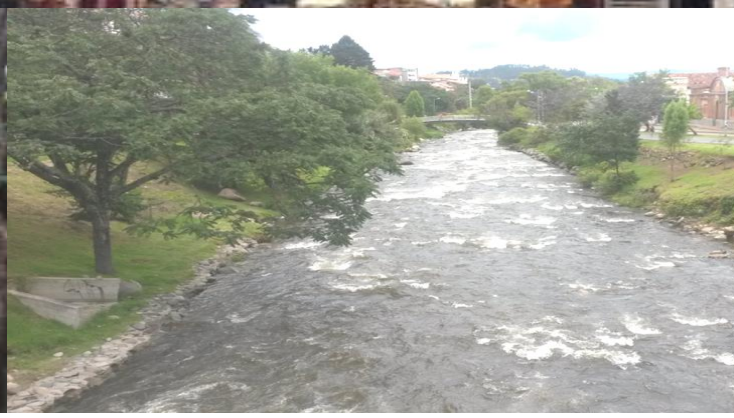



Sound sustainability, or playing with fire?

Battling future water scarcity in Quito, Ecuador



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Executive summary

This thesis presents an analysis of the Trends and Pressures Framework (TPF), City Blueprint Framework (CBF), and Governance Capacity Assessment Framework (GCAF) of Integrated Water Resources Management (IWRM) in the Ecuadorian capital of Quito. The TPF analysis comprises 12 social, environmental and financial indicators (18 if all sub-indicators are counted). The CBF assessment measures the performance of IWRM based on 25 different indicators that are divided up into 7 different categories: water quality, solid waste treatment, basic water services, wastewater treatment, infrastructure, climate robustness and governance (Koop & Van Leeuwen, 2015c; 2016). As the OECD (2016) states that the global water crisis is predominantly a governance crisis, a GCAF analysis is added to explore the room for improvement of the current policies on the level of urban governance. In total 9 overarching governance capacities (conditions) were assessed, each consisting of 3 (sub-)characteristics, resulting in a total of 27 indicators for the GCAF. This was done on the basis of 26 qualitative semi-structured interviews, of which 14 were with experts on the area of IWRM in Quito, and 12 were done with citizens. The CBA revealed that Quito had a Blue City Index (BCI) of 2.0, can be classified as a wasteful city, and that wastewater treatment (WWT), which is absent, is its main IWRM-bottleneck. Financial means to solve the problems on this area however, are lacking. In the GCAF analysis, therefore, the focus in this study is placed on water scarcity. At this point, shortages of water are not a problem in the metropolitan district of the Ecuadorian capital, as the percentage of the people that has access to drinking water lies close to 100%. Nevertheless, Quito might face serious water issues in the future, in part due to the rapid population growth that is predicted for the upcoming years (INEC, 2013). Although there are solid long-term plans to obtain, operationalize and protect new sources for drinking water, part of the city's drinking water at present is obtained from the area around the active Cotopaxi volcano, of which the last eruption took place in August 2015. Regardless of the promising long-term strategies, a sudden event like a volcanic eruption could be a major risk for the city as a whole. To deal with these risks in an adequate manner, completeness, availability and accessibility of information, as well as cooperative power between different stakeholders and participation of citizens need to be improved. Furthermore, the lack of incentives and clear policies to restrict the use of certain substances or certain quantities of water are other major obstacles Quito finds in its transition to becoming a climate adaptive city, while the strong leadership, strong organization and cooperations within the drinking water authority itself and the widespread awareness among experts about the issues at hand can be considered additional positive points. Finally, as the GCAF was never applied to an urban context like that of Quito before, it first had to be adjusted to make it fit the local context. It was established that the characteristics of protection of core values, progress and choice variety and (political) authority were a source for a critical discussion due to the centralist character of governance in Ecuador. In turn, it was proposed to add a tenth condition, integrity, to the GCAF, consisting of the characteristics transparency, accountability and participation/anti-corruption, a result which is possibly also relevant for local contexts other than that of Quito.

List of tables, figures and used abbreviations

IWRM = Integrated Water Resources Management

TPF = Trends and Pressures Framework

CBF = City Blueprint Framework

CBA = City Blueprint Assessment

GCAF = Governance Capacity Assessment Framework

EPMAPS = Empresa Pública Metropolitana de Agua Potable y Saneamiento

EMGIRS = Empresa Pública Metropolitana de Gestión Integral de Residuos Sólidos

INAMHI = Instituto Nacional de Meteorología e Hidrología

FONAG = Fondo para la protección del Agua

WIGO = Water Integrity Global Outlook

WIN = Water Integrity Network

OECD = Organization for Economic Cooperation and Development

TAP = Transparency, Accountability, (and) Participation (basic principles of Water Integrity)

DMQ = Distrito Metropolitano de Quito

BCI = Blue City Index

WWT = Waste Water Treatment

1. Introduction

1.1 Introduction

From 17 until 20 october 2016, the United Nations Conference on Housing and Sustainable Urban Development, Habitat III, will take place in Quito, Ecuador, after having known preceding editions in Vancouver, Canada (1976) and Istanbul, Turkey (1996). The main objective of the conferences has been to address problems of rapid urbanization throughout the world. Recent decades have shown a progress of this rapid urbanization globally, leading to a situation where 80% of the Gross World Product (GWP) comes from cities and almost 75% of the global material and energy flows are consumed in cities. In this light, besides the fact that cities are concentrations of economic opportunities, they are also a concentration of risks for health and environment. Urbanization takes place at a rate of approximately 200,000 people per day worldwide (Koop & Van Leeuwen, 2016). In this situation, climate change, inadequate water management and poor solid waste collection and treatment are likely to cause water scarcity, water pollution and other potential health issues that can negatively alter the resilience of cities and its inhabitants. Moreover, due to this rapid increase of the global urban population it can be stated that the largest part of this kind of problems, more than in rural areas, also increasingly becomes concentrated at the level of the urban. Therefore, the greatest global challenges on the areas of health, environment, waste and water are best addressed at the city-level (Koop & Van Leeuwen, 2016). It is one of the reasons why the OECD (2016) has put the assurance of proper urban water management at the top of their agenda.

The City Blueprint Framework (CBF) and the Governance Capacity Assessment Framework (GCAF) are methodologies that can play an important role in tackling these problems, as they are able to quickly uncover rooms for improvement on the terrains of, for example, water quality, solid waste treatment, infrastructure and governance. In other words, the City Blueprint assessment can, for any given city, give an accurate overview of the Integrated Water Resources Management, or IWRM (See also: Koop & Van Leeuwen, 2016). As soon as the main gaps in this IWRM are identified, with emphasis on the technological aspects, the GCAF functions as a tool to identify the most important options to improve the city's governance. As a part of the CBF, the Trends and Pressures Framework (TPF) analysis comprised 12 social, environmental and financial indicators (18 if all sub-indicators are counted). The CBF assessment measured the performance of IWRM based on 25 different indicators. For the GCAF, in total 9 overarching governance capacities were assessed that each consisted of 3 sub-conditions, resulting in a total of 27 indicators for the GCAF. By incorporating as many urban case studies as possible into the assessments, a platform is created to enhance city-to-city learning. The City Blueprint Assessment (CBA) has already been applied in 45 different cities in 27 (mainly European) municipalities and regions. It is however important to extend this to regions outside Europe, such as Quito, where room for improvement is possibly limited by a variety of economic, social and cultural factors. Accordingly, the following central research question is addressed in this thesis:

"What are the opportunities and limitations of the Integrated Water Resources Management in Quito, Ecuador and how can the main limitations best be resolved?"

With the UN Habitat III conference coming up in Quito later this year, this city seems like a useful next step to enhance the platform of the CBF. However, as the global water crisis is often stated to predominantly be a governance crisis (OECD, 2016), it is also crucial that detailed governance analyses are done to identify possible rooms for improvement and to ensure optimized results. This case study of the city of Quito forms no exception to that. At this point, the percentage of the people that has access to drinking water in the *Distrito Metropolitano de Quito* (DMQ) lies close to 100%. However, the city might face serious water issues in the future. Despite promising long-term strategies to obtain, operationalize and protect new sources for drinking water, part of the city's drinking water at present is obtained from the area around the active Cotopaxi volcano, of which the last eruption took place in August 2015. Hence, regardless of the promising long-term strategies, a sudden event like a volcanic eruption could be a major risk for the city as a whole. Moreover, the population of the DMQ is expected to rise from 2.24 million to 2.78 million by 2020 (INEC, 2013). This is an increase of almost 25% since the last census was held in 2010 (INEC, 2010b). If this growth rate of 25% per 10 years persists, it will mean that the population of the DMQ will exceed 5 million by 2050. This makes the possibility of water scarcity due to a combination of population growth and climate change a realistic one for Quito. In order to deal with these challenges, a number of improvements in efficiency will need to be made on areas such as drinking water consumption and financial investments, among others. These improvements should at the same time take into account the centralist and socialist governance structure in Quito (and Ecuador as a whole), which forms a unique case within the existing CBF and GCAF platforms of cities assessed until now. More importance should also be assigned to the development of a better climate for citizen and stakeholder participation and more accurate transparency and accountability. These are factors that, regardless of the presence of a centralist governance structure like that of Quito and Ecuador, might also be relevant for other local contexts anywhere in the world because of the increase in efficiency it can potentially provide on a variety of areas.

In the remainder of this thesis report, first the relevant theoretical literature that has been used as the framework of departure to this study is reviewed. Then follows a description of the research questions and methodologies used. Chapter 3 shows the results of the TPF and CBF assessments, while chapter 4, 5 and 6 deal with the results from the GCAF. Finally, in chapter 7, the results are discussed critically, before a conclusion of the main findings is offered. The report closes with recommendations for the future, while all information about interview questions, and operationalization of variables, formulas and scores of the GCAF as well as from the CBA are given in the annexes.

