system that adapts

Building upon a definition of governance that emerges from the literature on water governance, where water is understood as a complex resource regime (a social-ecological system), the concept of adaptive governance focuses attention on features of social-ecological systems that are able to coordinate and cooperate despite complexity, abrupt change (Pahl-Wostl 2009), renewal and reorganization (Folke et al. 2005). At the level of complex resource governance regimes as a type of social-ecological systems, a system that is seemingly adaptive will be consistent with the following definition:

1. knowledge and understanding of resource and ecosystem dynamics which also includes incentives for knowledge generation;

2. ecological knowledge in adaptive management practices which includes continuous testing;

3. monitoring and re-evaluating to enhance adaptive responses; and

4. support for flexible institutions and multilevel governance systems (adaptive management) and capacity to deal with uncertainty and surprise (Folke et al. 2005).

Features of systems that are seemingly able to adapt emerge from literature from engineering, ecology, environmental science regarding concepts of adaptive capacity, resilience and transformation. Evidence from these characteristics has also been identified in aspects of planning which includes, for example, having specific policy areas integrated as a way of coping with complexity (Rijke et al. 2012). Characteristics of systems that can adapt include having collaboration of a diverse set of stakeholders, different levels, networks from local users to municipalities, regional and national organisations (Folke et al. 2005). There is also evidence that these systems are better equipped to handle conflicts among diverse stakeholders (Duit et al. 2010). Social capital and trust may also strengthen a capacity's capacity to succeed. "Trust is the basis for social institutions, building trust and the growth of social networks (trust, reciprocity, common rules, norms, sanctions, and connectedness in institutions" (Duit et al. 2010). Social capital and trust have also been widely discussed in the

context of formal institutions as well as in the emergence of “informal networks, orchestrated by key individuals, that help facilitate information flows, identify knowledge gaps, and create nodes of expertise of significance”(Pahl-Wostl, Craps, et al. 2007). Adaptive governance of social-ecological resilience also requires capacity to deal with the broader environment and preparation for uncertainty and surprise with respect to the growing literature on polycentric institutions (Ostrom 2010; Andersson & Ostrom 2008; E. Ostrom 2009) with flexible coping with external drivers and rapid change enhanced by systems of governance at different levels (Duit et al. 2010).

Taking the definition of adaptive governance into account, proposing a way to identify features should encapsulate adaptive management practices, understanding of resource and ecosystem dynamics in planning and opportunities for monitoring and re-evaluating and support for flexible institutions in spaces for multi-stakeholder engagement (Folke et al. 2005). Adaptive features to identify as associated with adaptive governance (not an explicit causal link) may include for example plans that integrate different systems such as water, land-use, social and housing. Other features may include opportunities for groups to cooperate, specifically to self-organise as a result of learning and interaction (Rijke et al. 2012). Taking these features of adaptive systems into account, adaptive management practices that identifiable in policy or activities that facilitate coordination can serve as proxies in providing evidence suggesting a system’s likelihood of being able to cope with challenges related to coordination in governance. Chapter 4 includes a basis for identifying the integration of policies and plans, as well as opportunities for groups to cooperate. Presently, these integration of policies and plans and opportunities for cooperation serve as a foundation for examining characteristics of a system presumed to have features of an adaptive system.

2.3 Governance characteristics in seemingly adaptive complex resource regimes

With an understanding of the definition of adaptive governance characteristics, what are the regime characteristics found in a governance system that is seemingly adaptive? By “regime,” this thesis refers to the organisation of the institutions and groups and the distribution of authority within the system. In reviewing the literature on adaptive governance which derives an association between regime characteristics and the governance of a water system

attenuated by contextual factors (Pahl-wostl 2012), regime characteristics within a system of governance require an understanding of actors who are involved in the system, their arrangements and the level of governance. There are features and patterns of governance characteristics highlighted by authors exploring this at the general level of social-ecological systems of complex resource regimes. Pahl-Wostl explores attributes related to the relationship between regime characteristics and a performance outcome (such as adaptive governance) (Pahl-Wostl et al. 2012). Pahl-Wostl looks specifically at complex resource regimes to test and develop a model in a global study involving 29 case studies of river basins as a form of complex resource regime (Pahl-wostl 2012). The theoretical frame for approaching governing arrangements of actors within a system emerges from examining the relationship between governance characteristics within the water system and adaptive governance (Pahl-Wostl 2009; Huitema et al. 2009; Pahl-Wostl et al. 2010; Huntjens et al. 2012; Pahl-Wostl, Sendzimir, et al. 2007; Pahl-Wostl, Craps, et al. 2007). Pahl-Wostl's theoretical framework was developed for complex resource regimes and then adapted for use in the water basin context. In this thesis (Chapter 5 and 6), this framework is adapted for use in understanding the context for water governance yet is presented first in its original form (for different complex resource regimes) for its extensive cross-referencing by studies of complex resource regimes and trialling in over 29 case studies in the water sector (Pahl-Wostl 2009; Pahl-Wostl et al. 2012). The following two sections describe how these features are identified based on the literature reviewed.

1) Relationship between regime characteristics and governance outcomes

Based on the literature, there are common regime characteristics in systems considered to be adaptive. With the relationship between regime characteristics and an adaptive outcome in mind – attenuated by contextual factors, the literature investigates to what extent there are common factors in settings that have adaptive governance (Pahl-Wostl & Knieper 2014; Lebel et al. 2006; Pahl-Wostl 2009; Pahl-Wostl, Sendzimir, et al. 2007). Common factors from these contextual factors highlight that these settings are considered to have characteristics associated with polycentricity (Pahl-Wostl et al. 2012).

Polycentricity was introduced by Ostrom as a system 'of many centres of decision- making which are formally independent of each other' (Ostrom et al., 1961 cited in (Aligica & Tarko 2012). Among scholars who have applied this concept, a common feature of polycentricity is

in reference to governance with multiple authorities with overlapping jurisdictions (Aligica & Tarko 2012; Green 2007; E. Ostrom 2009; McGinnis 2011; Ostrom 2010; Pahl-Wostl & Knieper 2014; Cole 2011). The theory in common across the different definitions is that groups that have polycentric systems of governance are better able to adapt. This theory has been applied at different scales to explore the governance systems of a diversity of geographic locations and governance systems (Meijers 2008; Brezzi & Veneri 2014; Pahl-Wostl et al. 2012). Table 1 provides a representation of the literature review of polycentricity. Table 1 includes the definitions which are referenced for identifying primary and secondary characteristics of a polycentric system in a case example in this thesis (their application is described in Chapters 3 and applied in Chapters 5 and 6).

2) How to identify these features (as they occur in practice)

In examining these three factors, how to identify these features becomes a question of mapping and interpreting the system. The definition and characteristics of polycentricity can serve as a starting point for mapping and interpreting to what extent a system has characteristics associated with adaptive governance. There is the possibility that examples may yield a system that is less polycentric. This opens the possibility for describing a system as having what is described 'monocentric' governance, where authority is increasingly centralised and in the form of single authorities (Termeer et al. 2010). While the literature on adaptive governance is seemingly less emphatic on monocentric governance, at this stage, the background highlights monocentricism as defined by Termeer (Termeer et al. 2010) to avoid excluding outliers.

Collecting information using identifiable characteristics of polycentricity will highlight to what extent a system has diversity and mapping a system as polycentric or otherwise can identify networks of the different actors within the system. Therefore, analysis of data can prioritise features related to polycentricity, and how the different actors have connected the form and direction of authority. The literature is dominant in theories, definitions and characteristics of polycentric governance systems which will be summarised in the following section and will guide the analysis in Chapter 3.

Coined by Ostrom, polycentricity has been cited extensively in literature related to adaptive governance and the performance of environmental governance regimes available in Table 1 Definition and characteristics of polycentricity which lists definitions of polycentricity by respective author and lists characteristics that help to identify evidence of polycentricity. Based upon the relative frequency of shared characteristics, evidence of overlapping jurisdictions, multiple authorities, different scales and knowledge sharing feature as primary characteristics. Polycentricity accounts for the complexity within a system related to the range of institutions and their relationships and relative importance of formal and informal institutions actor networks with an emphasis on the role and interactions of state and non-state actors, multi-level interactions across admin boundaries and vertical integration and governance modes (Huitema et al. 2009).

If a system is considered to have features of polycentricity, there are several features that serve as identifiers. In order to discern between features, in the overview of definitions in Table 1, primary and secondary characteristics are delineated based on relative frequency in the literature on complex resource regimes reviewed. This includes features and characteristics such as multiple authorities (primary) overlapping jurisdictions (primary), evidence of knowledge sharing (primary), different scales (primary), horizontal and vertical integration (secondary), allocating authority duties (secondary) and/or evidence of investment in scientific information (secondary).

2.4 What does a lens of adaptive governance offer? The 'So What'

What an adaptive governance lens offers is an opportunity to navigate a complex resource system that provides an essential resource with attention to how the different groups within a social-ecological system interact and cooperate.

Exploring cooperation and interaction of different groups situates this work at the intersection of governance literature from political science and the natural science, in the space of environmental governance in which adaptive governance (building upon governance-related themes in ecology, engineering and environmental science) and literature on water governance (geography and development studies) using the common link of complex resource regimes and social-ecological systems. While the governance of a water system varies across settings and acknowledging that there is variation in different sources for water supply (i.e. river, groundwater), a system of provision includes in a basic form, the following process:

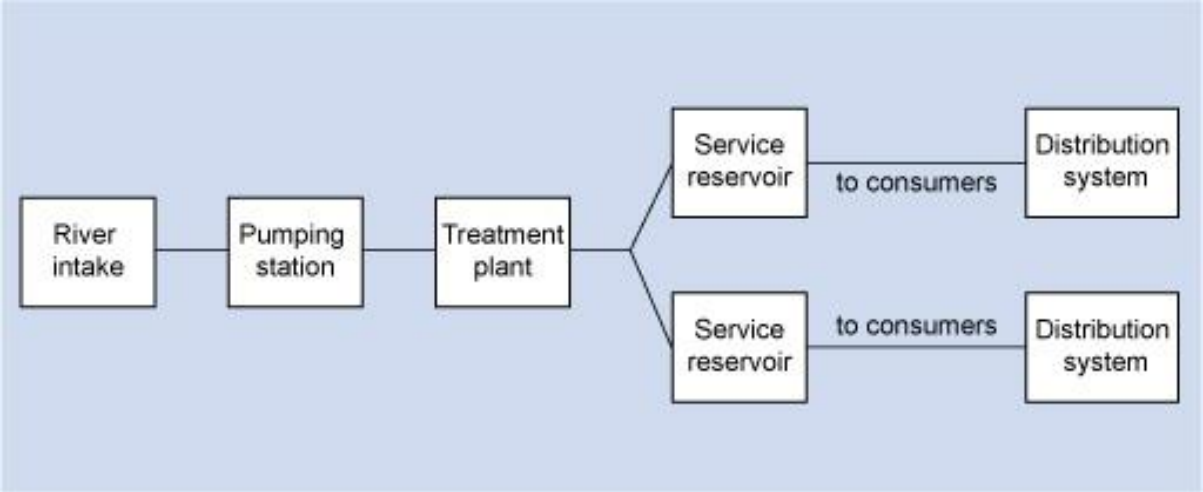


Figure 4 Elements of the water supply system (The Open University 2017)

By incorporating the technical understanding of a process for water provision in fields such as ecology, engineering and environmental science[3] with the dominant literature on water governance in the fields of economics, law and geography,[4] an understanding of the process

[3] The literature exploring adaptive governance is cross-disciplinary however is dominant at a general, multi-system level and in system-specific levels (ie. water, river basins) in journals such as *Ecology & Society* where there is also an attention to theories of resilience, adaptive capacity and transformability of complex social-ecological systems (Walker et al. 2004; Folke et al. 2010; Gunderson 2010; Armitage et al. 2009; Olsson et al. 2006; Pahl-Wostl, Sendzimir, et al. 2007; Bodin et al. 2006; Berkes 2006; Pahl-Wostl, Craps, et al. 2007; Claudia Pahl-Wostl et al. 2008; Jones & Martin 2003; Chapin et al. 2009; L. Gunderson & Holling 2002).

[4] The literature discussing water governance is also cross-disciplinary with an emphasis on themes related to policy and economic arrangements related to water governance such as privatisation, new public management, alternative service delivery and debates on the commons in journals such as *Environment and Planning, Water*

for water provision can be situated in its social and relational context. By incorporating these different perspectives, an adaptive lens can identify where governance structures, actors, institutions, natural environment and technologies are best suited to facilitate an outcome such as cooperation. All of these aspects are involved in regulating, enabling and implementing the different aspects of a process for water provision within an adaptive system through feedback loops as shown in the Figure 5 below (Pahl-Wostl 2007).

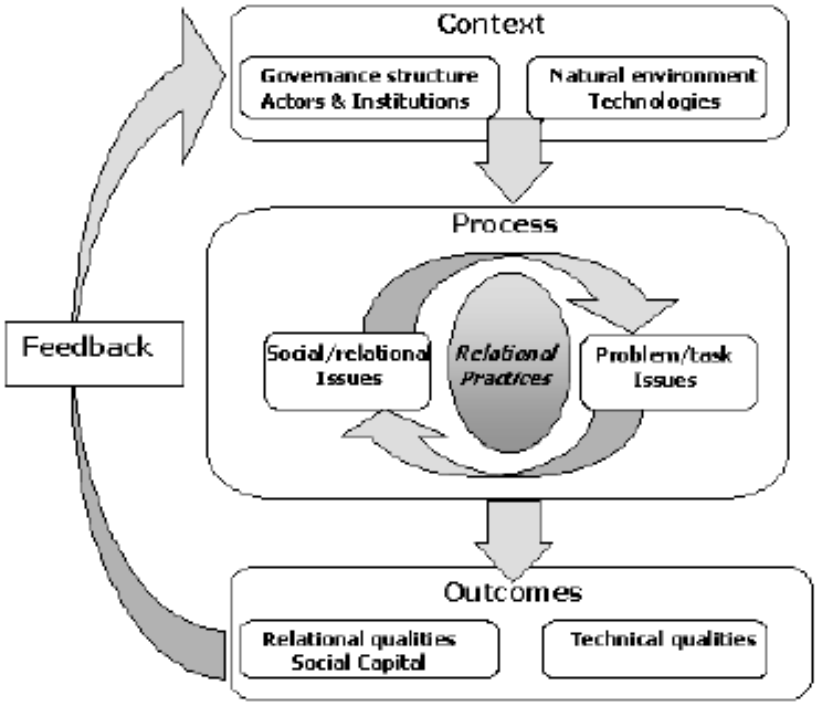


Figure 5 Conceptual framework for social learning and resources management Pahl-Wostl, 2007

While the different disciplines referenced for adaptive governance and water governance have different and sometimes competing assumptions, the perspective on governance includes a shared recognition that the challenge for governance, and cooperation, more specifically, has strong social components. The role of society is the link between the different disciplines because social components are the basis for exploring human involvement and cooperation in adaptive governance and water governance literature. With these disciplines

Resource Management and *Environment and Urbanization* (Furlong & Bakker 2010; Furlong 2012; K. Bakker 2003; Bakker 2008; Connors 2005; Franks & Cleaver 2007; Hordijk et al. 2014; Tortajada 2010).

which have a recognition of the role of groups in society in common, present an approach for addressing a gap in understanding of the arrangement of societal groups and the connection to adaptive governance. In the literature reviewed, these disciplinary fields share several areas of common ground related to context-driven approaches to governance.

Within the environmental governance literature informed by perspectives more specifically related to environmental science, engineering and ecology, water governance literature provides insight on the range of governance models and issues related to cooperation within a system which this thesis will respond to in applying through the lens of adaptive governance. This section will present these underlying theoretical perspectives on water governance, models that emerge from these theoretical perspectives and summarise the calls for research cooperation.

2.4.1 Theoretical perspectives on water governance, models that emerge and calls for research

Governance systems are complex and include a combination of formal regulations and informal self-organizing processes among a range of actors with "attempts to classify them in different modes of governance by the type of hierarchies, networks, and markets as three principal modes" (Pahl-Wostl et al. 2008). Pahl-wostl argues that "identifying the dominating influence in a given governance arrangement may come from governmental control, from specialized networks, or from market-based structures" which in this thesis are situated within a range of theoretical perspectives of how water should be understood in a society ranging from one extreme of water as an economic good governed by the market with relatively little regulation (Rogers 1993; Rogersa et al. 2002). The other perspective may be that water is a public good, a form state property and in some cases, treated as a human right (Castro 2007; Swyngedouw et al. 2002; Gandy 2004; Eric Swyngedouw et al. 2002). For models of governance that emerge between these perspectives ranging from private to public models with mixed and alternative models. The next section will summarise these models.

With some background on theoretical perspectives that underpin different models, review of water governance models and case examples of expanding access to services were investigated to identify calls for more research.

Common water governance models (for service delivery)

From the mid-20th century, water governance models in the global south were highly influenced by partnerships between a local or national government and a private company

facilitated by a multilateral organization such as the World Bank. In many cases, the previous model suggests water is understood as a human right, governed and supplied by a public water company. When these public water companies wanted to expand access, they would need funds to finance the infrastructure. A loan from a multilateral institution such as the World Bank was a common option and especially in the 1970s-80s, the terms of the loan included participation in a structural adjustment program. This often required privatization of the sector through a form of a public-private partnership between the state and a private provider (World Bank 2007).

While the PPP is arguably the most common model, the partnership model has a variety of different forms. In a concession arrangement, a private provider becomes responsible for both operation and investment. Public-Private Partnerships for Urban Water Utilities provides an in-depth discussion of these different partnerships (World Bank 2007). In a leases-affermages arrangement, a private utility operates a publicly owned system, collects revenues which are shared with the public owner. Divestitures are an arrangement where the infrastructure assets are sold to private investors the most common is the concession arrangement. Management contracts take a range of forms where services are typically provided by a publicly owned utility that is managed by a private provider. In mixed ownership companies, the private investor has a minority share in a water company and operates it on behalf of local authorities. The most common PPPs are the concession and leases-affermages arrangements (World Bank 2007). While the lion's share of global water provision is provided from the public sector, 80% of the world's private water market is controlled through partnerships by leading multinationals such as Suez (France), Veolia (France), Saur and Thames Water (with Suez and Veolia having ⅔ of the market (López, n.d.).

Case studies of different models for service delivery

Cases reviewed having these different models included scholarship on work in cities such as Cochabamba, Porto Alegre, Brazil and different areas of Latin America (Lobina & Hall 2007), sub-Saharan Africa and N. Europe (K. J. Bakker 2003), Istanbul (Altinbilek, 2006), Mumbai (Nallathiga n.d.) and Johannesburg (Smith 2006). A multi-country study investigation comparing cities of different scales/city sizes by including an overview of governance challenges in cities such as Jakarta, Dhaka, Johannesburg, Sao Paulo, Mexico City, Riyadh, Istanbul and Singapore (Varis et al. 2006). Further in depth case studies included work on

Bangalore (Connors 2005), South Africa (Smith 2006), the Netherlands WMD (Furlong 2015) and a review of different examples in Sub-Saharan Africa (Schwartz 2008). The majority of these cases followed a model similar to those described above (public or private or a form of public private partnership).

Issues raised and calls for research

Issues raised in the case studies were consistent with the barrier introduced at the onset of the challenge of managing the expectations and incentives of "different people or institutions with different and even conflicting goals (Tortajada 2010) in a water governance system." While the evidence is not conclusive on the characteristics of stakeholder relationships that are associated with good practice, this is an area to investigate further. In governance research more broadly, there is a call for research among stakeholders beyond those in managerial positions (McNulty et al. 2013).

From the case literature reviewed, there is an emphasis on models of governance in public, private and PPP systems. One of many of the dominant authors in this arena is Karen Bakker who calls for more research on alternative models of water governance (Bakker 2008) and a focus on community engagement (Bakker 2008; K. J. Bakker 2003). Authors such as Bakker and Furlong have flagged that there is "a retreat from privatization, a reassertion of the commons or the community over the commodity property relation (K. J. Bakker 2003). Described as "associative self-governance," these alternatives question whether "alternative ownership and management structures under consideration entail changes in the commercial governance model implemented in 1989" (Bakker 2008). There are examples in this context where the failure of public led not to a private, for profit alternative but instead to the creation of an independent not-for-profit trust (K. J. Bakker 2003).

An appetite for examining alternative models does not necessarily mean a retreat from public or private models entirely. Nonetheless, Lopez describes that the bulk of research has looked at the failings and/or successes of private models and relatively little on public models that have a corporate dimension. These perspectives however, still situate the debate around public vs. private which does not necessarily address the societal issues that are common to both models (Furlong 2016). Responding to this call for alternative models and the challenge of cooperation within a system would include understanding how cooperation works within a system that is seemingly adaptive.

The growing field of research on alternative service delivery which has pushed for a shift away from what Kathryn Furlong call “dominant, often constraining binaries” (Furlong 2016) which manifests in a binary between market-led and state led management models. Instead, there is an opportunity to explore models that retain public ownership while also seeking independence from local government draws attention to a gap on the role of local government in service delivery. Furlong argues that in exploring new questions about the role of local government, there can be further, nuanced discussion on the purpose of service delivery, circumstances where alternative service delivery models may help to meet certain goals and the governance arrangements required to achieve that (Furlong 2016).

The literature also calls for exploration into the role of multi-stakeholder cooperation, community engagement and alternative service delivery models (particularly public ones that are corporatized –(López, n.d.). For multi-stakeholder cooperation. Kathryn Furlong shows that this is an area for further work in exploring water conservation examples from across the Canadian context where a focus on efficiency has been associated with poor integration of a range of actors in decision making and where greater degrees of local authority, flexibility and wider engagement fostered good governance. While there is not a causal link established, her work shows that alternative service delivery models that can engage and broader range of actors and municipal governance that can engage actors in a way that better shares authority may be better equipped to confront complex governance challenges (Furlong 2016).

These calls for more research include a recognition of the role of groups within a society and their role within an alternative service delivery model, the need for emphasis on stakeholder-driven approaches and the need for community-based approaches for good governance (Pahl-Wostl et al. 2010; C Pahl-Wostl et al. 2008).

With an understanding of these calls for more research, the next sections will discuss in detail an example from among the cases reviewed where these gaps are visible, highlight the implications of not taking a governance lens, or further, an adaptive governance lens, into account. The next section describes an approach to understanding the role of actors (groups within a system) which show examples where the type of model and change of model brings theoretical perspectives on water (economic good and human right) into a debate and revisits commonalities raised in the broader governance literature regarding the importance of governance being distinct from government, governance being context-driven and social and

resource regimes being the site where these varying viewpoints are contested and challenged in light of global shifts such as globalisation. The contextual and social nature of cooperation will include a method for understanding the linkages between actors with a regime identified in an adaptive system (See 2.7 and Chapter 7).

Before describing the case, this section notes why an extreme case is selected. This is to illustrate where an analytical approach to exploring cooperation could be used to understand the role of multi-stakeholder cooperation and to envision where alternative governance models may inform a more adaptive form of governance. This extreme case is not included to suggest that adaptive governance will be analysed through a market-based or rights-based lens, that are explicit in this case.

2.5 Possible implications of not taking a societal approach to governance

2.5.1 Cochabamba water wars

Systems that can adapt to change in the literature have highlighted common features and regime characteristics associated with adaptive governance. What this perspective on adaptive governance offers is a lens for navigating and accounting for how cooperation is facilitated in a system through the integration of policies and plans and opportunities for multi-stakeholder engagement. The implications of applying an adaptive governance perspective is that it offers possible approaches for transformative thinking for how complex resource governance regimes are currently addressed. Conventional governance models for understanding governance have placed a binary emphasis on the public or private model for delivery of water services and limited emphasis on engagement and direction of authority (Furlong 2016). An example includes the case of Cochabamba, Bolivia, where a lack of attention to the governance of existing networks between actors for delivering services resulted in a societal breakdown related to the provision of water.

Cochabamba had decades of water service delivery provided by the public sector. International pressure in the 1990s from international financial institutions and a desire to reap the benefits afforded by the private sector resulted in a sale of the water business, land and water rights to Bechtel. At the time, Bechtel was part of a conglomerate (Aguas del Tunari) set up for this agreement through a public-private partnership agreement (PPP) (Nickson & Vargas 2002). Unfortunately, these changes did not take into account the different actors, namely communities that would be impacted by this shift in ownership, nor were

there efforts to broker linkages. Rates tripled overnight and, in some areas, civil unrest erupted, in settings where poor people would not have the capacity to pay. Within three months of this arrangement, 'water wars' broke out. Repeated debates and discussions between civil society groups and the government eventually broke down resulting in violent protests over a series of days during which Aguas del Tunari announced it was withdrawing the project (Nickson & Vargas 2002; Norris & Metzidakis 2013; Shultz & Draper 2008). Within a few weeks, the international partners exited the market.

A review of the literature suggests that a stronger understanding of the complex landscape of water governance in Cochabamba, namely the role of actors such as community water providers and local civil society action groups, could inform greater understanding of the social dynamics underlying the system's breakdown (Assies 2003; Shultz & Draper 2008). Where there is knowledge of this complexity, opportunities to understand and incorporate their incentives, and/or different interests, and to acknowledge more broadly the relationships between the different actors within the system, could provide insights to view the complexity of relationships as a rich repository of context-specific knowledge of the governance system. By potentially overlooking key stakeholders such as community-based providers who had a long-standing history of participation influenced by a long history of stakeholder relations in Bolivia, the governance arrangements designed during privatisation could adapt to system change. While the shift towards privatisation, facilitated by a public-private partnership (PPP), was introduced to address the problems of inequality of access, insufficient infrastructure and misallocation of resources that had existed under the previous public system, these problems persisted within this newer regime (Assies 2003; Shultz & Draper 2008).

The situation in Cochabamba also underwent dramatic change that could not cope in an adaptive manner and so did the complexity of the system. Complexity of a governance system, as described previously, means there is a combination of formal regulations and informal self-organizing process among a range of actors (Pahl-Wostl et al. 2008). However, what was described as a 'water war' is described in a manner that is consistent with a war over the governance of water and how that would change. The "crisis" was over who would govern, how and why. An understanding of adaptive governance and in particular, the direction of authority, could aid in navigating the complexity. Using, for example, a process

for mapping out the regime characteristics (polycentricity), contextual factors and understanding of its adaptive governance may provide insight on the importance of accounting for the complexity of a social system that emerges from an evidence base that is fit-for-purpose. What is needed is an exploration of a case that demonstrates strong adaptive governance and the possibility of exploring more fully how the relationships between the different actors operate, evolve and adapt.

2.6 Deficit in societal approaches to governance, a summary of case examples and a case for social contracts

What the Cochabamba case and different case studies of water governance (Rouse 2014; Tortajada 2010; OECD 2016) suggest is an example where inclusion of an adaptive governance lens in the supply of water services, which, if included, could potentially transform the provision of an essential resource for society in the wake. The example of Cochabamba specifically highlights the consequence of not having an approach to governance, and to adaptive governance in particular, in the provision of an essential resource as a utility where governance is at the centre. In the case of Cochabamba's resource regime shift from a public to private system, failure to account for the governance of the resource, the complex landscape and the different and often competing arrangements led to a societal breakdown (Shultz & Draper 2008; Assies 2003; Nickson & Vargas 2002; Norris & Metzidakis 2013). In this case, the relationships between actors are fundamental to understanding how the system operates and what is required to serve the needs of society. In the context of the broader literature discussed in this chapter, the needs of society are consistent with calls for further investigation of the role of stakeholders and the relationships between them, the community–based approaches and alternative service delivery models.

The importance of stakeholder relationships is consistent with the literature on adaptive governance of complex resources which highlights strong mechanisms for coordination as a feature of systems that tend to be resilient, transformative and adaptive. At a granular governance level, the literature also provides evidence of regime characteristics (namely, network, diversity and polycentricism that provide a relative understanding of how adaptive a system is). An understanding of regime characteristics information aids in unpicking the role of stakeholders and how they relate to one another. What is required further is to understand the relationships between them, decision-making authority, and the extent to which groups in society cooperate. Social contracts, the agreements between groups within society that

emerge from a necessity to cooperate, provide opportunities for addressing this need in a complex resource regime.

2.7 Social Contracts

There is evidence in the water governance literature of approaches to understanding how groups within the water sector interact in applying social contract theory in the water sector (Brown et al. 2009; Wong & Brown 2009; Brown et al. 2008; Wong et al. 2011).[5] Social contracts serve as a tool for identifying arrangements between groups and their capacity to adapt. An application of this concept by Brown, Wong and colleagues includes typologies from within the water system achieves this yet is derived specifically from examining systems connected to the water sector. These typologies also do not start from a position of how groups in society cooperate. While this thesis uses a problem in the water sector as an example of a complex resource regime, theories and frameworks that are not sector-specific at the stage were included in order to allow for the potential for future dialogue with other sectors which widen the possibility for a discussion on requirements for transferability and generaliseability. This approach also enables flexibility to develop other typologies that could emerge outside of the established typologies.

The contributions on common-pool resources and the conventional theory of collective action provided by Ostrom were also considered. Collective action refers to "settings where decisions about costly actions are made independently but outcomes jointly affect everyone" and has been consistently applied to questions in environmental governance related to social dilemmas in global environmental issues such as climate change (Ostrom 2010). From this theory of collective action, Ostrom's understanding of polycentric systems will be used in (Ostrom 2010). Ostrom's perspective on collective-action is taken into consideration within the context of social-ecological systems. In order to more closely examine the basis for social cooperation between different actors, an approach to examining the different forms of

[5] There is an application of social contract theory in the water sector focused on resilience and sustainability. This emerges from the Australian context and examines the relationships that occur in cities as having 1 of 6 typologies5, with the 'water sensitive city' as the ultimate vision (Brown et al. 2008). It is a vision for a city that has a diversity of water sources that come from "a diversity of centralised and decentralised infrastructure, provision of ecosystem services for the built and natural environment and socio-political capital for sustainability and water sensitive behaviour" (Wong & Brown 2009).

cooperation based on observable attributes of human political nature is used. This approach is utilised in the literature on water governance that applies social contract theory to the water sector, using political theories as a foundation for thinking about how groups in society cooperate and why. Beginning with the political theories, which are not specific to a resource sector, opens the possibility for further discussion of social contracts in other contexts and other sectors. This section introduces "social contracts" (non-sector specific) from the political theory perspective to contextualise application to the water sector.

Social contracts are the agreements between groups within society that emerge from a necessity to cooperate. Jacques Rousseau, Thomas Hobbes, David Hume and John Locke developed and contributed to concepts which have a prevailing view that societies come together with the purpose of meeting a universal need or goal (Barker 1947). Groups will cede certain freedoms to reap the benefits afforded by the cooperation. There are several applications of social contract theory. The Hobbesian application of social contract theory views authority through the lens of a sovereign that has a top-down form of authority. Individuals cede authority to a sovereign in order to reap benefits. Another interpretation of the social contract, put forward by Locke, includes societies that come together through groups, with the purpose of sharing resources through cooperation. Regardless of the type of application, the theme in common is that the groups form out of a necessity to cooperate. They form agreements, which are a type of contract.

For the scope of this thesis, this section presents an application of social contracts that are in connection with the water sector, yet derived from their origin in social and political thought. The application of social contracts strongly retains the roots in the work of Thomas Hobbes, John Locke and John Rawls from political and social thought (Barker 1947; Lundqvist, Narain and Turton 2001) describes how to identify features that are consistent in the concrete example of the water sector. Lundquist et al. applied and described the different forms of what they describe as a “hydro-social contract,” taking into account these examples and applying the perspectives of Hobbes (top-down) and Locke (mixed). The third social contract typology draws upon the further applications Lundquist et al. suggest, a view that is consistent with the work of John Rawls (bottom-up). By starting first with the 'social contract' and then applying it to the water sector as a “hydro-social contract,” these typologies open up an

opportunity for discussion of feasibility in other complex resource systems (as it is not derived from the water sector exclusively).

2.8 Overview of application of theory for the research questions

By taking the adaptive governance and water governance literature into account, approaching the macro question *(What can an adaptive governance lens offer for tackling governance crises related to cooperation in the provision of water resources?)* begins with a series of sub-questions. The sub-questions emerge from a review and acknowledgement of calls in the literature for approaches that examine multi-stakeholder cooperation, community-based approaches and alternative models of governance that are seemingly adaptive. A case study will be presented and justified in chapter 3 where these sub-questions will be honed to pose specific questions for the case study investigation.

1) What places seemingly demonstrate a capacity to coordinate (stakeholder engagement/community based are features of an adaptive governance system) and do they have features of adaptive governance?

2) What types of regime (resource governance) characteristics does this place have? In this example, to what extent does it have a polycentric form of governance?

3) What/How are the arrangements between the different stakeholders?

The thesis addresses Question 1 using a literature review of examples in the water sector that will later be used to explore an in-depth case (justification for a case study and search criteria described in the methods). The features of adaptive governance are used to explore how/to what extent it features in a given case.

The thesis explores Question 2 using the definition of polycentric and monocentric governance as a metric for interpreting the governance arrangement in the case example. Where it may depart from the definition it is described and discussed. The method also tackles complexity by understanding stakeholder relations through mapping.

The thesis explores Question 3 building upon the literature for understanding governance as a set of societal arrangements, building upon work on social contracts and its application in the water sector. It approaches complexity, building upon an understanding of stakeholder relations in question 2, yet seeks to understand how groups, communities cooperate and form arrangements and to what extent society is at the centre (alternative forms of service delivery have attempted to look at this, but not with a lens of adaptive governance).

The next chapter, Chapter 3, describes the setting and method for investigating the research questions. This chapter includes an introduction to the case study and the methodology used to investigate it.

Table 1 Definition and characteristics of polycentricity summarised from authors (the content is derived from the source in 1. Author).

1. Author	2.Definition	3.Features and characteristics
(Andersson & Ostrom 2008)	Institutional theories of polycentricity (refer) to the relationships among multiple authorities with overlapping jurisdictions.	Number and arrangement of institutions (secondary)
		Multiple authorities (primary)
	Polycentric systems are complex, adaptive systems without a central authority dominating all of the others in regard to all policy arenas.	Overlapping jurisdictions (primary)
		Multiple scales (primary)
	Institutional arrangements at other governance scales (national, regional, NGOs, private associations) and degree of "nestedness."	Distribution of authority (secondary)
		Evidence for allocating capability and duties (secondary)
	Distributes capability and duties so that perverse incentives and information problems at one level are offset to some extent by positive incentives and information capabilities for actors at other levels.	Knowledge sharing (primary)
		Evidence for autonomy to cope with specific duties (secondary)
	Effort to enable institutions of multiple scales to more effectively blend local, indigenous knowledge with scientific knowledge (Berkes and Folke 1998).	
	Each has some degree of autonomy to cope with one set of discrete policy arenas.	

1. Author	2.Definition	3.Features and characteristics
(Ostrom 2010)	‘‘Polycentric’’ connotes many centres of decision-making that are formally independent of each other...To the extent that they take each other into account in competitive relationships, enter into various contractual and cooperative undertakings or have recourse to central mechanisms to resolve conflicts, the various political jurisdictions in a metropolitan area may function in a coherent manner with consistent and predictable patterns of interacting behaviour. To the extent that this is so, they may be said to function as a ‘‘system.’’	Multiple scales (primary) Knowledge and information sharing (primary) Experimentation and learning from experience with diverse policies (secondary) Evidence for experimentation and learning (secondary) Local knowledge and knowledge sharing (primary) Evidence for experimentation and learning (secondary)
	Polycentric approaches facilitate achieving benefits at multiple scales (local, regional, national).	Evidence for investment in new scientific information (secondary)
(Pahl-Wostl et al. 2012)	Polycentric governance systems are defined here as complex, modular systems where differently sized governance units with different purposes, organizations and spatial locations interact to form together systems characterized by many degrees of freedom at different levels.	Characterized by a distribution of power but effective coordination structures have higher performance. This finding is valid for diverse contexts. The results show a weaker and more context dependent influence of legal frameworks on performance. (secondary) Evidence for allocating capability and duties (secondary)
(Ostrom et al., 1961)	Characterised as a system with many centres of decision making which are formally independent of each other’ (Ostrom et al., 1961).	Multiple authorities (primary) Evidence for horizontal and vertical modes of coordination (primary)
	Multi-level governance in polycentric systems implies that decision making authority is distributed in a nested hierarchy and does not reside at one single level, neither top (only highest level government enforcing decisions), nor medium (only states/provinces enforce	Different scales (primary) Distribution of power (secondary) Evidence for allocating authority duties (secondary)

1. Author	2.Definition	3.Features and characteristics
	decisions beneficial for their region without considering others), nor individuals with complete freedom to act or being connected in a market structure only. (local, regional, national).	
(Huitema, Mostert, & Pahl-wostl, 2009)	The oldest publications on polycentric governance (e.g., Ostrom et al., 1961) are strongly concerned with the self-governing capacity of (local) communities. This had a normative background, rooted in democratic thought about self-government, but there is also a practical component to it. The suggestion was that local communities all face their own problems, and that their skills and local knowledge place them in the best position to address these problems.	Evidence of self-governing capacity (secondary) Overlap and sharing: Polycentric systems have a high degree of overlap and redundancy, and this makes them less vulnerable: if one unit fails, others may take over their functions (primary) Evidence for overlap and sharing of information (primary)
	Polycentric governance refers to governance systems in which "political authority is dispersed to separately constituted bodies with overlapping jurisdictions that do not stand in hierarchical relationship to each other" (Skelcher 2005:89).	Knowledge sharing and learning: (primary) Evidence for experimentation and learning (secondary)
(Rijke et al., 2012)	Polycentric institutional arrangements, which are nested quasi-autonomous decision-making units operating at multiple scales (124, 125). Systems of governance that exist at multiple levels with some degree of autonomy, complemented by modest overlaps in authority and capability (155).	Multiple scales (primary) Evidence for horizontal and vertical modes of coordination (primary)

1. Author	2.Definition	3.Features and characteristics
(Bulkeley, Broto, Hodson, & Marvin, 2011)	A polycentric model in which multiple overlapping and interconnected horizontal spheres of authority are involved in governing particular issues (Bulkeley & Betsill, 2003; Bulkeley et al., 2003).	Evidence of overlapping jurisdictions (primary) Evidence for horizontal and vertical modes of coordination (primary)
(Ostrom & Cox, 2010)	A complex arrangement between multiple sources of governance, or what has been referred to as polycentricity (McGinnis1999;Ostrom 1999a,	Evidence of multiple governing authorities(primary)
(Pahl-Wostl, 2009)	A system 'of many centres of decision making which are formally independent of each other' (Ostrom et al., 1961). Polycentric governance systems are defined here as complex, modular systems where differently sized governance units with different purpose, organization, spatial location interact to form together a largely self-organized governance regime.	Evidence of overlapping jurisdictions (primary) Evidence of multiple governing authorities (primary)
(Chapin, Kofinas, & Folke, 2009)	Multiple scales: Interdependence of demographic, economic, social, built, and ecological challenges and solutions that cities face; (2) plan for the long term within the context of uncertainty and change; and (3) adjust governance structures to meet changing needs. (local, regional, national)	Evidence of different scales of governance (primary)
(Pahl-wostl, 2012)	Polycentric systems can be characterized as neither centralized in power, nor fragmented, nor are they fully connected. Hence polycentric systems reside somewhere in between these three poles. Polycentric regimes, which are characterized by distributed centers of power with effective coordination, are highly conducive to the adoption of the	Distribution of power: Characterized by the distribution of power with effective structures for coordination. (secondary) Evidence for allocating authority duties (secondary)

1. Author	2.Definition	3.Features and characteristics
	good governance principles in practice, meaning that they help to make water management processes more participatory, transparent, effective and efficient, as well as equitable and inclusive.	

Chapter 3 Introduction to the case study and Methodology

Chapter 1 introduced the topic of adaptive governance in relation to a global problem of cooperation in the provision of essential resources and described the evidence in the literature for why social factors are crucial in systems where society and natural ecosystems intersect. The chapter introduced the example of water resources, a resource critical to the functioning of human and planetary life, where social factors underpin coordination as a core governance challenge. This example provides an opportunity for exploring the macro question of what an adaptive governance lens offers mainly as these systems are evolving and changing about factors such as climate change, economic and fiscal challenges, political and civil conflict.

Chapter 2 described in more detail features of a system of adaptive governance which emerge from studies of complex social-ecological systems and resource regimes, theoretical frameworks for mapping the relationship between regime characteristics within the system and an application of social contract theory to understand the arrangements between actors within the system. In summarising familiar themes from a review of different models for water and sanitation provision, the chapter highlighted two examples where failure to account for governance in system change and reform was associated with failure to cooperate with relevant stakeholders. With this literature in mind and consideration of the gaps in and calls for research (See 2.4.1) the following macro question was posed: **What can an adaptive governance lens offer for tackling governance challenges related to cooperation in a complex resource regime?** The chapter concludes by proposing three sub-questions for tackling this macro question:

1) What places seemingly demonstrate a capacity to coordinate (stakeholder engagement/community based are features of an adaptive governance system) and do they have features of adaptive governance?