1.2 Theoretical framework

1.2.1 Integrated Water Resources Management (IWRM) in the global south

The term Integrated Water Resources Management (IWRM) has been subject to extensive discussion in the past. At the beginning of the current millennium, the Global Water Partnership (GWP) defined IWRM as a process which promotes the co-ordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Jønch-Clausen, 2004). Known definitions to IWRM are not exceptionally concrete ones and one of the main reasons for this might be that the term itself in practice has many different aspects. The guarantee of clean drinking water in a given city might also be dependent on the ways in which solid waste is managed. The water quality of a city may be related to certain governance issues, while climate change and (lack of) climate adaptation measures can have their effect on all four of those. In a way, this is the main strength as well as the weakness of the concept of IWRM. Pahl-wostl & Sendzimir (2005) illustrate this by stating that the word 'integrated' suggests that the concept should indeed be approached from a broad perspective, taking all possible trade-offs and different scales in space and time into account. However, this approach potentially makes the issue so complex and multifaceted, that implementation of possible policy improvements as a result of the approach becomes highly problematic. It is therefore suggested that two main knowledge gaps are to be overcome before the implementation of new policies can proceed in a smoother manner: first, a rigorous conceptual foundation, or a very clear understanding of what determines a system's resilience, vulnerability and adaptive capacities, or how to define a clear set of indicators on which the performance of a certain management system is assessed and analyzed at best. Second, there should be clearly defined trajectories of adaptation, or clear long-term planning of pathways that make sure those parts of the IWRM in a given case that score poorly are improved (Pahl-wostl & Sendzimir, 2005). The first of the two knowledge gaps described above by Pahl-wostl & Sendzimir (2005) resembles with the approach presented by Koop & Van Leeuwen (2016) who, with the introduction of the City Blueprint methodology, assess IWRM on the basis of 5 classifications: cities lacking basic water services, wasteful cities, water efficient cities, resource efficient and adaptive cities and water wise cities. While it is difficult to find a completely sound framework in which all different aspects of IWRM are sufficiently represented, the city blueprint assessment pays attention to the aspect of clean water of a given place itself, but also the related influences of for example solid waste management, governance aspects and climate adaptation policies of the same place. This also corresponds with the point made by Snellen & Schrevel (2004), as they argue that the word 'Integrated' in IWRM should go beyond traditional concepts such as the coordination among water management agencies. It should involve a planning approach that considers all possible strategies and impacts. Only then can the concept of IWRM be presented as a sustainable model.

What is described above is an ideal type of how the IWRM of any city could be assessed. However, in cities in the global south this may work differently. Clean drinking water for example is often guaranteed in Western European and Northern American countries,

whereas it is sometimes less self-evident in developing countries. This has implications for the ways in which a city's IWRM should be assessed. As the results of the City Blueprints that have been done until now show, most Western European cities are classified as either water efficient cities or resource efficient and adaptive cities (categories 3 and 4), while the few cities in developing countries that were assessed until now were classified as cities lacking basic water services (category 1). An example of how a situation can in that sense be more precarious in a developing country is given by Rammelt et al. (2014), in a case study on the contamination of arsenic in drinking water in Bangladesh. The technological solutions that are offered to solve the problem in this case of Bangladesh especially benefit the richer segments of the population. Moreover, attempts made to construct an adequate infrastructure are also more likely to especially benefit those who have more means to gain from it, instead of creating a situation of social equity, if the related aspect of governance is not executed adequately. Another example is provided by Challcharoenwattana & Pharino (2015) in a case study of solid waste recycling initiatives in Thailand. They illustrate that Willingness To Pay (WTP) can be a determining factor in some developing countries. In their results, even when taken into account that there is a general depreciation of illegal dumpsites in Thailand, WTP still declines because solid waste recycling initiatives are often still considered too costly by too many people, especially those with lower income means. These kinds of factors can potentially thwart solutions to environmental pollution in the global south.

Case studies such as the ones described above, one about water contamination and the other about solid waste recycling give useful insights in additional problems that emerge when assessing IWRM in developing countries. The same is also illustrated by Chandrappa & Brown (2012) who argue that solid waste management is one of the most important problems of our time as development and subsequent use of materials generates enormous quantity of wastes. The possibilities one has to manage the problem are dependent on (and often limited by, in that sense) income factors, but also cultural and geographical issues. This poses problems for environmental issues in the future, especially if you take into account that populations all over the world are growing and urbanization rates are rising. Henry et al. (2006) state the same about the issue of municipal solid waste management in Kenya. In Kenya there was poor economic growth in the recent years before the time of doing research, whereas rural-to-urban migration led to an accommodation of 60% of the urban population on just 5% of the urban land area. In conditions like these cities are very likely to be vulnerable to environmental degradation and pollution and the surface and groundwater is likely to be polluted. This has already happened because of illegal waste dumping practices in the river that runs across the Kibera slum in the city of Nairobi. To improve these conditions, a better infrastructure is needed in these cities for people to be able to process waste and other polluting substances that otherwise may end up in the groundwater. If these improvements do not happen this can also have major implications for agriculture and food security, as a reported case of a massive diarrhoea outbreak in the Kenyan city of Nakuru, as a result of a farmer irrigating his land with what turned out to be extremely polluted wastewater, has already illustrated (Henry et al., 2006).

This is where another problem comes up. IWRM in general is often not only a problem of technology, but also one of implementation and financing. Moreover, these issues of governance are in many cases more complicated in countries in the global south. Hence, to tackle the bottlenecks of IWRM, one must also be able to come up with solutions for issues with governance. The next two sections therefore deal with the issue of governance and set out to find the principles of governance that should be adopted to reach an optimal result.

1.2.2 The importance of good urban governance

The tackling of IWRM issues is highly related to the solving of bottlenecks in governance. The preceding section saw an outline of the concept of Integrated Water Resources Management (or IWRM), with an additional focus on how corresponding policies and their assessment work differently in countries in the global south. It can also be said that governance structures (and the problems that go with it) in cities in the global south can be considered different from governance structures in cities in Europe and North America. However, this is not to state that all elements of a certain governance construction that are present in European and North American cities are absent in cities in the global south. It is therefore useful to explore some of the basic governance principles that are available in the existing academic literature on IWRM governance, despite the fact that most of these principles are written in a predominantly European and North American context. Moreover, as the available governance literature mostly deals with rather abstract concepts, these are more safely compatible with different contexts and can be considered less place-specific. This section deals with this more general part of the spectrum of urban IWRM governance, while a more detailed description and analysis of the more specific political context of Ecuador can be found in section 1.2.4.

When attempting to solve IWRM matters, many cities experience difficulties especially in the phase of implementation. Hence, it is no coincidence that the former Secretary General of the United Nations, Kofi Annan, once stated that good governance is perhaps the single most important factor in eradicating poverty and promoting development (Graham et al., 2003). This same good governance can thus be seen as one of the major keys towards solving problems in different aspects of urban IWRM, also in economically and environmentally more vulnerable regions. Nevertheless, Brown & Farrelly (2009) indicate that despite an existing consensus that sustainable urban water governance requires an integrated, adaptive, coordinated and participatory approach, its effectiveness still seems to be coming to a halt in the phase of implementation. An explanation for this could be that the problem of water governance is complex and fragmented and that better and more integrated cooperation between policy-makers and the technological sector is necessary yet absent (Brown & Farrelly, 2009). The fact that the necessary technology is often already there, but that troubles are especially encountered in the phase of implementation, is a recurring problem in more issues. Another example could be food security, which is more than often not necessarily a problem of food shortage, but rather of weak policies, institutions and governance that reinforce an unequal distribution of the food that is available. In the same

way, the "global water crisis," as it is sometimes referred to, can also primarily be seen as a governance crisis (OECD, 2016). This, then, leaves one with the question of what good governance should consist of. Graham et al. (2003) argue that a common misunderstanding about the principle of gover*nance* is that it is the same as govern*ment.* Such an understanding would imply that whenever there is a problem of governance, the responsibility lies solely with the government to solve it. The notion of governance however, should be seen as something much broader, as it also includes the interaction between the government and other social organizations, and the relation between the government and citizens. It is therefore to be seen as a system of decisions that are being made, that consists of different parties being involved in the process. Additionally, the question of *"who is involved?"* simultaneously is a question of *"who has influence?"* In some cases, certain social or civil society organizations may not be included in the initial decision-making process and as an alternative they attempt lobbying to exert influence across a different channel. In other cases, the government might not be a single actor in the decision-making process and incorporates citizens into the system to get a better view of what decisions are suitable to make (Graham et al., 2003); something which is increasingly experienced as useful by policy-makers in more recent years (See also: Horelli et al., 2013; Verhoeven & Tonkens, 2011).

In the case of natural resource management however, contrary to other contexts, advanced outlines of governance principles have until now been limited (Lockwood et al., 2010). Possibly this is due to the fact that until now there has also been limited cooperation between the sectors of technology and governance and a lack of recognition for the relation, and therefore the necessity to coherence and cooperation, between the two (Brown & Farrelly, 2009). What is also evident, is that the environmental problems are so-called 'wicked problems,' which means that most of these problems are highly complex in nature, and perspectives on problem causes and solution strategies are divergent and contested. The tackling of these problems therefore requires multilevel governance that sometimes needs to overcome broadly divergent interests. Hence, a certain degree of guidance is needed, by means of a set of principles that is not context-specific or sensitive to change under the influence of diverging interests and different proposals for solutions (Lockwood et al., 2010). Such guidance by a set of principles that are part of a sound framework has another advantage, as it provides an opportunity for interurban exchange of knowledge and possible solutions. While every solution is to a certain degree local, methodologies like the City Blueprint or the Governance Capacity Assessment Framework give cities a useful tool to exchange their best practices (Koop et al., 2015), and in turn look over their own boundaries to cities that have a similar geography, culture and political economy and get new inspiration for creative solutions. In other words, frameworks such as the one addressed by Lockwood et al. (2010) provide opportunities to enhance city-to-city learning (Koop & Van Leeuwen, 2016), which also means an opportunity to translate knowledge and educate, raise awareness and monitor progress in many more than one place at once. Moreover, besides the fact that the application of the City Blueprint Assessment, the GCAF methodology and both of their results could theoretically lead to cities obtaining a Blue City Index-value of 10 (Van Leeuwen, 2013), the frameworks also show that even cities that perform very well at this moment, can still greatly improve. As has been stated, of the City Blueprints that have been

carried out until now for example, most cities in Western Europe (such as Amsterdam, which is known for its advanced water management compared to many other parts of the world) can be classified in category 3 (water efficient cities) or 4 (resource efficient and adaptive cities) out of 5. Up until now however, the first city to be classified in the highest category, water wise cities, is still to be found (Koop & Van Leeuwen, 2016).

Van Rijswick et al. (2014) add to this debate the point that an approach is needed in which different values, interests and uses of water are interconnected, in order to develop a method that is embraced by all stakeholders involved. In other words, the challenge is to develop an integrated and sustainable framework for water governance, in which all interested stakeholders involved get to have their input to contribute. Such a framework and its effective application however, is at this point still to be developed (Van Rijswick et al., 2014). Consequently, this same challenge leads Huitema et al. (2009) to the formulation of the idea that a structure of urban water governance should commit itself to 'adaptive (co-) management,' or the notion that good water governance embraces four basic institutional prescriptions: collaboration in a polycentric governance system and public participation (i.e. co-management), as well as an experimental approach to resource management and management at the bioregional scale (i.e. adaption). Theoretically this seems an ideal blueprint for good water governance. However, it is also exactly these four principles that are considered to encounter severe difficulties in practice, as one can ask oneself whether it is a good idea to experiment with the environment in real life settings. Besides that, it is argued that participation and collaboration do not always work as well in practical applications as they do on paper. Collaboration between different stakeholders, for example, does offer a diverse body of information from many different perspectives to work with, while at the same time the danger exists that one loses the overview of a situation (which in turn also negatively influences the transparency and accountability of that same situation). Similarly, theoretically participation of citizens and stakeholders is something nobody will object to, whereas in practice people might be reluctant or unable to participate due to various reasons (Huitema et al., 2009).

Hence, the importance of good governance is evident, and so is the fact that this notion of governance is not a *one man show* in terms of the government not being the only responsible stakeholder involved. However, with the inclusion of more stakeholders and perspectives also comes the necessity of a clear structure and order, simply because of the newly present danger of losing surveyability. There should be a clear overview of which layers of society are involved and what the functions and responsibilities of each of these layers are. The next section deals with these responsibilities, as well as with how they should manifest themselves to ensure solid and fruitful collaboration between different stakeholders in the governance arena.

1.2.3 Towards a state of collaboration

The idea that a governance structure is a system of multiple layers and an ever changing process at the same time, instead of an entity that stands free from the other layers of society

involved, is a useful one. It feeds the suspicion that in contemporary politics a government is not able to take many decisions solely by itself, and that a government does not necessarily and self-evidently have significantly more power than a civil society, whether organized or not. To put theory into practice, Corfee-Morlot et al. (2009) for example indicate that there are basically two strategies of environmental governance that can be adopted. One of these is the spectrum of locally-led strategies where local initiatives influence national action (bottom-up), whereas another is that of nationally-led strategies where enabling frameworks empower local players (top-down). However, what should be seen as the most promising are the frameworks of environmental governance that combine the two into a hybrid approach, where cooperation between different layers of society is established and guaranteed (Corfee-Morlot et al., 2009). Besides that, including the civil society in political decision-making has more advantages for the government. By delegating, they are also more likely to be able to play their own role more effectively and therefore increase their own capacity (Nwaka, 2005).

A best possible practice for urban governance is thus one which enhances a collaboration between all relevant stakeholders from all different layers of society. For the sake of clarity: in this thesis, 'layers' are layers of governance, that roughly divide the society in three parts - the government, citizens, and the (united and organized) civil society that forms a layer in between, of which for example also social movements are part. All these different layers should be attempted to be included, to ensure that decisions can count on support from all stakeholders involved, as well as to provide the parties involved with a diverse body of perspectives and information to work with. In an ideal situation within this process, a win-win situation for all parties arises in which there is gain for all stakeholders. It is important to realize that when addressing the role of the urban government, or the role of the civil society, it goes for every stakeholder party that it is not simply a case of handing over the initiative and leaving the responsibility with the other party or parties involved. When taking theory into practice, what the greatest goal should be is also the greatest challenge, namely to efficiently and effectively collaborate and in that way make sure that none of the societal layers involved 'misses out' on important issues that are normally overlooked when solely reasoning out of their own perspective. In other words, the objective is to create an integrated team of stakeholders that work together to reach a mutual goal. Indeed, also theoretically a collaboration is better funded than the idea of responsibilities shifting between stakeholders. Horelli et al (2013) for example emphasize in their study of two cases in Helsinki that it is especially important to realize a cooperation between urban planners and inhabitants of the city. Finding a balance in the links between what the authors call the formal, the semi-formal and the informal is desirable, eventually creating a network of power relations between all the different stakeholders and parties involved. It is to be prevented that an image develops in which it is unclear who has which responsibility due to, for example, miscommunication. Hence, it is best to create a situation in which urban government planners, communities and possibly also social movements or organizations (that can form a layer in between) work together as efficient as possible.

Horelli et al. (2013) in their study point towards several municipalities in The Netherlands as good examples, where the potential of participation by the civil society has

been recognized and optimally utilized. Indeed, a very useful guideline that can be referred to here is one that is set out in a Dutch study by Verhoeven & Tonkens (2011). The main idea behind this case study of so-called 'civil initiatives' in Amsterdam, The Netherlands, is that a new national government policy aimed to strengthen the civil society by drawing back the initiative of the government. In the course of time, the state became convinced of the idea that too much creativity and problem-solving qualities of the civil society had gone lost, as the welfare state had taken over too many of their tasks and responsibilities. In response, the national Dutch government wanted to make it easier for citizens that for example wanted to organize events or meeting places, to increase the social cohesion in their neighbourhood. In order to reach this objective, a national budget was made available to all municipalities, who in turn got to divide this among a number of ideas or initiatives that were presented by inhabitants of the city. What is interesting about this particular case is the varying role of the municipalities in every application or request for a part of the budget. In some situations applications were spontaneous and voluntary initiatives 'from below' that were aimed at 'solving mutual problems together.' The only task for the government was in this case to provide a framework of preconditions, but by no means take over the task of the civil society to fill in this framework or to determine the ways in which these preconditions would be met. In different situations an 'active city council' was of more importance. In other words, in some situations the government would merely have an advisory or facilitating role that mainly occurred 'at the side,' whereas in other situations there was more support from professionals or the government in terms of generating ideas, help with budgetary practices or cooperation with initiators throughout the whole process. Whichever worked best was dependent on the situation and could also differ per municipality. The researchers concluded that as a result of this loose and varying relationship between government and civil society in Amsterdam, and of an 'activating policy' by the government, participation by members of the civil society had increased (Verhoeven & Tonkens, 2011). This is also a valuable conclusion when connecting it with the need for public participation that was addressed earlier (Huitema et al., 2009).

Hence, the goal should be to *include* all relevant stakeholders of all layers of society, as well as to create a situation in which all these stakeholders and layers trust each other enough to exchange necessary information and perspectives, forge a fruitful collaboration in general, and therefore utilize the functions of all stakeholders and layers optimally. Moreover, despite the fact that the cases described here are mainly European cases, it is interesting to apply these principles to the case of Quito and see which principles are present and which principles are not (and thus which governance capacities should be improved to make sure these principles are present in the future). For Ecuador specifically, this political context is highlighted in the section hereafter.

1.2.4 Ecuador and Quito: national and local political contexts

Ecuador is a country located in the North-western part of South America and is bordered by Colombia in the North and Peru in the South and the East. The entire Western border of the country is a shoreline marking the beginning of the Pacific Ocean. The biggest city in the

country is Guayaquil in the Guayas region, being a home to around 2,35 million people (INEC, 2010a). The capital city of the country however, is Quito, located in the Pichincha region and situated on the equator with a population of around 2,24 million (INEC, 2010b). In 2016, the population of the entire country of Ecuador was just under 16.4 million (World Population Review, 2016), of which 64% lived in one of the country's main urban areas (World Bank, 2016f). In Ecuador as a country, five main ethnic groups can be identified. These include distinctions between **(1)** the *Mestizos* (a multiracial group of mixed European and Amerindian ancestry), **(2)** the indigenous population who traditionally mainly lived in smaller villages in the mountainous Andean areas, but have more recently more and more moved to either one of the bigger cities in the country, **(3)** the white population (a group mainly of European descent), and smaller shares of **(4)** Afro-Ecuadorians (mixed Ecuadorian and Sub-Saharan African descent) and **(5)** *Mulattos* (mixed European and Sub-Saharan African descent). Specific and consistent data about how large the shares of each of these ethnic groups are in Ecuador are lacking. However, it can be said that the last 3 categories listed here are no more than 10 or 15 percent of the total Ecuadorian population, leaving 85 to 90 percent for the *Mestizos* and the indigenous population together (Sánchez, 2005).