2) What types of regime characteristics does this place have? In this example, to what extent does it have a polycentric form of governance?

3) What/How are the arrangements between the different stakeholders?

Chapter 3 includes two sections and describes where this macro question is investigated by first introducing the case study and providing justification for its selection. Section 2 of this chapter describes the methods used to answer these questions and the justification. Where relevant, the chapter refers the reader to annexes for more in-depth examples of methodologies considered and the application of the methodologies selected.

3.1. Introduction to the case study

3.1.1 Criteria for case selection

The selection process for the case study considered several cases. In reviewing different cases, there is a predominance in the literature on success and failure in traditional public-private partnerships (PPP) related to governance (Kwami & Ashmore under review). The literature review begins from the perspective of PPPs because it is where system change through reforms over the last three decades has been driven, and thus dominates governance discussion (World Bank 2007).

As the system change challenges models such as public provision, further review of the literature of success and failures in public sector provision includes evidence of the performance of water utilities (Baietti et al. 2006; Noll et al. 2000). The review includes academic and policy-relevant literature which discusses where these private and public sector provisions goods intersect using the terminology “new public management,” (K. J. Bakker 2003; Schwartz 2008). These different models were taken into account before selecting a case. The review establishes that the challenge of governance occurs in each of these different models and there is a deficit in models that have a societal approach to governance embedded in the governing arrangements. Therefore, in selecting a case study, there is a preference for cases that provide substantial evidence for an alternative model and/or evidence for a system of governance with strong evidence for society at the centre, was prioritised.

There were several case scenarios related to public water utilities with an alternative model (mixed ownership model).[6] There are several success stories that have been well documented by the World Bank. These success stories range from government-owned corporations at the

municipal level such as Johannesburg Water (JNB) in South Africa (Baietti et al. 2006; Smith 2006) to Sociedade de Abastecimento de Água e Saneamento S.A. (SANASA), a mixed ownership utility in Brazil (Baietti et al. 2006). Contextual evidence of a system adaptiveness includes integration with other sectors and a vision for society at the centre of institutions. The well-documented social urbanism model in governance in Medellin (Brand 2013; Turok 2014) which includes evidence of community engagement, stakeholder engagement and opportunities for collaboration, positioned the Medellin case study as a stronger candidate for comparison with the established literature on adaptive governance, regime characteristics and social contracts.

3.1.2 Contextual background information for Medellin, Colombia

The following section introduces several features of the Medellin case to highlight contextual factors relevant for the case for study (geographic, political, social and governance) that would be of relevance for exploration using an adaptive lens.

Medellin is the second largest city in Colombia and for centuries was an industrial hub for the country. It is located in the Aburra Valley and is the capital of the Department of Antioquia. It currently has a population of 2.4 million, and 3.7 in the metropolitan area, which includes ten municipalities. The city itself has 16 sections, known as communes or *comunas* as shown in Figure 3. While Medellin is well-known in recent years for its innovation in social and public architecture (Brand & Davila 2011; Davila & Brand 2013), Medellin boasts a long history of innovative infrastructure, utility development and management of essential resources dating back to the early 17th century.

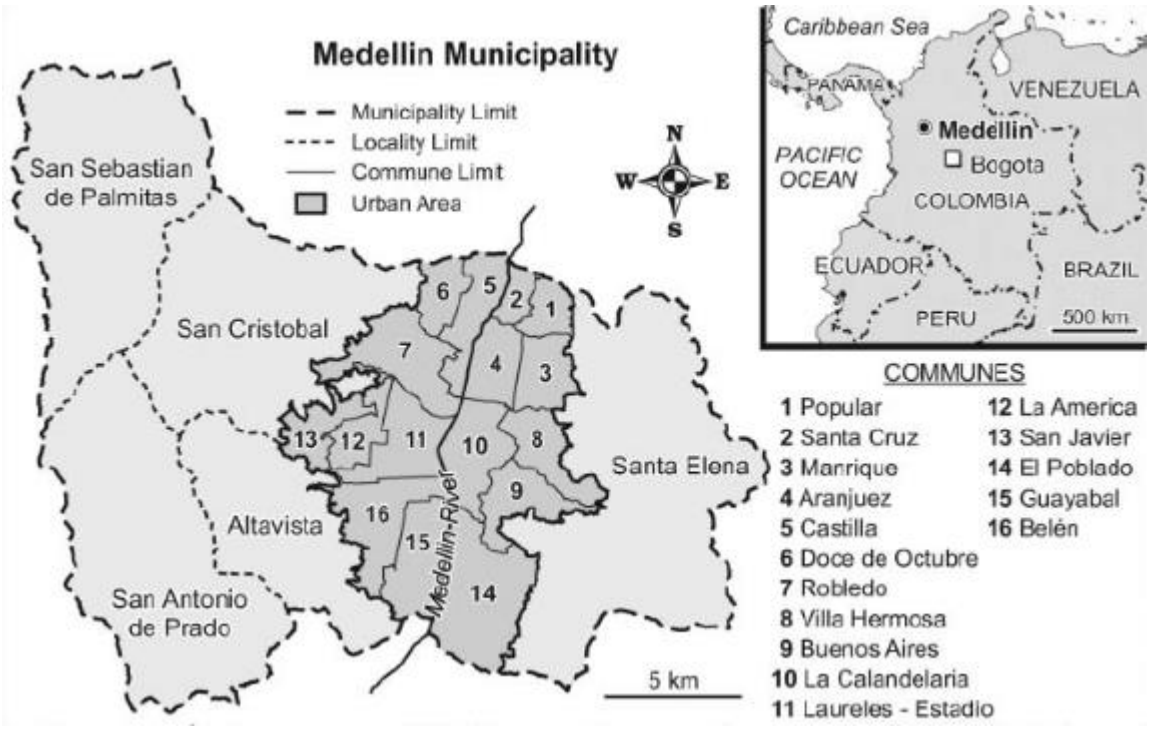


Figure 6 Medellin Municipality, including socio-economic tiers and (Furlong 2013)

Concerning utility development, the 20th century witnessed rapid growth with the expansion of infrastructure, services and hydroelectric plants to support the growing demand for energy for sectors such as transport. With expanded infrastructure for transporting goods, markets for raw materials and industries such as textiles grew considerably. This industrial growth was occurring as the population grew dramatically from 60,000 to 360,000 from 1905 to 1951 driven by immigrants seeking economic opportunities and later would include migrants fleeing violence in areas associated with the beginning of the civil and political conflict (Hylton 2008).

The population boom was connected to changes in land-use and housing development. Despite several political and social shocks during the 1950s, public institutions providing utilities in Medellin developed a tradition of participation and integrated approaches to urban planning. In the 1950s, the Medellin Master Plan was developed to manage urban development and promoted legislation that would impact infrastructure for housing, transport and infrastructure for utilities (López n.d.). A specific brief introduction to the history of water utilities is provided in Table 2. Planning for the city was done in an integrated manner by the municipality and with Empresas Públicas de Medellín (EPM), the publicly owned company integral in the provision of public services and participation in land-use and

housing planning. Several programs including *Habilitacion Viviendas*, literally meaning "Fitting Out Dwellings" spearheaded integration of new settlements in the city through a series of regulatory processes to obtain legality (Lopez 2016). Connection to public services such as water was one of several ways these plans had an impact on the city's planning activities. Changing migration patterns related to the conflict, internal issues in Medellin and worsening political and economic conditions during the 1970s were also having an impact on the city's planning activities (Hylton 2008). In the 90s, following a rapidly changing regulatory environment, EPM commercialised, while remaining still the property of the municipality. EPM is considered neither public nor private entirely, nor a public-private partnership. For more detailed information on the history and development of water utilities, refer to Figure 5a (Furlong 2013; Lopez 2016).

Box 1 Brief history of water utilities in Medellin

In 1914, municipal accords sought to reinforce the autonomy of the service from the city council and augment the independence of the utility board (Accord 45). It was assigned the board responsibility for "all matters relating to water supply and distribution through the city's iron pipe system." The board responsibility was expanded in 1918 to include (Accord 158) all utilities: water and sewerage (EPM), electricity, water, telephone, and slaughterhouse, new public multi-utility corporation to "be independent from the municipal government."

During the 1940s, Sociedad de Mejoras Publics (SMP), a private organisation, drove urban planning and development in Medellin. This organisation had a strong influence over public and private sectors: a relationship that was indistinguishable according to Botero Herrera (1996). The role of local entrepreneurs and industrialists was facilitated through this organisation as they had stakes and an interest in the management of the utilities. Some industrialists financed service development and the management of local banks. Management and organisation of the multi-utility were done through direct supervision and through family relations (Furlong 2013). Industrialists had a stake in the management and organisation of utilities as most were in some way dependent on electricity. Their interests were at stake to the point where they so tried to separate it so it would not subsidise less profitable services (like water). A separate energy entity, Empresa de Energia Electrica was created in 1940 and later reunited 1955 with EPM services in 1955 (Furlong, 2013; Tubb, 2013, Lopez, 2016).

Industrialists were looking to create an autonomous form for public utility corporations to protect commercial interests (access to utilities at prices they could afford). An organisation called "the Asociación Nacional de Empresarios de Colombia" was founded in 1944 with the aim of strengthening utility corporatisation. It included several autonomous entities with independent status for the management of public functions (Legislative act of 1954). This legislation codified services for the public as autonomous. This autonomy was understood to apply to apolitical entities (Furlong et al. n.d.).

One of these apolitical entities was what would later become EPM. Medellin had the first legally independent utility, initially called EEPPM, Accord 58, 1955, a single city-owned multi-utility corporation (Lopez, 2016).In contrast to understandings of privatisation, corporatisation did not refer to exclusion of the local state or a negation of social goals. In this context, it suggests autonomy from the government in decision-making, however, requires legislation in order to provide public goods and services. Within these limitations, the boards have a commercial license to explore ways to improve service reliability and extend infrastructure without government driving decision-making. At the same time, there were/are several programs implemented with city government and utility management which fought business and guilds to pursue programs aimed at service extension and cross-subsidisation (Lopez, 2016, 12).

With a brief understanding of topography and the historical features of Medellin related to its provision of public services (since the 1950s), there are two major (and possibly more) conflicts in this context which created several challenges and crises in Medellin. Firstly, and most prominently in the press, is the Colombian civil conflict with early beginnings in 1946 with La Violencia (1946-1957). The conflicts coincided with a period of rapid population growth of 350,000 to 1.5 million people (Fukuyama 2011; Hameiri 2007), political compromise (1958-1978 and nearly two decades of war between two forms of military violence (1980s-1990s) (Mendieta 2011). Secondly, with the backdrop of the civil conflict, Medellin was embroiled in a narco-war led by the Medellin cartel and Pablo Escobar that intertwined with the civil strife, and decimated the social fabric of the city. The relationship between the narco war and the civil conflict in Colombia is highly complex,, however, specific to Medellin, the narco war during the 1990s mainly devastated the city with the highest murder rate at the time, societal and public breakdown (Ashoka 2014; Drummond et al. 2012; Fukuyama 2011). Even with the dismantling of the Medellin cartel in 1993, violence continued as different drug cartels, guerrilla groups and paramilitaries vied for power (Fukuyama 2011). Contextual factors such as these conflicts are integral to understanding the social fabric of planning in the city.

Descriptions of the transformation that brought the city out of the aftermath highlight the role of civil society, the multi-utility EPM, public architecture and social cohesion. There is also an emphasis on the literature of the mayors of Medellin who were committed to the vision. Success has also been linked to a succession of leaders, namely the city mayors Luis Perez (2001-2003), Sergio Fajardo (2004-2007) and Alonzo Salazar (2008-2011), all very young, highly qualified with a vision for the city beyond traditional politics (Fukuyama 2011; Ashoka 2014). Programs shared similarities with the concept of social urbanism which focused public investment in the city's more deprived areas through high-quality infrastructure and striking architecture (Davila & Brand 2013).

Medellin's transformation garnered international and national recognition. Described as the "Medellin Miracle" particularly in the areas of social urbanism and mobility, there are several features in the Medellin context associated with its "perceived success" which are part of the landscape of an integrated and adaptive society (Fukuyama 2011). Success in Medellin from a social perspective is associated with a range of factors: cultural aspects of the

entrepreneurial class (Antioquian people with a strong work ethic, Catholic, close-knit community) associated with a strong business elite and a sense of duty, decentralised governance structure of Colombia, public trust, regional pride, high returns on human development, disciplined business culture and well-educated elite that serve in the public sector (Hameiri 2007; Drummond et al. 2012).

Municipal programs have played a significant role in integrating and normalising informal sectors during the transformation (Davila & Brand, 2013). These programs emerged in response to barriers such as social inequality, spatial segregation, under/unemployment, social exclusion, weak state control, insufficient provision of essential services, housing density etc. These programs also existed alongside strong paramilitary and police presence in surrounding areas. This pressure to respond created a dichotomy of investment in social programs to "improve people" and "excessive policing" to "control undesirables" (Tubb 2013).

Different scales of governance

There are several scales of governance in Medellin and Colombia more broadly that feature in association with complex resource regimes such as water in the city. Firstly, Colombia is a decentralised regime, which in Medellin includes the national level setting policy where implementation is within the remit of the regional and local governing authorities. Secondly, the Constitution in 1994 and subsequent reforms in public services (Secretaria 1994) placed specific regulations about who could provide public services (public, private and community-based entities) and how (Furlong et al. n.d.). This law had several implications, namely that sectors cannot cross-subsidise one another after the 1990s reforms. Thirdly, there is evidence of the role of the multi-utility, EPM, and its implementation of the law as a public service provider at local, regional, national and international levels. The governance arrangements internally require more information.

With these different scales of governance in mind, monitoring of water in Medellin is overseen at a local and metropolitan level by the municipality and Area Metropolitano de Valle de Aburra, the metropolitan authority for ten municipalities including Medellin. EPM is the primary service provider. Recalling the image of the water supply system as a complex resource regime (See Figure 4) and the variety of actors involved in that system, the provision in Medellin is the following.

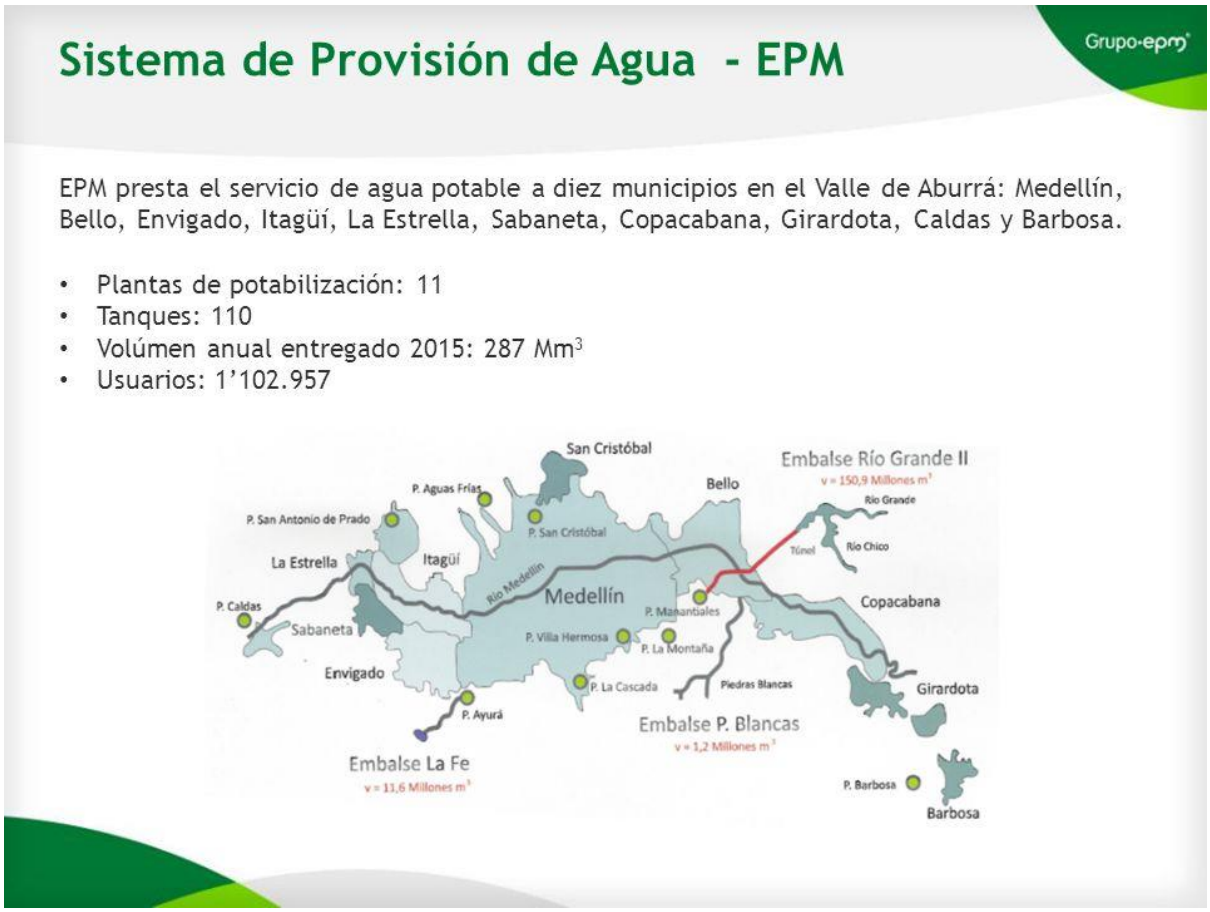


Figure 7 Water provision system EPM (Revuelta San Martin 2017)

"EPM provides potable water services in 10 municipalities in the Aburra Valley: Medellin, Bello, Envigado, Itagui, La Estrella, Sabaneta, Copacabana, Girardota, Caldas and Barbosa."
Treatment plants: 11
Tanks: 110
Annual volume 2015: 287 Mm3
Users: 1, 102, 957

3.1.2.1 Research gaps in water governance in Medellin

While there are several contextual factors that suggest associations with governance, this section features findings that emerge from the literature review of the case (Section 3.1.2). For exploring to what extent a perspective on adaptive governance could inform efforts to tackle coordination challenges in complex resource regime, the Medellin context also presents opportunities to address research gaps that the literature review raises. There has been substantial research examining water governance in Medellin. However, this research has a particular emphasis on water regulation, expansion of access from the perspective of the service providers (Furlong et al. n.d.; Furlong 2012; Furlong 2013; Furlong 2015; Guerrero et al. 2015) and efforts to unpick the corporatisation model (Furlong et al. n.d.; Lopez 2016).

The available literature on contemporary water governance in Medellin suggests reasons why Medellin's utility provider has been successful and the perspective of community-based groups. Investigating features of this system that are consistent with adaptive governance and what arrangements between the different stakeholders, contributes to a societal approach to governance that offers an opportunity to contribute new and/or improved understandings of the governance landscape in which coordination challenges occur.

3.1.2.2 Summary of contextual features in Medellin that stand out

In reviewing literature related to the context of governance in the city, there were several case-specific features that emerged supporting Medellin as a case. 1) There is a seemingly successful corporatized public system of the city of Medellin that places social, environmental and economic goals at the helm which features in literature about Medellin specifically and also from several scholars in the water sector (Bakker 2008; Furlong et al. n.d.). Further investigation is required regarding the extent to which this extended to water governance. 2) There is evidence of community participation historically, and currently 3) there are well-documented examples of stakeholder relationships (Furlong 2015; Smith 2006).

A comparative case study was taken into consideration, however due to the perspective of governance as emerging from a context, there was a stronger argument for an in-depth case examining the regime characteristics and governance arrangements. While further research could include for instance comparisons with the other cases, an in-depth case provides greater value in terms of answering the specific set of research questions (See 1.4). Additionally, as the study is examining a cooperation problem that has characteristics specific to the water sector, the problem itself is not unique to the sector, and thus offers an opportunity for cross-sectoral dialogue.

3.1.3 Summary of justification and refined research questions for the Medellin case

Building upon the gaps in literature (alternative service delivery, emphasis on stakeholder engagement and the secondary city), the Medellin case study is selected for its potential contributions to societal approaches to governance. Beyond having a mixed utility model, Medellin, Colombia is a city where there has been extensive analysis of the city's success in community engagement in adapting to several challenges in the city related to rapid population growth, civil and political conflict, the effects of climate change, inequality and economic uncertainty. With respect to the provision of public utilities such as water and

electricity, the role of its public utility EPM, not only in the provision of services but also in the societal transformation of the city (Davila & Brand 2013; Drummond et al. 2012; Fukuyama 2011). The extent to which this is the case in a complex resource regime such as water offers the opportunity for exploring what a lens of adaptive governance can offer. Additionally, this lens for analysis can contribute to efforts to bridge a gap in understanding the characteristics of its adaptiveness, how the governance of water is coordinated among the different actor groups and the social cooperation among the various agents.

With this background information specific to Medellin, the following sub-questions adapt the research questions for exploration using the Medellin case which contributes to the investigation of the macro question: *What can an adaptive governance lens offer for tackling a governance challenge related to cooperation in a complex resource regime?*

Question 1: To what extent is the case study (water governance in Medellin) consistent with features of an adaptive governance system?

Question 2: With an understanding of Question 1, what regime characteristics typify how the system is arranged? Any contextual factors that are strongly associated will be highlighted.

Question 3: To what extent does the case study typify typologies of social contracts? Which ones seem to dominate? If any that depart from these typologies. Where they differ will be highlighted.

Section 3.2 will describe how Questions 1, 2 and 3 were investigated.

3.2 An approach to analysing adaptive governance, regime characteristics and societal arrangements (Methods)

Section 2 will provide information on the case study, and the methods used to explore questions will be investigated using the case study of water governance in Medellin (See Section 3.1).

3.2.1 Method for establishing Medellin as a case for adaptive governance

Answering questions related to the governance of complex resource regime characterised by social and human involvement requires a method for analysis for capturing the human and social dimension. A qualitative approach with a constructivist epistemological paradigm provides a perspective that is sensitive to the possibility that there are realities that can have multiple conceptualisations or simply that there are multiple realities that may emerge (Lee 2012). This first section will explain this perspective as background for how the research questions will be tackled.

This thesis will use the perspective advocated by Lincoln and Guba that accounts for individual perspectives, yet that is flexible to incorporate multiple interpretations. Lincoln and Guba say in relation to constructivist thinking that "realities are social constructions, selected, built, and embellished by social actors (individuals)" (Lincoln, Y. S. & Guba 2003). In that sense, "constructions are intensely personal and idiosyncratic and, consequently, as plentiful and diverse as the people who hold them" (Lincoln, Y. S. & Guba 2003). Distinguishing constructivist paradigms (meaning-making from the individual) from social constructionism (collective generation of meaning), the constructivist paradigm is included as an approach to frame the interpretation of realities from individual stakeholders. Lee argues that including an aggregate of interpretations invariably applies a social constructionist approach to meaning (Lee 2012). The constructivist approach assumes a relativist ontology (there are multiple realities), a subjectivist epistemology (knower and respondent co-create understandings), and a naturalistic (in the natural world) set of methodological procedures. (Denzin, N. K. & Lincoln 2005). This epistemological and ontological frames inform the qualitative approach to the research questions in this thesis.

Question 1 *(To what extent is the case study (water governance in Medellin) consistent with features of an adaptive governance system?)* involves comparing evidence from in-depth semi-structured interviews from different stakeholders discussing issues of water governance to identify elements that have a strong association with adaptive governance systems.

Understanding this feature then establishes a pathway for examining the regime characteristics (Question 2) and social contracts (Question 3). Because this approach to governance places society at the centre, insight on these features has to emerge from members within and connected to the system of governance within the society.

The following section will describe why interviews were an appropriate choice as a method for data collection.

3.2.2 Justification for method of data collection - qualitative interviews

The discussion of complex resources shows that human and social involvement tends to dominate governance in social-ecological systems. Because societies are complex, context-specific and people-centred, having the views of individuals and groups at the centre of the data was paramount in answering these questions. Therefore insight from people within the system of water governance was collected using qualitative interviews in a way that would enable analysis close to the views of those within the system of governance (See 2.1.10).

Semi-structured interviews were selected as the method of data collection for analysis using thematic content analysis (Boyatzis 1998). Semi-structured interviews were chosen as opposed to open interviews in order to ensure discussions of context were understood in relation to water provision in the Medellin context. Semi-structured interviews were preferred over a survey using closed questions as it would enable gleaning of contextual information and not exclude content inconsistent with theory, mainly as this is an alternative, outlier case. Focus groups were considered, however, due to the politicised nature and ethical concerns over whether individuals in the sector knew one another or had conflicts of interest, semi-structured interviews were used to protect the identity and well-being of participants (Braun & Clarke 2012; Boyatzis 1998).

3.2.3. Justification for method of analysis - thematic content analysis

Thematic content analysis was chosen because of its demonstrated use for investigating questions where existing data is limited, however, promotes a systematic approach for comparison of results with existing theory (Boyatzis 1998). The method uses the data from semi-structured interviews, open-ended questions and probes to identify themes to compare with existing theory. This approach is associated with content analysis as a suitable approach for model generation and based on experience in the literature that an open approach to coding using thematic content analysis facilitates theory emerging from the data (grounded

theory) (Glaser & Strauss 1967). This is also useful in having a broad view of themes that can be compared with existing frameworks facilitated when a theory-based approach to coding is applied (Boyatzis 1998; Creswell 2007; Denzin, Norman K. (Ed); Lincoln 1994; Denzin & Lincoln 2005; Glaser & Strauss 1967; Hsieh 2005).

3.2.4 Justification for sample – purposeful sample of representatives within and related to the provision of water and sanitation services in Medellin, Colombia

Sample size was discussed at a scoping stage and the process combined 1) saturation, 2) purposeful sampling, and 3) snowball sampling. The people interviewed were selected with the objective of providing an insight on the water sector from a system's perspective that accounts for the range of actors within the social-ecological system. A scoping study was conducted to identify the key speakers with support from local partners at the Universidad Nacional de Colombia sede Medellin (UNM). This collaborative approach identified 6 actor groups to include: water utility, governing bodies at city and metropolitan level, community-based organisations involved in a political and social capacity, universities collaborating on different aspects water supply and water user associations. Ultimately, 25 interviews were conducted informed by the three approaches to sampling.

Firstly, a guiding principle was the concept of 1) saturation: increasing the pool of participants until the information provided by participants was repeated (Mason 2010). This is a concept used in methodologies linked to grounded theory (Glaser & Strauss 1967). However, this alone was not sufficient as the choice of an alternative case integrated with different systems may require relevant perspectives that could be overlooked, even when saturation is reached. This challenge leads to the second consideration which is purposeful sampling. 2) Purposeful sampling, due to its emphasis on experiences *per se* rather than people, provided an approach to mitigate the challenge of overlooking an outlier. For this study, this approach casts a broad view of the possible links to water governance through scoping and focusing data collection to participants with direct and personal knowledge of practices within the water governance system (Sandelowski 1995). This does not immunise the sample from missing experiences, however, but it embeds the method with the awareness of the importance orienting the work towards including a diversity of backgrounds. Thirdly, building upon the merits of saturation and purposeful sampling, a 3) snowball approach to building a network of experts in the

sector evolved to build the sample and identify gaps that could be supplemented with literature and/or further investigation.

3.2.4.1 Sample limitations

There were some limitations considered at the planning stage. The sample represents a snapshot of a network at a point in time, with the understanding that the system is changing. The sample may not always necessarily capture this change, however, awareness would justify the following efforts to mitigate this challenge: an iterative review of the literature, repeated contact with experts at different levels and close policy analysis, which mobilised other resources to address not having a constant update on sampling.

Where specific speakers were unavailable for an interview, literature and/or proxy voices such as communications' officials for that group were consulted for a view on that issue with the caveat made explicit that the speaker is a representative of the organisation but may not reflect the exact views of the particular individual of interest in the organisation. As the study is focused on perspectives from these different views with an acknowledgement that different views could emerge from the same organisation, triangulating viewpoints contributed to an awareness of the differing perspectives that emerge from an absence of a voice. This further contributed to efforts to conduct reliability checks.

3.2.4.2 Participant recruitment

To recruit interviewees, contacts with the utility provider, Empresas Publicas de Medellin, the universities (UNM and UCL) and Penca de Sabila, a civil society organisation working closely in water governance and environmental issues more broadly, provided the first channels for recruiting interviewees. Individuals with expertise across departments within the organisations were requested including regulation, new business, infrastructure, social programs, pricing, sanitation and connected energy sectors (i.e hydroelectric power). These individuals had a range of experience related to for example decision-making for new investments regarding access to water, the relationship with the service provider and the municipality and local communities' acceptance of EPM's activities.

A pilot of the interview was conducted (See 3.3.5 for information related to the interview guide). The pilot results provided evidence that there was a need to expand the sample to include greater representation from municipal and metropolitan area authorities, as per multiple participants recommending people to speak within these categories. The sample

following the pilot stage includes other perspectives identified as integral to an integrated urban water system – experts in sanitation, industries working closely with shared water sources such as hydroelectric power and representatives from planning units within the service provider that provide insight to planning utilities.

The final sample includes representatives identified in scoping research (literature review and conversations with informed, local experts). This included municipal authorities, metropolitan area authorities, university experts, utility provider (EPM), members of the different community and civil society organisations and water user associations working in different parts of the city. Of these participants, approximately 1/3 of the perspectives were from EPM. This was due to the large scale of the organisation diversity in departments connected to the water sector working on issues related to water: water and wastewater, sanitation, infrastructure, planning, payments, regulation, energy-water, finance and business development etc. In the scoping (pilot) phase of the study, there was evidence that EPM's various departments interact with some of the same actors as well as different actors. Thus interviews with the different departments were needed.

3.2.4.3 The role of informants

There were several individuals who were not interviewed, but who provided an invaluable role in identifying and connecting with individuals for the study. For each of the stakeholder groups selected, there was at least one of these individuals described as informants for the purpose of this thesis. Involvement may have ranged from informants suggesting individuals who would also be integral to the study, to facilitating introductions. In some cases, where access to a particular individual was a challenge, the informant not only enabled or promoted the introduction but was also present during the interview. While this may have introduced a bias to the data collected, it was of greater importance (and priority) to have access to these individuals to access speakers. Having the trust of the informant enabled access to the speaker. Where informants were present, there was an understanding that they would not be the focus of the interview. In each of the categories, there was at least one informant. The strength of these relationships also contributed to more effective follow up after the interview.

Informants were of critical importance for following up after the interview. Their input ranged from providing insight into the meaning or use of words in a particular context, following up contact with other participants and for verifying any additional information.

3.3.5 The interview guide

With an understanding of the method for data-collection (Sections 3.2.2 and 3.2.3) and the desired sample (Section 3.2.4), this section will describe the tools used to collect the data. A guide was developed to collect "conversations" that would be analysed with the lens of "the overall content of those conversations" to apply data-driven approaches informed by grounded theory (Glaser & Strauss 1967) and theory-driven approaches informed by thematic analysis (Boyatzis 1998) (Section 3.2.3**).**

The interview guide was developed with reference to methodological tools for qualitative research methods (Denzin, Norman K. (Ed); Lincoln 1994) that would suit open-ended questions, followed by prompts. This method captures a wide range of understanding of the water governance system as perceived by the speaker and to also get their perspectives specific to the aims and objectives set out by the research question. As a parameter for the semi-structured interviews, interviewees were informed of the topic for conversation (on the theme of water governance) with language adapted for user-friendliness. Following conversation cues from the speaker, some prompts in the interview guide were developed. The interview guide was designed with the following theoretical lenses considered (See 9.1.4). For example, the proposed theory by Wostl (2007) suggests that there are contextual factors that explain the relationship between the regime characteristics and performance, so prompts were included to learn more in examples where a speaker describes a context-specific feature. This might, for example, be the role of community groups during the transformation currently engaged with water provision. This is critical as evidence in the literature suggests that contextual factors may attenuate features such polycentricity, diversity and networks, which are strongly associated with adaptive systems (Huitema et al. 2009).

Tools in grey literature (which includes policy and reports from development partners) were considered as examples of language that is easy to engage with that for example, conveys the meaning of governance, but that does not confuse or distract the speaker. Examples such as Price Waterhouse Cooper's guide for investigating multi-stakeholder collaboration for water

(PWC, n.d.) was consulted to aid in framing the style for the interview questions in language accessible to a range of actors. There were also several discussion with local partners on the language and process for working in Spanish and English.

3.3.5.1 The pilot phase of the interview guide

Before the pilot, the interview guide was included and approved in the ethics' review (UCL Ethics, Project 814/001). The interview guide was shared with local partners, informants and translated (by an informant). A pilot was conducted. After a pilot run of the preliminary interview guide, there were a series of changes made and suggested by peers at UCL and the engineering faculty of UNM in Medellin. This was an iterative process of writing, rewriting and testing. This included substantial work with translations developed with local speakers in Medellin, Colombia designed to incorporate validity internally. This included one academic and one linguistic expert. This process suggested that the guide should aim to identify themes of interest for a conversation on the system of water provision and provide opportunities for participants to speak freely. Optional prompts were included to ascertain detail for a particular theme. As this study focuses on the contextual factors of the relationship between regime characteristics and adaptive governance from the perspective of actors in Medellin, conversations where these factors could come up was of greater importance than answers to specific questions.

3.3.5.2 Changes made after the pilot

The revised interview guide was then shared with local partners at the national university in Medellin, the water service provider and colleagues at UCL to involve the main partners in the process and make corrections based on feedback. Feedback was incorporated following a pilot of the guide.

A preliminary review of the pilot transcripts included identifying themes in the data as they emerge (data-driven, grounded theory approach to coding) that may not be captured by a predetermined list of topics to guide data review (theory-driven approach to coding). Based on feedback, the interview guide was amended with attention to the ordering and syntax of phrases, however, the main themes remained the same. This was shared in consultation with partners to identify with greater specificity comments related to, for example, best practices in water governance, where the action is taking place and future visions of alternative approaches.

3.3.5.3 Interview procedures and protocol

Interviews were coordinated between the researcher and the interviewee. The level of engagement before the meeting ranged from very limited to several informal introductions and conversations leading up to an interview. Consistent with the ethics' review and protocol (UCL Ethics, Project 814/001) all participants, regardless of the level of involvement in the study were provided with information sheets and consent forms outlining their rights and responsibilities in the study in both English and Spanish (in advance or on the day of the interview). All participants could select the choice of language spoken for the interview. For interviews in Spanish, a translator from Medellin provided added support for both the interviewee and interviewer. In a few cases, access to the interviewee was required with an informant known and trusted by the interviewee. As it is possible that this may have introduced a bias (See Section 3.3.7), the opportunity to speak with this group was prioritised. In these cases, the informants were made aware of their role to provide support as opposed to providing content in the interviews. These interviews were still treated as one interview. If there was a difference of opinion expressed, where relevant, information presented is interpreted with an understanding of the presence of the informant. Subsequent analysis of this group was conducted to rule out bias that would undermine conclusions drawn from those in the sample.

Interviews were recorded, anonymised, transcribed (by a local partner) and translated (as some interviews were in Spanish). For all cases, the final interview transcript was provided to the speaker for review. Interviews were also reviewed by both a local translator and the investigator. Any questions and/or discrepancies were discussed over a series of 8-10 video-conference conversations after the interviews had been transcribed. This was particularly important for nuances in the dialect spoken specifically in Medellin where often there were subtleties that varied by the speaker.

3.3.5.4 Non-verbal data – the use of visuals and maps

All interviews provided an opportunity for speakers to describe how they perceived the water governance system and the actors involved in the system. In some cases, speakers described the different actors. In this case, these lines or groups of lines are coded as "verbal maps." In some cases, interviews provided drawn maps ranging from names of organisations jotted down on a series of paper to detailed maps of the geography of Medellin, jurisdictions and the actors that work in different settings. These drawn maps were also scanned and included

in the corpus of data where speakers made a specific reference that required further clarification.

3.3.5.5 Language and cross-cultural knowledge-sharing

The issues that arose with working with translations as data and in the analysis were considered in light of literature (Hsieh 2005; Ritchie & Lewis 2003; Boyatzis 1998). Actions to mitigate skewing of information were taken with the support of different informants. For example, because the frameworks were derived in English, challenges in adapting the language were considered. In using a translation, there is an inevitable change that the meaning can have differences (strong to weak). Interlocutors who understand the nuances of both languages were critical. The translations are thus positioned as a tool for consistency checks.

An iterative approach to checking the data as it was being transcribed and translated was utilised as an internal consistency check. This entailed a local expert transcribing and flagging aspects of certain words and phrases that could be misinterpreted or were ironic in tone. During translation, any of these that arose were discussed over a series of 8-10 meetings (in person or over video). This was intended to allow a full conversation to take place and identify blind spots.

When there were discrepancies flagged that the local expert could not resolve, the question and transcript were provided to the interviewee to verify. All transcripts were also provided to the interviewees with the opportunity to amend or clarify what was said.

A preliminary list of themes was generated that would potentially be used for coding consistent with the approach of Boyatsis for data-driven coding (Boyatzis 1998). The transcripts were read through highlighting noting topics of interest. They were reviewed a second time and flagging possible codes and identifying when and where different actors were mentioned to compare with the preliminary list.

3.3.5.6 Iterative review of raw data and theory

After raw data was collected and an iterative process of reviewing the data underway, there was a need to compare the initial literature review and theoretical underpinnings and update new literature. The following section will describe this process.

The initial scan of the documents was conducted noting themes that arose. After transcription, descriptive analysis using Nvivo 11 (QSR International, USA) was administered to get a sense of the following:

1. Diversity of word choice
2. Word cloud representations
3. Use of similar words

Examples of this exercise are included in the appendices (Section 11.3).

3.3.6 Two-pronged approach to coding – why and how

Data-driven approach – for exploring to what extent Medellin's system had features of adaptive governance (Question 1)

A two-pronged approach to coding was conducted to ensure that contextual themes were not ruled out by data exclusively (Braun & Clarke, 2012). A data-driven approach was used at first to identify themes or ideas that may be overlooked with the purpose of having a breadth of context for the study as a whole and to address question 1 *(Question 1: To what extent is the case study (water governance in Medellin?) consistent with features of an adaptive governance system?*). For data-driven codes, this proved consistent with the theory of letting the data speak for itself particularly as there may be features of the system of adaptive governance in Medellin that depart from what the theory predicts (Boyatzis 1998; Glaser & Strauss 1967).

Coding literature was consulted to ensure a range of approaches was considered (Creswell 2007; Fereday & Muir-Cochrane 2006) with the arguments for a data-driven approach (See Section 3.1.3) in favour. In this approach, the coding starts with observation, and codes are derived from data (Hsieh 2005). Data-driven approaches are useful not only for identifying features associated with adaptive governance, but also for creating an index of themes which can be used as a reliability check should themes provide conflicting information.

3.3.6.2 Manual process for coding – overview of data-driven

Codes were generated from the participants' perspectives and grounded in the data by actor category, which created an overview of themes discussed generally which was used to identify consistency with adaptive governance (Question 1) in Section 3.1.11. Then, themes were coded using Nvivo 11 (QSR International, USA) coding software. A preliminary word cloud was generated based on the 100 most frequently occurring words (> 4 letters in length)

excluding conjunctions, speaker identifiers and other connecting words (See Section 11.3). Next, transcripts were coded based on the content discussed in a line or given set of lines. Information was organised by columns labelled:

1. Transcript number
2. Type of speaker (utility, government or community group
3. Location

The transcript number, type of speaker and information that contextualises the item coded is included in the presentation of all quotes for easy retrieval and reference checking if required.

Keywords - these are taken directly from the data, words that one would see in a paper for example 5) codes - these are extracted directly from the data as well, yet a word such as “social program” may be used instead of the name of a specific program to allow for grouping later. Words such as “process” “project” “strategy” “crises” or “approaches” were also used in this respect to capturing a general category for specific keywords used. The codes and themes are available in Sections 11.2 and 11.3 respectively.

Codes were assigned in a non-discrete manner meaning that items could be coded more than once. For example, a system assigned “intervention” could also be coded as “linkages between actors” when describing different actors also working together. In another example, a line that says “the environmental authorities issue water concession permits to the service provider to occur after a series of applications showing how the proposed project will impact the water source” could be coded as “description of actor role” as it describes the role of the environmental authority. Themes like these could be coded as “linkages between actors” as the water concession permit is assigning responsibility from one actor to another in the form of a contract agreement or as an example of “water regulation” which acted out by the actors.