Since the current president, Rafael Correa, came to power, growth in Ecuador has been visible (although declining). The country has done a major job in reducing poverty and income inequality, although there is still some space to cover. With Correa, Ecuador took a clear 'left turn' in national politics. He made it his priority to battle the corruption in congress. In this respect, success was obtained in the sense that the Supreme Electoral Tribunal dismissed and replaced 57 members of Congress because they would have violated campaign laws. In April 2007 a majority of 64% voted in favour of rewriting the constitution (which would be Ecuador's 20th since its independence), giving the congress less power and allowing Correa himself to run for two more consecutive terms, of which his last one commenced in February 2013 when he received three times more votes than his closest competitor. From this can be derived that his opposition was rather weak and divided ("Ecuador – Politics," 2016). One of the current presidents' showpieces when elected for the first time was that he called for a so-called 'Citizens' Revolution,' which meant making an effort in creating an active and powerfully participating civil society ("Ecuador – Politics," 2016; Ortiz, 2015). According to Ortiz (2015) however, while Correa had promised in his campaign to pay more attention to and empower civil society, he has ended up exerting a form of governmental control on this same civil society. And while attempting to establish a form of a participatory democracy, this has led to over-regulating the organizations that he wanted to empower. Correa subjected civil society organizations to more bureaucracy. This severely controlled and limited the action of the critical civil society and public opinion in general, instead of facilitating it (Ortiz, 2015).

Accordingly, Correa received a great deal of criticism, domestically and internationally, on his relation to the media and the governmental pressure that was said to be exerted on the political commentators of radio and television stations. The number of state-owned media organizations grew, and Correa is known to have pursued criminal charges against columnists and newspaper owners. This also created an atmosphere of fear among many other journalists in the country to be criticized or even prosecuted in the future

("Ecuador – Politics," 2016). Correa also tried to battle activists or organizations who attempt to put government policies in a different perspective, as has also been visible through a presidential decree that dates from June 2013 which enabled Correa and other officials to oversee and dissolve international NGO's working in Ecuador. According to the law, international organizations would be required to undergo an extensive screening process in order to seek permission to operate legally in Ecuador. Moreover, officials would get the right to shut down organizations if this organization would *"move away from the objectives for which it was created,"* as has already happened with the shutting down of *Fundación Pachamama* in 2013 (Appe, 2014). In other words, with this law the Ecuadorian government can basically regulate what these international organizations say and do (Human Rights Watch, 2013). Correa has lifted Ecuador out of a great deal of the state of poverty the country was in barely two decades ago. However, he has reason to be criticized of restricting flows of information that oppose the government. Besides that he is also accused of using the democratic process and trying to influence it for his own political and personal benefit ("Ecuador – Politics," 2016).

Hence, the Ecuador with Correa in power has had an interesting yet complex relation with organizations in general, domestic as well as international. With the publication of an interview with Ecuadorian social entrepreneur and policy expert Orazio Bellettini Cedeño, Appe (2011) points out that Ecuador is one of the countries in Latin America with the highest density of civil society organizations and public participation. This makes Ecuador one of the most progressive countries on the areas of for example women's rights and rights to political participation. However, as there is a broad platform for supporting civil society organizations and participation on the one hand, on state level there are also institutions of highly concentrated power on the other. Moreover, the major challenge on this area is that the country is highly fragmented. There is little cohesion, little coordination and this reduces the power of the civil society to exert pressure, although one could also argue that it is exactly this chaotic structure that has moved government officials to introducing more control and regulation. (Appe, 2011). Ecuador is in the middle of a process to find the right balance in this process towards a reciprocal relationship between state and civil society. It seems that as long as organizations are transparent in what they do, the state will not be reluctant to relieve its pressures and regulations. A main factor that has also played an important role is the realization that civil society organizations actually complement the work of the state. To achieve development in Ecuador they must work together with the government, with universities, with the private sector, but also vice versa (Appe, 2014). Hence, the principal importance of the existence of the platform of organizations is evident. However, more cooperation between and acknowledgement of the complementarity of the civil society and the state and vice versa would foster the results from the work done by both sides even more and contribute to a smoother national political climate.

In Quito as a city, the contextual situation may in some respects differ from the national one. Politically, but also climatologically. With its situation at 2850 metres above sea level, Quito is the highest capital city in the world in terms of altitude. This makes its geography very different from that of for example Guayaquil, which is a 6 hour trip further

down south, located at the coast and situated at sea level. And also in terms of differences in climate, which is much hotter and dryer in Guayaquil, while Quito has much cooler weather that is more reminiscent of a mountainous climate. Politically, the mayor of Quito is Maurcio Rodas, who is originally a lawyer and now the leader of the *Sociedad Unida Más Acción* (Municipio de Quito, 2016a), which is, according to several respondents that were interviewed as a part of this research, a relatively new political movement and positions itself as a liberal right-wing political party. This is almost the opposite to Correa's PAIS movement, which is in charge nationally and viewed as a left-wing socialist party ("Ecuador – Politics," 2016). According to interview respondents this hardly ever leads to situations of major conflict, although it should be noted that this is also because it is simply not possible. The municipal government can only take individual decisions by itself, but never decisions that oppose national regulations and for every decision authorization is always needed. Still however, this creates an image of Quito being an island within the rest of a bigger country, since around two third of Ecuador elected the left-wing Rafael Correa as the national president ("Ecuador – Politics," 2016). Nevertheless, Quito remains the politically important heart of the country (while Guayaquil is its main economic hub) where the national as well as the local government are seated. Besides this, as will become clear in the chapters that deal with the results to the research, environmental factors (at this moment) are also still in favour of a solid provision of drinking water now and in the upcoming years in Quito, while in other parts of the country this has already become a major problem. Before these chapters on the results however, the methodology of this research is described hereafter.

2. Methodology

2.1 Research questions

As stated in the introduction, the following central research question is addressed in this thesis:

"What are the opportunities and limitations of the Integrated Water Resources Management in Quito, Ecuador and how can the main limitations best be resolved?"

This research question is being operationalized into four sub-questions:

- *"What are the main strengths and bottlenecks of the Integrated Water Resources Management policies of Quito with regard to the indicators of the City Blueprint assessment?"*
- *"How can the most important bottlenecks of the Integrated Water Resources Management in Quito be improved regarding the interests of 4 particular stakeholders, i.e., (1) technical and political authorities; (2) respondents active in social, environmental or other civil society organizations; (3) university students; (4) the entire urban community?"*

- *"How can the Governance Capacity Assessment Framework be optimized and operationalized in order to adequately assess governance capacities in Quito, regarding the most important challenges in Integrated Water Resources Management as well as the interests of the 4 most important stakeholders identified?"*
- *"How can this optimized Governance Capacity Assessment Framework be used to address the governance capacities that need to be developed in order to maximize the opportunities for more climate adaptive water management and governance in Quito?"*

2.2 Description of research instruments: the CBF and the GCAF

The research that was carried out consisted of two parts: the **City Blueprint Framework (CBF)** and the **Governance Capacity Assessment Framework (GCAF).** The CBF, in turn, also consisted of two parts: first, the analysis of trends and pressures, which consists of social, environmental and economic background-indicators (including all sub-variables, 18 in total) that cannot be influenced by local urban authorities. Examples of indicators that were assessed on this area are urbanization rate, inflation rate and flood risk. Second, there is the City Blueprint performance assessment, which is the measurement of the 25 performance indicators to assess the IWRM performance of the urban water cycle in Quito. Examples of performance indicators that were assessed were drinking water quality, drinking water consumption and climate adaptation. The GCAF, then, aims to identify the most important rooms for improvement from an urban governance perspective, which has already been explained as something playing a vital role in tackling challenges on the area of climate adaptive water management (Koop – Forthcoming, Graham et al., 2003). Examples of indicators from the GCAF that were assessed are awareness, financial viability, information availability and implementing capacity. A full overview (with operationalization, definitions, used formulas and their final scores) of the in total 43 indicators that form the CBF are given in Annex 1, while a full overview of the 9 overarching governance capacities and their conditions (3 per capacity, so 27 in total) along with their operationalization, definitions and references is given in Annex 2, although an overview of the list of conditions in characteristics is also given in table 1 in section 2.3. A full description of all capacity levels (- -. -, 0, + and ++) for each of the 27 conditions is given in Annex 4. Finally, any limitations to the CBF and the TPF are mainly dealt with in the discussion in chapter 7, while some of the (methodological) limitations to the research process and application of the GCAF are described in section 2.5.

2.3 Strategies and methods used

This report presents a case study of Quito within a broader comparative platform, which carries out research with the same setup and the same set of indicators in as many cities as possible globally. The comparison with other cities however, is left outside the scope and focus of this study. This thesis focuses specifically on the case of Quito, where management

and governance analyses were carried out to identify the main bottlenecks in the city's IWRM, as well as the most important governance capacities that should be improved for Quito to refine its transition towards a climate adaptive water management. To do this, a mixed methods research strategy was adopted, in which the quantitative part consisted of the CBF and the corresponding questionnaire (Koop & Van Leeuwen, 2015c). The execution of the questionnaire of the CBF again consisted of two phases: first, all (together 43) indicators involved were subjected to an extensive literature study. The results of this literature study were documented in a concept report of the City Blueprint, which was presented to EPMAPS, EMGIRS and INAMHI. All these institutions were then asked to provide their most recent, and above all correct, information on the indicators that were of relevance to them, resulting in the final scores for all indicators and eventually the definitive City Blueprint report of the city of Quito (See Annex 1). After carrying out the CBA, the IWRM of Quito was classified in one of the following five categories: cities lacking basic water services, wasteful cities, water efficient cities, resource efficient and adaptive cities and water wise cities (Koop & Van Leeuwen, 2015b).

The qualitative part of the mixed methods strategy, then, corresponded with the Governance Capacity Assessment Framework (GCAF), which was applied to the city of Quito in order to assess the most important governance gaps to be improved. Unlike the TPF and CBF, the GCAF is not yet applied on multiple cities. Hence, the application of the GCAF served two main goals: first, to test the GCAF by optimizing and operationalizing the framework with respect to the most important IWRM challenges in Quito. As the GCAF has been developed based on western oriented scientific literature (mainly via Scopus, Web of Science; OECD and UN), it was required to adjust the existing framework with respect to the Latin American and Andean situations and specific context of Quito. In this process, new indicators have been added to the framework, whilst the indicators that were of less relevance to the local context were excluded. Second, the GCAF of Quito was used to identify the aspects of the city's water governance that most urgently need improvement. Both of these goals were achieved by gathering qualitative information from 4 different groups of stakeholders, by means of the conduction of 26 qualitative semi-structured interviews among the different stakeholder categories identified. Which indicators were excluded and which new indicators were included in the process, as well as the resulting framework for final analysis and the results that followed from it, are dealt with in chapters 4, 5 and 6 of this thesis, which discuss the results of all the interviews conducted.

Table 1: all Governance Conditions of the GCAF and their corresponding characteristics

Knowing	**GC1 Awareness**	1.1 Community knowledge 1.2 Local support 1.3 Internalization
	GC2 Useful knowledge	2.1 Information availability 2.2 Accessibility 2.3 Cohesion

Wanting	**GC3 Continuous learning**	3.1 Smart monitoring 3.2 Evaluation 3.3 Cross-stakeholder capacity building
	GC4 Stakeholder engagement process	4.1 Inclusiveness 4.2 Protection of core values 4.3 Progress and choice variety
	GC5 Policy ambition	5.1 Ambitious and realistic goals 5.2 Discourse embedding 5.3 Cohesive policy
	GC6 Agents of change	6.1 Entrepreneurial agents 6.2 Collaborative agents 6.3 Visionary agents
Enabling	**GC7 Multi-level network potential**	7.1 Room to maneuver 7.2 Clear division of responsibilities 7.3 Authority
	GC8 Financial viability	8.1 Affordability 8.2 Willingness to pay 8.3 Financial continuation
	GC9 Implementing capacity	9.1 Policy instruments 9.2 Legal compliance 9.3 Preparedness

2.4 Sampling strategies

For the quantitative part of the research (City Blueprint trends and pressures analysis and the City Blueprint performance assessment) no real sampling strategy was required, as it is a measurement of non-human indicators that are all filled in by doing extensive literature research and contacting persons with technical knowhow at *EPMAPS*, *EMGIRS* or *INAMHI*. On the contrary, the optimalization and operationalization of the Governance Capacity Assessment Framework (GCAF) needs to be done by conducting semi-structured interviews. The first selection of respondents was accessed by means of a cluster sampling strategy. This is a sampling method in which certain groups or areas are defined as research sites, and within these research sites an attempt is then made to obtain a representative sample (Bryman, 2008). The cluster sampling strategy has been applied by dividing the population into 4 different groups of stakeholders, as they have been defined in the second sub-question of this thesis: (1) technical and political authorities; (2) respondents active in social, environmental or other civil society organizations; (3) university students; (4) the entire urban community. These groups of stakeholders have been included for the following reasons:

(1) the group of authorities consists of respondents who work for the *EPMAPS*, the drinking water authority in Quito. They possess the necessary technological knowhow on Quito's water systems and services and what is needed to make plans for improvement and

how to make these operational. This institution operates (and has always operated) under the direct authority of the municipal government in Quito (Carrillo et al., 2007). The autonomous character of this institution has made it unnecessary to also interview respondents from the municipality of Quito separately.

(2) Environmental movements, social movements and other civil society organizations have always had a position more or less in between authorities and citizens. They lobby for or against government policies. Moreover, they possess a certain expertise that has the potential to stand free from government policy interests and can place these government policies in a different perspective.

(3) University students are often young people and have the potential to think differently in relation to people that are not studying anymore. As a result of this idea, it seemed logical to include university students as a separate stakeholder category within the broader category of citizen respondents, in the hope of getting answers that are slightly more creative and innovative in nature.

(4) Finally, a residual category (consisting of respondents that are not identified with any of the three categories above) is formed to not exclude any part of the population. Moreover, with two categories of water experts and two categories of citizens, a more or less equal division between governance perspectives is realized.

After these four categories were accessed, a snowball sampling strategy, which is the selection of new respondents through existing respondents (Bryman, 2008), was applied to contact more respondents until the total amount of 26 respondents was reached. Of these 26 respondents, 14 were water experts (7 authorities and 7 respondents from civil society organizations) and 12 were citizens (7 university students and 5 respondents from the 'entire urban community' group). The sample consisted of 14 male and 12 female respondents. Due to time constraints a number of issues emerged with the representativeness of the interview sample. These, together with some other limitations, are reflected on in section 2.5.

2.5 Limitations to the methodology

The research maintains cluster and snowball sampling strategies and hence has its strengths and weaknesses. On the one hand, there is no large dataset with many questionnaires that has to be divided equally over Quito with a more complicated sampling strategy such as stratified sampling or simple random sampling. This gives the researcher a great deal of freedom in which respondents to choose and how to choose them and access their environments. However, there is a risk of non- or less representative sampling compared to the possibilities that large-n sampling methods pose (such as with a civil register when using simple random sampling, etc.). On the areas of age and gender this bias has been successfully avoided, as the division over the different age categories and generations of all respondents together was more or less equal, and the same was more or less true for the division between male and female respondents. On the areas of education and neighbourhood however, the used sample

of interview respondents cannot serve as a representative one for the entire city of Quito. All respondents for example had either a university background, whether finished or not, or a PhD. Also those in the category 'Entire Urban Community.' Besides that, while for the Northern, Western and Eastern neighbourhoods and the smaller towns just outside Quito that are still part of the metropolitan district (Cumbaya, Tumbaco, etc.) enough respondents could be found, only one out of in total 26 interview respondents was a resident of a neighbourhood in the South of the city.

Given the limited time and means, the choice had to be made to accept a less representative sample of interview respondents on the areas of education and the neighbourhood that people lived in. Another limitation on this area was that the originally planned amount of interviews to conduct was 28 (7 per stakeholder category). The last 2 interviews in the category of the Entire Urban Community were planned on the last day of fieldwork, but were not conducted due to planning issues. As a result, contrary to the amount of interviews conducted in the other three stakeholder categories, the amount of interviews in the entire urban community category was two short. Finally, a substantial part of the interviews was conducted in Spanish. Out of 26 interviews, only 8 were conducted completely in English, 2 were conducted partly in English and partly in Spanish, and 16 interviews were conducted completely in Spanish. However, after data collection all interviews were transcribed in English. This might have had implications for the accuracy of the final results due to the translation process.

3. The City Blueprint of Quito

3.1 The analysis of trends and pressures

In table 2, the scores for the TPF Analysis of Quito are given. The TPF consists of indicators that can hardly be influenced by local policy makers, but which can nevertheless be controlled for when comparing the results from the CBF of different cities to each other. Urbanization for example, is a national trend that is hard to control on the local level. However, as more inhabitants come live in a city, this increases the pressure on the water resources (Koop & Van Leeuwen, 2015c). Similarly, several economic indicators (such as inflation rate and poverty rate) can influence the financial situation of a city and of its stakeholders, which makes it equally necessary that this type of indicators is taken up into the assessment. The analysis uses the following ordinal classes, expressed as degree of concern: 0–0.5 points (no concern), 0.5–1.5 (little concern), 1.5–2.5 (medium concern), 2.5–3.5 (concern) and 3.5–4 (great concern) – (Koop & Van Leeuwen, 2016). In the remainder of this section the most important results from this analysis are highlighted (for a more detailed description of the results from *all* TPF indicators, along with their definitions, operationalizations and the formulas that have been used for their calculation, see annex 1).

Table 2: analysis of trends and pressures – summary of scores

Main indicator	Sub-indicators	Score	Degree of concern
Urbanization rate	-	2.4	Medium
Burden of disease	-	1.0	Little
Education rate	-	0.7	Little
Political instability and absence of violence	-	2.0	Medium
Water scarcity	Fresh water scarcity	1.0	Little
	Groundwater scarcity	0.0	None
	Salinization and seawater intrusion	0.0	None
Flood risk	Urban drainage flood	2.0	Medium
	Sea level rise	0.0	None
	River peak discharge	0.0	None
	Flood risk due to subsidence	0.0	None
Water quality	Surface water quality	0.7	Little
	Biodiversity	1.0	Little
Heat risk	-	2.5	Concern
Economic pressure	-	3.5	Great concern
Unemployment rate	-	1.2	Little
Poverty rate	-	1.4	Little
Inflation	-	2.5	Concern

As can be seen in table 2, there are no environmental factors which carry a particular risk for Quito, except two: urban drainage flooding and heat risk. For urban drainage flooding for example, it was chosen to look at the open space ratio of the city of Quito, as analyzed of 77 cities globally (hence including Quito), by Huang et al. (2007). They indicated that with around 13%, Quito has an open space ratio which is just below the average of the cities assessed. While the open space ratio of a city certainly does not say everything, it can be argued that a lower open space ratio means that a larger share of the soil is sealed (see discussion section 7.1.2). Urban drainage flooding is therefore a medium concern for the city. The other environmental pressure, heat risk, is the predicted number of combined tropical nights (>20 °C) and hot days (>35 °C) in the period of 2071 – 2100, in relation to the share of green and blue area in the urban centre of Quito (Koop & Van Leeuwen, 2015c). The first part of the indicator was assessed on the basis of a prediction of minimum and maximum temperatures for the area around the Antisana volcano (provided by INAMHI), which is situated close to Quito. It was established that the number of combined tropical nights and hot days in the period of 2071 – 2100 is 0 (see discussion chapter 7.1.2). The share of green and blue area in the city was determined to be 6.01% of the total surface area of the urban centre

of Quito (see discussion section 7.1.2 and annex 1). This would give the second part of the indicator of heat risk a score of 5.2 (see annex 1) and therefore a concern that is higher than the highest concern possible. The overall score for the indicator of heat risk is the arithmetic average of the standardized scores, which means that the final indicator score is 2.6. However, 6.01% is presumably an underestimation of the real percentage of green and blue area, as the total share of green and blue area includes more than only parks. The final score for the indicator of heat risk is therefore slightly adjusted downwards to 2.5, implying a concern for Quito (see discussion 7.1.2 for a more detailed explanation).