For the purpose of establishing the Medellin context as an example of adaptive governance, a range of themes and topics discussed in conversations about governance were needed. These themes in Chapter 4 are presented in a form that lends to analysis supporting or challenging the definition of adaptive governance from a governance perspective (ie. integration of infrastructure in different plans, linkages between different actors). This format also showcases tools and/or activities that may contribute to a revised definition for

governance for adaptive governance. While all themes coding in the "open phase" of coding is beyond the scope of this section, a full index of all themes coded is available in Section 11.2.

An iterative process of reviewing the codes at the end of each category provided an opportunity to discuss the central themes as they present themselves. The top 5 themes are discussed in more detail. This does not mean less popular topics are not reviewed – they were indexed or listed in a list format to be consulted for queries regarding context.

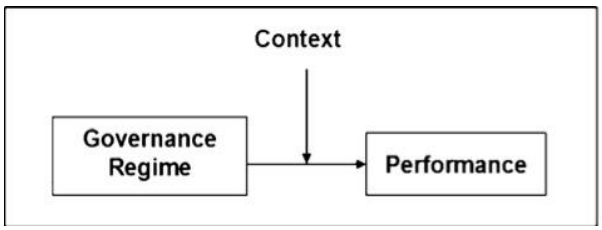
A full description of the results that establish Medellin as an example of adaptive governance are detailed in Chapter 4.

3.3.6.3 Theory-driven approach to coding for analysing the relationship between regime characteristics and adaptive governance

A Justification for a theory-based approach

To answer question 1, Section 3.3.6.2 describes a process for understanding the breadth of themes in the data and for comparing Medellin with the definition of adaptive governance. Examining to what extent the regime characteristics are consistent with one of adaptive governance, requires applying theory in deriving codes to test this in the Medellin context *(Question 2: what regime characteristics typify how the system is arranged?).* The assumption would be that there is weak evidence of the Medellin case having regime characteristics associated with adaptive governance as an example of adaptive governance.

The theory associating polycentricity and adaptive governance introduced in Section 2.3 was used to analyse the relationship between regime characteristics and adaptive governance. Recalling the theoretical framework established by Pahl-Wostl (Figure 7 Relationship between governance regime, performance and context (Claudia Pahl-Wostl et al., 2012)), which associates regime characteristics with performance (in this case adaptive governance), a method for analysing the regime characteristics draws upon theories for assessing complex resource regimes.



Research design and analytical approach making a distinction between a governance regime, its performance and the influence of context on the relationship between regime characteristics and performance.

Figure 8 Relationship between governance regime, performance and context (Pahl-wostl 2012)

The theory in the literature on adaptive governance and in the governance of natural resources suggests that systems that have decision-making power among different authorities ("many authorities") with overlapping areas of influence (polycentric governance) are more likely to coordinate. There is also a counter-example of monocentric governance ("single authority"). The former is strongly associated with adaptive governance (which would be the performance variable) (2.1.14.1). Adaptive governance is the proposed outcome (y) for having a system of polycentric governance (x).

The application of these theories at the stage of analysing the data will be discussed in the following section.

3.3.6.4 Application of the theory of polycentricity and monocentricity for coding

To answer question 2, the data (semi-structured interviews) were analysed with the lens of polycentric governance and nested hierarchies *(See Section 2.1.14.1)* monocentric governance (Termeer et al. 2010). Evidence that was consistent with the definition of polycentricity and characteristics associated with it (i.e. having 'many groups' involved in decision-making) were used to identify different types of arrangements. See Table 1*,* Chapter 2).

There was some evidence at an early stage of scoping that there were examples of a polycentric system, which range from 'very polycentric to 'not polycentric' as well as contexts where the same organisation in one circumstance may be described as polycentric and other times where it features as more monocentric. To account for the variability, an iterative approach to creating the codebook and coding the interviews was taken. The codebook is based mainly on the definitions of polycentricity put forth by (Section 10.1.6) and was created with several iterations with input from supervisors, local partners and coders who were included in the reliability check. Secondly, three coders not familiar with the topic, but familiar with qualitative interviews and coding were included to provide input on the codebook through discussions and notes. This iterative process was undertaken on a sample of interviews. Further description of the reliability and validity check is described in Section 3.3.7. The results and analysis of this are included in Chapter 5 and Chapter 6.

3.3.6.5 Tackling the societal arrangements – applying social contract theory

To answer *"Question 3: To what extent does the case study typify typologies of social contracts? Which ones seem to dominate?"* a societal approach to looking at governance was incorporated. This section will describe the methods for defining the arrangements in the Medellin case.

Using the semi-structured interview approach (theory-based) in Section 3.2.3 and taking into account the material coded and analysed based on its perceived degree of polycentricism and nested hierarchies, the interviews were coded again with theory from the literature on social contracts (Section 2.7). For the purposes of coding, proxy measures of top-down, mixed or 'bottom-up approaches in decision-making and implementation were utilised. These typologies emerge from theory on social contracts and its application in the water sector described in full detail in Chapter 2, Section 2.7.

These items were coded non-discretely as there were several examples where an organisation (ie. an environmental authority) may operate in a top-down manner (i.e. in a land-use plan). The same example could also be coded from a different perspective and include a combination of bottom-up and top-down approaches. These items were coded alongside items marked as polycentric and/or monocentric.

The process for coding, grouping and analysing themes was as follows:

1. Assigning unique variables to each of the speakers, grouped by category as top-down, mixed and bottom-up

2. Grouping the material coded as 'top down', 'mixed' and 'bottom up' by category and under what type of authority (polycentric ('many groups') or monocentric ('single groups') by category)

3. Analysing the speakers in each category for common themes

4. Comparing the common themes between the categories

3.3.7 Reliability and validity

This section will summarise how reliability, validity and generaliseability considerations were taken into account.

Different reliability and validity checks (Ritchie & Lewis, 2003) were reviewed and incorporated into the study process (DeCuir-Gunby et al. 2011; Hruschka et al. 2004; Jick

1979; Morse et al. 2002). Firstly, having the two approaches – data-driven (inductive approach) and theory-driven (deductive approach), provide an internal check on the study's reliability. This provided an internal form of triangulation, by looking at the same data from different analytical perspectives. For example, a contextual factor that emerged from the data-driven approach concerning the role of EPM historically in the transformation of Medellin, was flagged several times. With this understanding, when the theory-driven approach was applied, this could be taken into account as 'contextual' as it would not have been identified if the theory-based codes were applied uniquely.

Secondly, triangulation was employed in another manner by having different representatives from the various organisations and from within the same organisation. Thirdly, including different researchers in coding a sample of the material ensured that the there was a common language and understanding for identifying what was considered to be a regime characteristic (polycentric) and a societal arrangement (social contract).

Generalisability is a concern for applicability of findings from case study research to similar as well as different contexts. There are several myths within case study research about the generaliseability of case study research (Flyvbjerg 2006) that can be mitigated by actions built into the design and analysis stage. This section will discuss some concerns and actions taken to mitigate the effects.

Further information on the process for building reliability into the design of the codebook using additional coders is provided in Figure 10.

Box 1 Process for building reliability into the design and application of the codebook

Deriving the codebook

This was an iterative process of more than 25+ drafts of the codebook, then shared with supervisors (2), local partners (2), possible coders (5) and several others. The intent of the codebook evolved from merely reproducing the definitions of the codes of interest to a user-friendly and concise code that could be used to read through the interviews and identify relevant themes.

The researcher coded the data-set twice, amending the codebook for improved internal consistency.

Applying the codebook

Secondary coders were identified and given the codebook. They were allowed to ask questions and to verify the codes they understood and ask questions about others. This varied from informal conversations to an email exchange, where the secondary coder wrote how they interpreted the codebook in plain English.

After a coding a sub-sample of the excerpts given, the coders could ask additional questions before continuing to code the sample.

Coded excerpts were then compared with the results of the researcher.

Measuring the application of the codebook

To apply an approximate a measure for reliability in coding, several examples were consulted (Boyatzis, 1998)**. The measure that was best suited to test this was the percentage agreement on presence: percentage of times the researcher and the second coder found information in common.**

After coding the interviews using the codebook and comparing results with the other researchers, analysing the coded material was conducted using the percentage agreement on presence. A threshold of 70% for inter-rater reliability was the agreed standard.

Percentage agreement on presence = 2(number of times Coder A + number of times Coder B)/(number of times Coder A+ number of times Coder B).

Three secondary coders were included to code a percentage of the interviews and yielded the following percentages on agreement. (Boyatzis 1998)

Coder A: .82

Coder B: .77

Coder C: .77

This concludes the methodology section. Part II which includes chapters (4-7) presents findings from the use of these methods.

Part II

Chapter 4 Medellin, Colombia – Adaptive governance of a complex social-ecological system

Part I provides an overview of the challenge of governance in the provision of complex resources in a social-ecological system and the dominance of social factors where natural and societal ecosystems meet. The literature review introduces the question of what an adaptive governance lens offers for tackling governance related to cooperation in a complex resource regime. The adaptive governance lens derives from the literature on features of an adaptive system, characteristics of adaptive regimes, and typologies of social contracts described in Chapter 2, which contributes a theoretical basis for tackling questions 1, 2 and 3 in Chapter 3. Chapter 3 also includes an introduction to the case study, the provision of water resources in Medellin, and an explanation of the reasons why it was selected.

Part II presents the results for questions 1 (Chapter 4), question 2 (Chapter 5 and 6), and question 3 (Chapter 7).

1) To what extent is the Medellin case for water governance consistent with a definition of adaptive governance?

2) What types of regime characteristics does this place have? In this example, to what extent does it confirm or challenge a polycentric form of governance?

3) How are the arrangements between the different stakeholders organised? To what extent do they confirm or challenge social contract agreements?

This chapter (Chapter 4) reviews the governance of the water sector in Medellin, Colombia in relation to a definition of adaptive governance (Question 1). The chapter discusses features that depart from the definition with the purpose of contextualising adaptive governance in the Medellin context. This chapter will also highlight context-specific characteristics, particularly those that show consistency as well as challenge expected features of an adaptive system. These provide evidence on the extent to which the case study is consistent with features of adaptive governance (as an outcome variable that can have multiple realities as per a constructivist paradigm), which is a foundation for further exploration of the regime characteristics and social contracts in the system (as an input variable that captures relations between different actors). These will be analysed in Chapter 5, Chapter 6 and Chapter 7 respectively.

4.1 Summary for identifying features of adaptive governance

Folke et al.'s definition for adaptive governance suggests that the characteristics of an adaptive system include "self-organis[ation] as social networks with teams and actor groups that draw upon various knowledge systems and experiences for the development of a common understanding and policies" (Folke et al., 2005). From this definition and from the discussion of adaptive governance in (as derived from Folke's work described in 2.2), there are two features that aid in identifying adaptive governance. The first feature includes evidence of integration of systems, for example, a water plan which is developed alongside and in dialogue with a plan for housing. Another feature is that there are spaces for networks, teams and actor groups to share knowledge and draw upon experiences for achieving common goals (Folke 2006). To meet those demands, an understanding of governance will have to account for the extent to which different systems interact (environmental, economic and social) and how the actors within them relate. There are actors in each of these features that enable integration of systems and spaces for cooperation to emerge. Cooperation is facilitated by the presence of "bridging actors," a feature described in adaptive systems (Folke 2006). These groups have and continue to be a voice for communicating the needs of citizens in day-to-day decision-making for critical infrastructure and services.

Table 2 Features of Adaptive Systems

Features	Example
Evidence of integration of systems	Water plan that is integrated with housing, land-use and environmental planning. Bridging actors may enable this.
Evidence of spaces for networks, teams and actor groups	Committees for co-creation, strategic planning and opportunities for actors to share knowledge and draw upon experiences. Bridging actors may enable this.

This analysis discusses examples in the Medellin case study that are consistent with, or challenge, these features with particular attention to the role of contextual factors. Within the broader context of the literature on complex resource systems of social-ecological systems, there is an acute awareness of the dominance of social involvement in a system such as water governance. The dominance of social involvement is important because the dominant narrative for water provision has centred on technical challenges, despite overwhelming evidence that many challenges are related to governance (OECD 2015b; Nallathiga n.d.; Van de Meene et al. 2011; Castro 2007; C Pahl-Wostl et al. 2008; Ostrom 2007). The impact of these governance challenges is that they have several implications for environmental, social and economic outcomes. Acknowledging that challenges to provision, such as coordination, are deeply rooted in social systems, positions complex resource systems, such as water, within a social narrative. Where and to what extent the case supports/challenges this assumption is taken into account in this example.

4.2 Results summary

The results provide evidence for features of water governance in Medellin that is consistent with a definition of adaptive governance; namely that water governance is integrated with other sectors and provides evidence of tools and mechanisms for managing the relationships between the different actors involved (See Section 2.2). At the same time, there are some examples where policy integration does not necessarily equate to integration at a practical level and vice versa. There are also examples where some tools and techniques privilege some stakeholders over others. This asymmetry may take the form of committees which may not be inclusive of all relevant stakeholders. Outcomes of this type of imbalance may suggest that some groups have access to more information, capacity-building opportunities and other

resources. In these scenarios, those with authority and decision-making power tend to benefit while the others are left behind.

In reviewing the results of this research question, there were four contextual features of adaptive governance in the Medellin context: 1) Integration of water policies, plans and infrastructure with other planning interventions at city level (housing and education efforts), 2) Practical arrangements for governance with people in the construction, design and planning of public infrastructure (including water infrastructure, 3) Adherence to environmental, land-use and housing standards in planning at a national, regional and local level that are overseen by autonomous environmental authorities, and 4) community-based processes for engaging with formal institutions and forums for communities to engage in planning related to different societal needs in the city (utilities, mobility, health and education).

The themes emerge from perspectives of a diverse set of stakeholders operating at different levels of engagement in multi-level institutions and organisations. Stakeholders include representatives from the: public service provider, municipal authority, environmental authorities, community-based groups, water-user associations, and universities. The section also highlights, where relevant, practical applications of adaptive governance in the form of tools and/or activities. Other themes beyond the scope of adaptive governance collected as an approach to indexing themes as a form of triangulating methods.

4.2.1 Descriptive summary of data-driven codes

The data-driven approach to analysing semi-structured interviews includes themes coded (non-discretely) to the most frequent themes. The most common codes were: linkages with other actors, challenges, interventions, multi-level governance and plans. Items could appear in more than one code beyond these top five, however, to answer the question of to what extent Medellin's system is consistent with one of adaptive governance, these examples are featured in this chapter as most closely describing the governance of this sector. Tools and practical arrangements for cooperation emerge from data coded to these five themes.

4.3. Governance tools: Plans that account for (are integrated with) other systems

The first section of this results chapter (4.3) shows how the water sector is integrated with broader planning for environmental, economic and social systems in planning activities. This

is consistent with the criterions of an adaptive system of governance having evidence of integration, of which a possible outcome is “the collaboration of a diverse set of stakeholders operating at different social and ecological scales in multi-level institutions and organisations” (Folke et al. 2005). These examples will demonstrate a range of ways that collaboration occurs in planning most specifically. The theme “plans” include several references to development and industrial plans for different systems that take into account water and sanitation utility provision and its connection to the needs of citizens, societies and the Medellin of the future.

4.3.1 Environmental management plans

There are several environmental management plans (See Table 3, Section 4.3.1) that integrate water and sanitation utility provision with planning, operation and maintenance with other systems and actors (i.e. the Metro of Medellin) that would not necessarily emerge from a purely technical view of water governance. This includes requirements of municipalities that account for the environmental impact of planning activities and to comply with the regulation of these sources in local land use-plans. The Ministry for Environment, Housing and Territory *(Ministerio de Ambiente y Desarrollo Sostenible)* oversees the planning for water resources and the requirements for implementation of regulation at a municipal level. This ministry ensures that environmental planning links the local to national level policies and facilitates integration of planning at a local level. There is also evidence of integrated planning and implementation requirements required by regional level governing authorities, namely through a regional monitoring program and activities to share information on the quality of the Aburra-Medellin river among the different municipalities that use the basin. Furthermore, there are planning and maintenance efforts to protect the water source that include actors such as the Metro of Medellin to participate in joint efforts to recover the river of Medellin.

Table 3 provides a few examples of programs, policies and present plans, where representatives from stakeholder groups discuss features of integration and where mechanisms are in place to connect other stakeholders and actors in a planning and/or policy capacity.

Table 3 Environmental management agreements, plans and comments that integrate water and sanitation through linking different stakeholders

Name of Plan and Description	Excerpt from interview, speaker ID, actor group
Program Integral Red Agua Integrated water network program	*"Program Integral Red Agua" – Piragua program of Corantioquia – this is important because the water quality initiatives they undertake affect what the resources that service Medellin including companies from the jurisdiction (80 different municipalities)."* -ID19, environmental authority (regional environmental authority) This quote is included here as it emerges from a discussion from the regional environmental body which is independent from the urban environmental body (AMVA). While it is beyond the scope of the metropolitan area, as this regional body has jurisdiction over water sources that the metropolitan are draws upon, initiatives like this Integrated water network program enable integrating environmental plans in response to shared water needs by the different Enivronmental authorities. This quote speaks to the transboundary nature of water governance from a regional perspective through integration of plans across governance bodies.
Nuestro Rio Agreement to protect the water source is a multi-level governance arrangement	*"There is a large agreement in this moment that is many different municipalities of the Área Metropolitana, us (epm), Área Metropolitana and obviously us, including the Metro de Medellin, the company of the Metro that is called Nuestro Río, and within the framework of that agreement, the idea is to implement actions that serve all that has to do with the recovery of the Medellin river."* - ID13, service provider, sanitation This quote is identified as being an example of integrated environmental management. While integrating water is part of environmental planning more widely, the different governing bodies mentioned here (Area Metropolitana (environmental authority), the metro of Medellin and the utility company, are distinctly different entities with separate internal governing bodies that do not overlap. Through the Nuestro Rio plan, these independent bodies jointly ensure that that the care of the river, is enacted in an integrated manner in each of the different bodies independent activities.
Environmental planning commission Multi-stakeholder planning body	*"At the national level, we are forming a joint commission. This joint commission that is chaired by the Ministry is that is as at the front of all the issue of the plans of planning of the water resources and the environmental management plan of aquifer."* - ID15, metropolitan area (urban environmental authority) This quote is included as it is speaks to the multiple levels of governance where planning for water resources is integrated at the different governance levels (beginning at the national level). Because Medellin, and Colombian regions and cities more broadly, underwent decentralisation in the 1990s, national level bodies ensure integration and harmonisation of policies, while regions and local governments oversee implementation. For integration of water within environmental policies and plans, this quote emerges from a discussion of this process of decentralisation, where now, implementation is overseen by individual governing bodies that now operate in a more integrated manner.

4.3.2 Plans related to social policies

There are several examples of plans (Section 4.3.2, Table 4) for new and existing infrastructure that require collaboration with communities. Referred to in 3.1, collaboration with communities in the Medellin context follows a tradition of participatory planning, using community workshops for dialogue about issues such as housing, public services, mobility and transportation.

Table 4 Plans related to social policies that integrate water and sanitation and link different stakeholders

Name of Plan	Excerpt from interview, speaker ID number, actor group
Congresos Ciudadanos **Citizen Councils**	*Congresos Ciudadanos for alternative futures for Medellin (provided) engagement with private and public...historical tradition of workshops with dialogue about different issues (housing, public services, mobility, transportation, mobility etc.* - ID21, metropolitan area (urban environmental authority) This quote is included as an example of integrating planning for water within social policies as it speaks of councils that emerged from the transformation period in Medellin during and after the decline of the Medellin cartel. As the city underwent transformations rebuilding civil society, councils like this used public services and public works as access points to build a stronger social fabric. Water services, as well as other utilities, were tangible ways to integrate with social and community-based leaders and programs.
Plan Estratégico de Medellin **Strategic plan for Medellin**	*After 1994, this engagement of the community, created the Plan Estrategico de Medellin, the strategic plan of the city. And this was from 1995 to 1997.So this was a kind of synthesis of this social collective dialogue. And if you look at this plan from 1997 and the high strategic lines and you will see what Medellin has been doing from 20 years now and this explains why we have had political changes, political differences, as neighbours... - ID21, metropolitan area (urban environmental authority)* This strategic plan, upon further investigation, was a transfomrative process of bringing together civil society leaders, planners, engineers and other groups in an integrated way. The social collective dialogue refers to the social and community-based way planning was conducted during the transformation which includes using utility services such as water as part of the social and community rebuilding.
Concejos de Cuenca **Watershed councils**	*"**Concejos de Cuenca**" are made up. In those Concejos de Cuenca there is participation of the community, there is participation by different users of the resource and generally there is space, a seat in this Concejo de Cuenca for the service provider of water and sanitation. So, we, for example we are right now participating in those "Concejos del Rio*

	Aburra and in the Concejo de Cuenca…Here there is a little river that is the main reservoir that supplies the Rio Negro. So we are part of the two, then I tell you. We have a member of staff of epm that is a member of this Concejo. So, that is it basically." –ID13, service provider This quote is included here as it is an example where water, and the basin area, as a trans municipal boundary organisation, utilises the need to protect and govern water resources across boundaries to involve the participation of communities. This involvement of communities has, upon further investigation, contributed to social policies and planning by connecting civil society leaders and community-based organisations to channels for planning through public forums and meetings.
El Sisben **National survey for allocation of subsidies**	*It's according to "El Sisben." It is a survey. It is a well-defined survey – created by the National Department for Planning – and this survey defines families that are considered to be at high risk, and those families that are at high risk they give them support in the for education, living together, to find work, health. And between those programs there is the minimum vital of water. So, they analyse the number of people that live in a house and they give them an allocation of 2.5 cubic meters per month per person – ID9, service provider* This quote is included as it refers to a national level policy and program for providing subsidies for basic services according to social strata. The strata system in Colombia includes 6 stratus, with 6 being the highest and 1,2,3 being the lower one. The social policy assigns tariffs based on social stratus (which is a reflection of residence and income level). The minimum vital, is the guaranteed minimum amount water that all are entitled by Colombian law. This program is administered through El Sisben's planning activity.

Activities to create spaces for stakeholder engagement include past efforts such as "citizen councils" called *Congresos Ciudadanos*. This was a type of engagement tool used to develop the strategic plan of Medellin through collective social dialogue to tackle issues such as access to water and sanitation infrastructure in informal areas of the city. There are some aspects of this activity shared in other efforts to tackle issues of water quality and use that continue today such as 'watershed councils'. Known as watershed councils, "Consejos de Cuenca,"

require participation by communities in overseeing the preservation of the watershed as well as other councils to preserve the river.

4.3.3. Land-use plans

The building of new infrastructure (public infrastructure and social infrastructure) for public services such as water is governed by land-use plans (Planes Ordenamiento Territorio). For plans related to the development of infrastructure around the Medellin River, plans for management of the river and the watershed must comply with land-use plans which are overseen by regional and municipal level authorities. Section 4.3.3, Table 5, includes evidence of where speakers make links to these land-use plans at a general level (context of land-use plans) and also a specific level (how the land-use plan integrates water and sanitation planning).

Table 5 Land-use plans that integrate water and sanitation and link different stakeholders

Name of plan and Description	Excerpt from interview, speaker ID number, actor group
El Concat/Plan de Ordenamiento y Manejo de la Cuenca Plan for river/Watershed management plan	*"This is the Medellin River, so there are plans for the river, there is a plan for the river that is called El Concat. This is the law that has to have a plan and management of the Cuenca: Plan de Ordenamiento y Manejo de la Cuenca. So, this is it. Who leads this? The metropolitan area. So, this is important because now, in Medellin, let's say, the urban planning of Medellin was a planning, let's say, that there in the 1950s, from the 1950s we had Planes de Ordenamiento – I don't know what they were called here before – there are some land-use laws, let's call them here, urban land-use."* - ID11, service provider This quote is included because El Concat upon further investigation, is a water basin management plan that is transboundary and provides input for the established land-use plans which have been enacted since the 1950s along the territorital boundaries for Medellin and the greater metropolitan area. Because El Concat provides input from all relevant stakeholders in the cuenca, or basin area, its contributions to the land-use plan, ensure that these transboundary considerations regarding water resources are taken into account.
Plan Ordenamiento Territorial Land-use plans	*"The municipalities, each municipality has to have a POT. The POT is a Plan Ordenamiento Territorial, and that must, let's say harmonise with this land-use plan for the watershed. For example, this, the river that, guides the plan, cannot be isolated, it guides, it's like an it can't be done in isolation, it's like an umbrella."* – ID11, service provider This quote is included as it is further evidence, in addition to El Concat, on the nature of how water is integrated with the land-use plan. As stated previously, El Concat is the basin-level management plan which is across the different municipal boundaries of the metropolitan area. For each municipal land-use plan, there is a mechanism for ensuring it is integrated, and accounts for the basin level plan.

4.3.4 Housing plans

Plans (Table 6) for expanding access to water for new housing settlements also integrate planning for water utilities with operational programs to improve housing and neighbourhoods and in efforts to legalise informal settlements. These planning efforts are consistent with the tradition of participatory planning efforts (See Section 3.1.1). One program, *Mejoramiento de Barrios (Neighbourhood Improvement)*, provides support to communities to develop utility provision and infrastructure networks. Similarly, there is another program that is designed to help ensure that housing is legalised before the municipal planning office as part of broader regional and national efforts to manage territorial growth. Part of the legalisation process includes evidence for the connection of housing units to a public utility as a pre-requisite for recognition of the settlement. This program is consistent with legislation that requires settlements to be formally recognised by the municipality to be connected to public services. Programs such as *Habilitacion Viviendas* historically and *Mejoramiento de Barrios* currently, create a channel for fulfilling the requirement of having housing settlements connected to public utilities. The example of housing plans requiring water and sanitation provides evidence of policy integration at the different governance levels.

This section on housing concludes the presentation of evidence of integration of water and sanitation policy and practice consistent with features of an adaptive governance system. The following sections will discuss to what extent this includes efforts and mechanisms that link different stakeholders.

Table 6 Housing plans that integrate water and sanitation and link different stakeholders

Name of Plan and Description	Excerpt from interview, speaker ID number, actor group
Mejoramiento de Barrios Program for the improvement of neighborhoods	*"And the other is the Mejoramiento de Barrios, that that Mejoramiento de Barrios, well practically is like a HV, well like Habilitacion de Viviendas, is something similar in parts where network parts are needed and the community can do it. Right now it is not attractive with making them urbanized, so it's like an approach to also have the same communities develop the networks they need."*- ID9, service provider This quote is included as it speaks of a program (improvement of barrios) which builds upon the tradition of HV which characterised the 1990s and early transformation in the 2000s. The 'network parts' here refer to the infrastructure-related parts of the water network that are needed in places with more limited access. This program, which is a housing program, offers an option for communities to improve, maintain and develop the water infrastructure networks they need.

Regularizacion de Requisitos Standardizing (housing) requirements	*"Regularizacion de Requisitos is different now, in other words, documents are required by the authorities of the municipalities for planning access to public services. It is a rule for how to control the territorial growth and that the housing is legalized before the municipal planning office. So there are some housing installations that are connected to our system but we have not been able to register them here as clients. So, it is a work together with the mayor in order to begin to make the requirements a little bit more flexible and they can be like our clients."* - ID9, service provider This quote is included as it also speaks to a tradition int eh Medellin context of utilising public services like water and energy as a way to standardise housing requirements. This was the case during the 1950s as well as in the rebuilding during the transformation in the 2000s. What the service provider here is referring to, is that this program is a way of addressing territorial growth of neighbourhoods on the periphery (which is outside their jurisdiction). This program enables a way for registering the homes with the service provider, together with the mayor, whose office oversees housing installations.

4.4 Governance tools: managing relationships between different actors

From a perspective of integrating water infrastructure with other plans and putting mechanisms in place for actors to connect across different scales, the Medellin case study shows consistency with features of adaptive governance, particularly with concrete examples for integrating policies, plans and activities. This section will show in greater detail how governance in Medellin promotes collaboration with tools for managing relationships among different groups.

These examples include institutional arrangements and tools used to manage the relationship between the different actors in the list in Table 7. These are tools used to manage relationships between different actors and create linkages between different systems. The tools that will be discussed and presented in context of the speakers are described by theme in the text to follow Table 7.

Table 7 Overview of tools and governance interventions

Tools and governance interventions	Problem that it is addressing
Congresos Ciuadadanos	Strategic plan for the city required input from all relevant stakeholders
Juntas Accion Comunal	Gap between local level organisations and city planning
Joint commission for managing water resources	Need for clarification of roles and responsibilities and monitoring and evaluation
Joint platform for river recovery	Need for addressing a gap between local, regional and national (vertical
Board composition of epm	Needed a governance structure of a public entity that reflected the positions of relevant stakeholders
Guidelines for how the city and the company interact	Need for clarifying the terms of engagement

4.4.1 Relationships with communities

There are some tools historically referenced as having contributed to opportunities to build relationships with stakeholders and forums for citizen participation. Citizen councils (Table 4 Plans related to social policies) were integral in shaping the strategic plan for Medellin and had to be adaptive to the changes in the city. This was particularly the case for territorial conflicts and migration related to the conflicts in Medellin and at a national level which has contributed to growth of the city on the periphery. These citizen councils were instrumental in the transformation and share similarities in practice with the *Juntas Accion Comunal (JACS)*. JACS are local level governing bodies in each of the *comunas (*neighbourhoods), which function as a bridge between the community and the service provider or another public/private entity (i.e. the public service company). These JACS share features of the concept of "bridging actors," a feature described in adaptive systems (Carl Folke, 2006). These groups have and continue to be a voice for communicating the needs of citizens in day-to-day decision-making for critical infrastructure and services. For example, if the public service company seeks to connect housing settlements with public services, yet does not officially operate in a given area, EPM supports a program called *Brigadas Comunitarias*, which organises local volunteers, mobilised by the *Juntas Accion Comunal*. In this example, *Juntas Accion Comunals* operate as a "bridging actor."

There are other examples where institutional agreements between different actors enable the institutions to maintain independence and sovereignty while also working together in an integrated manner. For example, the public service company is technically the property of the municipality but exercises a degree of independence in its business affairs regardless of the political party in power. This means there is autonomy in how the company can conduct its business. However, at the same time, a percentage of profits that are transferred annually to the municipality for public projects are allocated at the discretion of the board. This form of transfer indicates a balance between independence and sovereignty as well as working together in an integrated manner. The board is another example where an integrated group of actors are included within an entity that has a level of independence in its governance. Table 8 includes this an example of a tool for managing relationships between different actors.

Table 8 Tools for managing relationships between different actors

Tools	Excerpt from interview, speaker ID number, actor group
Board composition of the main service provider	*"The board of epm is: the mayor, who is the president, with 3 representatives from the municipality, then we have one from the regional governments, from Antioquia, represents the governor, then you have 5 citizens, that represent different sectors, but two of them are "locals" that are elected by elected by local councils and they have control, responsibility (23:31), and need to provide information to the citizens, but the power of the mayor of Medellin is really important because it is 100% legal owner. And epm is a group that provides services in Bogota, Bucaramanga, Cali, everywhere in Colombia, in most of Colombia."* - ID21, metropolitan area (urban environmental authority This quote is included as it offers an innovative example of a governance design at a leadership level can ensure diversity of stakeholders in a decision-making seat of authority. This includes the mayor who is the president, 3 municipal representatives, 1 regional representative, 5 representatives from sectors (2 of which have to be private citizens).
Terms for municipal interaction with the service provider	*"Internally, so I think that is a central focus that they assure a certain independence in the governance of the company regardless of who is the mayor and so I would expect more things and so the debate of the, how the resources are used. Because right now, they give the money to the municipality and the municipality decides without really…"*- ID23, civil society The governance of the company is orchestrated through its corporate code. This quote is included as it speaks to the boundaries and areas of authority that are independent of the mayor, who in effect is the CEO. This refers specifically to how resources are used, as well as other areas found in further follow-up research, on expansion overseas. When it comes to money that is allocated for the municipality, it is the mayor and municipality who decide.

As shown in Section 4.3.2, Table 4, there are several examples of forums for citizen participation that have integrated water infrastructure with social planning as well as arrangements that have functioned as dynamic processes for developing the city. These dynamic processes for developing the city are contextual features to take into account in considering its adaptiveness as a social-ecological system. For water resources and the infrastructure required for service provision, there are also examples of different forums working collaboratively across different scales (national, regional and local). A representative from the environmental authorities discusses a joint commission for water resources and a joint platform for water recovery. The latter is designed so that from a financing perspective, different groups such as EPM, the regional authorities and planning authorities can commit and invest jointly in protecting the resource. Table 8 shows different tools for creating

linkages between different actors including an explanation for how these tools achieve this aim.

Table 9 Tools for creating and strengthening linkages between different actors

Tools and Description	Excerpt from interview, speaker ID number, actor group
Congresos Ciuadadanos Citizen Councils	*"The engagement with private and public, has…with the Conserria Presidential they started a very interesting thing called Congresos Ciudadanos, Citizen Councils for alternative futuro para Medellin. (Congresos Ciudadanos) for alternative futures for Medellin ("engagement with private and public") (ID21)//historical tradition of workshops with dialogue about different issues (housing, public services, mobility, transportation, mobility etc…"* -ID21 metropolitan area (urban environmental authority) This quote is used here, in addition to its use in showing evidence for integrating water with social policies, because the councils created workshops for dialogue, which in effect are a form of tool, or mechanism for creating and strengthening linkages between actors.
Joint platform for river recovery	*"We, the work from about 1 year and a half approximately, we think precisely in integrating the different actors, we signed a cooperation agreement with the main actors in the territory that are concerned with the bodies of water. So, we signed an agreement with Empresas Publicas de Medellin, Alcaldia de Medellin, the government of Antioquia, the Metro of Medellin, the Metropolitan Area, Corantioquia, Cornare, all that are concerned to join efforts in such a way that all the resources of the various entities can focus, to say so, in a single bag and to invest jointly in the recovery of the river and its major streams. In other words it seems to me very significant (…) in an important platform for the management of the resource, the protection, the conservation is very important."* – ID15, metropolitan area (urban environmental authority) This quote is included, in addition to a similar reference to the integration of water within wider environmental plans because it refers to the platform, which is both a relational and digital one for creating linkages for the management of the resource across the various stakeholders.
Junta Accion communal Local neighbourhood level community governance	*"La Junta de Accion Comunal is like the community that organizes and nominates a leader, and that leader comes and speaks with the company and such, no right? So, it is like a mediator, it is like a communicator, a bridge between the institution and the community. So, there are some work contracts that they do, they execute them through those Juntas Accion Comunal."* – ID15, metropolitan area (urban environmental authority) Juntas de Accion Comunal features frequently throughout this thesis, yet are included here as it functions in this quote as a bridge, or interlocutor for connection communities with the formalised institutions of governance. Historically, these groups formed during the transofrmation and were instrumental in rebuilding the fabric of the civil society. Today, they are an established force for local level governance and democratic participation for all aspects, including public utilities that locals may need.

Concejos de Cuenca Watershed councils	*"Concejos de Cuenca" are made up. In those Concejos de Cuenca there is participation of the community, there is participation by different users of the resource and generally there is space, a seat in this Concejo de Cuenca for the service provider of water and sanitation. So, we, for example we are right now participating in those "Concejos del Rio Aburra and in the Concejo de Cuenca…Here there is a little river that is the main reservoir that supplies the Rio Negro. So we are part of the two, then I tell you. We have a member of staff of epm that is a member of this Concejo. So, that is it basically.* – ID15, metropolitan area (urban environmental authority) Concejos de Cuenca are also included here as they were in the integration of water resources in environmental plans because they have allocated a space, an explicit seat, or chair for EPM (water and sanitation provider) which is a mechanism for enabling communicationa and coordination between the council and the provider.
*Local governance context	*"Medellin has its own local democracy, constitution provides a strong autonomy to the cities, the mayors… And Medellin is the result of its own capability of developing local authority. Local institutions. So the institutional growth and the Alcadia of Medellin, is really one of the strengths of Medellin."*- ID21, metropolitan area (urban environmental authority) *CAR – autonomous regional authorities: "They do not depend on the government, not the local, not the regional. Metropolitan area – "But the metropolitan area, that is the last one. Metropolitan area is like a CAR for the urban sector."* -ID21, metropolitan area (urban environmental authority) This quote is included because it provides contextual information related to the CAR which are autonomous regional authorities that are involved in the governance of water resources and work closely with one another with respect to transboundary water issues.

There are a few characteristics of the local governance in Medellin that speakers raise which form a series of contextual factors of the city as a social-ecological system that has adaptive features in the example of the water sector (complex resource regime). Table 8 Tools for creating linkages between different actors includes these features because they shape and are shaped by linkages between different actors in the system of local governance and other scalar entities (i.e. the regional authorities). Medellin has a relatively young local democracy, which in the context of Colombia emerged with changes to its constitution in the early 1990s (OECD 2013). Among different reforms, this granted substantial autonomy to the cities and to the mayors. This feature, along with the success of its public services company, EPM, contextualises a discussion for water governance in an urban context that wields considerable power at a local level in the governance of its utilities' services. At a regional level, the environmental authorities within the department of Antioquia wield power in governing the construction of substantial infrastructure that crosses multiple jurisdictions and monitors the

use of natural resources (transboundary). Taking these features into consideration is invaluable for understanding the political context surrounding the Medellin example of adaptive governance.

4.5 Summary of themes

Section 4.3 identifies policies and plans in the governance of water provision in Medellin in relation to a definition for adaptive governance. Section 4.4 examines mechanisms and tools in the system are in place to create opportunities for actors to engage, share knowledge and develop solutions. Together, these sections provide examples of what form features of adaptive governance in the Medellin case study take. The section(s) to follow, will discuss in more detail, four themes that emerge:

1) Integration of water policies, plans and infrastructure with other planning interventions at the city level (housing and education efforts),

2) Practical arrangements for governance with people in the construction, design and planning of public infrastructure (including water infrastructure,

3) Adherence to environmental, land-use and housing standards in planning at a national, regional and local level that are overseen by autonomous environmental authorities, and

4) community-based processes for engaging with formal institutions and forums for communities to engage in planning related to different societal needs in the city (utilities, mobility, health and education).

The subsequent sections discuss and refer to these themes. The subsequent chapters also examine the relationship between adaptive governance and its institutional arrangements, and the social contracts within the system. Based on findings from this chapter (Chapter 4), Chapters 5, 6 and 7 include an assumption that water governance in Medellin is strongly associated with adaptive governance.

4.5.1 Integration of water policies, plans and infrastructure with other planning interventions at the city level (housing and education efforts)

Empresas Públicas de Medellín manages the majority of new and existing water services and infrastructure and the environmental authorities oversee regulation at the regional level. The regional level and metropolitan area jurisdictions (ten municipalities including Medellin) ensure that implementation of the national level policies set by the Ministry of Environment,

Housing and Territory. At a city level, land-use and territorial zoning policies ensure water infrastructure (i.e. sanitation and water treatment facilities) is integrated with systems drawing from shared water sources (i.e. dams for hydroelectric power) and other policies for housing and social planning. Provision by a multi-utility which oversees water, solid waste and energy contributes to an institutional arrangement that shares commonalities with policy integration. There is evidence of a policy approach that integrates new and existing infrastructure. This integrated approach to planning takes into account environmental regulations, housing and land-use plans (*Planes Ordenamiento Territorial*), broader economic development plans for the city and plans for social infrastructure such as *El Sisben,* the national survey for determining subsidies is used to identify recipients eligible for the minimum vital (minimum amount of water).

This evidence suggests that at a policy design level, there is perceived integration by stakeholders of water with other systems level plans, programs and projects at a city level. This suggests that if the policy design is carried out as intended, implementation of services and infrastructure at a city level, and the integration of plans may be strongly associated with adaptive governance.

4.5.2 Practical arrangements for governance: the relationship between the city and the company

An emphasis on the relationship between the city of Medellin and EPM in the responses by speakers from every stakeholder group suggest that an understanding of this relationship is significant in considering the association between water governance in Medellin and adaptive governance. The evidence includes information on the city's ownership of the public services company. This is a form of integrating policy and implementation at a city level from a governance perspective. Evidence also includes how the city uses the 30% of the annual profits transferred from the company. This relationship enables support for stakeholder engagement. The relative autonomy of the company challenges the model for integrated governance, particularly evident in the company's capacity for developing new businesses (e.g. the city is limited in its decision-making on where the company invests abroad) however there seems to be a balance of sovereignty and autonomy of the company while at the same time it is integrated in particular areas (planning, financing for 30% of its profits).

This balance of both integrated governance and stakeholder collaboration may occur for several reasons and is discussed more fully in Chapter 8 (Section 8.2). The balance may be primarily due to the governance of the company itself, which includes a board of directors comprised of: the mayor, three representatives from the municipality, a representative from the regional government and five citizen representatives. The tenets of the agreement are also explicitly articulated as an institutional agreement with the municipality. While the extent to which this system could favour the interests of the elite is not supported or ruled out by evidence, nonetheless there is a continuity that this agreement affords despite elections every four years.