At present, the city of Quito is able to provide all of (or at least most of) its inhabitants with enough potable water. Quito, as the capital city of Ecuador, is also an example to the rest of the country in that sense. It is one of the few places in the country where practically everybody has access to potable water, contrary to a substantial number of cities and villages where inhabitants have limited access such as the biggest city of the country, Guayaquil. In Guayaquil, water scarcity issues are significantly more pressing than in Quito. However, also in Quito risks of scarcity may increase in the future. While concrete effects of climate change are hardly predictable, a factor that is more important to look at is the rapid population growth of cities (Buytaert & De Bièvre, 2012), since this is another factor that has substantial influence. Moreover, it was indeed already stated in the introduction to this section that urbanization (which basically means growth of the populations in cities) puts more pressure on a city's water resources (Koop & Van Leeuwen, 2015c). With 63.7% Ecuador already has an urban population that is a rather large share of the country's total population. Besides that, the annual urbanization rate of change is 1.9% (CIA, 2016). The score for the indicator of the urbanization rate is therefore 2.4, implying a medium concern. Finally, the last important trend that deserves to be highlighted is the economic situation of Ecuador. The income of an average Ecuadorian is $8237.7(0) per year (IMF, 2013). This gives the indicator of economic pressure a score of 3.5, implying that economic pressure is a great concern for the country. Moreover, the inflation rate of the country was 4% in 2016 (World Bank, 2016c). This gave the indicator of inflation rate a score of 2.5, which can also be seen as a concern. These economic factors together with the rapid urbanization and the non-presence of green and blue areas should be seen as the main concerns for Quito, in the light of the TPF analysis.

3.2 The city blueprint assessment

As was also highlighted in chapter 2 on the methodology, the CBF analysis is a snapshot of the situation on IWRM in a given city at a particular point in time. While the scores can change over time, the goal of the assessment is to provide an overview of the main bottlenecks of a given city's IWRM *and* to attempt to keep these scores updated by repeating the same research with the same indicators, for example every 5 years. This part of the assessment does not provide any measures to unblock the present bottlenecks. These are provided in chapters 4, 5 and 6, which deal with the required improvements in Quito's governance gaps.

In the remainder of this section the most important results from this analysis (which are given in table 3) are highlighted (for a more detailed description of the results from *all* CBF indicators, along with their definitions, operationalizations and the formulas that have been used for their calculation, see annex 1). Unlike in the TPF analysis in the previous section where scores were given on a scale from 0 to 4 (and 4 meant the greatest concern), in the CBF analysis in this section scores are calculated on a scale from 0 to 10 (and 10 is the highest score, whereas 0 would mean a concern).

Table 3: City Blueprint assessment – summary of scores

Category	Indicator	Score
Water quality	Secondary WWT	0.0
	Tertiary WWT	0.0
	Groundwater quality	6.0
Solid waste treatment	Solid waste collected	7.9
	Solid waste recycled	0.1
	Solid waste energy recovery	0.0
Basic water services	Access to drinking water	9.9
	Access to sanitation	9.3
	Drinking water quality	10.0
Wastewater treatment	Nutrient recovery	0.0
	Energy recovery	0.0
	Sewage sludge recycling	0.0
	Energy efficiency	0.0
Infrastructure	Stormwater separation	0.0
	Average age of the sewer	1.0
	Water system leakages	4.1
	Operating costs recovery ratio	7.9
Climate robustness	Green space	0.0
	Climate adaptation	8.0
	Drinking water consumption	8.7
	Climate robust buildings	4.0
Governance	Management and action plans	7.0
	Public participation	4.2
	Water efficiency measures	8.0
	Attractiveness	0.0

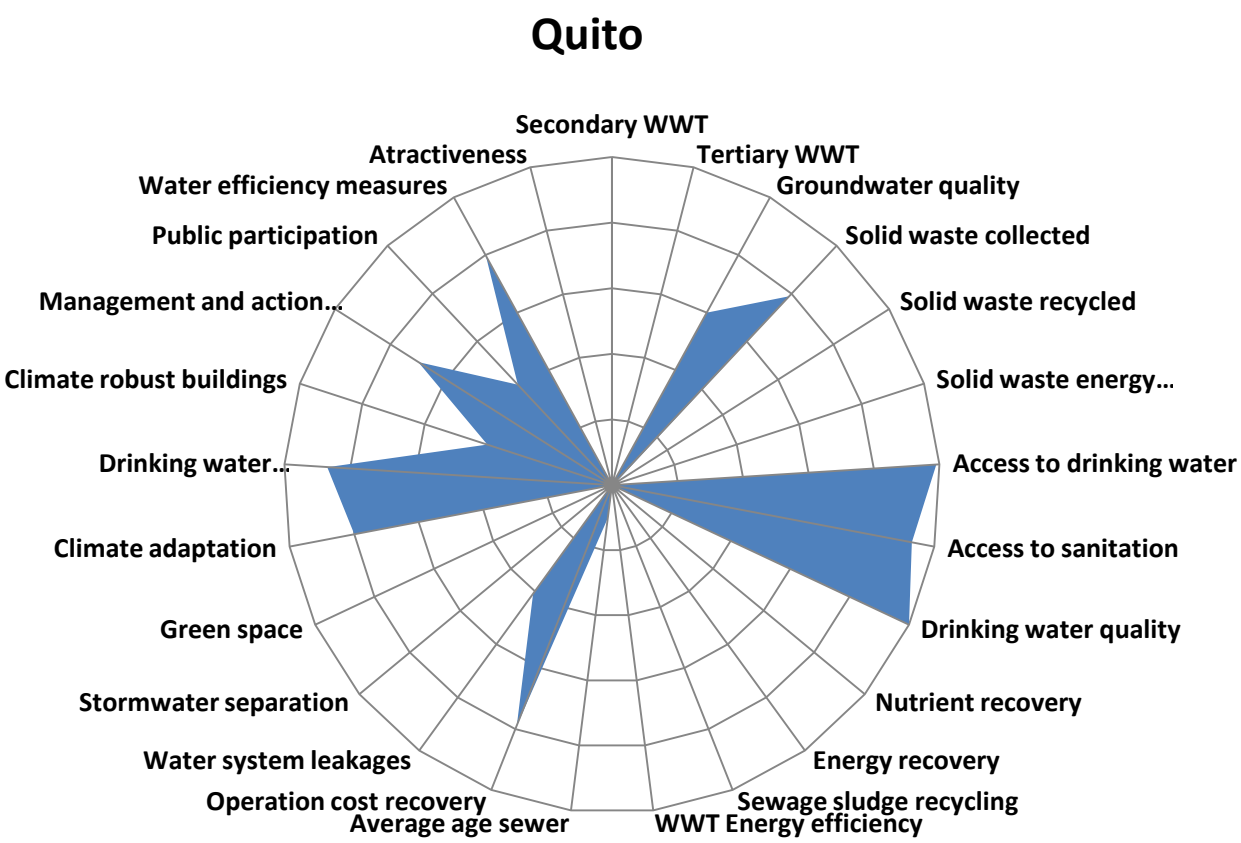

Figure 1: City Blueprint Quito – Graphic View

Based on its hierarchical clustering analyses, BCI scores and key City Blueprint indicators of 45 municipalities and regions Koop and Van Leeuwen (2015) propose a categorization of different levels of sustainable IWRM (see table 4).

Table 4: Categorization of different levels of sustainable IWRM in cities (Koop and Van Leeuwen 2015). Based on the indicator scores, Blue City Index and key indicator scores Quito can be categorized as *Wasteful city*.

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

The BCI-score of Quito is 2.0, which leads to Quito being categorized as a *Wasteful city*. Basic water services are indeed largely met as the percentages of people that have access to drinking water and sanitation facilities are both close to 100%. Besides that, almost 100% of the drinking water samples meet the quality standards. However, solid waste treatment is of poor quality, while wastewater treatment is even completely absent. That Quito is a wasteful city is also reflected in the separate indicators of the CBF (figure 1) in various ways. To begin with, the area of solid waste treatment is indeed strongly limited. Quito almost fully collected its moderate solid waste generation of 253.5 kg/cap/year in 2015, resulting in a score of 7.9 points for indicator 4 (*Solid waste collected*). However, despite the strikingly high amount of waste bins on the streets in Quito in which it was possible to dispose different waste materials separately, the amount of solid waste that was being recycled in 2015 was only 0.89%, and none of the solid waste materials collected were used for energy recovery. Another IWRM-sector in which Quito has room for improvement is the treatment of wastewater, which is absent at present. This causes major environmental pollution and damage to surrounding ecosystems (Vredeveld, 2008; Watkins 2014). There have been advanced plans to set up

wastewater treatment facilities in the future, in the form of a tertiary wastewater treatment plant, which when completed should treat (close to) 100% of Quito's wastewater (Watkins, 2014). However, this project was planned to be completed by 2015, but has now been put on hold because the city government has given priority to the construction of a metro network that should connect the entire DMQ. At this point, (also because of the difficult economic situation of Quito and of Ecuador as a whole) this has inhibited the construction of the wastewater plants, for which nevertheless all studies have already been finished. Besides the fact that the wastewater that comes out of it is left untreated, the sewer system in Quito is also of a fully combined type, automatically resulting in a score of 0 points for indicator 14 (*Stormwater separation*). The infrastructure does not collect the rainwater separately, making Quito vulnerable to flooding during periods of heavy rainfall. The combined sewer overflows lead to major water pollution that affect the ecosystem as well as human health. Infrastructural issues do not only hamper the procession of wastewater, they can also be seen back on the area of operational maintenance, which contributes to the city's drinking water leakage rate of 29.335%. Needless to say, all this water that is being lost could play a great role in arming the city against a possible water shortages and in a reduction of costs. At this point however, indicator 16 (*Water system leakages*) scores 4.1 points.

These high water leakage losses are expected to become an important issue as the water demand is growing rapidly. At present, the population connected to drinking water and sanitation are 98.55% and 92.73% respectively, resulting in scores of 9.9 points for indicator 7 (*Access to drinking water*) and 9.3 for indicator 8 (*Access to sanitation*). Moreover, drinking water quality control tests have revealed that 99.96% of all samples tested in Quito meet the Ecuadorian standards, resulting in a score of 10.0 points for indicator 9 (*Drinking water quality*). These are basic water services of which can safely be assumed that Quito has them relatively well under control. However, Quito can be classified as a vulnerable city when it comes to climate change. The city has already recognized this and as a result has managed to adopt climate adaptation policies that are better and more promising for the future than most other cities in the global south. The city has policies in place to reduce energy consumption, public awareness campaigns are organized and attempts are made to block urban deforestation (Boselli et al., 2010). The Quito Strategy for Climate Change (EQCC) was released in February 2008 and formally approved by the Metropolitan Council in October 2009 (Carmin et al., 2012). This strategy is also quite unique in the sense that it is constructed on the city level rather than on a national level (ELLA, 2014). Besides that, there is a concrete plan of funds that have been made available for the implementation of the strategies (ELLA, 2013). Quito therefore receives a score of 8.0 points for indicator 19 (*Climate adaptation*), as plans are implemented, clearly communicated to the public, as well as accompanied by subsidies to facilitate this implementation.

Quito is however lacking behind on managing energy use in buildings. The use of sustainable materials and earning of accompanying certifications has only just initiated in Ecuador and will take some more time to develop (Naranjo, 2015). On the other hand, the Ecuadorian government has been awarded $1.9 million from the Global Environment Facility (GEF) to support a series of energy efficiency projects during 2002- 2006, with another

US$4.9 million of local co-funding. In 2001, an energy reduction goal of 15% for public buildings had been defined (Van Wie McGrory et al., 2002). However, these kinds of goals take a long time to be implemented. In 2010 the city still scored poorly for its eco-buildings policies, which were lacking an environmental code for new buildings or any substantial incentives and awareness campaigns to motivate businesses and households to lower the energy consumption of buildings. Except for small energy-saving schemes in place since 2008, such as using LED light bulbs in city offices, there were no green standards for public buildings in place (Boselli et al., 2010). As this issue is merely described in limited quantity and not very much addressed in local and national policies, Quito receives a score of 4.0 points for indicator 21 (*Climate-robust buildings*). Specifically on water, Quito does much more. As one of the few, the city recognizes the fact that climate change is a multifaceted problem. Indeed, IWRM has become a central focus for local and regional governments in all of Ecuador (Vredeveld, 2008). In addition, Quito is the test case for a pilot project to apply concrete IWRM-principles in the city, as part of the *AguAndes* research project (Pouget et al., 2008). Nevertheless, by 2010 Quito was still one of the few cities in Latin America that failed to enforce water pollution standards and measures on local industries in 2010. This resulted in untreated residential and industrial solid waste and wastewater, and instead dumped into the city's two main rivers, Machángara and San Pedro (Boselli et al., 2010). After having conducted the interviews as part of this study, it was further clarified that such policies, as well as the treatment of wastewater in general, are still non-existent. Nevertheless, the management and action plans are there, and despite the fact that they may take time to be executed, Quito receives a score of 7.0 points for indicator 22 (*Management and action plans*).

Quito is also doing a good job with respect to water efficiency measures. A variety of measures is implemented, ranging from the creation of vegetation maps, climate and forest-fire maps, and watershed models, to an analysis of the socioeconomic demographics of the city. The city has also already begun to relocate families living in high-risk areas and to integrate climate impacts into sustainable plans for land use, including slope and hillside management (Baker, 2012). In terms of funding an innovative public-private partnership (i.e. FONAG) has been initiated to protect and manage the grassland-covered watersheds above the city. This fund is financed by a 1.25% tax on municipal water in the metropolitan area, supplemented by payments by electrical utilities, donations from private water users and more international as well as domestic donors (Dodman et al., 2009). Finally, this way of working, together with its ways for finding sources for funding is being replicated by some countries around Ecuador, such as Peru and Bolivia, which has resulted in a regional adaptation project of which the three countries are all part (Carmin et al., 2013). The plans are implemented and clearly communicated to the public, and concrete funds have been made available for them, resulting in a score of 8.0 points for indicator 24 (*Water efficiency measures)*. Despite all this, and despite public awareness campaigns that have been in place to reduce the domestic drinking water consumption (Boselli et al., 2010), the results from the City Blueprint assessment also show that the drinking water consumption in Quito is still 201.14 litres/cap./day. While this may be low for European standards and gives Quito a score of 8.7 on indicator 20 (*Drinking water consumption*), it can be considered a figure that is

substantially high when comparing it to other cities in the Andean region. Policy makers in Quito named the example of Bogotá, which has a daily drinking water consumption of only 140 litres per person. All in all, Quito is on the right track towards becoming a climate adaptive city. However, in order to really make this transition, more governance capacities will need to be improved. These governance capacities are dealt with in the next three chapters.

4. Assessment of governance capacities in Quito

4.1 Introduction

As has been explained in table 1 in chapter 2 on the methodology (see also annex 2), the GCAF consists of 9 overarching governance conditions, which are in turn divided up in 3 characteristics per condition. All 27 characteristics have been scored separately first, which also resulted in an average score for each condition. In figure 2, the blue bars represent the average scores per condition, while the red dots are the separate scores per characteristics. Additionally, in figure 3 the results are given in spider web view. These graphic views give a good snapshot of which governance conditions generally most urgently need improvement. It can be established that GC. 4 (*Stakeholder engagement process*) and GC. 9 (*Implementing capacity*) are the most evident governance gaps in Quito. Moreover, as will be explained in the chapters that follow, for some governance conditions there is some discrepancy between how this applies to experts and how it applies to citizens, in part due to the limited climate of participation in Quito. The outline of the rest of the description of results is as follows. In the section hereafter, it is first explained which IWRM-challenge (that came out of the CBF analysis) is focused on in this GCAF analysis and for which reasons. In chapter 5, first a quick overview of all the relevant stakeholders operating in the water network of Quito is given. Section 5.2 then places a focus on the role of the drinking water authority (EPMAPS) and the indicators from the GCAF that are of relevance to them, while section 5.3 treats the role of other civil society organizations. Section 6.1 deals with the role of the citizens and their relation to the authorities and other stakeholders, while the results-part of this thesis report is closed with a suggestion for the optimalization of the GCAF for the specific context of Quito.