Interviews with all stakeholder groups highlight the relationship between the city and company. The governance of water (as an example of one form of utility provision) seems to be characterised by a continuity that the relationship between the city and public services' company sustains. Participants discuss a continuity offered by a board that is made up of different actors from within the city and a substantial agreement of where the state can and cannot intervene. Some possible questions that emerge from this include "what existing governance arrangements might enable continuity in the system to be adaptive?" and "what relationships between actors in the system would be suitable for this?" How can the relationship between different actors such as the public service provider and the local government be designed to enable this environment? This finding also raises questions as to whether the relationship between the city and the public services provider may be an integral part of this design. These questions will be discussed more fully in Chapter 8.

4.5.3 The role of the regional environmental autonomous authorities: ensuring adherence to environmental, land-use and housing requirements in planning

Perspectives from different stakeholder groups highlight the role of regional environmental autonomous authorities as an integral part of the system of governance. The evidence suggests that the environmental authorities wield considerable authority in translating national-level policies to the local municipalities and operate with autonomy concerning the regulation of water use in a particular area. They are a form of "bridging actor" (Folke 2006). They seemingly are a form of institutional infrastructure for bridging public, private and community-based water organisations (*acueductos communitarios*) who build and operate services across the regions as the authority for issuing and approving the construction of

projects, water use permits, monitoring and evaluating the quality of resources. Mainly from the perspective of the public service provider, the regional authorities (which include the metropolitan area and three other rural authorities), which serve as gatekeepers on a legislative front that authorise or prohibit projects proposed by companies such as EPM.

Taken into consideration with the relationship between the city and the company, a regional authority that bridges different actors seems to have a strong association with a process for managing cooperation.

4.5.4 The legacy and tradition of community-based, local level action

The Medellin case study provides evidence of a social and cultural context where community-based and civil society participation in the construction of a new future for the city was a necessity for survival and regeneration. Perspectives of individuals who worked in the municipality, metropolitan area and universities include references from each of the different actor groups to activities led by community-based groups for: developing the strategic plan for the city (Plan Estrategico de Medellin), interacting with the public service company, providing infrastructure outside of the formalised sector and providing a forum for voicing the concerns of citizens. Speakers also express that success that followed the transformation during the 2000s has brought challenges in sustaining a shared vision.

This evidence suggests that community-based approaches to solving urban challenges were integral during the transformation and in designing infrastructure with communities to meet their current and projected needs. The Medellin case has evidence that seemingly includes people as the foundation, much like hard infrastructure and institutional arrangements, as the governance infrastructure that has to strengthened and adapted over time. One example that is mentioned by participants, and was investigated further, that shows this is a community intervention that developed from the integrated urban initiatives is the Unidades de Vida Articulada or UVAs. UVAs were water tanks converted into public spaces for community use supported and financed by EPM. This example provides an example of how an approach called social urbanism integrated different stakeholder groups including the water system (Brand 2013). While EPM supports this project, the planning, design and management are managed by local organisations. Examples like the UVAs and the other examples in Figure 5 show evidence for integration that can be facilitated through different channels.

4.6 Recap of the main findings and questions

This chapter presents a summary of the central themes raised by speakers' discussion of water governance in Medellin, Colombia. There is evidence that the system of governance is consistent with features of an adaptive governance regime and acknowledges the social, cultural and historical context of the city. The outcome of 'adaptive governance' serves as a reference to the features presented in this chapter and also serve as a repository for contextual features that inform a broader landscape for water governance as part of an even more extensive complex social-ecological system.

This chapter compares the Medellin case study with a definition for adaptive governance and highlights themes or features of a definition of governing infrastructure that would account for different systems and an understanding of the needs of citizens, societies and cities of the future. This chapter explores these features in the case of Medellin, to establish a contextual example for adaptive governance. **Error! Reference source not found.** and Table 11 ummarise the various linkages between integrated plans and tools and governance interventions. With an understanding of how adaptive governance features in the Medellin case present a basis for further analysis of the characteristics of the regime, its arrangements and how actors relate to one another. Chapter 5 and Chapter 6 present characteristics of the regime and Chapter 7 examines the social contracts in response to the following questions:

2) What types of regime characteristics does this place have? In this example, to what extent does it confirm or challenge a polycentric form of governance? (Chapter 5 and Chapter 6)

3) What/how are the arrangements between the different stakeholders organised? To what extent do they confirm or challenge social contract agreements? (Chapter 7).

Findings from this chapter (4) and subsequent chapters aid in tackling the macro question of: **What can an adaptive governance lens offer for tackling governance related to cooperation in a complex resource regime using the example of the provision of water resources?**

Chapter 5 Characteristics of an adaptive system, a description of polycentric governance in the water sector in Medellin, Colombia

5.1 Summary of previous chapters and chapter overview

Chapter 4 presented evidence for the governance of water in Medellin having features consistent with an adaptive governance model. One of these features is the integration of water in planning for environmental, land-use and housing at a policy level and in planning activities that contribute to the implementation of efforts such as *Habilitacion Viviendas* and *Mejorimiento de Barrios as examples*. There are also contextual themes that inform an understanding of adaptive governance in the Medellin context: the balance of autonomy and integration of the utility, EPM and the city government, bridging actors such as the environmental authorities and a legacy of community-based and civil society-led action. These contextual themes from the data that contribute to an understanding of how the form of adaptive governance takes this in context, which contributes to a narrative of adaptive governance that makes visible features of a social-ecological system.

Positioning adaptive governance as an outcome, enables exploration of research Question 2 which asks "What are the regime characteristics of the Medellin model of water governance in an urban area that has features of adaptive governance?" Recalling the theoretical frame for adaptive governance, a system is likely to have features of diversity, network and polycentricity (Pahl-Wostl et al. 2012; Pahl-Wostl & Knieper 2014).[7] Chapter 2 presented a justification for why and how polycentricity can account for diversity and actors within the network (See Section 2.3).

Chapter 5 and Chapter 6 explore regime characteristics through testing to what extent the evidence demonstrates consistency with polycentric and monocentric forms of governance. This chapter, Chapter 5, compares the evidence with the definition and characteristics of polycentricism which includes identifying evidence for different authorities with overlapping jurisdictions and other characteristics such as knowledge sharing identified in the literature

[7] The theory for this relationship is presented in 2.3 and revisited in Figure 5 Chapter 3, which basically outlines an assumption that performance (adaptive governance) is associated with regime characteristics and attenuated by contextual features. Regime characteristics, namely polycentric ones, are considered for several reasons discussed in 2.3, to be most highly correlated with adapting to change

review (See 2.3). This chapter also highlights context-specific features of these characteristics in the Medellin governance model.

While polycentricism is associated with adaptive governance in complex resource regimes and is a characteristic for exploring how cooperation occurs within a social-ecological system, the thesis approaches this association with an awareness that a causal relationship between adaptive governance and polycentricity is not conclusive from this analysis alone. Nonetheless, a contextual understanding of how the different actors are arranged (Chapter 4) informs dialogue on a governance design that is associated with adaptive governance. The perspectives of different stakeholders contributes to this approach with an awareness that social and human involvement tend to dominate systems of complex resource regimes.

5.2 Overview of the definition used to determine polycentricism

The results demonstrate to what extent the Medellin case study, "the Medellin model," is consistent with a definition of polycentric governance.

This section will compare the evidence from the interviews with characteristics summarised from the definitions of polycentricism in the literature on adaptive governance and complex, socio-ecological systems using Table 1. Chapter 2, Section 2.3 introduces the basis for (See the definition(s) for polycentricism present in the literature summarised in Table 1. Overlapping themes in the different definitions were used to craft codes for identifying evidence in the data. See Section 3.1.6.2. Once coded, common features and characteristics expressed by different stakeholder groups were grouped and analysed according to common themes.

Using the definition of polycentricity put forth by Pahl-wostl as a guide ("Polycentric governance systems are defined here as complex, modular systems where differently sized governance units with different purposes, organizations and spatial locations interact to form together systems characterized by many degrees of freedom at different levels") and the primary and secondary characteristics from the review of the literature (See Table 1), this section presents evidence showing that this system is strongly associated with polycentricity. As Chapter 4 establishes strong evidence for this context as consistent with adaptive governance, returning to Pahl-Wostl's theoretical framing (which understands the performance outcome (adaptive governance) as associated with the governance regime and shaped by context, this section will examine the arrangement of the governance regime. In order to identify these arrangements, the following characteristics in Table 9 allocated as primary and secondary characteristics were used to identify evidence of polycentricism in the literature from the coded interviews.

Table 9 Characteristics for identifying polycentricism (abridged)

Characteristic	Range	Primary or Secondary
Number and arrangement of institutions	**Multiple scales** **Local** **Regional** **National**	**Primary**
Evidence for allocating capability and duties	**Yes** **No**	**Secondary**
Evidence for knowledge sharing	**Yes** **No**	**Primary**
Evidence for autonomy to cope with specific duties	**Yes** **No**	**Secondary**
Evidence for experimentation and learning?	**Yes** **No**	**Secondary**
Evidence for investment in new scientific information?	**Yes** **No**	**Secondary**
Evidence for horizontal and vertical modes of coordination?	**Yes** **No**	**Primary**
Evidence for allocating authority duties?	**Yes** **No**	**Primary**
Evidence of self-governing capacity?	**Yes** **No**	**Secondary**
Evidence for overlap and sharing of information?	**Yes** **No**	**Primary**

5.3 Overview of themes

Applying the definition from Table 1 to identify evidence of polycentricism this section (5.3) provides examples of polycentricism using the abridged guide for identifying evidence of primary and secondary characteristics as shown in Table 9 in evidence expressed by representatives from the stakeholder groups.

Table 14 includes statements that describe the type of interaction (for example a collaboration, a plan for implementation where a particular grouping of actors was involved). In some instances, there was a temporal dimension (either past, present or future).

This section will briefly summarise the findings which will be followed in 5.4 with a detailed description of themes by stakeholders group and in 5.5 with a detailed description of common themes:

1) The relationship between the city and the company

2) Environmental authorities

3) River recovery efforts

In the theme of the relationship between the "city and the company," most speakers describe the city and the company (2 actors) operating at a local scale through a series of institutional agreements and policies. Within each of these, there is evidence for allocating authority, knowledge sharing and overlapping authorities and duties. In the second theme related to the role of "environmental authorities," there is a discussion of collaborative efforts in the system at the local and regional level with two to four actors in collaborative planning in land-use policy and implementation activities. In these examples, there is a sharing of duties that are specific to one actor, which seems to characterise this form of polycentric authority. Finally, the theme of "river recovery efforts" includes at least two scales (local and regional) and a range of actors (from 2-10) which are involved in institutional agreements for monitoring water quality, water management planning and project implementation. In these examples, there is a discussion of allocating capabilities, specific duties, horizontal and vertical coordination alongside self-governing capacity.

5.4 Overview of findings by stakeholder group

Table 10 Characteristics of polycentricism grouped by themes

Theme	Quote, stakeholder group, ID number
1.City and the company	*"So EPM is 100% property of the citizens of Medellin, 100% property of the municipality and its profits, a percentage, about 30% of its benefits, goes to the mayor for social investment. So it supports the capacity of the city to solve problems. Not only to provide but also to develop social services and development. That is really really important and special and particular to Medellin."* - (Municipal authority, ID21) This quote is included as an example of polycentricity because it describes two actors (EPM and the municipality) which overlap in efforts to solve problems. Contextually, this quote is taken from a conversation related to the role of epm and the municipality during and after the transformation which included social innovation efforts by the city and epm. *"There are two things: EPM is of the municipality of Medellin, period, right? And is always presented as a successful company – and it is not possible to deny that in many ways – people from Medellin have a lot of their identity, meaning of their identity, of appropriation with their company because it is a paisa company, Antioquian, successful, right? So the people that do not suffer, that have nothing to suffer for…that have no trouble paying their bill, it's easy, they identify EPM as a municipal company of great pride… And that is also dependent on the level of information the people have, it is the issue of the relationship with EPM – Municipal Administration because technically EPM is a company of the municipal administration and so."* - (Water user organisation, ID3) This quote is included as it reflects the speaker's understanding of EPM as "of the municipality." While epm is the property of the municipality, it has overlapping areas of work that is consistent with primary characteristics of polycentricity. EPM is a public company however the literature (Furlong, 2013), describes it as a corporate entity as its governing body is independent from the municipality with regards to decision-making about corporate expansion. Because of this distinction, at times it behaves like a separate entity.

2.Role of Environmental authorities	*"Yes when you [company, community or other institution] have a project, you have to present the project to several authorities, the regulatory, municipal authorities of the place you are looking at. Depending on the size of the project, you may have to go to the ministry. Not even, foreign projects you have to go to the planning...what is it called...energy and planning mining unit that will give you the permissions to engage in the project and you also have to talk to the environmental authorities, you could get your environmental license and also your water usage permits.", small skill projects are dealt by the environmental authorities…large projects…at the national level –Universities, ID14)* This quote is included as it provides an example of a polycentric arrangement of four actors across three different scales (local, regional and national) that oversee the permissions and enforce regulatory aspects of project approval. The primary characteristics of multiple actors across scales and the secondary characteristic of allocating specific duties is taken into account. *"We [metropolitan area] for…for example for the subject of the plans, the Plan de Ordenamiento of the river, the management plan of the aquifer and the rest, we are working jointly with the other environmental authorities that have seats here in this territory, it's worth saying Corantioquia and Cornare. For them, with the support of the ministry, here in our country, the Environment…" - (Environmental authorities, planning, ID15)* This quote from the environmental authority is included because it showcases a polycentric arrangement of four actors (environmental authority for the urban area, two regional ones (Corantioquia and Cornare), and the national environmental ministry) which work jointly in delivering the POT. Further details (drawn by the speaker and through desk research) show that there is overlap of authority and sharing of responsibility through contributions to the POT that each body contributes separately. This requires both horizontal (among environmental authorities) coordination and vertical coordination (with the ministry).

3.River recovery efforts	*"For these two entities [epm, metropolitan area] the agreement has their functions and interests, we are interested in working together, for example, for the protection of the watershed supply, for the implementation of sanitation solutions, for subjects of environmental protection. And they [epm] began to shape agreements for each of those subjects, depending on the interests that each may have. There are other ways of interacting that are more like guidelines. For example, like we were saying, by law legislation plans, the action and management of the watersheds are those that tell me what I can do in a specific basin. For the development and updating of those legislation plans for the watershed shape these "Consejos de Cuenca" (Watershed Councils). Those "Concejos de Cuenca" are composed by different institutions…" {Service provider, ID13)* This quote is included because it is describing the way in which these two actors – the metorpolita area and epm – interact with regard to the protection of the watershed supply. The quote provides information consistent with a polycentric arrangement (multiple actors, different scales and horizontal coordination), yet is also reflective of secondary characteristics such as allocating capabilities (the management plans that dictate what each entity is responsible for). The watershed councils (Concejos de Cuenca), which include several actors, are shaped and composed by different institutions that have autonomy to cope with specific duties. *"And there are agreements, in other words, in AMVA there are agreements with the municipality, the AMVA and us [epm] have agreements. There is a large agreement in this moment that is many different municipalities of the Área Metropolitana, us (EPM), Área Metropolitana and obviously us, including the Metro de Medellin, the company of the Metro that is called Nuestro Río, and within the framework of that agreement, the idea is to implement actions that serve all that has to do with the recovery of the Medellin river." – (Service provider, ID13)* This quote is included as it refers to Nuestro Rio (which was also referred to in Chapter 4) which is a multi-actor, multi-scalar organisation that contributes to the protection of the river. Because the river crosses municipal boundaries, the municipalities that comprise Nuestro Rio have interests in access to a source that may be from another boundary. This is an example of a transboundary water issue which is where a group like Nuestro Rio offers a forum for coordinating (horizontally and vertically) and sharing information and activities that overlap with respective work by each municipality. *Rio 2030 – Sociedad parques del Rio [multi-stakeholder company formed to deal transform the river into city*

	parks] And you can look at the 9 municipalities here with urban projects on the river...and that is not new...and the government of Alonso Salazar in 2008 made an agreement with the private sector to make an APB concession to build the river parks...they did not succeed, and so they developed the plan Rio 2030, Director Metropolitan plan, that plan [land-use plan] is like that...legal agreements that require the municipalities to develop their POTs. Rio 2030 was approved, 48 hours before the last election. When Mayor Gaviria was elected. And the main factor of Rio [Rio2030] was the transformation of the river. – (Municipal authority, ID21) This quote is included here because it provides an example of an integrated development program that includes 7 actors (within the multi-stakeholder company) that also includes the 9 different municipalities in a joint project to develop and care for the area around the river. As an example of a polycentric governance arrangement – it provides evidence of primary characteristics like overlapping jurisdictions (the different municipalities have overlapping boundaries with respect to where there water sources originate) and are involved in complex horizontal and coordination with the different actors in the company. *"So, we [environmental authority, AMVA] signed an agreement with Empresas Publicas de Medellin, Alcaldia de Medellin, the government of Antioquia, the Metro of Medellin, the Metropolitan Area, Corantioquia, Cornare, all that are concerned to join efforts in such a way that all the resources of the various entities can focus, to say so, in a single bag and to invest jointly in the recovery of the river and its major streams. In other words, it seems to me very significant (…) in an important platform for the management of the resource, the protection, the conservation is very important." – (Environmental authority, ID15)* This quote is also included here (in connection with the previous). It is presented separately as an example of polycentric governance as the speaker is describing here how the various actors invest jointly in the company which is a form of overlapping interests and horizontal and vertical coordination.

5.5 Thematic areas and other characteristics

Before describing each theme, a note on the temporal dimension of themes is included to frame the findings within the context of a change of over time. The temporal dimension was a feature emphasised by speakers, particularly in reflections by the speakers on aspects of the system that were and are changing (as they are captured here as a snapshot by speakers at the specific moment in time. For Medellin, rapid change characterises the transformation it underwent from the 1990s until now, with a time frame from 2000 to present (See Section 3.1.2 for more information). While the changes do not have the severity that characterised the transformation in the 1990s and early 2000s, there is an awareness in the perspectives of speakers from the different stakeholder groups of changes over time (demographic shifts, conflict-related migration, migration-related and changing age-distribution) that contributes to an understanding of this system of adaptive governance as a dynamic social-ecological system.

With an understanding of this temporal dimension, the previous quotes and the reflections to follow provide an image of Medellin as having features of a polycentric system, shown by a combination of primary and secondary characteristics. The following reflections will delve further into a selection of quotes to show the variety of scenarios, or realities, where an example of a polycentric arrangement occurs. The final summary will conclude that these regime characteristics, like the actors that comprise them, can take on different arrangements. These institutional arrangements come in different forms of planning, policies and implementation and awareness of this diversity provides a deeper understanding of how polycentricism features in a system and where perspectives from speakers present fuzzy interpretations or multiple realities that appear contradictory. For example, in Table 10, “1. City and company,” a speaker describes the relationship between two institutions, the municipality and EPM, in which there are overlapping jurisdictions and responsibilities, yet while epm is 100% public, there are times where its responsibilities cast it in a light where it is described as a separate entity. The presence of both overlapping jurisdictions and separate spheres is an example of an arrangement that has different forms or scenarios. Sections 5.5.1-5.5.3 discusses these themes, and seemingly contradictory realities, in more detail, by highlighting where a diversity of scenarios occurs within a single theme and present similarities and differences expressed by the different stakeholder groups.

5.5.1 City and the company

In descriptions of the relationships between the city and the company consistent with polycentric governance, representatives from all stakeholder groups presented in "Table 3 Characteristics of polycentricism grouped by themes" refer to the municipality and EPM as distinct groups involved in decision-making, planning and implementation. Consistent with the definition of polycentricity, these examples show overlap in jurisdictions and where shared responsibility is strongest. In most examples, stakeholders discuss how these two groups both shape, and are shaped by, one another. The municipality is the owner. In one case, a representatives from the municipal authority describes this overlap in jurisdiction in transfers of funds by and within the company to the municipality for social investment:

> *"So EPM is 100% property of the citizens of Medellin, 100% property of the municipality, and its profits, a percentage, about 30% of its benefits, goes to the mayor for social investment." - municipal authority, ID21"*

This quote is an example of how the speaker perceives epm, which is the property of the city, however the institutional arrangement, or "agreement" as described by the speaker, does make a distinction institutionally between the city and the company. With an understanding of this agreement, a public company owned by the city, can be understood as two separate actors. The manner in which the two groups cooperate provide an understanding of how a polycentric arrangement operates in this context:

> *"Look, the mayor is the managing director. Institutionally in the company there is like an agreement – I do not remember what it is called – but it is like an agreement, let's say, like the governability of the company. So, in that agreement of governability, it is like rule of the game between the mayor and the company as such right?" - Service provider, ID11*

Speakers from different stakeholder groups refer to the municipality and EPM as involved jointly in decision-making, planning and implementation as well as separately. The municipality is the owner, however in terms of financial power and oversight over its business, EPM exercises a degree of autonomy, which characterises the polycentric arrangement within this context. This autonomy is written in specific guidelines: Section 5.5.1, Figure 9 to ensure that the municipality does not interact with the company except through the board, does not intervene in EPM's contracting processes or other aspects of its financial planning and

management. The agreement stipulates that the City agrees to "appoint no less than 5 independent directors."

Figure 8 Corporate governance of epm (examples from agreement between the City and the company) Supplementary material from ID1, (EPM, 2016)

Speakers from representatives of the public utility (EPM), universities, municipal authority and water user organisations also discuss the subsidiaries of EPM as part of the autonomous character of the organisation. This form of corporate governance gives the utility company autonomy over decision-making apparatus. Speakers discuss this particularly with respect to diversification and expansion of the company globally. Grupo EPM is coded as a multi-group authority. The internationalisation of EPM (2010) includes features of its influence as a majority shareholder in its subsidiary companies:

> *"EPM and its subsidiary companies: Because EPM makes, creates subregional companies big companies that include several municipalities where it is the majority shareholder. So, under the frame of Grupo EPM it ends up being the majority shareholder of these companies…an expansion that goes not at a national level, but at*

a transnational level: EPM already has businesses in Spain, the United States, in Mexico, in Ecuador, in Chile." - Water user association, ID3

5.5.2 The role of environmental authorities

The second theme that emerges in the data which shows evidence of the governance regime having characteristics of polycentricism refers relates to the role of the environmental authorities. Primary characteristics (multiple actors with overlapping jurisdictions, knowledge sharing and horizontal and vertical cooperation across scales) were used to identify potential evidence of polycentric. Secondary characteristics such as allocating responsibilities or allocation of specific duties contribute to the contextual understanding of how polycentric governance operates in practice. As shown in Section 5.4, Table 10, representatives from different stakeholder groups discuss the role of environmental authorities with multiple scales of governance taken into consideration (local, regional and national) with at least 2 actors involved. Most groups (service provider, universities and environmental authorities) discuss the role of the environmental authorities (referring to the three autonomous environmental authorities with overlapping jurisdictions) in decision-making for water-use permits, plans (land-use plans in particular) and water quality monitoring activities. There are examples where an overlap of responsibilities and sharing of duties, operates in concert with specific duties within the remit of the environmental authority. Overlap and sharing of information is a feature of the planning process in the example of the management plan for the aquifer that the metropolitan area oversees with input from the other environmental authorities and the national level:

> *"We [metropolitan area] for…for example for the subject of the plans, the Plan de Ordenamiento of the river, the management plan of the aquifer and the rest, we are working jointly with the other environmental authorities that have seats here in this territory, it's worth saying Corantioquia and Cornare. For them, with the support of the ministry, here in our country, the Environment." -* Environmental authorities, ID15

In contrast with joint planning with the other environmental authorities, there are other examples of different scales of authority in decision-making for projects. For small, medium-sized infrastructure projects, local and regional level authorities issue water use permits. For large projects, the national level environmental authority has self-governing capacity and autonomy to authorise water usage permits:

> *"Yes when you [company, community or other institution] have a project, you have to present the project to several authorities, the regulatory, municipal authorities of the place you are looking at. Depending on the project size and scale, you may have to go to the ministry. Not even, foreign projects you have to go to the planning...what is it called...energy and planning mining unit that will give you the permissions to engage in the project and you also have to talk to the environmental authorities, you could get your environmental license and also your water usage permits, small skill projects are dealt by the environmental authorities…large projects…at the national level."* – (Universities, ID14)

The environmental authorities, as found in Chapter 4, oversee land-use and spatial planning at a regional and metropolitan level. This is an attribute of planning in the city of Medellin, which is part of the metropolitan area whose boundaries are in near constant change and flux as informal settlements grow on the periphery. The environmental authorities oversee the use of the Medellin River which covers several jurisdictions outside of the metropolitan area. They are also aware that EPM-Medellin draws upon resources outside of their area and there is some evidence (Section 4.1.9) that the push for integrating services is related to a desire to control and maintain access to water by epm as a single authority over these resources. The existence of many authorities creates a balance, yet there is evidence from speakers from stakeholder groups such as the public utility and municipality where environmental authorities are described as having separate spheres and wield considerable decision-making authority as a single authority in their jurisdictions, as shown in the example of where environmental authorities have decision-making authority for water use permits and collectively as a group of regional authorities for issues such as transboundary water basins (Table 10 2. Environmental Authorities). In the example of transboundary water basins, overlapping authorities and jurisdictions require the participation of different regional authorities. Overall, where the environmental authorities feature in descriptions related to polycentric governance described, this is often as a convening authority for larger multi-stakeholder initiatives.

5.5.3 River recovery efforts

The third theme where there is strong evidence for polycentricism is in efforts to recover the river in Section 5.4, Table 10, 3. Several groups (service provider, universities, municipal authorities and the environmental authority), discuss efforts to recover the river in a way that shows there are several institutions involved with overlapping jurisdictions. These river recovery efforts take place in the context of institutional agreements, planning and

implementation activities. These typically include at least two scales (local and regional) and as many as ten different actors. River recovery activities tend to require more capacity than organisations may have, and while many would not take on the responsibility, even if shared, the risk of not having the resource is great enough for groups to invest time in these efforts to recover and protect the river.

Characteristics of polycentricism such as evidence that is more aligned with an interpretation of polycentricity as including evidence of information sharing within an arrangement where horizontal and vertical coordination takes place in joint investments in recovery efforts:

> *"So, we [environmental authority, AMVA] signed an agreement with Empresas Publicas de Medellin, Alcaldia de Medellin, the government of Antioquia, the Metro of Medellin, the Metropolitan Area, Corantioquia, Cornare, all that are concerned to join efforts in such a way that all the resources of the various entities can focus, to say so, in a single bag and to invest jointly in the recovery of the river and its major streams. In other words, it seems to me very significant (…) in an important platform for the management of the resource, the protection, the conservation is very important."* – Environmental authority, implementation, ID15

Several representatives discuss efforts to recover the river in a manner that is consistent with having polycentric approaches to plans, policies and implementation at local level.

5.5.6 Summary of findings

In the presentation of the themes of the 1. city and the company, 2. the environmental authorities" and the 3. river recovery efforts, there were scenarios in which institutional agreements, policies, plans and collaborative efforts featured characteristics of the definition for polycentricism that also included secondary characteristics where stakeholders, in addition to primary characteristics (insert cross-reference) show examples of allocation of authority and specific duties. In some examples, such as epm's decision-making around expanding its business, speakers describe the company as having autonomy in decision-making from the municipality as well integrated cooperation when it comes to social investment. Other examples of more autonomous characteristics include the muncipality's autonomous decision-making on how to invest the 30% profits from epm in the city. Another example of autonomous decision-making includes the environmental authorities' as a collective (Corantioquia, Cornare, AMVA) in issuing water use permits. Each of these examples includes the primary polycentric characteristics of at least two actors, with a

description of the allocation of responsibilities. In some examples, there is an overlap of authorities. For the relationship between the "city and the company," there are two actors operating at a local scale. There is strong evidence for allocating authority, knowledge sharing and overlap of authority in specific institutional agreements and policies. In these examples where speakers emphasise autonomy, there is evidence suggesting overlapping authorities and sharing of duties (for example for the group of autonomous environmental authorities), yet there are also specific duties that only one organisation (a single environmental authority for a given jurisdiction) that will oversee water use permits. In the second theme, environmental authority, there is a discussion of a single actor such as the metropolitan area engaging in efforts to collaborate in planning and implementation of plans to manage the aquifers that are overseen jointly by several different environmental authorities. This evidence of autonomy and integrated approaches also features in the third theme of "river recovery efforts." There is a scenario consistent with features of polycentricism where there are at least 2-3 scales (local, regional and national) and upwards of 10 different actors engaged in efforts to recover and improve the quality of the river. There is evidence of a lead organisation allocating capability and specific duties to organisations that self-governing capacity within integrated institutional agreements, planning and implementation.

The governance of water in Medellin appears to have strong associations with polycentricism with at least two actors operating at local and regional scales in planning and implementation primarily through institutional agreements, planning and implementation activities. The governance regime in this context which demonstrates features of polycentricity includes examples that are consistent with greater autonomy (for example epm and decision-making overseas, the municipality and investments in social programs, environmental authorities and water permits) to greater integration based on the level of governance of the different actors. For governance of the water system at a city level, a delegation of responsibilities and agreements between the municipality and EPM is associated with greater autonomy to the city and the company in policy and business expansion respectively. This is in contrast with greater integration when speakers reference policies and plans for the city that are created jointly at a regional level. This is the case concerning land-use planning with particular attention to the role of environmental authorities and combined activities to recover the river.

In understanding the characteristics of the governance regime in the Medellin context which is associated with the performance outcome (adaptive governance), this section will conclude with a brief note on contextual features that emerged from the data which is consistent with Pahl-Wostl's conceptual framework (Figure 5).

There are several themes referenced by at least one actor group that provide insights on other actors in the broader system of water and sanitation provision. These are actors that may not have direct authority in the system of water governance, yet contribute to the context for adaptive governance in Medellin, which has other actors in addition to the leading ones. CBOs and water user organisations discuss community-based strategies and networks for providing services and resources such as water via community-based water user associations. Some of these actors have a mandate for water provision (such as the civil society organisation, Penca da Sabila) while others work on water issues in the context of broader social, environmental and economic issues (La Mesa Interbarrial de los Desconnectados). Speakers from universities also highlight the role of non-state actors such as illegal groups, though more information is needed. Another non-state actor that speakers from universities discuss is business associations such as the Grupo Empresarial Antioqueno (GEA) that have an indirect impact on governance with representation on boards of all public institutions.

These results show to what extent this governance system is consistent with a view of polycentricism. The interviews also yield information that shows a polycentric view of governance, but also describes the arrangements of actors at different levels and in which scenarios there is evidence of polycentricism which contributes to a view that the system has several examples of polycentricism occurring in particular scenarios at any given time.

There is also evidence where speakers describe the system as challenging a purely polycentric governance design. Examples, such as the city and the company, have features consistent with monocentric characteristics or nested forms of governance (See Chapter 2, 2.3). These examples are discussed further in Chapter 6. While inclusion of monocentric and nested forms of governance renders a polycentric view more complicated, the combination of both polycentric and monocentric governance suggests an overall polycentric system with multiple authorities with overlapping jurisdictions, yet there are combinations of arrangements (polycentric, monocentric and/or nested) and different scenarios (plan, policy or project) that

may contribute to a complex, unique understanding of governance design in the Medellin context.

Chapter 6 Characteristics of an adaptive system - monocentric governance and other forms of nested governance within a polycentric system

6.1 Summary of previous chapters and chapter overview

Chapter 4 presents evidence for the Medellin case study's consistency with adaptive governance. Using evidence of adaptive governance as an outcome and an assumption, Chapter 5 establishes the Medellin case study as having characteristics of a polycentric system and describes the scenarios in which these regime characteristics occur. The chapter concludes with a summary of the different themes where polycentric governance is most present: the relationship between the city and company at a local level, the role of autonomous environmental authorities as a collective and river recovery efforts.

The end of Chapter 5 also acknowledges where are features of monocentric governing arrangements (Termeer et al. 2010) present in the data. In some examples, representatives of a stakeholder group describe a governing arrangement as being polycentric which when described by a representative from another stakeholder, may present a different perception of reality. In the latter, we observe perceptions of governance arrangements as having consistency with monocentric governing arrangements. This occurs frequently in descriptions of the relationship between the city and the public utility. Chapter 4 and 5 show where this relationship is a public model (Chapter 4) and how it is consistent with a polycentric governance structure. This chapter, Chapter 6, features descriptions of when and how these arrangements arise in the interview data. For this chapter, monocentricity is identifiable in descriptions of single authorities where there are specific jurisdictional characteristics, hierarchies of constitutions and laws, levels of engagement and linkages between general and specific knowledge (knowledge scale) (Termeer et al. 2010). The section presents evidence of decision-making held by one group or authority, its features and should be interpreted In light of the examples of polycentricity previously described.

6.2 Overview of the themes

Representatives from stakeholder groups provide perspectives of the system of local water governance that are consistent with the definition and characteristics of monocentricism. These perspectives share commonality with themes presented in Chapter 5, Sections 5.5.1-5.5.3 (city and the company, environmental authorities, river recovery projects) and different themes that emerge exclusively to evidence coded as "single" authority or "monocentric."

These include themes such as “multi-level governance” and “decentralised authority.” Monocentric governance is dominant when participants discuss the role of the national government and regional authorities. Themes in association with a level of governance and transfers of authority feature mainly in relation to procedural elements of policy and institutional allocation of roles.

Speakers also describe scenarios of nested governance, which refers to the situation in which one institution is set within another and arranged in a hierarchy (Rammel et al. 2007; Ostrom 2007). For the theme related to the city and the company, discussions refer exclusively to the institutional agreement between EPM and the municipality. There are frequent features expressed by all stakeholder groups such as this relationship having two actors (the city and the company) operating at the local level. While these perceptions appear contradictory, in light of the constructivist view of multiple realities (Chapter 3, 3.2.1), acknowledging them in this chapter is included as the different perspectives may inform how cooperation is perceived, understood and potentially enacted. Some stakeholder groups highlight that the utility company is nested within the municipality and others highlight features of the company, such as its decision-making for overseas investments that are external to the municipality. In the examples that will be presented in this chapter, there will be illustrations of where the evidence is consistent with monocentric governance.

Other nested forms of governance include an organisation that is nested within a plan or policy which is suggested in descriptions by representatives from different stakeholder groups in relation to the environmental authority. For this chapter, monocentricity is identifiable in descriptions of single authorities where there are specific jurisdictional characteristics, hierarchies of constitutions and laws, levels of engagement and linkages between general and specific knowledge (Termeer et al. 2010). An indication of monocentric governance could occur for example within the context of a select committee that emerges from an institutional agreement that assigns roles in a hierarchal manner. These include 1 actor who receives authority in a mandate (decentralised from a higher authority). In these examples, there are still characteristics consistent with polycentricism such as allocation of specific duties, authority and self-governing capacity feature, yet at a local level seems to have a stronger association with monocentricism (single authority) and nested forms of governance. This is

an example of a complex arrangement that has features of polycentrism as well as monocentricism where authority is devolved or delegated to others.

In the example of river recovery projects, there are examples where speakers indicate a single authority. Examples include initiatives such as an organisation with a mandate for overseeing new scientific information. This includes a form of an institutional agreement for a single authority at the local scale where speakers describe a specific duty and self-governing capacity.

While the parameters of the study participants are limited to governance in the city, there are references to monocentric governance in discussions of multi-level governance. Examples of multi-level governance that are relevant at the local level include policies and plans that are decentralised from the national government. This includes evidence where single authorities have assigned roles that refer to different levels of governance. These roles are associated with how services and efforts are conducted at the city level.

Participants reference the national level of governance (which was beyond the scope of analysis regarding interviews from relevant national stakeholders) for this study. However, where these references have implications for understanding local level governance, they are included to the extent that they inform a sophisticated understanding of governance in the city. These examples include information for institutions whose set roles, duties and remit within the city are devolved from a national ministerial level. An example of devolution of authority to the local level includes the establishment of local governance institutions which implement national guidance for public services, environmental standards and land-use codes. Another example of devolution of authority occurs similarly at the regional level, where procedures feature in the form of institutional agreements which allocate capabilities and specific duties to the municipal government. While some of these devolved arrangements include horisontal and vertical levels of coordination, they are classified as monocentric because they contain a single authority with limited overlap or sharing of authority.

A full list of examples where these themes feature is included in Section 6.2, Table 11 which includes descriptions of the type of interactions, or scenarios in which these themes occur and features that are consistent with a definition for monocentric or other forms of nested governance.

Table 11 Monocentricism and other forms of nested governance

Theme	Quote, policy-making, stakeholder group, ID number
1.City and the company	*"So if, if they speak a lot about the vision. One important thing is that we [epm] are a decentralized company but we are in other words, our owner is the municipality of Medellin, we are a public company."– {Service provider, policy arrangement, ID13}* This quote is included as an example of monocentric governance because it involves a single authority (the municipality) in relation to the service provider (epm) in a hierarchal setting (as the owner) where decentralisation has engineered levels of engagement. *EEPM and the government: I think EPM and the government has to work together because they have....shared resources...it is moving between them. EPM is giving and then receiving to reinvest so it has to work together and sometimes it is also because it is a public company…the leaders are from the government, and they elect the one to lead EPM for 4 years so it is together."* - Service provider, ID24 This quote is similar in that it describes the arrangement between epm and the municipality in a way that is consistent with monocentric governance in that it is a single authority (the municipal government) that is hierarchical (with the leadership from the government). There is also some tension in this quote as there is a single authority with a jurisdiction, the sharing of resources presents some contradictory information that appears more consistent with the polycentric "overlapping jurisdictions" showcased in Chapter 5. *"Profits go back to the city. So one of the reasons Medellin is the city that it is is because [of] EPM, it's a lot of money and what they do is they reinvest it in the city...so the relationship with the city...they kind of depend on them."* – Universities, ID14 This quote is included as it also shows features consistent with monocentric governance with the city as the single authority (the City) wherein EPM depends on them (hierarchical) in decisions about how they reinvest. *"They are completely different. EPM is a public company looking for profit. Being owned by the municipality, they can do profit in a non-just [for] profit way. Being a public company and being owned by the municipality - it's working really well…but as EPM does...the EPM mayor...it was designed...the CEO was designed by the mayor, the CEO does what the mayor tells me [him] in this case."* Universities, ID14 *This quote is included as an example that is consisted with monocentric governance as the single authority (the municipality) that owns epm (hierarchical) with the levels of engagement between the CEO and the mayor being nested. Even though the profit-driven component of epm is governed differently (separately from the mayor as in Chapter 5) than the reinvested funds, 'doing profit in a non-just profit way' is directed by the municipality.*

Theme	Quote, policy-making, stakeholder group, ID number
	"The municipality...they are thinking more, they [epm as the property of the municipality] are service provider and a cash machine. The environmental authorities, they are just following the national regulation."- Universities, ID14 *"And EPM being a company, it is creating profit and giving lots of money to the city."* -Universities, ID14 *"being a public company and being owned by the municipality - it's working really well…"*- Universities, ID14 These three quotes are firm affirmations of the single authority of the municipality in relation to its property, epm (hierarchical relationship). *…the power of the mayor of Medellin is really important because it is 100% legal owner. And EPM is a group that provides services in Bogota, Bucaramanga, Cali, everywhere in Colombia, in most of Colombia."*- Municipal Authority, ID21 This quote is included because it affirms, from the perspective of the municipality that the power (authority) is singular (mayor) which is the 100% legal owner (hierarchical in nature). *"And if you analyse the history of EPM, founded in 1957 like a company 100% public in Medellin, and had not known the 1970s have various programs for "Habilitacion de Viviendas", in other words, delivered precisely those services to the neighbourhoods of the common people."* – water user association, ID3 This quote provided by a representative is consistent with epm as the property of the city (single authority) which oversaw the delivery of services to people (hierarchical relationship). *"There are two things: EPM is of the municipality of Medellin, period, right? And is always presented as a successful company – and it is not possible to deny that in many ways – people from Medellin have a lot of their identity, meaning of their identity, of appropriation with their company because it is a paisa company, Antioquian, successful, right? So the people that do not suffer, that have nothing to suffer for…that have no trouble paying their bill, it's easy, they identify EPM as a municipal company of great pride."* – water user association, ID5 This quote from another representative from the water user association's stakeholder category presents epm as the property (hierarchical relationship) of the municipality (single authority), yet casts this in relation to the people of Medellin as the municipality, as it represents them. *"Because EPM was like a "benefactor company", even when it started in the 60s to implement a plan, a project called "Habilitacion de Vivienda", and was bringing public services to the neighbourhoods…-water user association,ID5* When this speaker describes epm as a "benefactor company" follow revealed that by benefactor company, is that it was intended to provide

Theme	Quote, policy-making, stakeholder group, ID number
	resources to the municipality (single authority) as well as services (hierarchical). *EEPM was contradicting the municipalitiy's policies, functioned like a benefactor company owned by the city of Medellin and bringing services. So, how did the philosophy of the company change from a benefactor company to a corporate company? Since the Law 142. So, because it already opened the market, already not dependent only… - like [ID5] was just saying – it was a company that was only concerned with urban issues, the company of Medellin, already engaged in establishing businesses internationally by neglecting the urban issues, because of the citizens compete here in Medellin."*- water user association, ID5 This quote speaks to an understanding of the municipality as a single authority over epm as a benefactor, however, the speaker is also describing a shift (current) of epm towards a corporate one. This corporate shift has not changed the explicit ownership, however may suggest that authority is not as singular as is presented by other speakers in this thematic area.
2.Environmental authorities	*"Environmental authorities (plural) "ordering and managing the watersheds...uses of the watershed…programs…users of the resource because we need to supply the city…permits…water concessions…if any user infringes…they have the power to sanction."* -Service provider, ID13 With respect to the power to sanction, the environmental authorities' are a singular authority and oversee the uses of the watersheds through legislation (hierarchies of laws) within their remit (jurisdiction) for issuing water permits and sanctioning. *"But they say we can give you the water in the river but we have to keep some flowing to continue either other users downstream or just the biological, ecologicial stream that has to be maintained so when you ask for permission they actually, you have to present your studies and they actually grant you the water usage for some years, some years, maybe 20/30 years and you have to pay for the use of water. Water is free but you have to pay for…[it]"*- Universities, ID14 Similarly to the previous quote, this speaker is describing the water permits (for a specific jurisdiction) issued by the environmental authority which is a single authority that operates in a hierarchical manner in relation to users who apply to use water. *"But anyway, we have your structure, you transport it, take it to the power house and then back to the river. The impact is that this section of the river has a lower flow than it usually has. That is what the environmental authority looks at. They look that you do not have, that you are not interfering with any users in this area. But if for some reason, you don't put the water to the river, and for instance to another river, you get an additional payment."*-Universities, ID14 This quote, similar to the one by the service provider regarding sanctioning is also describing this specific jurisdiction (for water permits) where the environmental authority (single authority) has the power to sanction by law (hierarchal institutional scale)

Theme	Quote, policy-making, stakeholder group, ID number
4.Policies and plans at the national level	*"Because regulation, we have a national regulation for each sector. For example, we have a regulation for water – Committee for Water and Sanitation (Commite por l'agua potable y sanemiento)…like a water and sanitation commission and those are for the economic regulation of the service – tariff, structure and establish how much we can charge people."* – service provider, ID1 *"Here there are other water regulators. There is one called the CRA that is the La Comision Regulatoria de Acueducto, Alcantarillado y Aseo – waste is that of the garbage. Yes? But you are interested in these two. This CRA also regulates tariffs and also regulates, let's say legality."- service provider, ID11* *"The regulatory commission of potable water and basic sanitation that corresponds to the tariff regulation of water companies, sanitation and cleaning.- service provider,ID9* *"In the regulatory commission they normally give clarification for the application of tariffs, what they are going to charge the user." – service provider, ID9* These quotes included here are examples of monocentric governing arrangement across scales (national to local) with the CRA (single authority) as the single authority for regulating the prices for water for the whole of the countries regions and municipalities (hierarchical institutional scale) for a specific duty (tariffs). *"Financing for large infrastructure: I want to develop the infrastructure for this city – it is by their own money. But you want to develop for this side, or any one of those, the minister of Environmental, Housing, City and Territory is the minister who pays the money to develop.*- service provider, *ID2* *And they contract all the building, all the project. They build it, they begin to operate and improve it and give it back to the municipality. Not to the enterprise. Aguas de Uraba…investment fund: Cito, Espina, Cali, That is a fund…Intervenias…a big fund with a lot of money. They get the control of the companies and they invest a lot of money. And not much changes, but you can't say that."*- service provider, ID2 With respect of financing for large infrastructure, there is a single authority (environmental ministry) at a national level who authorises projects and pays for them. In this respect, this is an example of monocentric governance within the remit of financing for large infrastructure projects across regions and municipalities. *"National department of planning: It's different. It's for "Sisben." It is a survey. It is a well-defined survey – created by the National Department for Planning – and this survey defines families that are considered to be at high risk, and those families that are at high risk they give them support in the for education, living together, to find work, health. And between those programs there is the minimum vital of water. So, they analyse the number of people that live in a house and they give them an allocation of 2.5 cubic meters per month per person."*-service provider, ID9

Theme	Quote, policy-making, stakeholder group, ID number
	This description of El Sisben, the national planning survey led by the Department of Planning is included here (as also in Chapter 4) as it provides an example of a hierarchical institutional scale for governing the provision of subsidies. It is led by the planning office (single authority) and oversees the implementation of the minimum vital in a top-down (hierarchical institutional scale). *"National level legislation: For that we are proposing a law at the national level because the change that is needed is structure, right? You can change at the local level, not in Medellin because EPM is…"- water user associations, ID5* This quote is taken from a discussion by a representative from the water user association who is describing the need for change in the law (a specific institutional scale) regarding provision by water user groups. It is the national government which is the single authority and dictates (hierarchical institutional arrangement) by law, how service provision is undertaken. *The following quote echoes this same perception of the governing arrangement pointing out that the space for acueductos to exist is dictate by the Constitution (which is an institutional scale) that operates, in effect, through a hierarchy.* *"On [the] one hand, with the Constitution of 91, they are allowed to legally say that the community organizations provide the service – already that was from the 60s, 70s – but the Constitution says that it is the [legal] capacity: public companies, private operators and community organizations. They are the three entities that can provide public services in Colombia, right? So, we say that it is the space that allows the acueductos to exist. But from the law 142 of 1992…94. - water user associations, ID5*

6.3 Thematic areas and other characteristics

6.3.1 City and the company

For the theme related to the city and the company, the discussions present interpretations of the institutional agreement between EPM and the municipality as consistent with monocentric governance. Where evidence was found indicating single authorities governing a specific jurisdiction or area of work (tariffs) in a hierarchical manner, and in some circumstances, across multiple scales, it is presented here. Its description suggests these two actors are operating at the local level. However, each is nested within the other. The institutional agreement between the two entities is a form of authority allocation, overlap and sharing of information and evidence of horisontal coordination.

For the relationship between the city and the company, some speakers discuss arrangements for how the company interacts with the city that is consistent with a monocentric, or a single form of authority. Examples that are consistent with this form of authority include

descriptions of the public utility (EPM) being "*totally and absolutely the property of Medellin" (ID13) its ownership model as "a public company, the leaders are from the government (ID24).* There are other examples that are consistent with monocentricism. In observing other examples, there is evidence that the company is nested within the government while retaining a level of autonomy:

> *"They are completely different. EPM is a public company looking for profit. Being owned by the municipality, they can do profit in a not-just profit way."* -Universities, policy arrangement, ID14.

There are several examples in Section 6.2, Table 11 that support an understanding of EPM as "nested" within the municipality, however, retaining features of singular authority. Not only is it the company nested within the municipality, the governance of the company is still dictated by the municipality as the sole owner.

> *…the power of the mayor of Medellin is really important because it is 100% legal owner…" - Municipal authority, ID21*

The speaker's emphasis on the ownership of the company by the city is why this data is coded as "one group" or as "monocentric."

Representatives from all stakeholder groups discuss the municipality as the single authority delegating duties via institutional arrangements that are consistent with top-down or hierarchical relationships. The mandate of the municipality, originates with the national government, and through decentralisation, is enacted through the powers vested in the constitution body, by the municipality.

While there is evidence for the relationship between the city and the company as a single authority, the evidence presents multiple realities, or different perspectives of the same governance reality that challenges the evidence for a polycentric view of authority as While this tension will be discussed further in Chapter 8, at this stage, this section will note that Chapter 5 demonstrates, namely that there features of polycentricity that emerge in understanding the nature of the relationship between the city and epm. The institutional agreement of EPM articulates this arrangement as a public company with autonomy in business expansion and diversification, however, governed by the municipality and the multiple authorities that comprise the governing body (insert cross-reference).

6.3.2 The role of environmental authorities

Representatives from different stakeholder groups discuss the role of the environmental authority consistent with a single authority in several arrangements. One arrangement concerns institutional agreements between the environmental authority and other public institutions. These agreements include procedures related to planning in the metropolitan area and procedures for implementation. Most of these planning procedures in this sample of interviews occur at the metropolitan area (urban environmental authority) in which Medellin is situated. Where there is an overlap in jurisdiction, most of the references concern other regional authorities and their relations with other actors (ie. municipalities). In some of these examples, the metropolitan area is designated as the single authority. However this is in relation to a delegated authority from the national or regional level and include evidence for allocation of specific duties and self-governing capacity.

Where the environmental authority features strongest with specific duties is in relation to specific duties articulated is where there is evidence for its status as being a singular authority with respect to permits for water usage;

> *"Environmental authorities (plural) "ordering and managing the watersheds...uses of the watershed…programs…users of the resource because we need to supply the city…permits…water concessions…if any user infringes…they have the power to sanction"- Service provider, ID13*

Similarly, there is an explicit allocation of duties as an authority regarding the use of the water, not just for permit recipients, but monitoring usage for all users:

> *"But they say we can give you the water in the river but we have to keep some flowing to continue either other users downstream or just the biological, ecological stream that has to be maintained so when you ask for permission they actually, you have to present your studies and they actually grant you the water usage for some years, some years, maybe 20/30 years and you have to pay for the use of water. Water is free but you have to pay for…[it]"- Universities, ID14*

Four stakeholder groups (public services, universities, environmental authority and the municipal authority) describe the metropolitan area as monocentric in relation to policies and planning. The role of the environmental authorities is also coded as monocentric when a specific environmental authority such as the metropolitan area, lead of specific programs. One such program is *SIATA (El Sistema de Alerta Temprana de Medellin, Alert System)*, a program that monitors environmental risk. Another program is *Mi Rio (My River)*, which is described by the universities, as a river recovery program. The role of a single authority seems

to feature strongly when the environmental authority is operating within the boundaries of its jurisdiction as is the case in issuing water use permits or in a planning capacity (the land-use plan (POT)), as described by the municipal authority.

6.3.3 River recovery projects

In the example of river recovery projects, there is limited discussion of a single authority relative to the themes of the city and the company and the environmental authority however where there is a discussion, it is in relation to an institutional agreement led by the metropolitan area (urban environmental authority) at the local level. This is the case where there is a designated duty and self-governing capacity for investing in ecological restoration of the river. With respect to river recovery projects, there is some evidence from the service provider that this program is led by the Ministry of Environment exclusively:

> *"Instituto Alexander von Humboldt: In this moment it is treated as an executive action within this agreement for an initiative that is for the ecological restoration of the Medellin River, and the idea is that this initiative of ecological restoration will be supported, led - so, the idea is that they are there - by the Instituto Alexander von Humboldt. You know it? It is here. Yes, it is an institute del Ministerio de Ambiente. El Ministerio de Ambiente they have some specific institutions." – service provider, ID13*

6.3.5 Other actors participating in the system of governance

While not described by more than one group, there are several organisations where speakers mention one group as having some decision-making power as single authorities within a jurisdiction across the different arrangements for governing the system (replacing the governance system). Universities describe the Grupo Empresarial Antioquia (GEA), a business association comprised of representatives from the private sector from industries such as construction, engineering and banking:

> *"Back in the day it was the Antioquenan Syndicat. Now it is called the Antioqueno Business Group. Grupo Empresarial Antioqueno. And Grupo Empresarial Antioqueno has Bancolombia, the largest bank in the country, Argos, the largest concrete...cement, concrete, they have the fourth largest power generation company, they have the largest insurance company, largest health company."* - Universities, ID14

Further investigation identified that as an entity, GEA has representation on the boards of several public and private institutions.

The water user associations also describe *La Mesa Interbarrial de Los Desconectados* which advocates at a regional level for connection to services and resources, with water being one of the areas they are working on:

> *"La Mesa Interbarrial de Los Desconectados, on the other hand, goes further there. They say: "it is a matter of…the city, a housing issue. It's not only about a minimum vital [minimum amount of water allocated to all] of water, but a minimum vital of conditions dignified for living."* - water user association, ID3

6.3.6 Summary

Chapter 6 demonstrates that there are several instances where stakeholders describe the governing range as consistent with characteristics of monocentric governance in aspects of policy and planning (the land-use plan and water permits by the environmental authorities) or in ownership of epm by the municipality within the system of local governance. The environmental authority features as a single authority and as an authority that facilitates decentralisation across different levels of governance. Environmental authorities, such as the metropolitan area, have the authority to issue water use permits within their jurisdiction, which is an authority decentralised from the national level to the regional level.

An example that is consistently described by all stakeholder groups is the relationship between the city and the municipality. The company is the property of the city even though there are aspects of governance that are not within the jurisdiction of the municipality (namely decision-making regarding expansion overseas). Taking these perspectives into consideration along with findings from Chapter 5 suggest that there are examples of governing arrangements that are consistent with polycentric and moncentric forms of government. A system of multiple authorities acting across boundaries is a possible explanation for how monocentric and polycentric features of governance coexist in a complex network of authority with overlapping jurisdictions, vertical and horizontal coordination as well within decentralised and established concentrations of authority.

The arrangements between these governing bodies suggest strong evidence for monocentric authorities in discussions of policies and plans, decentralised from the national government. This is also similar at the regional level, where procedures are delineated by law in the form of institutional agreements, procedures and regulations (for example water quality monitoring and requirements for water use permits) which allocate capabilities and specific duties.

6.3.7 A complex landscape for water governance: polycentric, monocentric and nested hierarchies

Chapter 5 presents evidence suggesting the Medellin case has many features of a model of polycentric governance which includes evidence related to the relationship between the city and the company, the role of the metropolitan area, river recovery activities and the representation of different institutions on the board of directors for EPM that is consistent with characteristics for polycentric governance. Chapter 6 provides evidence that suggests this form of polycentric governance in the Medellin context includes single authorities and nested types of institutional arrangements, mainly where there are references to multiple levels of governance associated with how governance occurs at a local level.

This diversity in regime characteristics may occur for example at a local level, where the governance arrangement may be consistent with a single authority (monocentric) from a planning perspective at the municipal level. At the same time, this governance arrangement may feature more strongly as a multiple authority (polycentric) when taking into account the different levels of governance when it includes overlapping jurisdictions and/or multiple actors involved in an implementation capacity at a metropolitan level. What seems to be a polycentric system in the implementation stage, for example, is a complex arrangement of single authorities guiding policies and plans.

There are features of the Medellin case that provide an example of where the perception of one governing arrangement can be both monocentric and polycentric depending on the speaker or the nature of the interaction. The relationship between the city and the company is one example where the ownership of the company by the city may have characteristics of these two governing arrangements. The city grants a mandate to the company to provide services, which is consistent with the land-use plan and the regional authorities' guidelines for planning in the city and region (See 4.3.3). There is some overlap regarding responsibilities and knowledge sharing of the two entities as multiple authorities yet there are also examples where there specific institutional jurisdictions that are hierarchical led by the municipality as a single authority.

The role of the urban environmental authority (the metropolitan area) and its interactions with other regional environmental authorities (Cornare, Corantioquia and Corpuraba) also present examples where the environmental authority operates as a single authority and/or

multiple authority. The urban environmental authority wields considerable authority in long-term plans for land and resource planning and as presented in Chapter 4, is associated with a form of continuity that is external to political cycles of the municipality (See 4.5.3). While presiding over jurisdictions beyond Medellin and the metropolitan area, the role of the other regional environmental authorities should be acknowledged to the extent that these authorities are responsible for overseeing watersheds where water for the city of Medellin is sourced. These environmental authorities should be taken into account as single authorities and as multiple authorities where they have overlapping jurisdictions.

This investigation also identifies that as an entity, the Grupo Empresarial Antioqueno (GEA) has representation on the boards of several public and private institutions. The implications of having both monocentric characteristics in a context where there is substantial evidence for polycentric governance is that there is diversity in the different forms a system of polycentric governance can take, particularly when different levels of governance are taken into account. This case study provides an example where an adaptive form of governance is associated with a coexistence of monocentric and polycentric governance arrangements. Explanations of these different governing arrangements require an understanding of the mechanisms that support the coexistence of different forms. The coexistence of these different governance arrangements also suggest that polycentricism, which is associated with adaptiveness, can include features of single authorities at a local level that are connected to multiple authorities across different levels and processes in place that are malleable - adapting to the different governing arrangements. This is particularly critical for identifying how systems that seem to contradict one another, coexist and can inform an understanding of local governance that accounts for these different scenarios.

Box 3 includes a list of these features of the landscape for water governance found in Chapter 5 and Chapter 6 after taking the views of polycentric, monocentric and other forms of nested governance arrangements into account**.**

Box 2 Key findings from Chapter 5 (Polycentric governance) and Chapter 6 (Monocentric and nested hierarchies)

1. **The governance system shows evidence for a form of polycentric governance that includes features of a polycentric system, monocentric governance and nested forms of governance which coexist and may vary in scenarios for planning, policy and implementation.**
2. **The Medellin case provides instances of polycentricism in scenarios related to implementation activities, local planning efforts and where decentralised authority oversees the implementation of national and regional policies at a local level.**
3. **The role of authorities at national, regional levels and transboundary levels have to be taken into account in an understanding of governance at a local level. There are authorities that feature as 'single' and 'multiple authorities' which has an influence on the governance in the city (ie decentralised authority to the municipality through policies and some plans).**
4. **The relationship between the city and company has instances of polycentric arrangements instances such as implementation and more monocentric and nested authority (monocentric) in instances such as planning and decision-making.**
5. **The environmental authorities show evidence for a variety of different governing roles which range from a single authority (monocentric) within a jurisdiction (metropolitan area, AMVA), a 'bridging actor' facilitating interactions between groups and as a member of a group of multiple regional environmental authorities (polycentric).**
6. **The environmental authority is associated with instances of monocentric characteristics such as specific institutional jurisdictions that are hierarchical and implemented as single authority (ie. water usage permits) as an autonomous regional authority.**
7. **Environmental authorities, joint community action groups and citizen councils are associated with opportunities where many groups and multiple authorities engage in planning and implementation activities.**
8. **There is some evidence to suggest that some non-state actor groups (illegal groups, GEA) are active in the governance of water either directly or indirectly. Further investigation is required to identify to what extent this influences the governance.**

Taking into account findings in Box 3 and understanding how they are contextualised, this chapter suggests a view of polycentric governance that coexist with instances of monocentric governance. Specific themes such as the relationship between the city and the company, situate characteristics of polycentricism and monocentricism within a historical and cultural

context. Figure 9 Regime characteristics of a complex resource regime (water governance in Medellin, Colombia) visualises these core findings as three different forms of regime characteristics and examples where they exist in the data. These arrangements of authority range from more single authorities to multiple authorities involved in the governance arrangement and can range from more overlapping jurisdictions to specific institutional jurisdictions. Taking the variety of perspectives from representatives from different stakeholders into account, there is strong evidence that these different characteristics coexist within a system that is strongly associated with adaptive governance (insert cross-reference to chapter 4). With an understanding of the system's regime characteristics enabled by an adaptive governance lens, the next chapter shows how these actors cooperate within these different governing arrangements.

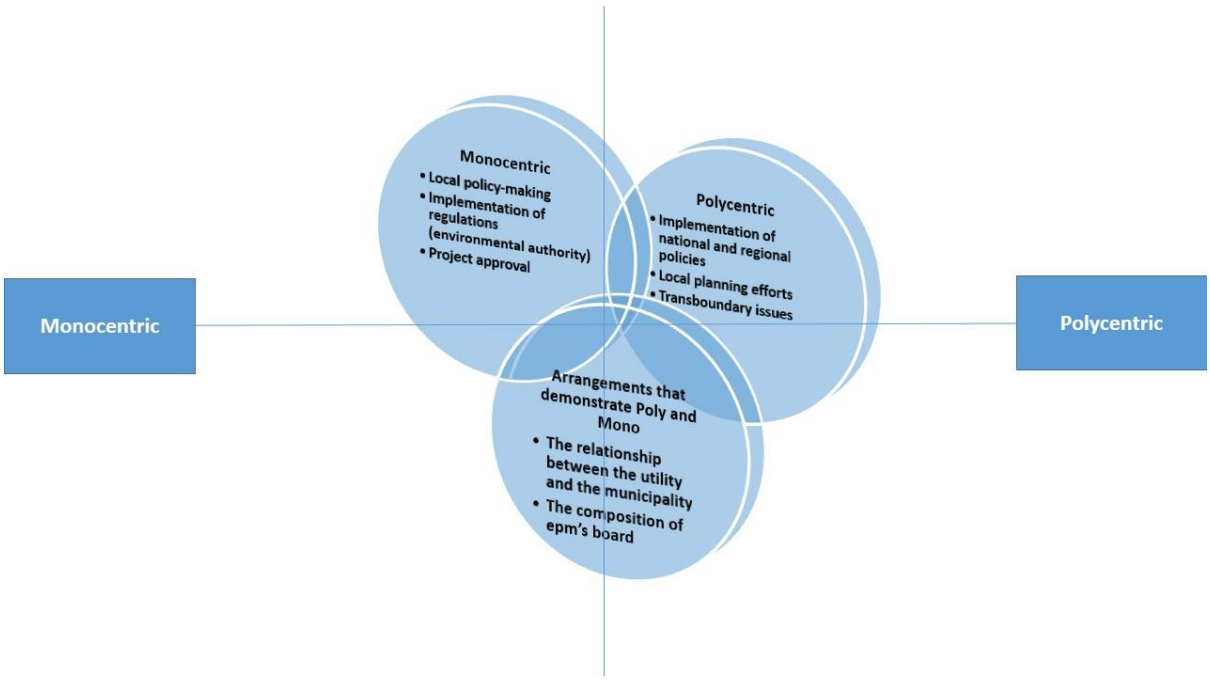


Figure 9 Regime characteristics of a complex resource regime (water governance in Medellin, Colombia)

Chapter 7 Applying social contracts to explain institutional arrangements

7.1 Summary and Chapter overview

Part II began with Chapter 4 presenting evidence that the Medellin case for water provision (and thus of a complex resource system) has features that are consistent with the adaptive governance of a complex resource system. Chapters 5 and 6 examines the regime characteristics and concluded that there is substantial evidence to suggest consistency with definitions of polycentric governance put forth from the literature (Chapter 1, Table 1).[8] Chapter 6 also identifies features where the regime characteristics demonstrate consistency with monocentric governance and nested hierarchies. [9] Chapter 6 concludes with an acknowledgement that these different regime characteristics coexist and adapt with regards to themes such as the relationship between the city and the company, the role environmental authorities and river recovery activities.

The previous chapters contribute an understanding of the variety of regime characteristics and more specifically, how authority is arranged, and the variety of forms this can take (polycentric, monocentric, nested hierarchies). There is a need for further understanding of the mechanisms, agreements or ways in which the different actors cooperate in these arrangements relate to one another in the broader context of water and sanitation provision which is at its core, a social interaction. This need emerges from a gap in understanding of linkages between actor groups and attention to interactions between stakeholders beyond a managerial level which aids in identifying what arrangements are critical for and consistent with adaptive governance (See Section 1.4 and Section 2.3).

7.2 Exploring social contracts in the Medellin case - why and how

This section refreshes the reader briefly on the argument for applying the social contract approach to addresses a gap in knowledge and the different forms (typologies) of social contracts in order to contextualise the evidence presented that correlates or challenge each

[8] There is evidence that the relationship between the city and the company, the role of the metropolitan area, river recovery activities and the representation of different institutions on the board of directors for EPM is consistent with characteristics for polycentric governance.

[9] The latter is displayed in discussions of the company and the city as well as the composition of the board of directors.

of the typologies. More detailed information on the justifications for selecting social contracts is available in 2.6.

Chapter 2 introduces the social contract approach (Section 2.7) as a useful starting point for understanding social interactions in a complex resource regime, a social-ecological system shows where social and human interactions tend to dominate governance. Ostrom's understanding of polycentric systems was used to inform exploration into the governing arrangements within the system. Ostrom's perspective on collective-action is also taken into consideration within the context of social-ecological systems, however in order to examine the basis for social cooperation between different actors, an approach to examining the different forms of cooperation based on observable attributes of human political nature, which is evolving and adapting, is used. Building upon a wider description on social contract theory (as described by Locke and Rousseau; (2.7) and its application for water governance in the context of Lundqvist et. al who was exploring the need for evolution of systems of governance, there is a framework for understanding how groups cooperate. In this understanding, social contracts can evolve yet there is not an assumption that they evolve in stages or in a necessarily sequential manner. For instance, the Hobbesian social contract theory which is governance by a central power where individuals cede authority can evolve to a more Lockean model where governance is shared between the government and the public.

Taking the application of Hobbes and Locke as presented by Lundqvist et al. for evolution of social contracts in the water sector into account and observing that John Rawls contributes a significant perspective on social contracts in the wider literature on political and social thought, that describes a more community-based model of social contract, an application of this social contract adapted for the water sector is included in Table 11.

For each of these social contracts cooperation is related to agreements that are formed out of necessity and for societal benefit. This chapter explores where the direction of authority is within these agreements, or social contracts, between entities – either formalised or otherwise – feature in the data with attention to directions of authority and how relationships are constructed. Social contract theory is applied taking into consideration the polycentric, monocentric and nested arrangements described in Chapter 5 and Chapter 6 and with an intention to understand how these agreements operate within the system.

This chapter presents evidence of representatives from the different stakeholder groups (in sections (Section 7.3-7.5) featuring how they describe the relationships between actors and to what extent the evidence is consistent with applications of the social contract. The coded evidence presents characteristics associated with hydro-social contracts (Section 2.7). The descriptions of these applications are used to examine how representatives from the different stakeholder groups perceive relationships between actors and to what extent they are consistent with social contract typologies described in Section 2.7 (top-down, mixed and bottom-up). For example, the public utility may experience top-down authority from the national government. Table 11 lists these descriptions.

Where it challenges or departs from the application of the water sector is discussed further in Chapter 8.

Table 11 Application of social contract theory to the water sector for coding (Hobbes and Locke social contract is adapted from Lundqvist et. al, (2001) and Rawls adapted for the water sector from Rawls (Rawls 1987)

Social contract type	Definition	Description of how to identify (the code)	Examples	Notes
Hobbes hydro-social contract Top-down typology) Definition and examples from (Lundqvist et al. 2001) Description of how to identify and notes are the work of the research except where indicated as a quote.	Governing requires a strong central power in which the citizens hand over authority in exchange for the State assuring prosperity and security, provision and protection of the resource (based upon political theory of Hobbes).	Evidence of a distinct group of professionals given authority by the state to oversee water for society.	1. Where water is described ie *"as a technical challenge that is the State's responsibility to solve and maintain."* 2. The provider describes its mandate as *"providing and protecting the resource which requires cooperation and a cost, in some cases from the user."*	There may be a grey area between the state and the citizens, however if the state is still seen as having power, still code: "Water is an asset as well as a resource that connects people, industries, cities and towns. We have to recognize this phenomenon in how we share responsibilities to plan and finance for it."
Lockes' hydro-social contract Mixed typology) (Lundqvist et al. 2001) Definition and examples from Lundqvist et al. 2001 Description of how to identify and notes are the work of the research except where indicated as a quote.	Governing that has a sharing of power, "a social contract" of formal and/or informal agreements between the Government and the public. This is based on a Lockean understanding of governance.	Evidence of shared responsibility between the government and the public for the provision and maintenance of the resource.	Costs are described beyond simply technical/monetary costs and include social, ecological terms. ie. *"The municipality and the surrounding communities should allocate responsibilities to preserve the watershed based on capacity."*	There may be a grey area between the state and the citizens, however the sharing of power is emphasised.

Social contract type	Definition	Description of how to identify (the code)	Examples	Notes
3.Rawls' hydro-social contract (Bottom-up typology) (developed by researcher, informed by (Lundqvist et al. 2001) Definition developed from (Rawls, year) and adapted using the approach from Lundqvist et al. 2001) Description of how to identify and notes are the work of the research except where indicated as a quote.	There is an understanding of governance where learning to work together efficiently and without violence is prioritised. This is based upon a Rawlsian view of governance where there is a clear acknowledgement of a process where groups learn that they are better off working with each other rather than against.	Evidence of different groups incl. civil society groups working together to form different political parties in order to build a system of governance. Governing that has a view of where "men agree to share one another's fate."	Different water basin organizations have worked closely with the different municipalities to provide services where there is currently no service. The process of designing the regulation for water quality in the region generates a process and know-how for working and creating new partnerships with other groups	*There may be a grey area* between the state and the citizens, however there is an emphasis in learning to work together.

4

5

6

These theories take into account the direction of authority with an understanding that social contracts can evolve (Lundqvist et. al, 2001). The results of observing the direction of authority will be presented considering the instances of single (monocentric) or multiple (polycentric) that were visited in Chapters 5 & 6. There may be repeated quotes where these features were coded in a non-discrete manner. In practical terms, this features in items coded as both 'many groups' (regime characteristic) and “top-down” (social contract) for example.

7.3 Application of Hobbesian social contracts (top-down) for polycentric systems

7.3.1 Top-down (The state and/or other governing holding authority)

There are three typologies which serve as guidelines for understanding the variety of forms a social contract as an agreement can take. The first one in this section is a social contract where there is an agreement which has a top-down relationship between a sovereign (an authority) and a group. This social contract is consistent with an understanding of a social contract as an agreement that grants the sovereign the right to govern over individuals who contract over one another, however, there is an emphasis on the evidence as top-down. The individuals give the sovereign the right to exercise power and “whose legitimacy depends on its capacity to secure the life, liberty, and the property of citizens” (Harper, 18). In other words, if the sovereign reneges on the agreement, that right can be taken away (in theory). [10]

7.3.2 Criteria for inclusion as “top-down”

For the evidence in the Medellin case considered a “top down” authority, there is evidence from the speakers describing an authority (‘sovereign’) of one group or many groups that exercise authority towards another group and/or society cedes authority. In these examples, there is a clear indication of the direction of authority which can take the form of explicit references to laws by the state that describe a top-down arrangement of authority or a speaker suggesting that there is a duty bearer (the state) and a beneficiary (citizens) that receives direction. Applied to the water sector, this may include references to the costs

[10] This application of the social contract theory to the water sector is an interpretation of Hobbes by Lundqvist et. al 2001. This suggests that governing requires a strong central power in which the citizens hand over authority in exchange for the State assuring prosperity and security. Applied to water, this means that citizens give up authority to the State which has the responsibility of ensuring the provision and protection of the resource (Lundqvist, Jan, Narain, Sunita and Turton, 2001).

involved and a commitment by the state to recognize planning and finance responsibilities (Lundqvist, Jan, Narain, Sunita and Turton, 2001).

7.3.3 Summary of results relating to top-down approaches

Top-down authority that is specific to one group or many groups is categorised in this section which groups evidence according to the stakeholder groups who describes them. The section presents information related to top-down authority in groups of common themes that emerge and describes in greater detail of how each stakeholder group describes 'top-down' social contracts.

Evidence include references that range, for example, the utility, Empresas Publicas de Medellin (EPM) as the leading institution in the implementation of projects to a committee or community deciding how to plan for the protection of the watersheds. Patterns of top-down interactions between actors also include references to environmental authorities and ministries at the national level who authorise policies which govern service provision (Law 142, 146) and the protection of public services (through the passage of environmental laws to earmark funds for sustainability purposes).

There are several references to (EPM), the public service provider, as a top-down authority related to its mandate to provide public services in Medellin. Nearly all groups discuss EPM as having a top-down authority (as a single authority) in relation to the implementation of services as a service provider which is the property of the state. In this application of the Hobbesian hydro-social contract, the state (through epm) has the authority to oversee the provision for the benefit of citizens (beneficiaries). This includes overseeing aspects related to water treatment, establishing connections, providing water and sanitation, installing prepaid meters, managing reservoirs, buying land, co-opting community service providers (acueductos comunitarios) and efforts to counter illegal use. These examples are consistent with a view of a single sovereign exercising authority in the provisionary aspects of water service (delivery, treatment, collection) which includes duties beyond the scope of an individual. By ceding authority to the sovereign, individuals in society through some form of tacit consent, or other forms of consent to being ruled.

Environmental authorities feature as a top-down authority which is a fuzzier application of the Hobbesian social contract as they are independent autonomous authorities from the government. However, for policies and plans, the environmental authorities serve the role

that would be filled by the state. Half of the stakeholder groups describe the environmental authorities as a top-down authority in monitoring and planning activities for conservation of the basin, overseeing pollution and the land-use plan, infrastructure approvals and sanitation plans concerning policies and plans (EA's managing land-use and political will). In this example, the top-down relationship helps to explain how an individual institutional environmental authority such as the Metropolitan Area (AMVA) relates to citizens as 'sovereign'. The example also shows how a group of environmental authorities as a unit at a regional level relate to another stakeholder group as a sovereign group. In both examples, ceding of authority allows the different forms of sovereigns to operate within this system of governance.

There are some types of top-down authorities that are mentioned by one of the stakeholder groups. Some groups mention business associations which are examples of 'top-down' authorities that wield power like the state with respect to dictating how services are delivered, but in a manner that departs from the typologies presented here. There is a form of a contract; these groups may be unknown by those who are impacted by decisions (business associations) and not have been given consent by the individuals governed (illegal groups). University representatives discuss the Grupo Empresarial Antioqueno (GEA), a business interests' organisation that is influential in planning and national laws that limit the provision of public services (limiting market share held by a particular public company). Other non-state actors such as illegal groups in the context of the narco war or civil war feature as participants in water provision (directly and indirectly) who fill a vacuum where the state is not active, though the extent to which this occurs requires further investigation. The following sections will describe examples where the speakers provide instances that are consistent with a top-down (Hobbesian) social contract.

7.3.3.1 Public service provider

Speakers from the public services' stakeholder group refer to national entities that decentralise authority to the municipalities (state) which oversee and direct the minimum vital, a national guarantee for a minimum amount of water for the most vulnerable (citizens). The system allocates subsidies based on social strata. When representatives from the public service provider refer to top-down interactions with more than one institution (functioning through or with state entities) having joint authority, there is a reference to EPM's interactions with environmental authorities (EA). The EA's set guidelines at the regional level for managing the watersheds, land-use and infrastructure planning which in effect, an indirect relationship with the end beneficiaries (citizens). In relation to efforts to manage the watershed, a speaker from public services discusses the role of the environmental authorities (as functioning like a state entity in a top down capacity) in issuing water use permits to public services such as EPM which are providing services for the citizens, which is part of wider efforts to protect the watershed.

> *"And the plans for ordering and managing the water sheds, this is the planning of the watershed, what are going to be the uses of the watershed, what programs they hope to have for improving the environmental conditions in the watershed, yes we…how…we are users of the resources, we are users of the resource because we need to supply the city, and each user of the resource needs a permit called a*

"water concession" for using the resource. Those are the main functions of them, not only at the level of the watershed but at the level of all you have to do with natural resources, and they are the environmental authorities…if any user – including us – infringe on any of the environmental regulations they have the power to sanction. They can, for example, stop an activity, I don't know, if an industry for example, is contaminating any body of water or something, they can impose a sanction." -ID13

This example shows the top-down nature of the environmental authority, and brings to light a fuzzier application of the Hobbesian relationship between the state and citizens. In this example, the EA is the state entity which dictates what the service provider can do for the citizens ultimately. This is another indirect relationship between the state and citizens but nonetheless top-down.The speaker also seems to demonstrate this understanding in describing the broader role of national authorities as a sovereign in setting standards that permit or prohibit certain building projects that epm would undertake for expanding services for beneficiaries (citizens):

"*And there are other fronts for example before ministries...for example standards limiting certain projects we want to do: we would like to enter to such site, but the law say that we cannot enter in this site, so "how to manage so that we can implement actions in these zones where the law says we cannot enter or we cannot enter in the manner in which we think is the "only way to enter (ventana unica)."* –ID13

In summary, speakers from the service provider stakeholder group describe top-down interactions concerning national level legislation laws to provide services. Several quotes related to Law 142 and Law 146 set out the guidelines for the provision of public service (Law 142 and Law 146, 1992).

7.3.3.2 Universities

When universities discuss top-down approaches to authority by one group, the examples are primarily in relation to EPM's role buying land for access to the water and for ensuring the provision of the resource. In these examples, epm can be perceived as a state entity (the property of the municipality) which is providing services for the beneficiaries (citizens). There are two conflicting views that seem to coexist: one that sees EPM as the central authority where water has a monetary (commodity) value and another which sees it as a right in a case with epm offering to buy land:

"Yes. What happens is that…look, for example in the union eh…Empresas Publicas de Medellin was offering to buy the land and administer water for treating it and for covering them. So, clearly the vision is completely privatised and there is another vision about water as a right. So, that the source is 5 metres from my house. Then, you are saying to me, you'll buy it, that you are going to purify it and then I am going to collect it. So, of course the vision is completely different, completely different." -ID12

The "them" refers to citizens who would be the beneficiaries. Further to buying land for the access to water, there is also evidence of EPM's ownership of and role in managing reservoirs. As the property of the state, the tension here is to what extent that authority includes the municipality's responsibility to provide services to illegal settlements:

"Because EPM has reservoirs everywhere. So it's not an issue. The big issue, is more political. Whether EPM should provide services to illegal settlements (ID25)."

There is also evidence of EPM as the leading provider in the city consistent application of the idea of the "sovereign" who has the authority, a mandate and a responsibility to provide services. The following quote shows how epm exercises this sovereignty and why they invest in buying land:

"EPM is the one who is going to provide all the services, to all the neighbourhoods and they also engage as they have investment...it is a good investment so we are going to invest in it". -ID14

Another speaker in the public services stakeholder group discusses the role of environmental authorities in overseeing permits, which is consistent with a top-down form of authority:

"But they say we can give you the water in the river but we have to keep some flowing to continue either other users downstream or just the biological, ecological stream that has to be maintained so when you ask for permission they actually, you have to present your studies and they actually grant you the water usage for some years, some years, maybe 20/30 years and you have to pay for the use of water. Water is free but you have to pay for…"-ID14

The articulation of the environmental authority as the sovereign is clear and the speaker seems to perceive the responsibilities from the position of the actor (who will implement on behalf of citizens) who is receiving the permit.

7.3.3.3 Environmental authorities

The environmental authorities discuss interactions that were top-down in relation to stakeholder groups such as EPM and the local authorities which can be understood as

indirectly enacting the connection between the state entity and the citizens. In particular, the metropolitan authority (AMVA) authorises permits for EPM for water infrastructure projects in the metropolitan area, oversees water quality monitoring and supervises the sanitation efforts which ultimately will benefit the citizens. There is evidence of AMVA, and other environmental authorities' as a top-down authority related to infrastructure projects:

> *"Already in the rural zone of these municipalities, the exercise of environmental authority is done by another environmental authority that is here called Corantioquia, good. From the part of the environmental authority, we at the Área Metropolitana are the authority in material of massive public transport, we are also an entity that is also in charge of territorial planning and also we are an entity that we are in charge of doing metropolitan infrastructure projects that may be of interest for the whole region, no for…no a project of a municipality in particular, if not to benefit the whole region in which we have jurisdiction." -ID15*

Other environmental authorities (Corantioquia) sometimes have overlapping jurisdictions with AMVA's as a top-down authority which has a supervisory role in ensuring compliance with regulations to prevent dumping and pollution:

> *"Additionally, we supervise the compliance of the Plan de Saneamiento y Manejo de Vertimientos [Plan for sanitation and management of dumping] that was moved forward by Empresas Públicas de Medellín, is of them, they have to implement it, they present it before the environmental authority and evaluate and check and track compliance of this Plan de Saneamiento y Manejo de Vertimientos. These are the projects, like we say, the most successful for us here in the management that we are doing. There is another important thing – that I have not told you – we have a calibration and validation model for the river. This model allows us precisely to try to simulate some conditions of specific dumping on the river that allows us, we say, to model future scenario and how we envision our river, right? No, it's easy, it is a work that has been, so, easy but we think that we are advancing in the correct direction." -ID15*

In this example, the environmental authority is the state like entity that requires all projects to be presented and validated by them.

This next quote shows a direct relationship between EPM (as the property of the state) as a top-down authority connecting people (citizens), however the issue of legality challenges whether epm has a social contract with those who are not connected legally to water sources. In this example, is where the notion of the social contract is incomplete (disabling connections):

> *"EPM would be willing to put connections for the whole world if they pay. "If you would like two, then, we put two. Two is better than one." That is what EPM has done, in*

other words, connect the informal – to those neighbourhoods that let's say they called subnormal or invasion, etc. etc…so put them in the system, right? Putting a meter for them, a meter, putting one…so they cannot connect illegally." -ID17

A representative from the environmental authority discusses another form of a top-down in the context of a water monitoring programs led by the environmental authorities as the state entity which is ensuring protection of the water resource for the people through a mechanism called Casa Retributiva:

"And from there, we already do a visit, right? We inspect what is there, if it is in the urban part, where the treatment plant is located. And have some requirements prior to accessing the municipality for resources that are from a specific source that is the Casa Retributiva, right? You know what the Casa Retributive is, the concept is that, let's say that: you are making a dump in X part, company, municipality and need to pay for this dump right? Because you are contaminating the water source, so you need to pay, right? So, this dividend that is returned to us, we invest in the communities, making sanitation also in the paths and in the municipalities." –ID19

7.3.3.4 Municipal authority

There is discussion by the municipal authority of historical and contextual features of governance in the city, referring to top-down interactions where the national government and the municipal authority wield power. Representatives from the municipal level discuss top-down interactions led by multiple authorities (as state entities) which citizens ceded authority in return for security and access to services. The main reference to this is the Concerria Presidencial, which was set up by the national government during the crisis in the 1990s to assist Medellin, and environmental authorities which have set the standards for land-use and environmental monitoring that engineered projects that ultimately would benefit, and be led by, communities (citizens):

"What? The process was like this...the first thing was the Conserria, and from 1990 til 1994 we had that, the Conserria also did some experimental urban things...one thing I liked was Nucleo de Vidas Ciudadanos, citizens' life nucleos, kind of PUIs [integrated urban projects], but the first version, urban interventions providing public interventions, in the middle of the barrios to create institutional development support. They developed a very important work for barrios upgrading, legal actions to provide, to provide, ownership of the people of their homes, becoming legal, very important initiative with the bank, KfW of Germany." – ID21

There are some implications for planning that may have implications for public interventions and provision of utilities (including water), yet this example by the state (at a national level) was put in place to ensure the provision and protection of the public at a municipal level:

7.3.3.5 Water user organisations

Water user organisations discuss top-down interactions in relation to EPM as the main service provider, its authority in legislating the minimum vital, implementing prepaid water schemes in areas with limited or fraudulent connections. In these examples, the power wielded by EPM is in its capacity as the property of the state. Thus in these examples, while it is not the municipality, it is treated as a state entity.

There is an explicit description of the minimum vital (the minimum amount of water guaranteed by the State) as being the responsibility of the municipality to provide and protect, even though the authority is top down from the national government: *"So, while there is not a national law, the municipalities decide how to implement a minimum vital or not. But, that depends on a change of government." -ID6*

While it is not explicit, the main service provider, EPM, has the responsibility to provide water through a mandate with the municipality *(4.1.13).* Through this responsibility, EPM exercises authority to implement a prepaid water scheme which the beneficiaries (citizens) cede authority in order to have services:

> *"The truth is that EPM guarantees this right in its own city, right? Without these entanglements of agua prepago, "is that you are not legal", "is that you do not have money", or "to be able to reconnect you must make a payment agreement and that you take a course on water saving", right?" –ID5*

Representatives from water user associations also discuss the municipality as having the responsibility to provide services, which is mandated by the national government through the National Planning Office which oversees *El Sisben*, a survey used to determine subsidies. At a municipal level, individuals who enrol in prepaid water cede authority to EPM in order to be able to access the benefits of El Sisben which is implemented at a municipal level:

> *"It's part of…before an era of a united Medellin – but although the Sisben that is a national government program with an emphasis on people in those stratuses [social stratus which in Colombia is categorised according to residence from 1-6 with 6 being the highest]. You have to make an agreement with EPM when you go to pay."-ID6*

7.3.3.6 Summary of top-down approaches to social contracts, in the context of single and multi-group authorities

Representatives from different stakeholder groups provide a range of perspectives on the agreements between groups involved directly and indirectly with the provision of water in the city which show some consistency with a top down (Hobbesian) social contract where a central body has the power which citizens hand over in exchange for provision, prosperity and protection (Lundqvist et. al, 2001). An application of the top-down authority provides a reference for explaining how institutional arrangements and power may be centralised for single and multiple authorities alike (See 2.7). There are scenarios where single authorities such as the environmental authorities have a mandate to oversee water use permits. In this example, the environmental authority operates as a sovereign, and the institutions involved (ie. the public service provider), facilitate the social contract with end beneficiaries (citizens) through provision of services, protection of the resource or ensuring the quality of the resource. Similarly, when representatives from water user associations discuss the implementation of the minimum vital, a top-down authority is exercised by the national government towards the municipality which operates as a 'single authority' (the sovereign) which has the power to ensure the right to water for citizens through programs such as the minimum vital.

While representatives from different stakeholder groups describe some authorities as single entities, there are also examples where multiple authorities exercise a top-down social contract. The environmental authorities as a group at a regional level implement the regulation and planning of activities as a strong central power in which citizens hand over power to the environmental authority which ensures the protection of the watershed. This recognition provides evidence of a tacit choice to cede authority to the environmental authority. Similarly, EPM's authority in the provision of public services, as it is the property of the municipality, has an agreement which features in one respect as a top-down agreement to oversee the provision of services.

Each of these examples show how a Hobbesian interpretation of the social contract applied to the water sector, provides a means for explaining the direction of the authority and for understanding how institutional arrangements are positioned.

The application of social contract theory is limited to examples with an indication of the direction of authority. Examples where there is not a clear delineation of authority are not included here though they may also be consistent with top-down interactions. For example, there may be a natural disaster scenario where an organisation intervenes, yet without a mandated authority. In other examples, there may be a need for identifying differences between formal and informal authority. For example, the presence of illegal groups may not include a formalised mandate of authority, however, there may be a tacit understanding of the direction of authority.

This section is devoted to the application of the top-down form of the social contract theory. Using this same process for identifying examples in the evidence, the next section (Section7.4) presents the evidence for a different application of the social contract theory.

7.4 Application of Lockean social contract

Mixed (Combination of top-down and bottom-up)

The Lockean, or mixed, application of the social contract features as a combination of bottom up and top down approaches and develops from an understanding of Locke's social contract theory. In this application of social contract theory, the critical principle is mutuality – that the social contract hinges on each party fulfilling his/her obligations. The logic of exercising authority from the "top", typically a state entity, remains (as the authority for provision and maintenance of the resource), yet there is also evidence of shared responsibility by other actors, from the bottom up, which distinguishes this application of the social contract from the top down Hobbesian typology in Section 7.3.

The Lockean social contract is described in some ways as a reaction to the centralised and technically dominated strategy of water management (Lundqvist, Jan, Narain, Sunita and Turton, 2001). Lundqvist is speaking to the evolutionary trend in governance of water, however aspects of the different typologies may still exist while other aspects have evolved. In this typology, even though the government is no longer the sole and dominant agent for water management and there is evidence of private participation, community-based organisations, non-governmental organisations involved, the role of public sector governance still has its role as a central authority. This, however, includes a presence groups (for example, government and community groups) who collaborate and cooperate in policy, planning and implementation more than in the Hobbesian social contract. Participation can occur between

individuals and groups participating on the basis of a relationship between the public and the government. In each of these examples, authority is mixed and includes notions such as checks and balances (Lundqvist et al, 2001).

7.4.1 Criteria for inclusion as a “mixed approach”

To be labelled "mixed," the approach or evidence includes a reference to one group or many groups having evidence of shared responsibility and a combination of top-down and bottom-up social contracts. Examples of this approach include discussions of joint activities for long-term planning and ongoing monitoring activities. Most of the representatives from the various stakeholder groups (public services, universities, environmental authorities and municipal authorities) discuss the role of environmental authorities in planning, policy (with other groups) related to the implementation of the land-use (POT) and the management plan for the river together with other partners.

7.4.2 Summary of results for mixed approaches to the social contract

The mixed approach includes references to agreements between single and multiple authorities. For one group with authority, there are features in discussions by the public services company regarding community activities led by EA-AMVA with municipal support such as Brigadas Comunitarias which is raised by the public services perspective. Mixed approaches are a prominent feature of activities carried out in informal settlements – a grey area between the formally recognised city and the part of the city that is on the periphery where the state needs support from other organisations. This form of social contract, which is about sharing responsibility, may arise for a variety of reasons and typically emerges from the necessity for mutual cooperation, particularly in areas with limited access to services. There also may be the presence of interest groups (bottom-up) who are participating in the provision of water services and can fill a vacuum where the formal structures insufficiently provide services. Mixed approaches may also arise due to a presence of environmental threats that serve to mobilise public opinion and several other possible explanations (Lundqvist et al, 2001). The following sections will summarise findings grouped by the stakeholder group.

CBOs, universities, EAs and municipal representatives do not refer to any authority that has this institutional arrangement. The public services company refers to Brigadas Comunitarias which is a community-based initiative which supported by epm (as the property of the state) to provide infrastructure for the provision of services. Another example of the shared

responsibility feature that characterises this social contract is raised by the water user organisation, who mentions the mayor-community policies for the minimum vital and EPM's role as a benefactor company that shares the responsibility as the implementing partner.

Half of the groups (public services, CBOs and municipal authority) refer to the role of EPM in a way that is consistent with the mixed typology. This is coded in examples such as in the implementation of subsidies (set at a national level) for the minimum vital, with implementation led and managed at a local level by the municipality and epm. Most of the stakeholder groups (public services, universities, environmental authorities, and municipal authorities) discuss the environmental authorities' role in planning and policy in conjunction with other stakeholder groups for implementation of aspects related to the POT, the land-use and the management plan for the river with aspects that are consistent with mixed approaches.

There are some instances of this social contract concerning 'multiple groups" with authority (polycentric) that are mentioned by representatives from public services who discusses the Concejos de Cuenca, (watershed councils) and Pilas Publicas, (standpipes installed by volunteers in the community supported by EPM) which combine approaches. Universities highlight cooperative features of the multiple groups involved with POMCA (partnership for the preservation of the watershed) and the Sociedad Parques del Rio (conglomerate of several industrial partners partnering with the municipality to develop land surrounding the river). Environmental authorities discuss a joint commission chaired by the Ministry of Environment that they participate in which develops and reviews environmental sanctions. The municipal authority provides examples from a capacity building perspective where they run workshops on how to manage informality, the role of the Concerria Presidencial in governing different aspects of public livelihoods and services during the transformation and the strategic plan for Medellin.

7.4.2.1 Public services

Representatives from public services describe the direction of authority as mixed and emerges in circumstances where capacities from different levels of expertise are a necessity. These circumstances include examples where authorities share responsibilities and/or develop the policies and decision-making jointly. The environmental authority collaborates with EPM in efforts to foster alliances for research (also with universities), solicits input for land-use plans,

developing a water fund to finance preservation of the basin with partners in a network called Cuenca Verde and develops joint activities to preserve the water basins through the Concejos de Cuenca (watershed councils). The examples in this section (Section 7.4.2) show where representatives provide evidence consistent with a mixed approach, a combination of top-down approaches as they feature in arrangements of both single and multiple authorities.

The Consejos de Cuenca, or watershed councils, are an example of a governing body where there is a sharing of responsibility between several actors and a formal agreement that stipulates each party's function and interest in preserving the watershed:

> *"So, basically, the way to act with them is through agreements, right? So to carry out those agreements between administrative areas, with some of them having framework agreements, some umbrella agreements and [we, EPM] make some actions, some small contracts, some small actions where we say: in this umbrella project that we have, what does the basic agreement have? For these two entities the agreement has their functions and interests, we are interested in working together, for example, for the protection of the watershed supply, for the implementation of sanitation solutions, for subjects of environmental protection. And they begin to shape agreements for each of those subjects, depending on the interests that each may have. There are other ways of interacting that are more like guidelines…law, legislation plans, the action and management of the watersheds are those that tell me [EPM] what I can do in a specific basin. For the development and updating of those legislation plans for the watershed shape these "Concejos de Cuenca" [Watershed Councils]." -ID13*

In addition to governing bodies, there is also evidence that EPM provides input for land-use plans in collaboration with the metropolitan area (environmental authority "AMVA"), which are the high-level planning tools that guide development at a local and regional level:

> *"EPM participating in planning: Now, a thing that is called, that Empresas Publicas may participate, and the other thing to note down that Empresas Publicas likes, but at the least, it calls it and participates, and Empresas Publicas goes and participates. Yes, yes, there are good relations in this sense. The most difficult thing is when it does the part of the ex-planner, but also the environmental authority is more complex. I think that we can be very united, but…good. It's not that we are to be enemies, but that we understand each other more in planning." -ID11*

There is also some evidence of additional efforts for defining roles of different actors involved in a committee that are consistent with a mixed approach. These efforts define spheres of responsibility for implementing actions to enact for the protection and preservation of the water basins:

> *"The committee is at the level of the Área Metropolitana that has the 10 municipalities of the Área Metropolitana. So, it is a committee that is very active with doing reviews*

of the watersheds, they identify what are the areas where there are impacts, like how to determine, to define actions that they have to implement. For example, there are certain users that they sanction, then the environmental authority proceeds. Or it is a problem, for example, because we are the largest provider." –ID13

The previous examples provide evidence of mixed approaches that include various levels of governance such as a committee that includes the ten different municipalities. This committee conducts reviews, and the environmental authority applies that information to sanction. While the environmental authority seems to have authority, the authority (mandate) of the municipality, and shared responsibility, enables the environmental authority to carry out reviews. There are also references to a program, Pilas Publicas, which is a program to install public water infrastructure (community standpipes), is financed and implemented by EPM and requires approval for planning and implementation from municipal councils and communities themselves:

"But, in this moment on the theme of Pilas Publicas, what is the principal restriction that we have been finding or that we must do in order to reach these places? The fact is that the municipal administrations must do some approvals inside the town councils (on the whole scheme of subsidies and how they are going to allocate them) because it is not a format, the service is not formalized), but it is one way to provide the service differently, they must begin to say good, how are they going to help those communities to access the service in this way, because we say we can expand coverage." -ID9

There is also discussion of the relationship between EPM and the city as having shared responsibility. In the application of the Hobbesian social contract (7.1.3.1), there are features consistent with a top-down interaction, yet in some cases, there are more mixed features:

"I think EPM and the government have to work together because they have...shared resources...it is moving between them. EPM is giving and then receiving to reinvest so it has to work together and sometimes it is also because it is a public company…the leaders are from the government, and they elect the one [CEO] to lead EPM for four years so it is together." -ID24

There is also some evidence of how speakers perceive collaborations between EPM and communities within municipalities (generally speaking) that are consistent with the mixed typology. In this example, a representative from the public services authority discusses a planning strategy led by EPM yet with the community involved in strategies which emerge from efforts to come to an agreement:

"But, not only EPM but that when you get the municipalities, when you get the people, the community, that is a huge business system. So, what are the strategies? Sit down and listen to the people. In other words, literally one has to

sit down and listen. Yes, because it is the only way that, how we can come to an agreement. It sounds silly, but sometimes one comes with many things, like the law, but sometimes we have to listen." - ID13

EPM has a duty to provide services within the city's jurisdiction. The municipality also has a duty and responsibility to implement programs for the minimum vital (minimum amount of water) by law (decentralised from the national government) regardless of the level of formality of the jurisdiction. As EPM has the capacity, one effort that shares responsibility between epm and the municipality's need to fulfil its mandate, is Brigadas Comunitarias (See also Section 4.4) which is a program that provides support for infrastructure in places that do not have access:

"*Brigadas Comunitarias. So, there are zones in the city that are of high risk, that is the urban planning. So, the company cannot give them the service, it cannot give them the service where it says High Risk, it cannot give the service, but there there are people, and that people need water. So, there are some people, some volunteers that go and do installations and go to the the company and they give me a little help."- ID11*

7.4.2.2 Community-based organisations

CBOs discussed collaborations between different community-based groups that are consistent with the "mixed" typology. This includes examples such a community, Moravia, which oversees its own aqueduct with input from community members, an organisation collaborating with different communities to address issues concerning access to water in the context of challenges with community-based work.

7.4.2.3 Universities

There are few references by representatives from universities related to cooperation that were consistent with the shared responsibility feature of this mixed typology. Where it does feature is in relation to how the municipal planning office works closely with the different environmental planning authorities:

"The planning office, they worked very closely with the planning office, mostly with the universities...the employers, they eventually, we used to have 2 or 3 really long talks with public services, with which were financed by Empresas Publicas, and we don't work much with them."- ID25

7.4.2.4 Environmental authority

For representatives from the environmental authority, features of cooperation that are consistent with a mixed approach which includes descriptions of how a vision for governance in the city [Medellin] in the future could be. This is discussed in the context of a proposed

project to develop the land surrounding the Medellin River which has been put on hold. This project and cooperation's name, *Sociedad Parques del Rio*, is designed with a form of governance which features different interests, shared responsibilities and levels of participation with shares held by several different actors:

> *"Sociedad Parques del Rio and that company, it was in the creation of such a company that was included in the zoning plan. Like we're going to give them the ability to develop the city and to negotiate with developers and whatever and it's composed by the municipality, the metro system, has a 10%, the municipality has a 30%, EPM, is also there…"-ID14 Environmental authority*

The environmental authority discusses approaches to cooperation consistent with a mixed social contract typology. This is in reference to examples including the land-use management plan (POT) for the river as well as collaborative research with a Medellin-based university regarding pollutants, community-based water quality monitoring and educational programs. The environmental authority discusses contributors to the land-use plan as "working jointly" with the other environmental authorities:

> *"If, we for…for example for the subject of the plans, the Plan de Ordenamiento of the river, the management plan of the aquifer and the rest, we are working jointly with the other environmental authorities that have seats here in this territory, it's worth saying Corantioquia and Cornare. For them, with the support of the ministry, here in our country, the environment…"-ID15*

There is also evidence of collaborative research between the environmental authority (AMVA) and the Universidad Pontificia Bolivariana (UPB) that is consistent with the shared responsibility aspect of the mixed typology. This emerges from a mutual interest in the results of a study on colouration to inform regulation, particularly as there is not a standard in place related to water colour:

> *"There do not exist standards. In fact, at the global level, it is limited to what exists on the subject of colour. Here, the river has presented with alarming occurrences of coloration from the visual point of view, from the point of view of the landscape. Last year we made progress with an investigation with the academic sectors, with one of the most prestigious universities that is the Universidad Pontificia Bolivariana to deepen the knowledge of the variable of colour. And with what objective? With the objective of getting a regulation for the subject of colour, and to be able in a given moment to have elements to eventually impose an environmental sanction to those companies that discharge colour on the body of water. There I think that we have advanced a lot, it is a very good project, a regulation that allows us to be able to act, because at the moment as there is no regulation, so simply it appears to us very scandalous that there is dumping of colour on the body of water, but nothing we can*

do against those responsible because we do not have anything to do that. So, this has been a very good project". -ID15

When representatives from the environmental authority discuss examples consistent with the mixed typology and involve the municipal level, there is an emphasis on efforts to improve environmental education, general discussions about working with the municipality and multi-stakeholder collaboration of partners involved in implementing a sanitation plan for managing pollution.

With respect to environmental education, there is a description of agreements together with the environmental authorities:

"We are permanently strengthening the environmental education from the education from the implementation, we do through the universities. The most well-known universities in our system, we make inter-administrative agreements with them so that they go for all river basins, the little watersheds, sensitising people so that they do not throw solid waste, so that they do not throw garbage, so that they empower the micro watershed and care." -ID15

7.4.2.5 Municipal authority

There are some general comments about how epm and the city share responsibility for tackling problems. This is suggested in descriptions of EPM as an international company with leadership and authority distributed among its different subsidiaries:

"EPM is an international growth that now is working in Mexico, Chile. So EPM is 100% property of the citizens of Medellin, 100% property of the municipality and its profits, a percentage, about 30% of its benefits, goes to the mayor for social investment. So it supports the capacity of the city to solve problems. Not only to provide but also to development social services and development. That is really really important and special and particular to Medellin. And that means governance. How a society has been able to maintain a company like EPM and standing over the last 2 decades. Most of the companies like that in Latin America became privatized, how this society did to maintain, to keep EPM as a public company with a high quality of efficiency, that is very very important." -ID21

There is also reference to cooperation between groups in efforts during the transformation. This includes the Concerria Presidencial (See also Section 7.3.3) community workshops, the strategic plan of Medellin and Rio 2030 (See Section 4.4). Each of these requires different levels of cooperation, however there is evidence for agreements that share authority. The Concerria Presidencial, in particular is coded as a top down form of authority (from the national government) and features as a mixed form of authority, particularly because leadership was required from the bottom up as well as the top:

"This councillor, this Concerria, started to, do a top-down work and also started to do a bottom up. The Concerria was here working with the mayor, he was the president, the committee, normally this has been the job but they didn't do that. They were quite smart. They understood that the first phase of the process was the…they realized with NGOs, universities and social organizations. And we understood that soon that the goal was...the lack of development in barrios, inexistence of...there was not education, there was but not enough. There were problems with social services, health services (41:49). Without public spaces. Transportation was almost inexistence. So we understood that we have to create a kind of dialogue, social one, social planning with urban planning, institutional planning, altogether. So in a way, we have developed, an internal process, that starts with the people, the institutions, and with the urban (blank) it is not that public spaces, metro cables have been the basement of the solution, the solution has been the people and let me talk a little about that. My main speech even though I am an architect, and I love by our job, our contribution, I think the best thing that Medellin has done: is not about architecture or engineering. It is really important because that is how we can really "do" "make things happen." But the first thing is that we make a good diagnosis, strong agreements, and we create a social collective vision for the future. We inspire a generation of people about its future: against violence, against poverty, against exclusion, drug trafficking, terrorism, collective co-responsibility around social inclusion. A sort of positive conflict to create political transformation of the society. But not political in terms of political. Political in terms of people who live politics. We are political. –ID21,

7.4.2.6 Water user organisations

Water user organisations discuss cooperation at the level of the municipality that is consistent with the shared responsibility that characterises this mixed typology. There is evidence for this in how the speakers describe mayor-community policies for the minimum vital, municipal associations for protection of the aqueducts, municipal role in minimum vital and the requirements for the minimum vital in Medellin.

There is some reference to where shared responsibility is dictated through an explicit agreement that enables a specific outcome. In the example of the minimum vital, the mayor is the head of the municipality which has the responsibility to provide the minimum vital (outcome), which is enabled by EPM fulfilling its agreement:

"Because it is the municipality of Medellin that has to pay a certain part to expand the minimum vital. They have to have public budget for the municipality to pay to EPM for those people to have a specific quantity of water. It's not that EPM opens faucets and that's it. -ID6

There are also municipal associations for aqueducts that have cooperated as a multi-actor in the territory in order to share responsibility in working towards dialogue and agreements with the local administrations:

> *"So, in a municipality in Antioquia there are municipal associations of aqueducts, So in each path there is an aqueduct, so there are 15 divisions, 15 aqueducts, they strengthen an association in order to become a strong actor in the territory – but no in Medellin, in Antioquia – they strengthen in order to be an actor in the territory and they thus manage to establish a dialogue with the local administration, right? So, how through these community organizations, the state can fulfil the obligation it has? More or less there are other levels that have risen from scale to the point that there is a national network of acueductos comunitarios with processes for 5, 6 departments and there is a national network that is proposing a law, in other words, a law like a counterpart to Law 142, a law for acueductos comunitarios made by acueductos comunitarios. So there is a process of resistance on one hand, but also proposed at the level…"-ID5*

There is also evidence of the municipality sharing features with the "bridging" actor role introduced in Chapter 4.1 and featuring in Section(s) 4.4.1, 4.5.3 and 5.1, which facilitates cooperation between via minimum vital which is between the service provider and the communities:

> *"Municipal role in minimum vital: The government takes the position a little more of consensus, because there began the policy of the minimum vital for potable water, prepaid energy, all that, like trying to maintain the balance between the service provider and the communities;" -ID5*

The Lockean typology of social contract theory highlight examples where mixed approaches to governance feature and where shared responsibility may emerge from necessity. This seems to feature most prominently in examples where there is a shared interest by state and non-state actors (watershed councils), capacity deficit where the state requires additional expertise (examples in collaborative research, input for land-use planning) and where communities are aligned towards a common goal order to move towards a particular objective (ie pilas publicas, acueductos comunitarios). In these examples, there is evidence of sharing of responsibility through an agreement (a form of social contract). In some examples an outcome is enabled by this agreement (the minimum vital) or new relationships are formed between the state and the non-state actors. In none of these examples, is there an absence of the state or a withdrawal of state responsibility. To that extent, the Lockean social contract shares characteristics with the top-down approach specific to the role of the sovereign. The characteristics differ to the extent that the other parties seem to demonstrate greater agency as participants rather than recipients.

7.5 Application of Rawls' social contracts (bottom up)

Bottom-up typology of social contracts as they feature in monocentric and polycentric arrangements

The ‘Rawlsian’ or bottom-up authority follows the same logic for applying the social contract theory described for identifying features consistent with the “top-down” and “mixed” typologies. However, in this case, the agreements originate from the ground up (from communities) and identifiable by evidence of different groups working together to build the system of governance. These examples can include single and multiple authorities. In some respects, there is an extension of the Lockean Hydro-Social Contract and develops as an explanatory tool to complement the existing theory on applying social contract theory in the water sector (See Section 2.7). The Rawlsian application of the social contract theory shares aspects with the Lockean typology and while also emphasising the importance of a system that is interconnected with different groups learning together, sharing the same challenges, goals etc., which is critical to reaching a goal.[11] To be considered "bottom up," there are examples of one group or many groups using bottom-up processes where groups learn that they are better off working with each other rather than against one another. In this typology is an embedded understanding by coordinated groups in governance where "men agree to share one another's fate" (Rawls 1985). In any of these examples, there is an understanding of the social contract which is a form of social cooperation: defined as guided by publicly recognised rules and procedures for which those cooperating accept and regard as properly regulating conduct. Cooperation in fair terms includes the idea of mutuality (as described in the Lockean social contract) and political justice (Rawls, 1985).[12]

7.5.1 Criteria for inclusion as “bottom up”

Criteria to for consideration as a “bottom-up” form of the social contract includes evidence from the different stakeholder groups which come together to build (create) a system of

[11] This is also consistent with features of adaptive systems and adaptive co-management of systems.

[12] Based on two principles of justice (from justice and fairness) for how basic institutions are to realise the values of liberty and equality, more appropriate than other familiar principles of justice, appropriate to the nature of democratic citizens (227). Certain arrangement of the basic structure, certain institutional forms, are more appropriate for realising the values of liberty and equality when citizens are conceived as such persons (two organising principles:

1. Each person has an equal right to a fully adequate scheme of equal basic rights and liberties, which scheme is compatible with a similar scheme for all. 2.

2. Social and economic inequalities are to satisfy two conditions: first, they must be attached to offices and positions open to all under conditions of fair equality of opportunity; and second, they must be to the greatest benefit of the least advantaged members of society. (229)

governance (insert cross reference) There may be features that resonate with the Lockean application of the social contract theory, however, to be considered Rawlsian, the bottom-up approach should be consistent with an acknowledgment that it is in each groups interest to work with one another rather than against (insert cross-reference). See Section 2.7.

7.5.2 Summary of results relating to bottom-up approaches

Half of the stakeholder groups describe features of many groups (polycentric) with decision-making power consistent with a bottom-up model. Public services, CBOs and the municipal authority mention the role of EPM in a mixed authority capacity (with the city) in relation to subsidies for the minimum vital, planning and political involvement).

In examples where the community is exclusively responsible for their level of delivery, participation of groups like Junta Accion Communal (JACS See Section 4.4.1) together with other community-led cooperation efforts shows consistency with the bottom-up approach. JACs serve as a form of "bridging actor" (introduced in Chapter 4.1 and featuring in Section(s) 4.4.1, 4.5.3 and 5.1), between the community and the company and enable agreements between communities and various other stakeholder groups. CBOs specifically reference Moravia (its construction and provision of its services and La Mesa Interbarrial). Universities mention *SIATA (El Sistema de Alerta Temprana de Medellin, Alert System* (see Section 6.3.2) citizen-led monitoring platform. Environmental authorities and public services do not mention any examples of this typology.

There are other instances where examples are consistent with the bottom-up approach and feature multiple groups (polycentric arrangements). They are referenced by public services, universities and water user associations in reference to the different actors involved in the provision of services. CBOs and water user associations discuss *La Mesa*, which represents different groups disconnected from utility and social services. There are some examples where a representative describes a single authority that has features consistent with the bottom-up typology. However, these groups tend to include several other groups whom they represent. Representatives from EPM describe Junta Accion Comunal (JACS See Section 4.4.1) and communities managing the provision of Pilas Publicas (public stand-pipes installed by community volunteers). Universities also describe the role of illegal groups as influencing access to services in a manner that is more top-down (Section 7.3.3.6), however, further

investigation is required to understand to what extent this constitutes creating other forms of governance.

The public service company EPM refers to forms of cooperation consistent with bottom-up approaches in relation to where many groups are involved in decision-making across different governance levels. This form of cooperation mainly in the community, neighbourhood and municipal level in examples such as acueductos comunitarios and their relationship with EPM, Juntas Accion Comunal (JACS) and their management of Pilas Publicas. See Section 4.4.1 for a full description of the role of JACS.

7.5.3 Community-based organisations

There is substantial evidence for bottom-up authority in places particularly where there are sometimes only independent water providers such as community aqueducts *(acueductos comunitarios)* which in some ways are engaging/may have to engage with the municipal department for public services (Secretariat de Servicios Publicos):

> *"But we are not the only provider of services in the municipality of Medellin, there are some acueductos veredales that are more in the rural zones. So, there is an identified problem, for example, some conflicts on the use of water that can begin to influence some of the las secretarías de servicios públicos."-ID13*

There is also evidence of different groups working jointly which suggests a recognition that all groups are better off working with each other than against – where social cooperation features as the basis for achieving a form of justice. The Junta Accion Comunal (JACS see Section 4.4.1), plays this role in representing the interests of the different localities:

> ***"****Yes. Within Colombia there is a thing that is called La Junta de Accion Comunal. La Junta de Accion Comunal is like the community that organizes and nominates a leader, and that leader comes and speaks with the company and such, no right? So, it is like a mediator, it is that, like a communicator, a bridge between the institution and the community. So, there are some work contracts that they do, they execute them through those Juntas Accion Comunal. I can't remember how it is called right now, but this other section…you were going to ask me the same thing to the other person and she can tell you…"-ID11*

This bottom-up typology features in the provision of services and their role together with EPM in installing local water access points where there is currently a gap. These "Pilas Publicas" are managed and installed by volunteers which the JACS coordinate:

> *"Junta Accion Communal and communities managing the provision of Pilas Publicas [public standpipes]: So, for example for some places, in this moment it is considering a program called Pilas Publicas, and this program has a different way of providing the service. Maybe in some conditions we say, normal that we have in this moment to construct big infrastructure, but practically through a general meter and the*

communities can be able to stick to this meter and that would be la Junta de Accion Comunal – that is an association (trade union) that has the communities to manage the supply of water there."- ID9

Where this features as only bottom-up (and not in relation to a single or multiple authority), is about one group where JACS is a participating organisation. Other general references include bottom-up approaches that are specific to informal development of neighbourhoods, sanitation in informal neighbourhoods and efforts to help communities develop the networks they need. Social cooperation in these examples appears to be one way to fill a gap where there is neither a state fully present in water management nor evidence of top-down and bottom-up efforts based on mutuality and shared responsibility.

Community-based organisations discuss bottom-up approaches about groups working together to provide a system that delivers water services. For example, Moravia (constructing water infrastructure itself, providing its services and facilitating connections to the water network) supported by *La Mesa Interbarrial de Desconectados* (Section 6.3.5). While more detailed information requires further investigation beyond the scope of this study, Moravia offers an example of bottom-up governance which extended, to the provision of its services, namely water and electricity:

"Good, what happens in Moravia is that it is a neighbourhood that was constructed by the same community, so for a long time the public services here were constructed in a communal manner, a rudimentary manner because the state did not have an intervention here."- ID10

La Mesa Interbarrial de Desconectados (Section 6.3.5) also serves as an actor that has long advocated and empowered communities such as Moravia to work together in a manner that is consistent with a bottom-up approach:

"Look, that does everything. Yes, the Mesa Interbarrial does everything: accompanies the communities in training leaders, a school for leaders, has a school for leaders where they teach people how to understand and read their utilities' bill, because of the prepaid cards." -ID10

7.5.5 Municipal authorities

Where municipal authorities discuss single authorities involved in bottom-up approaches concerning how understanding and accounting for informal housing settlements in formal land-use plans. Workshops to provide input to the land-use plans (POT) provide evidence of an approach to planning where there is a mechanism for facilitating participation of different groups, input from the bottom-up in the design of the land-use plan:

> *"Because we did an international competition, the POT was discussed, with the public and all sectors. Can you imagine for instance a call with the private sector, stakeholders where permanent workshops with us and the public office to evaluate the feasibility of the projects. We offered them the regulation proposal and they evaluated it. So we took decisions with the responsibility of understanding that we have a POT for all." -ID21*

There is some evidence that future legislation for informal settlements is consistent with a bottom-up governance practice by a commitment to incorporating some cooperative practices already existing within the settlement:

> *"To innovate in the law and regulation that permit the community to cooperate some of the processes they use as well and to cooperate the time in the process. So how to build those kinds of solutions. I think the only way is work in a collaborative way. So I am...this is one of the reason because I am saying workshops in relation with community, experts and relationships between experts and the government and the workshops where altogether to modify and bring an agenda that is possible, not ideal and incorporate the culture of the local conditions and itself how the process became a pedagogy process because it is very important that the community learn to occupy...they themselves...it is possible that the government control everything in this part of the city." -ID22*

Similar to the perspective of representatives from public services, many of these examples are references to managing the informal settlement of the land.

7.5.6 Water-user organisations

Water-user organisations refer to single authorities and bottom-up processes that would be needed for the creation of the national law and legislation for community water providers (acueductos comunitarios): "*For that we are proposing a law at the national level because the change that is needed is structure, right? You can change at the local level, not in Medellin because EPM is…"-ID5*

and

> *"Things can be achieved at the local level, depending on the mayor in office, but so it's very fragile, you always have to be defending them, making them follow up ie. It requires an effort of resistance to remain strong, right? Because it is contrary to a structure that is on the other side toward privatization. Then, clear, we work from the local, but we also know that is needed is a change of structure, and so the question of what the legislation for acueductos comunitarios."-ID5*

Otherwise, the majority of bottom-up processes are in relation to community water providers (acueductos comunitarios) functioning independently of EPM and in relation to EPM:

> *"So, with the communities, with the acueductos comuniatrios there is a process of resistance and of proposal. And in Antioquia, and EPM, we are like the symbolic or emblematic case of resistance to privatization."- ID5*

There is also a further description of the scope of *La Mesa Interbarrial de Desoconectados* (6.3.5) that gives evidence that it is consistent with different groups coming together to build a system of governance. Specifically in this example, this includes strategising with communities and neighbourhoods as a collective array of many groups involved for an alternative way of governing:

> ***"****La Mesa Interbarrial de los Desconectados – like I was saying – is not only limited…they have a difference with regard to Penca de Sabila, because Penca de Sabilia is limited to thinking about the…" the defense of water as a public and fundamental right." The community…La Mesa Interbarrial de los Desconectados, on the other hand, goes further there. They say: "it is a matter of…the city, a housing issue. It's not only about a minimo vital of water, but a minimum vital of conditions dignified for living. Therefore, that implies living in a neighbourhood located in zones that are in other words, zones of high risk, counting those with water and sanitation supply, counting those with electricity, and counting also with those programmes that improve the city, that also are improving the roads, improving the security, everything – so…"- ID3*

There is further evidence of the role of municipal associations and the success of consolidating community water providers (acueductos communitarios) as an actor from the communities which also provides evidence of bottom-up approaches:

> ***"****As far as good practices, what I told you is from experience in advocacy on public policy. That is to say, accompanying acueductos comunitarios that have been a part of municipal associations and with the support of the organization have managed to build a project and support of everything they had done until it was approved. There are public policies for acueductos comunitarios in different municipalities, in Girardota, La Union and Tamesis, above all. That experience of success is in the sense of being able to consolidate acueductos comunitarios like an actor in the territory and effectively influence public policy to reach it achieve this. –ID5"*[13]

[13] Further quotes supporting the role of municipal associations in governing from the bottom-up: "And we are even encouraging it in other places. And these cases of municipal associations, i.e., that several community aqueducts be a part of an organization of second degree, and that are consolidated as an actor, has also served to generate resistances in the municipal councils for the approval of certain public policies affecting them or to articulate with other territories, or even articulated resistances as mining , because the same community aqueducts are the first to account of the water sources are, how they affect, then they are also articulated to other resistances. It has been a success achieved by having removed the community aqueduct of the sidewalk, with its community, there hidden, and visualize it and articulate it among themselves and other actors. Even this

The bottom-up approach to governance within these different arrangements appears to occur where there is an absence of the state in water management or where the state necessitates input from the communities in order to best reach a stated objective. This is particularly the case in the provision of Pilas Publicas and inquiring for input in land-use planning and or formalising informal neighbourhoods. For the latter, the bottom-up approach is specific to the data input stage. Community water providers (acueductos comunitarios), advocacy groups such as Penca da Sabila (Section 5.5.6), and organisations that mobilise around rights related to access to the city (*La Mesa Interbarrial de Desoconectados* (Section 6.3.5) tend to have the strongest bottom-up efforts. These feature where there is currently limited to no involvement by the state.

job takes at least ten years, right? Since the referendum by water, community aqueducts emerge - to put it in some way - as an important actor, and in these ten years has consolidated the national network of community aqueducts, we have national meetings, have already had two public hearings in the Congress demanding "the acueductos are there", "we exist, we violate and demand such matters and propose other issues." Then, this whole process can be identified as a success story.

7.6 Key Messages: A complex landscape for water governance through the lens of the social contract

7.6.1Summary applications of all social contract typologies

The application of social contracts features in approaches to cooperation that are “top-down” “mixed” and “bottom-up.” This analytical lens of social contracts contributes to an explanation of how representatives from the different stakeholder groups perceive cooperation within the system. In this case study, the variety of social contract typologies is not exclusive to a system where many authorities (polycentric) or single authorities (monocentric) dominate, however, includes a dynamic and malleable application of social contracts that adapt to necessities and capacities of the different actors. A system wherein a social contract can take various forms suggests that there is a complex narrative within a system that suggests this malleability. While Chapter 8 discusses malleability in greater detail, malleable refers to the capacity of governance to incorporate different modalities. Traditionally, malleability would refer to hybrid forms of governance. However, these findings suggest that malleability, and malleable governance more broadly, is associated with adaptive governance in complex resource regimes (Gross 2017).

Box 3 summarises several messages and questions from this presentation of results that emerge from this complex landscape for water governance.

Box 3 Key messages on the landscape for governance through the lens of social contracts in Medellin, Colombia

1. **Speakers describe the system primarily as having features consistent with a top-down form of cooperation (through single and multiple authorities) with mandates to deliver policies at national, regional and local levels.**
2. **Land-use and watershed planning has features of top-down and mixed cooperation between the environmental authority, metropolitan area (AMVA) which at the urban level operates a single authority and other actors. When cooperating jointly with other regional authorities as a "multi-authority," there tend to be more forms of mixed cooperation.**
3. **Where there are features consistent with top-down forms of cooperation led by a single authority, there seems to be a continuity in governance over time. These features are found in examples such as 1) EPM's mandate to provide water services and 2) land-use policies set by the environmental authorities that are largely autonomous from political interference.**
4. **Where mixed approaches to social contracts feature, it is about river and water shed conservation that require governance from different expertise and across different jurisdictions, providing services and infrastructure (pilas publicas) in the informal settlements and in expanding access through efforts like the minimum vital.**
5. **Bottom-up approaches to cooperation are more prominent in efforts where neighbourhood councils (Junta Accion Comunal) interface with the municipality or EPM, citizen-lead water monitoring platforms (i.e. SIATA, Piragua) as a 'bridging actor' or 'enabling actor'. It also features in the work of water user associations that advocate for the rights of those disconnected (either who had access and disconnected or residing in informal settlements where there is currently no access).**
6. **The different approaches to social contracts vary by plan, policy or project, seemingly generating a process for governance which can take various forms alongside the different forms of regime characteristics.**

There is evidence from this snapshot of the system of governance that the different approaches used by authorities within the system include established necessities for social cooperation (Social Contracts 2.7). At the same time, the different applications of the social contract to this system of governance inform conclusions about how cooperation operates in this system. 11 visualises the forms of social contracts (as arrows) that can occur within the different arrangements (polycentric, nested arrangements and monocentric). Like the governance arrangements, the social contracts can be top-down, mixed or bottom up.

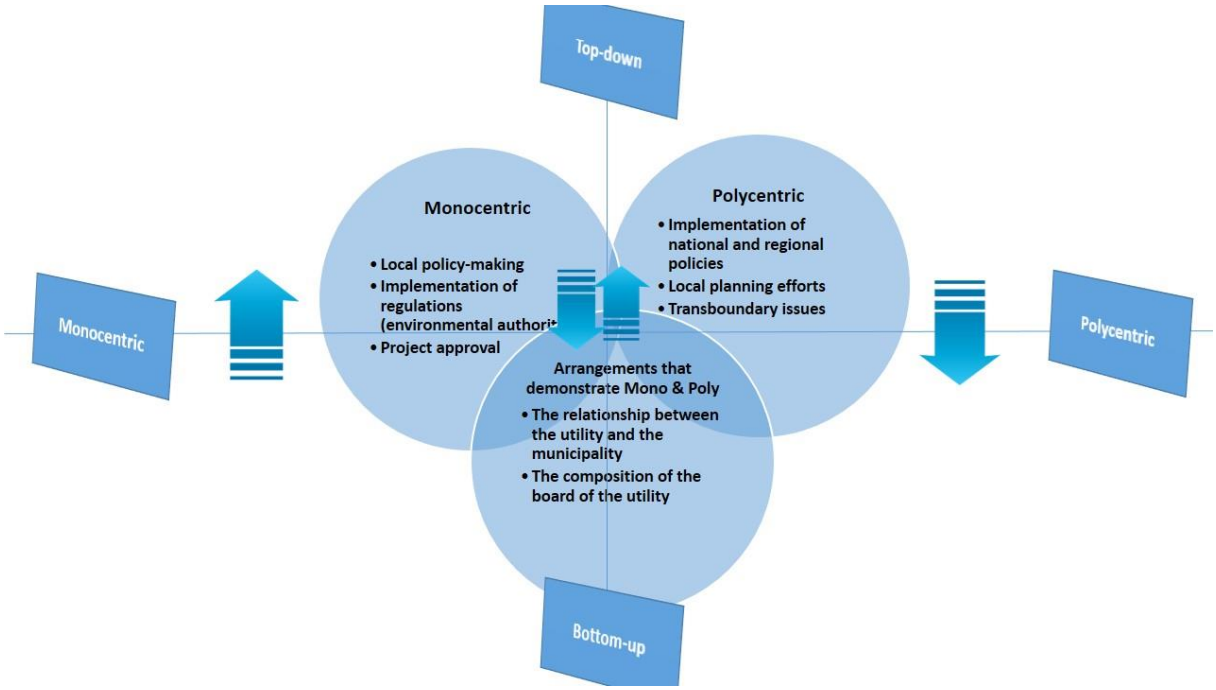


Figure 11 Regime characteristics and forms of social contracts in a complex resource system (water governance in Medellin, Colombia)

This portion concludes Part II which includes the results' components of the thesis presented in the form of 4 chapters. Chapter 4 presented the evidence for the water sector as an example of adaptive governance (verifying the assumption for a theory relating performance to the characteristics of the system of governance). Chapter 5 and Chapter 6 presented evidence of the characteristics of the system of governance (polycentric) and (monocentric and nested hierarchies). Chapter 7 took the findings of Chapter 5 and Chapter 6 and examined the landscape of governance through the lens of the social contract. Chapter 8 discusses conclusions related to cooperation within the system in light of results from this chapter (Chapter 7) and findings Chapters 4-7 in relation to the macro question of what an adaptive governance lens offers for constructing cooperation within a complex resource regime. Chapter 9 includes a summary of conclusions, contributions to research, strengths & limitations and further questions that these results generate. These findings and implications will be discussed further in Part III.

Part III

Chapter 8: What can a lens of adaptive governance offer for tackling the challenge of cooperation in a complex resource regime using the example of water resources?

8.1 Summary

This chapter will present the main findings in the context of water, environmental governance and the wider governance literature.

This chapter discusses how “malleable governance” emerges from a reflection on the collective results of Questions 1, 2 and 3. The chapter begins first discussing where findings from the individual research questions are positioned in relation to the environmental governance discipline and governance literature more broadly, highlighting where findings confirm, challenge or amend understanding of adaptive governance from the perspective of Medellin. The chapter then discusses where “malleable governance” emerges as an interpretation of these collective findings, the implications for understanding adaptive governance in the Medellin context, governance design in the water sector and for complex resource systems more broadly.

Research questions 1, 2 and 3 explore to what extent the Medellin case study is consistent with features of adaptive governance in order to tackle the broader research question of what an adaptive governance lens offers for tackling challenges related to cooperation in complex resource regimes?

1) To what extent is the Medellin case for water governance consistent with a definition of adaptive governance?

2) What types of regime characteristics does this place have? In this example, to what extent does it confirm or challenge a polycentric form of governance?

3) What/how are the arrangements between the different stakeholders organised? To what extent do they confirm or challenge social contract agreements?

The following three sections will discuss these findings in light of the literature on governance in resource regimes (water and environmental governance) and the governance literature provided in Chapter 2.

8.2 What does the adaptive lens provide for understanding governance in a resource regime and governance within social-ecological systems?

Chapter 4 provides evidence that the Medellin case has features strongly associated with a view of adaptive governance put forth by Rijke from ecology and environmental science which provides a reference for dialogue with the work of water governance thinkers such as Bakker, Furlong, Swyngedouw and Rogers. In tackling Question 1, there was evidence for integration of water in environmental, land-use, housing, social policies and plans in plans and planning activities with the participation of the watershed councils (Concejos de Cuenca), citizen congresses (Congresos Ciudadanos) and the planning survey (El Sisben). The chapter also provides tools and governance mechanisms (Table 7 & 8) such as the Juntas Accion Comunal, Congresos Ciudadanos, the joint commission for managing water resources, joint platform for river recovery, the board composition of epm and guidelines for how the city and epm interact provide examples of how to facilitate spaces for stakeholders to engage which provide evidence consistent with an adaptive system.

These findings are consistent with literature from ecology, engineering and environmental science which position an interpretation of governance at the intersection of social and ecological system. Particularly in the case of the planning survey (El Sisben), water is integrated holistically in the system for distributing subsidies such as the minimum vital (the minimum guarantee of water) through an integrated planning mechanism that takes into account social factors in providing allocations. A system that is able to integrate water in social planning in this way provides evidence for an association with adaptive governance. Further areas for discussion in the wider literature on resilience and adaptive capacity in social-ecological systems. The historical context in which these different integrated planning emerge is both from the 1950s where rapid population growth was tackled through integrated and joint sector approaches as well as the transformation period from the 1990s to the early 2000s. Integrated strategies and planning are related to a historical and cultural context where cooperation across sectors is required to meet the demands of a growing city and where agreements between different organisations were essential for rebuilding the society (See Section 3.1). The transformation was driven and dominated by efforts of actors and action by civil society to restore the city, which provides a possible explanation of the context in which different stakeholders learned, created and participated in the system of governance. From an ecological perspective, the integration of planning is consistent with a view of resilience as

how a system develops in the face of change (Folke et al. 2003). As these efforts include integration of social, environmental, land and housing policies and plans, this tradition of integrating social, environmental and economic benefits is situated in the historical context of epm's history as a key actor in building the city, namely through standardising housing and connecting services.

The evidence also includes explicit mechanisms for stakeholders to engage across and within organisations which run counter to as a view of resilience as how a system develops in the wake of change, provide consistency with a view of resilience commonly held in engineering of resilience as how a system returns to equilibrium in light of change, maintains constancy and efficiency of function (Berkes, Colding, & Folke, 2003; Ludwig et al., 1997, Pimm 1991).

Evidence of mechanisms which provide opportunities and spaces for stakeholders to engage provide support for a reconsideration of this way of thinking away from "the return to equilibrium" and towards how a system handles change in an adaptive manner in institutions and regimes (Young et al. 2006 quoted by Duit et al. 2010). Of the tools and governance mechanisms (listed in Table 7 & 8), the Juntas Accion Comunal provide an example of a bridging and continuous actor in the system of local governance in Medellin that has linked communities with formal planning units before, during and after the transformation, yet has adapted its role as the needs of citizens and challenges have changed. This contributes to examples that show where resilience gives rise to adaptive capacity (Smit & Wandel 2006) and how resilience is the capacity to persist in the face of change.

Considering resilience and adaptive capacity for social-ecological systems places an emphasis on examining cross-system interactions and dynamic social-ecological systems (Duit et al. 2010). The focus on integration of planning activities and mechanisms for stakeholder interaction provides examples where these interactions occur. Given the transformation and periods of rapid change that Medellin underwent, examples like the role Congresos Ciudadonos, show how actors within the a social ecological system participated in planning through changes (such as the transformation) or where opportunities were created for self-organisation (such as the strategic plan for Medellin which was led through a participatory process beginning with the Congresos Ciudadonos).

8.3 What does the adaptive lens provide for understanding regime characteristics within a governance design?

Tackling Question 2 (Chapter 5 and 6) shows to what extent the regime characteristics of the Medellin case are consistent with regime characteristics of an adaptive complex resource regime. This section summarises and discusses these findings in light of the literature on regime characteristics within a resource regime.

Chapter 5 includes examples where primary characteristics of polycentricism (multiple authorities, overlapping jurisdictions, coordination across scales and knowledge sharing) were identified in the data. This includes descriptions such as the relationship between city and epm, the environmental authorities convening a management committee for the aquifer and efforts for river recovery. Chapter 6 provides examples which are consistent with characteristics in monocentric governance such as single authorities with specific institutional jurisdictions that often operate in a hierarchical manner. This includes examples such as the relationship between the city and epm as the owner and the environmental authority issuing water use permits.

Chapter 5 presents the governance design as having different authorities with overlapping jurisdictions in activities related to planning, implementation and knowledge sharing. These features in the governance design are consistent with polycentric governance which was formally introduced as a system of "many centres of decision-making which are formally independent of each other" (Ostrom et al., 1961 cited in (Aligica & Tarko 2012). What we find in examples such as Nuestro Rio, a multi-stakeholder agreement to protect the water source, is many centres of decision-making by different organisations participating in the broader network of governance. Where it shifts from thinking on polycentric governance is in examples such as the relationship between epm and the city, where these centres of decision-making are not always formally independent of one another. For epm and the city, decisions about investments locally are done separately by the municipality from investments abroad which are conducted separately from the municipality. For aspects such as expansion of water services, decision-making involves many overlapping jurisdictions with different actors often acting jointly. Instead, there are multiple authorities with overlapping jurisdictions which is consistent with the application of polycentricity as an arrangement found in adaptive systems (Pahl-Wostl et al. 2012; Pahl-wostl 2012; Pahl-Wostl 2009).

Chapter 5 is challenged by findings in Chapter 6 which shows examples of where the adaptive governance system of the water sector in Medellin is consistent with aspects of a monocentric governance system. Chapter 6 includes cases, where single authorities (AMVA) and authorities nested within a system (EPM company-city) are dominant. These single authorities are associated with integrated planning efforts and mechanisms for coordination, which are features of an adaptive governance design (Section 4.1).

For adaptive governance and the performance of environmental governance regimes, these findings from Chapters 5 and 6 suggest that the governance design in Medellin is complex and includes elements of polycentric governance, monocentric governance with a broader, complex system. For examples such as EPM-city and the environmental authority, the perspectives from stakeholders suggest that these actors can be polycentric, monocentric and nested arrangements under different circumstances.

The presence of these different regime characteristics demonstrate that a governance design emerges from a context and presents a method for describing the coexistence of these different modes of governance, rather than prescribing a model for governance. The methodological approach and theoretical framework of adaptive governance provide a process for identifying the characteristics of the regime that are consistent with theories of adaptive governance. By including a data-driven component in the method, the analysis also provides an opportunity for identifying and investigating features that challenge assumptions of how an adaptive system is designed. For Medellin specifically, monocentric constructions of governance are closely associated with integrated planning and mechanisms for cooperation which features strongly in adaptive systems (Termeer et al. 2010). Through undertaking a process of identifying features of polycentricity and where these features are challenged, we are able to account for "the complexity within a system related to the range of institutions and their relationships and relative importance of formal and informal institutions actor networks with an emphasis on the role and interactions of state and non-state actors, multi-level interactions across admin boundaries and vertical integration and governance modes" (Huitema et al. 2009). The capacity of the governance system to enable coexistence of these different modes of authority is consistent with an adaptive system and a form of governance that will be discussed further in this chapter in light of the findings and broader literature.

8.4 What does the adaptive lens provide for understanding social contracts within a governance design?

This section summarises and discusses the results to Question 3 (Chapter 7) in light of the literature within environmental and water governance related to social contracts. Chapter 7 explores to what extent cooperation within the system is consistent with social contracts as presented through the lens of hydro-social contracts (Lundqvist) and an application of Rawlsian social contracts using the theoretical framing of Lundqvist.

Chapter 7 tests to what extent the Medellin case is consistent with the social contract typologies considering findings from Chapter 4, 5 and 6 (regime characteristics and adaptive features). The chapter presents the Medellin case as a complex coexistence of top-down, mixed and bottom-up forms of cooperation that involve multiple and single authorities. These different forms of cooperation may occur at the same time among the same actors and adjust due to capabilities and changing circumstances.

This approach allows for identifying aspects of social cooperation that link to the original thinking behind social contracts as forming out of human necessity to cooperate. Examples such as the municipality overseeing the implementation of national subsidy for the minimum vital, which is consistent with the Hobbesian hydro-social contract where the government has a strong central power in which citizens give power over in exchange for the state assuring prosperity. As Lundqvist applies this framework in the context of evolving systems, an interpretation suggests that these hydro-social contracts are in fact linear. This would mean that the Hobbesian one would evolve towards a Lockean hydro-social contract where governing has a sharing of power of formal and/or informal agreements between the government and the public. What the next section describes is that by identifying features of each of these social contracts which are occurring within the Medellin context, there is evidence that there are different forms of these social contracts that exist at the same time, and in some cases, an institution may have multiple forms of each contract.

In the relationship between the city and the utility company EPM for example, there may be a top-down form of cooperation for connecting new water users to the existing water network but at the same time there may a social contract for cooperation that is more mixed, for planning a long-term infrastructure strategy. The social contract for cooperation can therefore

vary based on the set roles and responsibilities of the city and the company or human and capital capacity as these change over time.

The environmental authority, AMVA, provides an example of an entity that operates as a top-down and more mixed authority when part of the collective of autonomous regional authorities (Section 4.5.3) and as a single authority in relation to other actors in the system. When analysed individually, these arrangements between actors demonstrate that there are different social contracts for cooperation occurring at the same and are flexible, or "malleable" to the context and the needs therein. This attribute will be discussed further in 8.4.1.

The application of hydro-social contracts from the lens of Lundqvist contributes to literature on social contracts within the water sector and beyond the water sector within resource and environmental governance. For literature within the water sector, the findings related to the combination of top-down, mixed and bottom up approaches echo Furlong's call for an attention to the societal issues that are common to public and private models alike (Furlong 2016). In exploring the different arrangements of social contrasts, there are examples such as the epm-municipal service provision model that include top-down, mixed and bottom up arrangements internally and with other groups with whom they partner with. This is an example of a shift from dominant, constraining binaries which scholars in the field of alternative service delivery model have been exploring. What this specific case study provides is insight from speakers regarding the role of local government where knowledge of this form of model, and the process for exploration, can provide examples of the governance arrangements required to achieve it (Furlong 2016).

In light of interdisciplinary work examining proposals for hydro-social contracts by Wong, Brown and colleagues, the typologies that emerge from their work also chart an evolution of social contracts in the water sector through typologies ranging from the water supply city which has a focus on water supply access and security through to a water sensitive city which focuses on intergenerational equity, resilience and climate change (Wong et al. 2011; Wong & Brown 2009; Brown et al. 2009). Wong's work takes into account the complexity of the social and ecological system in the water sector is contextualised using an interdisciplinary approach. What the findings from this application of Lundqvist as well as Wong's application confirm is that these social contracts are not always evolving but instead are a continuum of

socio-political drivers and service delivery responses. While Lundvist's approach was applied because it was adapted for water, based on the political and social origins of social contract theory, and therefore could be discussed in relation to other sectors where social contracts have been applied, Wong's work serves as a reference for the type of social and institutional factors that would underpin paradigms for sustainable water management.

Beyond the water sector and wider participatory, resource and environmental governance fields, what the social contract findings offer is a case example of how social dilemmas related to cooperation in global environmental issues can be explored. Complexity from a participatory governance perspective arises in relation to several changes including the proliferation of different political actors such as civil society organisations and the unequal and asymmetric relations of power. Mapping different actor relations as top-down, mixed and bottom up such as the relationship between the environmental authority and service delivery projects (top-down), epm and the municipality (mixed), Juntas Accion Comunal (bottom-up) aid in deciphering this complexity. Understanding the direction of authority and the way in which local governance can be created with groups working together to build a governance system (bottom-up), also provides a way of navigating environmental politics and community development where civil society is a site for governance (Fischer 2004). While these social contracts are simple in the directions of authority identified, the Medellin context offers a case-based, local example where an exploration of participatory governance in relation to transformative power and the potential for decision-making processes conventionally dominated by hierarchical and top-down state structures, to be opened up to new social actors (Chhotray & Stoker 2010).

8.4.1 Collective findings: Shifting view of governance within a resource governance and beyond

This section discusses what these findings collectively contribute to understandings of governance within a resource governance area of study and in context of the wider governance literature.

The coexistence of both polycentric and monocentric forms of governance and the different types of social contracts within a system of adaptive governance suggest that the view of governance in the Medellin context accounts for this diversity of governing arrangements and the capacity to have multiple arrangements. This contributes evidence for understanding governance in this context as "malleable." Malleability suggests that actors can exhibit

multiple arrangements of authority (single or multiple) and have different forms of social contracts which occur between the same actors. This suggests a form of malleable governance - which comes to represent the form of adaptive governance in the Medellin context. To develop another typology upon malleable governance to express this interpretation of the collective findings, requires a systematic approach to researching this question which will be discussed again in Section 9.5. The adaptive governance lens in this case provides a means for identifying the coexistence of different forms of authority and the different forms of social contracts which resonate with an understanding of malleable governance and draw from theoretical framings from social and political thought (Gross 2017).

The findings interpreted through a lens of malleability for findings from Chapters 4-7 collectively indicate that for governance in adaptive systems, malleable governance enables a system to have multiple arrangements that evolve based on the needs and capacities of its given context. Figure 9 visualises the regime characterstics (polycentric, monocentric and nested arrangements) and social contracts (top-down, mixed and bottom-up) from chapters 5-7. The figure shows that the different modes are relative and in states of flux and that the different regime characteristics and social contracts are also in a state of flux (long curvy arrows). This is consistent with an understanding of malleable governance.

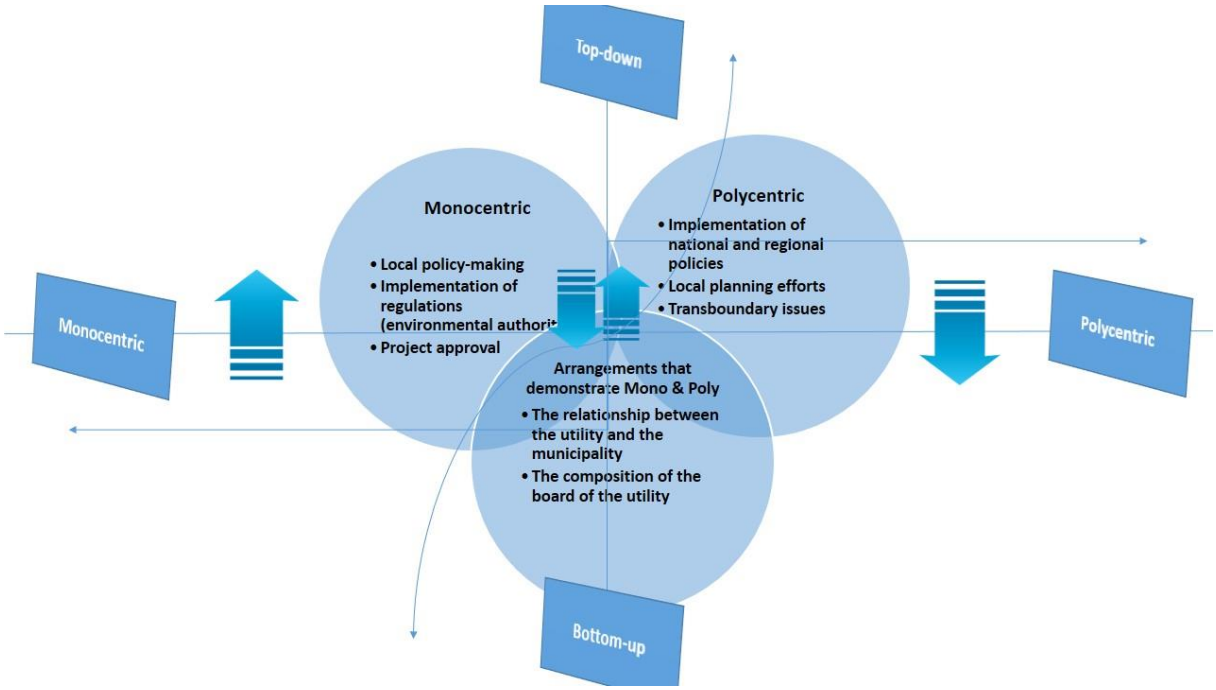


Figure 10 Regime characteristics and social contracts in a malleable governance system (water governance in Medellin, Colombia)

8.4.2 Further areas for development

To develop this definition in future research (Section 9.5) and in an approach consistent with understanding this from environmental science and from political science, these findings position malleability for complex resource regimes as also consistent with a political and social view of governance as described in the *Discourses* by Machiavelli (Machiavelli ed. 1983). In this view of governance, the "sovereign" is a leader who knows when to lead and when to follow. Adapted to the context of a complex resource regime such as water in Medellin, a "sovereign" adopting different roles could refer to governance at an institutional and systemic level adopting different roles and forms of cooperation at different times, in response to different needs. A consideration of this sovereign from the perspective of Machiavelli's *Discourses* can serve as a metaphor for the coexistence of these different social contracts in a form of malleable governance (Machiavelli ed. 1983). An application of malleability and the *Discourses* with further testing could refer to a collection of regime characteristics, and social contracts that are operating within a system departs substantially from the standard technical and technical understanding of what governance is and how it functions within a society.

To set up a question for future investigation, the processes within "malleable governance" could be explored further using the *Discourses* as a governance typology that includes the flexibility to employ different forms of social contracts. The *Discourses* proposes a form of governance (a model for governance) based on the understanding of a (good) sovereign that decides when to exercise autocratic (sovereign) power and when to act in a republican (consultative) way based on the needs and capacities within the society (Machiavelli ed. 1983). The Machiavelli typology that would emerge may allow for a determined choice of autocratic or republican approaches, which more broadly allows for multiple forms of governance. From a system level understanding, sovereign and autocratic power are elective and can be exercised via single or multiple authorities. While the Machiavelli model does not include the possibility of a participatory, bottom up model, the core of this potential typology is that there is a choice or opportunity to have multiple forms of governance. The key from this study is in identifying adaptiveness within a system and the design that associated with in order to further identify malleability within a system. Developing this typology in future research (Chapter 9.4) could evaluate the various forms of governing characteristics and arrangements, taking the Medellin context into consideration. Based on the collective findings

and analysis in this discussion, “governing” in this context seems to have features of this consultative and sovereign authority. The commonality in these forms of authority is that there are multiple forms of social cooperation that enable having different forms of governance and orchestrate how cooperation occurs between the different forms (top-down, mixed or bottom-up approach).

8.4.3 Generating dialogue with resource governance literature and other governance literature

For generating dialogue with the literature on resource governance for this chapter, interpretation of malleability for this case example is consistent with an approach that incorporates a hybrid focus in order to grapple with the nature of complexity and allow for governance to be conceptually moulded to accommodate hybridity (Gross 2017). This perspective emerges from governance of resource regimes within an urban context. The example of governance in the water sector in Medellin aligns with an understanding that different modes of governance, and even contradictory ones, coexist and adapt. The understanding of malleability as incorporating different modes of governance is consistent with the evidence for various forms of authority and social contracts coexisting in a system of governance.

For water governance as a subset of resource governance regimes, this interpretation is consistent with views of governance as a process of decision-making structured by institutions and shaped by ideological preferences (Bakker 2010) as well as “comprising all social, political, economic and administrative organizations and institutions”, as well as their relationships to water resource development and management (Tortajada, 2010). What it does contribute to water governance is an understanding and a process for identifying the multiple arrangements of authority together with the different social contracts that coexist in a form of malleable governance. As a form of social-ecological system, this finding leads to the question of to what extent malleability might be a characteristic of a seemingly adaptive system (in addition to the criteria set by Folke et al. 2005). The next section discusses where these findings are in dialogue with the wider governance literature, beginning with governance in social-political science, environmental sciences and concluding with environmental and participatory governance.

Social-political sciences

In the context of social-political science, there are several opportunities for dialogue with fields such as new institutional economics, international relations, development studies, legal governance, corporate governance as well as participatory and environmental governance (wherein resource governance is situated). For new institutional economics, the opportunity for dialogue is related to how adaptive governance, and in the Medellin case, malleable governance might contribute to understanding the nature of human exchanges which are more complex in relation to common-pool resources (North 1995) such as water. A process and a view of governance that clarifies this complexity and allows for multiple form coexisting governing arrangements can allow for linkage to the work of Ostrom on common-pool resources.

An understanding of malleability and a case example from a place that has undergone drastic social transformation contributes knowledge of governance as a process in which cooperation through social contracts can take place. This is particularly acute for a field such as international relations where governance studies grew in response to globalisation. The emphasis in IR on power relationships, how they shift, at what scale and how coordination is enacted in a system (Rosenau, McGinnis and Mann) is where the approach to understanding social contracts (and the direction of authority as an indicator of power), an approach to mapping the governance regime (type and number of authority) and the means by which coordination is enacted (through integrated plans or stakeholder engagement) could provide an example for dialogue.

An understanding of malleability in the context of governance in Medellin also suggests that governance can accommodate different arrangements that are contextual to the needs and agreements between social actors which could contribute a process for understanding what good governance and stewardship would look like in development studies. As development studies is concerned with the unequal nature of relationships between and within the developing world (Chhotray & Stoker 2010), a case-based example of how these multiple governing arrangements coexist might highlight new perspectives to consider in how governance initiatives are implemented by donors and how knowledge can facilitate aid policy outcomes.

Implications of these findings on social-legal studies, which has a dominant focus now on understanding the position of the individual in relation to the law, might provide a case example for dialogue around the concept of malleability and a core concept in social legal studies that emphasise how legitimacy is or can be widened beyond the state. As malleability is associated with hybridisation and the capacity of a governance system to include and move between different modes in governance disciplines, could contribute to a framework that examines how legitimacy, through authority takes into account the multifaceted environments of policy and complexity of governance processes (Gross 2017).

For corporate governance, which focuses on an understanding of governance informed by human behaviour at a micro level in the governance of firms and private companies, the case example of Medellin, and more specifically epm, may provide contributions to discussions of how to navigate governance in firms that have alternative or mixed models of governance drawing upon the experience of epm and the municipality. This contribution may also point to further questions of how epm's code of corporate governance was facilitated and how the dynamics within the board or directions are played out.

Environmental sciences

When insights from Chapter 4-6 are considered in dialogue with the literature presented in Chapter 2 where the view of governance in water governance, environmental governance and participatory governance is in line with Ostrom's "rules-in-use" for collective decision-making (Ostrom). For a resource governance regime, these "rules-in-use" capture the "combination of formal and informal institutions that a group of people determine what to decide, how to decide, and who shall decide" how common-pool-resources, such as water, are governed (Ostrom 1999). The Medellin case study which provides evidence for adaptive governance, regime characteristics (polycentric or monocentric) and the social contracts contribute a case that is seemingly adaptive and the combination of regime characteristics (formal and informal arrangements) and role of the people that comprise it in governing it through top-down, mixed, and bottom-up approaches.

In dialogue with the literature on resource regimes within environmental governance which approach challenges in governance as collective action problems eliciting institutional responses from states, markets and communities" (Chhotray & Stoker 2010), this case study shows consistency of features of an adaptive system such as integrated modes of planning for

social ecological systems that provide insights on mechanisms for stakeholder engagement (Rijke) which situate the roles and activities of principal actors such as epm, the municipality and the environmental authority that facilitate integration of institutional responses and enable spaces for cooperation between states, markets and communities. The thesis also presents regime characteristics of seemingly adaptive systems (polycentric governance, Pahl-Wostl) but also challenging the dominant assumption that adaptive systems are polycentric; showing where monocentric forms of governance are also in operation alongside and at times in contrast to polycentric governance. The array different forms of governance that this system can have and embody is also consistent with an understanding of the management and supply of water through the lens of a resource governance regime that allows for a mix of mechanisms (state regulation, privatisation, user base) (Jessop, 2003).

Implications for governance more broadly

Recommendations from this finding would be to promote context-based governing arrangements that enable integrated planning and mechanisms for cooperation. These governing arrangements can have a variety of forms – they could be polycentric, monocentric or mixed as well as have top-down, mixed or bottom-up forms of cooperation. The findings also contribute a case example that can inform further development of a definition for "malleable governance" for complex resource regimes.

8.5 What does this lens provide for understanding design and construction of governance models beyond Medellin?

Chapters 4-7, as a body of results on governance in the water sector in Medellin, provide insights on features associated with adaptive governance, regime characteristics and social contracts. Collectively, these results contribute to a concept of "malleable governance" for complex resource regimes in a social-ecological system using the water sector in Medellin as an example. This case example provides some useful insights to encourage the water sector to consider complex resource regimes more broadly. Features specific to the design of Medellin, such as bridging actors (the environmental authorities and local neighbourhood councils that act as facilitators and negotiators respectively) if found in other contexts that are consistent with a malleable form of adaptive governance, could identify factors for modelling governance design.

Other features specific to the design of Medellin that if found in other contexts could be used to model multiple systems are the presence of active, historic relationships such as those

between the city and the utility company. These relationships are identifiable in the corporate code of practice, composition of the board and the collective memory of its role in the transformation). For these features, there is a strong acknowledgement of the continuity they are perceived to provide in the city. Another feature is the presence of various types of social contracts (top-down, mixed, bottom-up) between and among the different actors. This plurality of social contracts among actors demonstrates that there are diversity and flexibility within the network. This diversity and flexibility to have different relationships is a form of malleability (various types of a social contract with the same actor and similar styles of social contract with different actors). More often than not, these coexist simultaneously. The presence of different forms of social contract offers flexibility of single and multiple forms of authority and suggests that governance can take various forms based on necessity.

If identified in settings beyond Medellin, malleable governance (different and multiple forms of authority and social contracts) and features such as bridging actors, could be explored as a pathway towards building a model for adaptive features in complex resource regimes.

8.6 What does this lens provide for understanding design and construction of governance beyond Medellin (Cochabamba, Bolivia)?

Recalling the implications of not including an adaptive governance lens in understanding the failures in provision of water in Cochabamba, evidence of governance that is flexible, adaptive and malleable and that has different, multiple forms that coexist offers an opportunity to inform current discussion on complex governance challenges. Malleable governance (as a coexistence of different forms of authority and social contracts) and actors that facilitate integrated planning and enable mechanisms for continuity and cooperation offer a process for approaching the challenge of cooperation in the water sector illustrated in the cases of Cochabamba (see Section 2.5) from the perspective of adaptive governance. The method of examining stakeholder views and identifying integrated planning mechanisms, mechanisms that enable coordination, regime characteristics and social contracts could apply for examining cases such as Cochabamba (Section 2.5.1-2.5.2). Applying an adaptive governance lens that is not constrained to one context, provides a means for examining a system relating to a set of factors but has flexibility in allowing context-based features to emerge. For Cochabamba, this includes identifying evidence of integration (policies, plans, and institutions) and spaces conducive to collaboration before, during and after the water wars. This analytical process may highlight existing features that are either conducive or restrictive of adaptive governance. Reviewing the regime characteristics (multiple authorities or single authorities) may provide an understanding of the types of authority within the governance system. A social contract approach would highlight to what extent there are existing forms of cooperation consistent with the social typologies (Section 2.7) as well as arrangements that challenge it. Reviewing these findings collectively would identify to what extent malleable governance accurately describes the system. What this process provides is a framework for analysing features in adaptive systems that emerge from studies of complex resources, but that also is flexible in acknowledging the context in which these systems are situated.

How do findings such as “malleable governance” from a secondary city in the global south (Medellin) contribute to thinking about the challenge of governance for complex resource regime in another secondary city in the global south such as Cochabamba, Bolivia? Moreover, why should they be taken into account? Findings such as malleable governance provide an

application of results for improving governance design. The implications of exploring this application would accommodate multiple governing arrangements that otherwise might be considered polar. This would be a shift towards alternative service delivery (Section 2.4, 2.6, 3.1.3) that not only depart from binaries (public vs private, centralised vs decentralised), but focus on the role of local governance in targeting factors such as equity, effective service delivery (Furlong, 2016).

8.7 How does this adaptive lens, and the experience conducting this study in Medellin, contribute to debates related to governance design?

Beyond understanding the design and construction of governance in other complex resource regimes beyond Medellin and beyond the water sector, insights from this study shift a dominant narrative in governance. This contributes to thinking about optimal governance model (for example through comparison of the merits of privatisation vs public ownership, see Section 3.1.1) towards a thesis that begins with a contextual narrative of adaptive governance and discusses to what extent the regime characteristics and societal arrangements are consistent with that narrative. In the case of "malleable governance," the dominant narrative shifts towards a thesis that reconciles binary thinking (single vs multiple authority and top-down vs. mixed vs. bottom-up) and includes systems that have various arrangements, and away from binaries and hierarchies. These narratives rely on recognisable factors such as regime characteristics as a basis for comparison. However, data-driven approaches enable discussion of contextual features that facilitate or constrict an adaptive system. This approach provides the opportunity for examining elements that challenge theory on what characteristics comprise an adaptive system. For example, in the Medellin model, there are strong forms of single authorities that operate within an adaptive system. This model is counter to a theory that polycentric governance systems are more adaptive. In the Medellin model, the coexistence of these polycentric and monocentric forms of governance underpin the model's malleability and include context-specific factors such as the continuity that single authorities have demonstrated concerning narratives of the city's evolution, transformation and vision for the future. This contextual narrative situates findings, such as the application of malleable governance, in a specific context that can be compared with existing definitions of adaptive governance more broadlyu and potentially, other case studies.

Insights from the Medellin case also provide an example of how interdisciplinary approaches can inform governance of complex resource regimes. In-depth interviews, data-driven analysis and theory-driven analysis, give a method for placing human and social perspectives at the centre. In social-ecological systems, which includes many complex resource regimes, social interactions tend to dominate (Walker et al. 2006). See Section 1.1. The approach for the Medellin case also identifies how the social contract typologies are integrated into the characteristics of adaptive governance and also acknowledge their theoretical foundations in political and social thought. What this integration achieves is an integration of the technical and social components within a complex system separately and as a complex whole (The social contracts were analysed as they were identified as top-down, mixed and bottom-up first and then where they overlapped with multiple and single authorities).

From a content perspective, these findings also contribute three insights from the Medellin case to the broader question of how an adaptive lens for governance adds to tackling the challenge of cooperation within complex resource regimes. Firstly, it offers an interpretation of the Medellin case as an example of "malleable governance" and a context in which there is evidence for cooperation. By identifying context-specific features such as the relationship between the city and the company (code of governance, board composition and role in the transformation), the insights and the process used to obtain them provide case examples of how this cooperation was enacted in the Medellin case which enables dialogue on the contextual features that would constrain it to its context and features that could be mimicked elsewhere. The Medellin case as a form of "malleable governance" also challenges the notion that a set of features or characteristics are fixed, by showing that they are flexible and sometimes coexisting simultaneously. Secondly, for understanding cooperation within a complex resource system more broadly, the Medellin case offers an example of a governance system that has multiple governing arrangements that seem contradictory, however coexist with a variety of social contracts that are evolving and changing. Thirdly, the Medellin case from a stakeholders' perspective contributes to a narrative that the context is changing, and therefore governance arrangements are malleable - moulded by social contracts that bind and twist.

8.8 Focusing the adaptive lens - summary of what the lens offers

In summary, these insights for complex resource regimes are consistent with the view that governance is about people – and how a system of governance includes different forms and

modes that coexist, adapt and change, like the people that comprise it. A process to understand a governance of this form has to grapple with the complexity of a design that is not fixed and to facilitate an understanding of context that accompanies the design as it changes. An understanding of “malleable governance” for complex resource regimes shifts the narrative from one that aims to assign the regime characteristics to one that is open to the possibility of multiple governing arrangements that are evolving and changing, much like the people that comprise them. The approach applied in investigating the Medellin case highlights an opportunity for using existing definitions for testing regime characteristics and social contracts while allowing the governance context to dictate different arrangements.

This discussion highlights the main findings concerning flexible, adaptive and malleable governance and what it offers for understanding cooperation in the Medellin model. The main findings are a starting point for tackling governance challenges in complex resources systems such as the water sector and more broadly for social-ecological systems. The following Conclusion chapter will describe the implications of these findings for future research, strengths and weaknesses and recommendations.

Chapter 9: Conclusions

9.1 Towards an adaptive lens for designing governance for essential resources?

An adaptive lens for the governance of essential resources takes into account features of adaptive governance, regime characteristics and social contracts to generate an understanding of governance as a malleable system. Embedded in the adaptive lens is the assumption that relationships between actors in a complex resource regime emerge from a context and where social and human involvement dominates (Walker et al. 2004; Walker et al. 2006). Using the context of water governance in Medellin and examining to what extent an adaptive lens can provide insight related to the regime characteristics and nature of cooperation within an adaptive governance system, the results contribute to an interpretation of malleable governance. While this case does not present a model for replication, the application of an adaptive lens accentuates the importance of accounting for the multiple arrangements and social contracts that coexist in a governance regime and a framing that is situated in resource governance and applied in the water sector. Because the theoretical frameworks derive from the literature on complex resource regimes, these findings and method can serve as a reference for other resource governance studies in other sectors and contribute (as discussed in insert cross-reference) to wider discussions in governance. The applicability of these theoretical frameworks may provide critical insight for understanding areas undergoing dynamic changes in population, as is the case in secondary cities, but also in places where resources such as water connected to other sectors, are experiencing states of flux due to climate change, economic volatility and civil, political unrest.

This concluding chapter highlights key messages in light of the governance literature, recommendations (Section 9.2), strengths, limitations and other considerations (Section 9.3-9.4) and articulates areas for future research (Section 9.5).

9.2 Recap and summary: Takeaway messages related to the adaptive lens

The adaptive lens contributes an understanding of "malleable governance" for a complex resource regime that embraces the coexistence of different governing arrangements and characteristics (single and multiple authorities), embraces static and dynamic features within a system with an awareness that a single actor or group of actors can have multiple governing arrangements and social contracts and embraces the variety of social contracts that a single actor can exhibit (top-down, mixed and bottom-up). These findings individually from Chapters 4-7 originate in frameworks regarding the governance of resources which are social-ecological systems from disciplines such as water governance, ecology, environmental science and engineering that have contributed to environmental governance and governance literature more broadly. With an interpretation of these findings as consistent with malleable governance (Gross 2017) which emerges from urban governance of resources, the findings are presented in relation to the political and social thinking in order to generate dialogue with a wider base of disciplines. As environmental governance is a field which draws upon contributions from fields in social-political and environmental sciences, these findings are then situated within the larger governance literature. Taking this disciplinary perspectives in mind, the following section describes several recommendations in resource governance studies that emerge in considering these findings.

9.2.1 Identify governing arrangements that enable an adaptive system

Recommendations for work examining governance designs should include an awareness that an adaptive, malleable system may have multiple governing arrangements that coexist. Whilst some governing arrangements may be contradictory (polycentric, monocentric or another hybrid form), features that enable this multiplicity should be identified and investigated further. Understanding what governing arrangements enable an adaptive system should also acknowledge the importance of context and social involvement can contribute to efforts and potentially inform models that embrace complexity (a plurality of different authorities in the governance of the resource).

9.2.2 Shift the governance narrative towards understanding circumstances where certain governing arrangements and social contracts are best suited

Malleable governance that allows for adaptation and change requires an understanding of where certain governing arrangements are best suited to achieve a given outcome. For example, for the purpose of delivering fair, just and equitable water services through a

national program, minimum vital (4.3.2), the municipality has the mandate to provide this and enacts a governing arrangement with epm, the service delivery provider. The municipality also has a top-down social contract in providing this. A narrative where this is the emphasis allows for a more nuanced discussion on the circumstances where a certain governing arrangement might suit best and the arrangements needed to achieve that.

In order to do this, different perspectives from people of different levels in different organisations are needed which may sometimes provide conflicting understandings of a given feature, regime characteristics or social contract. In the example of the Medellin case study, the inclusion of different perspectives provides evidence of different governance arrangements within the system that seemingly co-exist, such as monocentric and polycentric authorities, nested governance arrangements and the presence of multiple types of social contracts. Each of the actors, however, demonstrate different perspectives, however the aggregate provides a textured and diverse perspective. This in a way, encourages the narrative of 'good governance' (2.2.1) to be widened beyond how governance is implemented by donors and how governance can facilitate aid policy (Chhotray & Stoker 2010).

9.2.3 Identify 'bridging actors' and highlight the diversity of different roles they play in adaptive, malleable systems

In addition to identifying circumstances where certain governing arrangements thrive, identifying "bridging actors" or actors that create or facilitate linkages emerge from triangulating perspectives of speakers from different stakeholder groups (Folke et al. 2005; Cash et al. 2006) which is consistent with existing literature on adaptive systems. In the case of Medellin, this was through examples such as the Juntas Accion Comunal (insert cross-reference). As these 'bridging actors' are strongly associated with a system that is adaptive and malleable, future studies should identify these actors and the diversity of roles they can play (in addition to their role integrating different actors). In the example of the environmental authority, for example, speakers associate this actor as convening spaces that maintain and strengthen relationships between actors. To what extent this enables other mechanisms in governance is another area of research. A recommendation would be to look more closely at the role of actors and to identify other associated factors.

9.2.5 Identify individual actors that have different forms of cooperation and different actors that have similar forms of cooperation

Malleable governance emerges from considering how several individual actors have different forms of cooperation with other actors and where different actors demonstrate similar forms of cooperation. Identifying forms of cooperation should be a core component of examining the characteristics of adaptive systems. In the Medellin case, the versatility of different actors was visible in strategising for land-use plans (or *Planes Ordenamiento Territorio*), particularly in providing services in hard-to-reach areas. The presence of these types of actors, and the variety of forms of cooperation they are involved with contribute an understanding of malleable governance that emerges from an application of an adaptive lens. The recommendation would be to explore further to what extent this is relevant for other contexts.

9.3.3 What the social contract component of the adaptive lens offers

The application of social contracts, and the various typologies (Section 2.7 and Chapter 7) they may take, provides an approach that is useful for explaining how social cooperation operates within a set of institutional arrangement(s) and the flexibility to take the different forms into account. Taking the different forms of social contracts into account in the case of Medellin where there are characteristics of polycentric governance, monocentric governance and nested arrangements contribute to an understanding of malleable governance which applied to complex resource regimes, demonstrate what an adaptive lens offers in terms of grappling with system complexity. Furthermore, the lens shows where the direction of authority in the governance system requires different approaches to social cooperation, be they top-down, mixed or bottom-up.

9.3.4 How inclusion of social contacts contributes to new questions on how governance can accommodate malleability

The inclusion of social contracts within the lens of adaptive governance contributes a shift on how governance can accommodate malleability. Recalling the call for exploring new questions in alternative service delivery models for resources such as water, Furlong calls for exploring new questions about the role of government, the purpose of service delivery and where certain models (in our case arrangements) may help to meet certain goals (See 2.4.1). What these findings introduce in addition to understanding the role of local government, or an actor

within the governance system, is what kind of social dynamics, or directions of authority, best provide what the resource regime is designed to do. An in-depth, context-rich analysis of a case study like Medellin contributes a narrative that begins with social contracts as the foundation for social cooperation in the context of different characteristics of governance and the societal arrangements. This provides insights on how multi-stakeholder cooperation (2.4.1), yet also provides insight on a model (arrangements) that "can engage and broader range of actors and municipal governance that can engage actors in a way that better shares authority may be better equipped to confront complex governance challenges as Furlong calls for (Furlong 2016). The inclusion of the different typologies of social contracts individually and collectively focus the narrative of governance towards one that embraces coexistence of these different arrangements. This narrative of governing as an active story and the construction of governance as an ongoing process includes a societal perspective of governance that is led and/or consulted on, based on needs, strengths and capacity of the actors.

The emphasis on social contracts challenges dominant narratives of governance specific to the water sector. The dominant narrative, and subsequent debate, prioritises the merits of models referenced in Section 3.1.1 and raised in the discussion (Section 8.7). Debates over the merits of public and private models dominate the literature on a case such Cochabamba, which have come to represent common models in water governance discourse. With the largest share of water service provision provided by public utilities, a narrative of state authority over water provision and its role as a steward of a public good cannot be dismissed entirely. Similarly, in efforts to capture the perceived strengths of the private sector, the debate over privatisation and public-private models also ushers in familiar narratives that emphasise service delivery as the main outcome rather than service delivery as a means of facilitating cooperation. Further efforts to bring a corporate face to a public model, through new public management and other alternative service delivery models, also dominates the discussion of service provision. What this study provides is a shift in the narrative towards one that prioritises social contracts as a way of deriving a model that emerges from its context and places an emphasis on social and human involvement.

9.3 Strengths and Limitations

The presentation of theories and the methods (Sections 2.3, 2.7 and 3.2) acknowledge the assumptions, constraints and justifications for the chosen selection. While Chapter 3 provides

greater detail of the justifications for the method, this section (Section 9.3) summarises strengths and weaknesses (Section 9.4) taking into account the results and discussion.

9.3.1 Strengths and limitations of the theoretical framework and methodologies

The existing literature of complex resource regimes provides the theoretical frameworks for adaptive governance (Rijke, Pahl-Wostl and Lundqvist). Because the theoretical framework is not exclusive to a specific sector (resource regimes which are form of social-ecological system for Rijke and Pahl-Wostl, and Lundqvist et al. is based on political and social theory of social contracts), there are opportunities for exploring other sectors and context and comparison in future research (Section 9.5.2).

Limitations of the choice of theoretical frameworks include having multiple frameworks that have origins in the disciplines that have assumptions that had to be integrated and accounted for in the research design process. As the interdisciplinary opportunities provided a means to explore regime characteristics and social contracts from a governance perspective, drawing upon theories and frameworks that have traditionally been situated within environmental governance, was an approach that included precedent. Nonetheless, further screening and discussion is required if exporting this model for further application in another setting. Secondly, in the case of examining a common-pool resource such as water, the work of Ostrom may have made provided a more consistent theoretical approach regarding participation of actors in governance of a social-ecological system. While this view informed understanding of governance, for the choice of framework(s), those that spoke more closely to the linkage with adaptive governance were utilised.

While polycentricity seems to be a characteristic of highly adaptive systems, a limitation of the theory is that it excludes other forms of governance that may be adaptive but not exist along a spectrum of governance looking at the number of different authorities (polycentric, monocentric and a nested hierarchy). Nonetheless, the interpretation of the governance system is through a lens of adaptive governance that emerges from the literature that emerges from studies of complex social-ecological systems and resource regimes. There is strong evidence from the scoping and piloting stages to suggest an approach that provides a strong case for examining places beyond the Medellin context. However, there may be other theories and frameworks that also capture the phenomenon in Medellin.

Typologies for social contracts are derived political and social thought feature in analyses of the water sector. This thesis includes an analytical perspective of the different theoretical frames and demonstrates how one might combine them. Because the theoretical framework is not exclusive to a specific sector, there are opportunities for exploring other sectors and context and comparison in future research (Section 9.5).

Limitations of the approach to the characteristics of governance also include examining the social contracts individually. For the scale of this study, the social contract theory in original works from political and social thought (Barker 1947) and then the application related to water governance (Lundqvist, Jan, Narain, Sunita and Turton 2001). However, there are several features that may also underpin why certain features are associated with the social contract. As the presence of these different social contracts such as top-down, bottom-up and mixed, is the outcome of interest, there is also the possibility of these features existing and not existing in isolation. Taking these different social contracts into consideration individually and collectively in Chapter 8 provides an opportunity for interpretations related to malleable governance (Section 8.5-8.8). The extent to which there is interaction and co-dependency was not investigated though could be taken up in further study.

There have been other applications of hydro-social contracts by Wong & Brown (2.7) that speak more closely to the type of service delivery models one would encounter in the water sector with a higher degree of detail. While this was considered, opting for a model that would allow the data to speak for itself and potentially allow for greater dialogue with other sectors was selected.

The data collection, management, verification and the analysis were conducted through field research in regular contact with representatives from the local system of governance. By including frequent cross-checking, triangulating perspectives and remaining close to the data, the findings and conclusions are grounded in the context in which the data was derived.

Besides the strengths of the theoretical approaches and the methods, the results highlight the strengths of including social contracts within the lens of adaptive governance. The following sections summarise what the social contract offers for understanding the system of governance in Medellin and highlights limitations.

The problem of coordination and governance in social-ecological systems dominated by human and social involvement (Walker et al. 2006; Walker et al. 2004) suggests that interactions between stakeholders would be of importance and would recommend a focus group. A focus group method of collection, however, was excluded, so that it was possible to preserve the individual views and privacy of the speaker. A method based on focus groups was also avoided because of the sensitivity and political nature of the topic. With this in mind, comments by speakers related to interactions or other groups were treated as a perspective, not an *a priori* reality. Thus where there were contradictions or incongruencies, they are treated as different perspectives of the same phenomenon (in some cases, some speakers describe EPM and the city with features similar to polycentric relationships whereas others provide evidence for one that is more monocentric).

The interpretations of the data are based upon in-person interviews at a given place and time. In providing a snapshot of governance in the system, the interpretations of the interviews are limited to the context of each speaker. As described in the methods section (Section 3.2.2), a plurality of different viewpoints from representatives from within a stakeholder group and sustained contact with speakers were an essential part of the effort to triangulate information and incorporate referential checks. The in-depth interview provided an opportunity for speakers to provide perspectives on water governance with temporal dimensions, despite those perspectives occurring at a snapshot in time. As the study was not examining change in perspectives over time, a longitudinal method was not selected, however future research may want to consider these changes and may require this approach.

9.4. Other considerations

9.4.1 Reliability and validity

In-depth semi-structured interviews were included to provide a diversity of perspectives drawing upon a constructivist perspective that reality is constructed and that multiple realities can coexist (see Chapter 3). Reliability, as an indicator of repeatability of findings were taken into account during the data collection and analysis stage. At the data collection stage, aspects of bias that might interfere were taken into consideration. During interviews, were the challenges for reliability related to bias (such as recall bias, desirability bias) (Morse et al. 2002) were mitigated in the following ways.

The constructivist lens for reality as a construction provided an approach that was open to multiple realities. A plurality of different viewpoints from the various stakeholders and triangulation of results were part of the effort to employ a constructivist lens and also identify where bias might occur (Morse et al. 2002). Biases such as desirability bias or recall bias, could be more reliably understood through having multiple viewpoints. Desirability bias is when a speaker amends his or her comments to please the interviewer. To address potential desirability itself at the interview stage, efforts such as confirmed anonymity and probing specifics (respectively) of speaker contributions were taken. While bias can remain, there is an awareness of this as a risk with any interview. Efforts such as question framing, piloting, receiving feedback and ensuring confidentiality were employed to mitigate bias.

Taking into account the challenges associated with bias in interviews, the variation in speaker perspectives also provide an opportunity for triangulating information. Variation included differences in how speakers describe plans, policies and implementation efforts and how they describe relationships between different actors within the system. When speakers discuss the system, there is also variation in descriptions of political changes. To harness the richness of this variation, the method includes sampling and checking the data was as an ongoing practice until repetitive information was identified between speakers (also known as “saturation” (Sandelowski 1995).

To ensure that the instruments were designed to measure what they were intended to measure (internal validity), a pilot of the interview guide was conducted with local partners at the Universidad Nacional de Medellin. After receiving feedback, a trial of the revised guide with a sub-sample was conducted to ensure changes reflected consistency with the intended measurement. For examining reliability of the frameworks used to analyse the data, an inter-rater reliability test was conducted with 3 external coders of the interviews (3.3.7).

While not a threat to reliability or validity, another issue related to the variation and diversity of the sample that should be noted is that speakers were assigned to a stakeholder group (such as the public service provider) reflective of the stakeholder group they were currently representing. As individuals within this system tend to move between institutions, they may have also spent time working within another, such as a public institution, university or community-based organisations. There were also individuals who, for example, were currently working in a community-based context, but were referring to his/her previous

experience working with one of the environmental authorities. While a challenge for data management related to uniformity, this multiplicity of experience was a strength in the depth of knowledge developed from an experience of a range of perspectives consistent with a constructivist approach, however, for analysis, this yielded challenges for classification. Where the current speaker was situated is where he/she was assigned, but the diversity of experiences they brought was taken into account. Thus the conclusions drawn represent the views of individuals within the system that should be taken in context, along with other features such as professional background.

9.4.2 Contextual factors that also emerged, yet not explored fully in this study: *Decentralisation and informality*

Due to the scope of the initial research question and sub-questions (Section 1.4), factors such as decentralisation and informality were investigated in relation to the extent that they offer insights and context for understanding the forms of governing arrangements and social contracts. Factors such as decentralisation policy and the growth of informal settlements are feature in results of adaptive governance in the Medellin context (Chapter 4), settings for the governing arrangements (Chapter 5 and Chapter 6) and as settings for social contracts (Chapter 7). These factors are areas for future research that may provide added interpretation of the plurality of forms governance can take is included in Section 9.5.

The discussion in Section 8.6 describes a need for further information concerning how the process of formalising and legalising neighbourhoods is associated with the changing landscape of water governance as well as a more in-depth exploration of the role of local neighbourhood authorities (JACS). Marcela Lopez discusses the historical role of Empresas Publicas de Medellin in its program *Habilitacion Viviendas* (Lopez 2016) in a critical analysis of the process for legalising neighbourhoods. The programs *Mejoramiento de Barrios* and the Brigadas Comunitarias *(4.4)* offer an insight of how informality is approached from a governance perspective, however, the context in which these changes are occurring has changed.

9.4.3 Causality

The results do not examine causality as to why the system is adaptive. However, in using the definitions, theoretical frameworks and assumptions as a basis for comparison, there is substantial evidence to establish the Medellin case as having strong association of features of adaptive governance and showing characteristics that are associated with an adaptive system.

While an absence of causality places limitations on a discussion of generalisebility and replicability of the model for governance, there is the possibility of dialogue on shared or different characteristics to consider applying different approaches for understanding models and narratives of governance in other settings.

With a summary of the strengths and weaknesses, the Section 9.5, will articulate areas for future research.

9.5 Future research

The scope for future research includes opportunities that range from developing other theoretical frames, scaling the method for understanding cooperation in another setting, conducting comparative studies and exploring features of this model in other sectors.

Using these collective findings (features of adaptive governance, regime characteristic and social contracts), the following sections detail areas for future research.

9.5.1 Future research within the Medellin context

Future research within the Medellin context should examine:

1. The role of the regulator at the national level and to what extent this is associated with the performance of the local governance regime. There are references in the literature and in the interviews consistent with a view that national and regional level regulatory bodies have features of polycentric and monocentric systems of governance (Section 6.3.4). They also are associated with a sharing power and of continuity in the system. Further research could look more closely at how this is accounted for in social contracts and to what extent these are dynamic (within and between political cycles).

2. The role of decentralised and integrated planning (for public services, environmental and housing ministries) was a contextual feature that taken into account in understanding relationships between the national and local levels. While specific questions were not included in the methods to look at how this has changed (before decentralisation), further research might probe to see how speakers perceived this and to what extent this process is associated with the regime characteristics and social contracts identified.

3. The extent to which adaptive governance varies within the different formal and informalised contexts and the role of different local actors (such as Juntas Accion Comunal) in the negotiation of governance is a finding that with further research, could provide insight

and opportunities for understanding governance in parts of the city that are undergoing demographic shifts.

4. The relationship between the city and the company features frequently. Exploration of factors associated with continuity of the relationship between the city and the company and how this agreement is negotiated over time may provide more insight on the evolutionary and changing aspects of the system of governance.

For each of these, the extent to which this process could be trialled and potentially scaled are areas for further exploration. Theories and a process that is not sector-specific provide flexibility for testing, however with the caveat that scoping and trialling are required. This process for understanding features of an adaptive system, its regime characteristics and the landscape of social contracts for application beyond the Medellin context, will be discussed in the following section (Section 9.5.2).

Future research beyond the Medellin context

Areas for future research beyond the Medellin context ought to examine the application of the approach to analysing regime characteristics and social contract arrangements in different contexts by:

1. Developing and testing a theoretical frame and typology for systems that have the presence of multiple regime characteristics and social contracts (a form of malleable governance). Initial scoping in the discussion includes consistencies with political writings in the *Discourses (*Section *8.4)* and descriptions of malleable governance (Gross 2017) that resonate with other complex resource regimes, however, additional literature review is required. This approach can map features in this context or in others.

2. Exploring opportunities for an in-depth comparative study with other complex resource regimes. For example, this could examine more closely the cases of Cochabamba in light of these findings. Comparing the Medellin case with other regimes in the water sector emerges from a need in the sector for adaptive approaches and an emphasis on alternative service delivery models (Furlong & Bakker 2010; Furlong 2016). The process would include questions such as 1) In what way are the arrangements organised? 2) What characteristics of this regime feature most strongly? 3) To what extent does the system feature polycentric, monocentric and nested forms of governance?

3. Exploring opportunities for comparison with other complex systems that have significant social and human involvement such as transport or energy.

In addition to a comparison with another water governance regime, there are opportunities for exploring synergies with other public services such as transport. For example initial scoping on Transport for London (TfL) suggests that the transport provider may have a governance structure similar to EPM. With further investigation, an interpretation of the different aspects of adaptive governance could identify to what extent an adaptive lens informs challenges relevant to the sector and to what extent a collective view of the system has parallels with malleable governance. At this stage, there is discussion for comparison with Transport for London. Possible next steps include applying the approach to exploring these governance features using an adaptive lens to examine the stakeholder landscape.

Another area for future research applies the approach to examine another sector such as the energy sectors with attention to the contextual features of the place and a view to creating typologies of where specific characteristics are likely to occur. Taking an example being scoped currently in partnership with the colleagues at the Energy Institute examining decentralised energy provision (Myanmar), initial scoping indicates some evidence for an adaptive system. Stakeholder mapping includes information related to where polycentric arrangements occur, where local authorities most commonly wield decision-making power, where regulatory authorities function as a polycentric vs monocentric authority and to what extent bottom up arrangements are stronger or weaker. Next steps include in-depth interviews with representatives from the various stakeholder groups.

9.6 What do these areas for future research reiterate regarding an adaptive lens for tackling complex challenges related to cooperation in the provision of essential resources?

Each of these areas for future research emerges from findings to answer the question “What does an adaptive lens offers for tackling governance challenges for essential resources?” Using the example from the water sector in Medellin to offer insights from a case where the issue of water provision within society has evolved and developed with a strong emphasis on the social and human involvement in that process. What an adaptive lens offers to the water sector is an opportunity to view governance within the subset of resource governance related to water and environmental governance more broadly, as having the diversity of different forms of authority and social contracts that is malleable and adapts, which is consistent with

the diversity, malleability and adaptability one would expect to observe in society. What the adaptive lens offers more broadly for tackling other complex resources, is an example whose features confirm as well as challenge assumptions about how adaptive governance systems operate. In so doing, this example offers an opportunity to explore how contextual understanding can inform approaches to enable cooperation. The merits of this method for doing so is that it is attuned to the context and developed from theoretical frameworks that are not constrained to a particular sector. More broadly, the adaptive lens shows the critical importance of context, social and human involvement in systems of complex resource regimes.

In examining the case of water governance in Medellin as an example of a complex resource regime, the findings and discussion contribute a case-specific understanding of what a lens of adaptive governance offers for understanding a system of governance. By examining a case that departs from the conventional models of governance in a secondary city and where there was evidence of stakeholder engagement (Section 3.1.1), the theoretical approaches provide a narrative of governance that can explore complex social-ecological systems in a manner that embraces multiple perspectives, multiple arrangements and societal dimensions.

A narrative of governance, and malleable governance, more specifically, from the perspective of social cooperation, presents an opportunity for rethinking society's role in constructing that form of governance. While it is unlikely that the Medellin model is transferable or suitable for all environments, the understanding of its features through this process provides a view for thinking about what is needed in the current discourse of governance discourses as seen in the water sector: 'water crises as governance crises' (OECD, 2015). The implications of including an adaptive lens for governance is that it prioritises the role of social and human cooperation in societies that form arrangements and agreements out of necessity.

Lastly, the application of the adaptive lens shifts the dominant narrative towards the context and culture in which these societies are forming arrangements and the different factors such as population growth, effects of climate change, economic and political volatility, that render a case more complex. The application of the adaptive lens also enables a standardised process for exploration. In the construction of governance models that will be able to respond to change and systems of governance that can more efficiently and equitably tackle challenges, understanding governance as a dynamic and malleable process provides a valuable

contribution for addressing the global need for essential resources. Furthermore, understanding the regime characteristics and social contracts formed to address the human and planetary need for essential resources, also provides a reference for applying an adaptive lens for tackling challenges related to the governance of essential resources.

Chapter 10 Impact Statement

Providing essential resources, such as water, is fraught with challenges related to governance and coordination. Governance challenges are particularly acute as they are influenced by factors such as climate change, demographic patterns, political and economic stability and development agendas, which are continually changing and evolving. There is substantial evidence in the literature on systems of complex resources to suggest that an adaptive lens may provide insights on how to tackle the challenge of governance of essential resources.

This thesis explores the question of what an adaptive lens offers for tackling the challenge of governance of an essential resource. Using the case study of water in Medellin, the thesis explores sub-questions to identify to what extent features of an adaptive system are present in the Medellin context. The thesis also examines to what extent those regime characteristics and social contracts confirm and challenge existing assumptions of what is expected in an adaptive governance regimes.

10.1 Contribution to the field

The impact of this thesis is in its contribution to the subset or resource governance for essential resources in water, environmental governance and governance more broadly where dialogue on this topic can 1) contribute to an approach for tackling governance challenges for complex resources that allows for malleability 2) contribute an understanding of the governance landscape and social contracts in Medellin through an approach that resonates with environmental and social-political sciences 3) demonstrate that in an investigation of alternative service delivery model, there is testing and analysis of results that shifts a dominant narrative studies in governance

1) contribute an approach for tackling governance challenges for complex resources that allows for malleability

Governance is a critical component for effective and equitable delivery of essential resources. This study proposes that a governance system, and a method for investigating it, that allows for malleability of the governing arrangements and social contracts, can contribute insights on the design of an adaptive system. The impact of this approach is that for future work, there is an example of how a governance system within resource governance can be understood as a system that is not only changing and adapting, but that a system can exhibit multiple

governing arrangements and have different forms of social contracts. What this thesis provides is an in-depth case study in Medellin, Colombia, to illustrate this.

The method in this thesis tackles this problem by deriving a method for analysing adaptive systems from the literature on complex resources in social-ecological systems. With this theoretical framework in mind, a data-driven approach and a theory-driven approach that acknowledges the complexity and context-specificity of the case investigated, provides a novel and systematic way of comparing observations in Medellin on adaptive governance, regime characteristics and social contracts with existing literature. The data-driven approach resulted in flagging context-specific features in Medellin that challenge the traditional view of an adaptive system. Together, these approaches contribute a way of verifying findings within a case study and present an approach for exploring governance challenges in a manner that recognises the technical and social features of the system.

2) Contributing an understanding of the governance landscape and social contracts in Medellin through an approach that resonates with issues tackled by environmental and social-political sciences and confronted by development in cities in the global south

Another impact that emerges from this method of analysing governance of essential resources is in the provision of an in-depth case example of the governance landscape and social contracts in Medellin through case that resonates with challenges in cities of similar size confronting challenges of resource governance in the future. By developing a multi-disciplinary approach that addresses common challenges faced by societies and actors around the globe, the impact of an in-depth case study is that it provides a framework that can be distinguished from the contextual features that characterise that location. For areas of development studies and good governance efforts that are tackling these issues in the global south, a case reference is a valuable tool for considering transferability of best practices.

The contribution of the method from a disciplinary perspective is that the theoretical frameworks and starting disciplines are not sector specific. For example, the theoretical frameworks for adaptive governance and complex resource regimes were not specific to water, which provides a starting point for engagement with sectors or resource regimes. Similarly, the theoretical frameworks for social contracts derive from sources in political and social thought that reflect how humans and actors cooperate in a state of nature that is also

consistent with an emphasis on human behaviour and the relationship between actors in society that is strongly explored by governance in the social-legal, corporate and participatory areas of study. While applying these theoretical frameworks does not ignore that assumptions specific to those disciplines vary, but it does allow for those assumptions to be brought into discussion as a means of comparing what is observed in a specific context with what the prevailing understanding is. Having developed and tested this in the water sector for Medellin, this method highlights that without these different disciplines and the constraints of sector-based theories, testing this method in other sectors changes how multi-disciplinary methods can be applied. For studies in governance, which underpins the provision of all essential resources where there is substantial human and social interaction, this serves to bring existing assumptions and the realities of context into dialogue.

3) Through exploring an alternative service model, the findings contribute to new questions about the role of actors and how malleable they are which allows for nuanced discussion on the purpose of governance for resource governance, circumstances where malleable governance may help to meet certain goals and the governance arrangements and social contracts required to achieve them

Apart from the method developed, the findings of this thesis related to malleable governance contribute to a nuanced discussion on the purpose of governance in the narrative of governance of essential resources. Recalling that Furlong calls for exploring new questions about the role of local government, the purpose of service delivery, circumstances where alternative service delivery models may help to meet certain goals and the governance arrangements required to achieve them (2.4.1), what this study contributes for the delivery of a resource is new questions about malleability of actors within a system and their relationships as well as the purpose of governance – which speaks to its role in enabling an adaptive system, and an example of governing arrangements and social contracts within a specific context that illustrates this malleability.

Illustrating this malleability shows how social interaction is joined up with the technical aspects of governance. The method provided a means of showing this through in findings that show the governance of water in Medellin as both polycentric and monocentric, as well as having top-down and bottom-up forms of authority. The findings also give policy and planning examples where actors such as the utility may have several different roles and authorities with

another actor such as the municipality depending on the needs, capacities and priorities. Similarly, the utility may have similar roles and authorities with a range of different actors. This method and findings show flexibility and dynamism that may not come through as strongly in a narrative of governance that does not illustrate malleability.

10.2 Contribution to utilities on essential resources and services

In addition to the contributions to the field, the method and findings also contribute to understanding through an example, of how utilities and resource systems, particularly in secondary cities in the global south, can consider the Medellin case in an approach to delivery of essential resources and services. Firstly, the qualitative approach to interviews and tools contribute a means of accounting for the multiple arrangements of social actors and their relationships to one another. Secondly, the analysis of the data provides a method for exploring similar questions beyond the academic space in policy and planning arenas for sectors such as energy and transport. Thirdly, the findings in Medellin (related to how the utility and its relationship to the city, continuity afforded by institutional autonomy in examples such as the environmental authority and the role of community-based organisations in strategic planning and governance) provide examples from a system that has features of adaptive governance (integrated policy, mechanisms for stakeholder engagement polycentric governance). The findings also highlight context-specific features for further investigation (such as nested governance of utility and the city, composition of the board of EPM) that may be strongly associated with its capacity to cooperate and thus adapt. Fourthly, the findings in Medellin related to the social contracts, show that these relationships are evolving, oscillating between top-down and bottom-up forms of authority in a dynamic way can simultaneously include features that are more singular in authority and plural in authority, can be autonomous and integrated as well as include features that are continually and constantly changing.

What these findings test and develop is an example for exploring questions such as *what does an adaptive system look like in another system of water governance or in another sector such as energy or transport given the characteristics of adaptive governance? For designing a system, what features, characteristics and social arrangements exist already and what mechanisms enable them?*

Similar to the contributions to the academic field, this work brings a narrative for resource governance that allows for malleability and views an adaptive system as one where leading and following as well as cooperation and coordination emerge from necessity and an acute understanding of the different capacities of the organisations and society involved. In demonstrating that governance in a complex resource system has features that is in dialogue with literature in resource governance and governance studies more broadly, future attempts to tackle governance challenges can be advanced and work in this area can do things differently in light of this narrative.

Chapter 11 Appendix

11.2 Semi-structured Interview Guide

Name:
Nombre:
Age Range:
Edad:
Educational Background:
Educación
Occupation:
Ocupacion:

Actors within the water system[1] (actores en el sistema del agua urbana)

Preguntas 1-2 son para entender/confirmar el conociemento del persona
1) Describe the main actors in the urban water system in Medellin.
Describe los actores principales en el systema urbana del agua en Medellin?

OR

¿Cuáles son las organizaciones con las cuales el sector del agua y los consumidores han tenido mayor satisfacción?
2) How many different authorities are there?
¿Cuantos differentes autoridades existen en el sistema?

Preguntas 3-6 son para entender la perspectiva sobre satisfacción y dificultades en el sistema de agua urbano...comenze con esas preguntas y obtiene detalles con un acercamiento abierto.

3) Who are the main partners with whom the water sector and users have witnessed the most success?
¿ Cuáles son los organisaciones y consumidores que han tenido satisfacción en el sistema de agua urbano?

4) What characteristics of that relationship do you think contributed to that success?
¿ Segun su opinion, cuáles son las caracteristicas que han contribuido tener satisfaction en esa colaboration?

5) Who are the main partners with whom the water sector and users have witnessed the most challenges?
¿Cuáles son los organisaciones y consumidaores que han tenido dificultades?

6) What characteristics of that relationship do you think contributed to those challenges?
¿Por qué piensa que se han presentado esas dificultades?

Relationships between actors/Visión compartida (actores en el sistema del agua urbana)

Preguntas 7-10 son para entender la relacion entre los actores en el sistema de agua urbano y las metas y objetivos...comenze con esas preguntas y obtiene detalles con un acercamiento abierto.

In the urban water system…
En el sistema de agua urbano…

7) Describe the relationship between the municipal water system and the public?
Describe la relación entre el municipio y el public con respeto del sistema urbana del agua.

8) In the water sector, what goals do the different actors share? Explain.
¿En el sector del agua, qué metas comparten los diferentes actores?

9) In what areas do they have different goals?
¿En qué áreas tienen diferentes objetivos?

10)Do they have similar interests or commitments and strong government support?
¿Tienen intereses similares o compromisos similares?

10a) Si “si,” estas metas/objetivos tienen apoyo del gobierno?

Cooperation and decision-making/Cooperación y toma de decisions (actores en el sistema del agua urbana)

Preguntas 11-14 son para entender la manera de participacion de los actores en el sistema de agua urbano...comenze con esas preguntas y obtiene detalles con un acercamiento abierto.

11) To what extent can different actors access opportunities for innovation and adaptation (ie. through experimentation and learning)?
¿En qué medida pueden diferentes actores acceder a tener oportunidades para la innovación y adaptación (es decir. a través de la experimentación y el aprendizaje)?

12) To what extent is there room for local knowledge and practices in the provision of urban water services?

¿En qué medida hay espacio para el conocimiento y practicas locales en la prestacion de los servicios?

13) To what extent do these different actors have control over specific policy arenas or geographical areas?
¿En qué medida estos distintos actores tienen opportunidades para contribuir en la creacion de politicas especificas en la comunidad locale?

14) *Describe the interactions between local politicians, resource users, providers and NGOs in the urban water system?
Describe las interacciones entre los politicos locales (consumidores de los recursos, los proveedores y las organizaciones no gubernamentales) en el

104sistema de agua urbano?
105

11.3 Catalogue of themes – data driven

Figure 15 100 most common words in the interviews

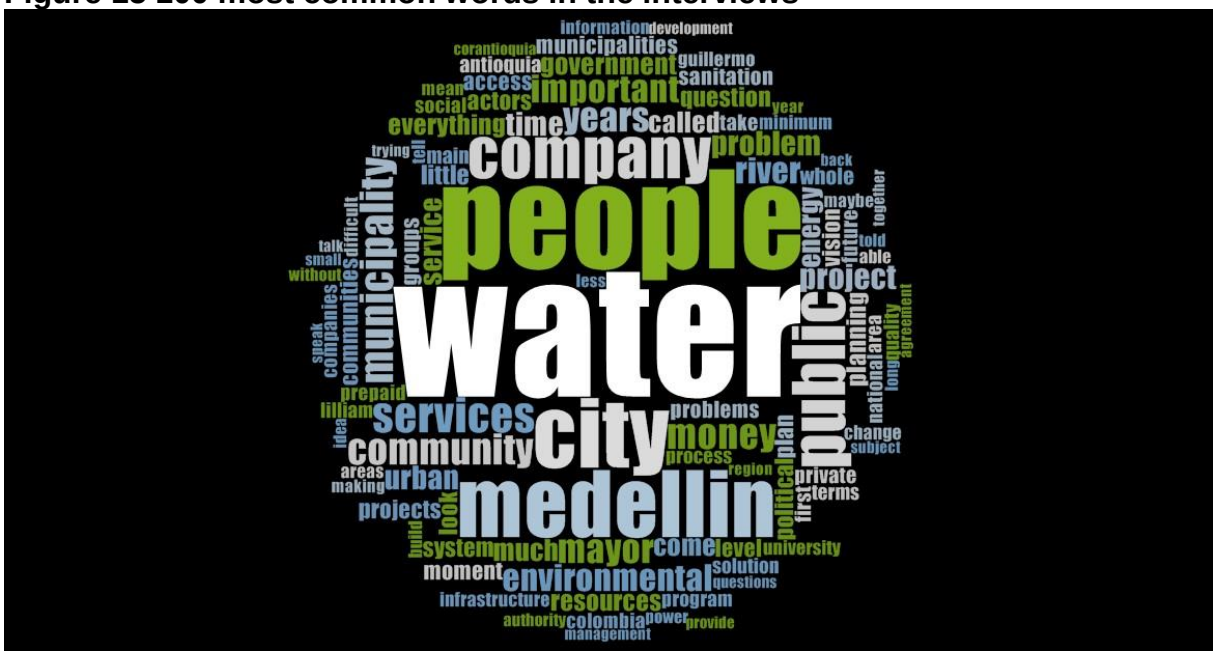
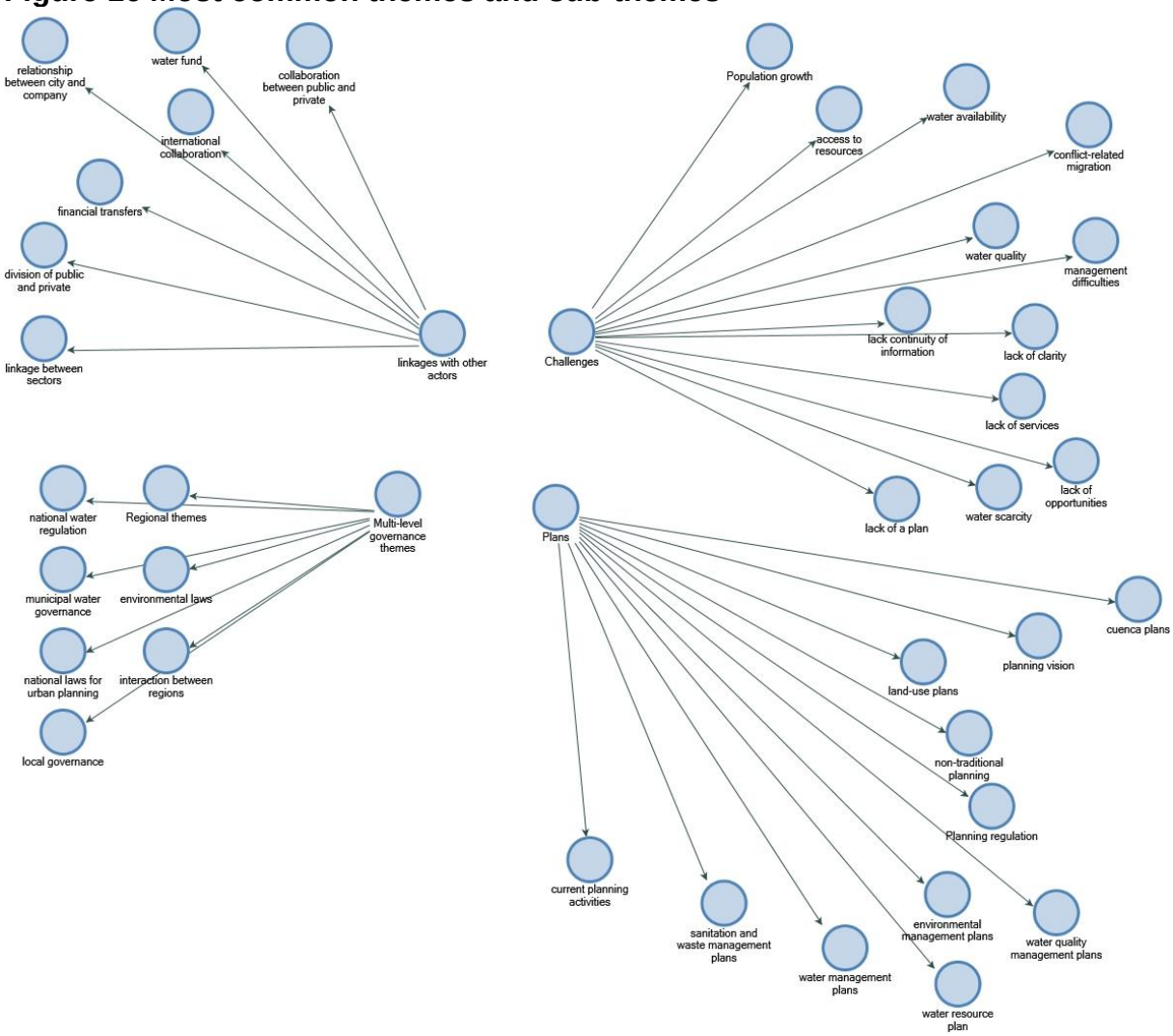


Figure 16 Most common themes and sub-themes



11.4 Theory-based code book

Guide for Coding

ONE GROUP OR MANY GROUPS

1. Is the speaker discussing <u>one group</u> (a) or <u>many groups</u> (b) in making decisions, plans or implementation of a policy or program?

If one group, code as <u>"one group."</u>

a. ***Example for "one group"****: "The environmental authority grants a permit to extract water in a given area."* In this example, there is no mention of other groups'.

DO NOT CODE EXAMPLES SUCH AS: "There is a budget for water services that different groups contribute towards, with the mayor's input."

If many groups, code as <u>"many groups":</u>

b. ***Example for "many groups"****: "We have a joint commission for conserving the watershed which includes the mayor's office, community and the water company."* In this example, different groups are mentioned in a planning capacity.

*DO NOT CODE EXAMPLES SUCH AS: **"**The different ministries of the national government are all interested in land-use policy."**** In this example, "different ministries" are referred to, yet they are not discussed in a decision-making, planning or implementation capacity.

AUTHORITY

3. Does the speaker describe the direction of authority as a) top down b) mixed c) bottom-up?

Code as <u>"top down":</u>

a. **Example for "Top down":** *"Water is a technical challenge and the State takes full responsibility in providing and maintaining it."*

DO NOT CODE EXAMPLES SUCH AS: ***"****The citizens' vote in politicians who develop policies that suit them."* This is discussing direction of power, but is coming from the bottom-up; the citizens are choosing the politicians.

<u>Code as "mixed":</u>

b. **Example for "Mixed":** *"The municipality and the surrounding communities should share responsibility of the watershed."*

DO NOT CODE EXAMPLES SUCH AS: *"The citizens chose whom they want to represent them."* This example does not make clear how the direction of authority is both ways: *"whom they want to represent"* would have to information suggesting the direction is both ways.

Code as <u>"bottom up":</u>

c. **Example for "Bottom Up":** *"Different water basin organizations have worked closely together to provide services where there currently is none."*

DO NOT CODE EXAMPLES SUCH AS: *"The public service company has tried to integrate the water-basin organizations, but cannot."* This example does describe different groups that are known to be working from the bottom up, but the text does not provide information on how this might be done.

General comments

A. Items can have more than one code. For example, there may be a plan that is decided upon by many groups at the national level (multi-group) and is given to the municipalities.

   For example, *"The ministries of health, environment and public services provide regulations to each of the local level authorities."*

   In this example, *"the ministries of health, environment and public services"* suggests **"multi-group" (code 1)** and the *"provide regulations to each of the local level authorities"* suggests "**top-down" (code 3).** Code the whole sentence using both codes (do not code the individual components of the sentence).

B. Items may also have instances where different forms of the same code are exhibited ie. One group and many groups, top-down and mixed etc.

   For example, *"The secretary of health has the responsibility also, to decide whether to allocate resources for water. They make a decision and they can it together with the company or they do it independently."*

   When they say, *"they make a decision but they do it together with the company"* suggests **"multi-group"** and *"or they do it independently"* suggests **"one group."** Code the whole sentence using both codes (do not code the individual components of the sentence).

C. All examples are fair game – specific to water or not. If they discuss other sectors like electricity or how governance occurs outside of Medellin, code following the same rules.
D. For generic references to groups such as "illegal groups", "environmental groups", or "private groups", label them as "many groups" as described in Code 1.
E. For epm, the public service provider, if they refer to again different companies owned by epm, label as "many groups". If they are departments within epm (ie. sanitation, hydro, planning etc.) label it as "one group." See Code 1.
F. The negative (ie. they are the authority, but they "don't go")

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