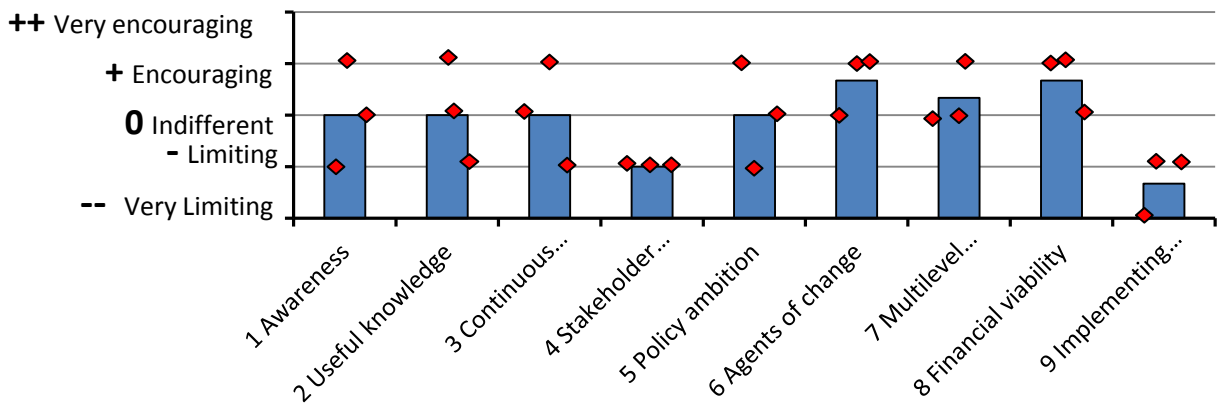

Figure 2: GCAF average scores per condition

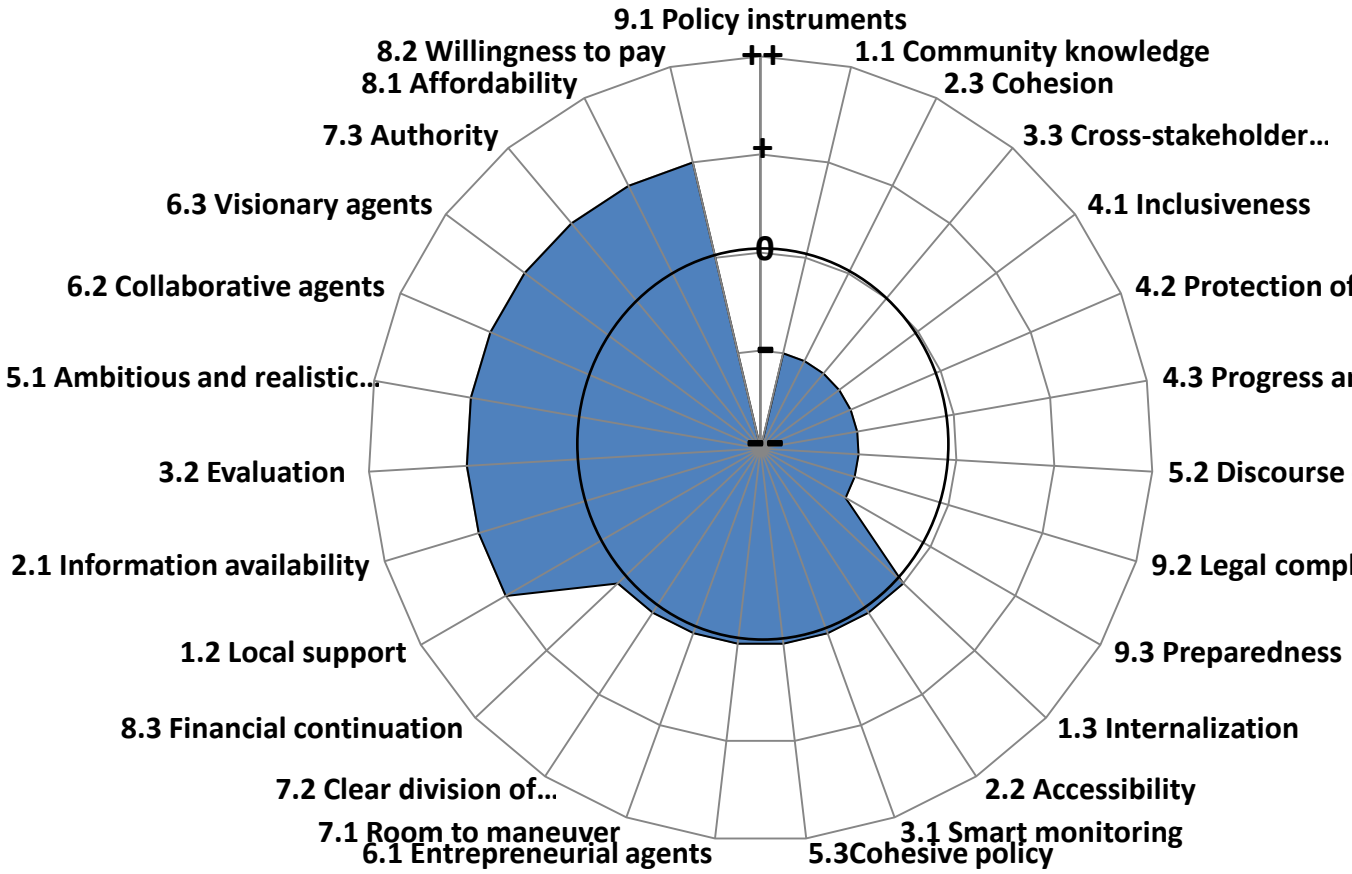

Figure 3: GCAF results per characteristic in spider web view

4.2 Wicked water problems and drinking water scarcity

The CBF assessment that was carried out and described in chapter 3 comprised many indicators that were at first sight quite different from each other. However, all indicators have at least one thing in common, which is that they are all related to the performance of a city's IWRM (see also theoretical framework, section 1.2.1). Given that IWRM in principle consists of indicators of drinking water quality as well as of climate adaptation, solid waste recycling and governance, becoming a climate adaptive city requires multifaceted solutions for multifaceted problems. The terminology that is normally maintained for such challenges is 'wicked water challenges,' which can be characterized by complexity, uncertainty, as well as by divergence and fragmentation in viewpoints. To provide an adequate solution to this kind of problems a number of things have to be taken into account, among which are the constantly changing nature of the problem and the fact that one should also question underlying assumptions (or the validity of the existing system) instead of merely fighting symptoms of

the issue itself (Head, 2010). A wicked water problem is therefore a problem with many faces and needs an approach that entails collaboration between many different stakeholders, as it can be hydrological, as well as chemical, as well as social, as well as economical in its nature.

The CBF analysis in chapter 3 has, next to its infrastructural and maintenance issues on the areas of solid waste treatment and water system leakages respectively, put forward two main IWRM- challenges that Quito has. One of these challenges is urgent at present and is the absence of wastewater treatment in the city. The other is the city's vulnerability to drinking water scarcity, which can especially become a problem in the future when the population of the DMQ will have doubled by 2050 (INEC, 2010b; 2013). However, also on the short term, a large part of Quito's water supply right now comes from the active Cotopaxi volcano which last erupted in the second half of 2015. In the case of another major eruption, Quito could be at large risk for its water supply. For the absence of wastewater treatment in the city, the new project of constructing a brand new tertiary wastewater treatment plant can at this point not proceed because of the priority that has been given to the construction of the metro network in the city. In effect, the financial means to unblock this bottleneck are simply not available. For the GCAF this makes it more interesting to focus on the city's vulnerability to drinking water scarcity, as there are many more governance conditions that can be improved having to do with this issue. The fact that the CBF analysis is an assessment of more aspects of IWRM than only drinking water scarcity, is the reason why until now (also in the research questions) few specific emphasis has been placed on it. It is nevertheless the most important issue that this study deals with and the CBF analysis has underlined this. For the remainder of this thesis report therefore, the focus is placed on drinking water scarcity, and wastewater treatment is left out of the further descriptions of the results. Finally, in the chapters that follow, it might seem that in the drinking water network in Quito EPMAPS is the single most important stakeholder and that all other stakeholders are especially described in relation to EPMAPS. While the dominant position of EPMAPS may to some extent be a reality, as after all, EPMAPS is the drinking water authority, the descriptions that follow are not meant to give this impression. In the first section of the next chapter, the most important stakeholders operating within the water network in Quito are described.

5. Relations between the different stakeholders in Quito

5.1 Overview of the relevant stakeholders

In this section, the relevant stakeholders operating within the water network of Quito are described shortly. The municipalities, two ministries and EPMAPS and FONAG can be seen as the most important and relevant bodies. Most of the descriptions that are given here are built up out of information retrieved from the interviews.

SenAgua – The *Secretariat Nacional del Agua* is the national water authority in Ecuador, however based in the capital city Quito. In that sense, they are one scale level above that of EPMAPS, which is the local drinking water authority of the DMQ. However, *SenAgua* also deals with all other water uses nationally (i.e. hydroelectricity).

Ministerio del Ambiente – the ministry of environment is the national environmental authority, which is also based in Quito. They have less to do with the specific situation on drinking water as they entail all possible environmental issues. However, as drinking water supply and the environment are highly related in terms of where the water comes from, for some decisions EPMAPS might have to report to this ministry or ask for their authorization. Sometimes, the environmental authority also carries out the enforcement of penalties when institutions or companies dump certain harmful or wasteful substances in the environment, that can end up in the drinking water.

Municipio de Quito – the municipality of Quito naturally is the government of the *Distrito Metropolitano de Quito,* and has the final responsibility for all the decisions that are taken on the local scale level, among which are also the areas of water- and environmental challenges. Regarding these, dependent on whether it is an environmental- or a water issue, they have to report to either the national environmental- or the national water authority for their decisions.

FONAG – as it was also already shortly described in chapter 3.2, the *Fondo para la Protección del Agua* is a funding organization that has been established in Quito around the beginning of the millennium. Their main mission is to protect the water sources and reservoirs that deliver water for the entire DMQ. Again, like *SenAgua*, FONAG does this for all water uses. However, they function on the contributions that they get from a variety of organizations and stakeholders. As at this point 90% of these contributions comes from EPMAPS, this mission of FONAG has mainly focussed its priorities on drinking water. FONAG reports to any stakeholder that is in its board of contributors, which hence at this point is mainly EPMAPS.

EPMAPS – The *Empresa Publica Metropolitana de Agua Potable y Saneamiento* is the drinking water authority in Quito. They manage all the potable water and sanitation issues and have the responsibility of providing the entire city with drinking water and sanitation. They are an autonomous wing of the municipality, which in practice means that they can take their own decisions, but they have to report to the municipality. It sometimes also happens that the municipality blocks a decision taken by EPMAPS, for example because of the construction of the metro which left no financial means for the construction of the wastewater treatment plant that EPMAPS wanted to carry out. The annual budget that EPMAPS can spend is retrieved from the tariff revenues they get from drinking water consumers on the one hand, but for a much bigger part from subsidies they get from the municipality, which means that if they don't receive this part of the money for a new project, the project cannot be carried out.

In the next two sections the results of the GCAF that are relevant to the drinking water authority and other stakeholders are highlighted.

5.2 The drinking water authority

In table 5, the indicators from the governance conditions 3. (*Continuous learning*), 5. (*Policy ambition*) and 6. (*Agents of change*) have been listed again. The most important ones among these indicators are highlighted in the remainder of this section.

Table 5: results for governance conditions 3, 5 and 6

3. Continuous learning	3.1 Smart monitoring	0
	3.2 Evaluation	+[1]
	3.3 Cross-stakeholder capacity building	-
5. Policy ambition	5.1 Ambitious and realistic goals	+
	5.2 Discourse embedding	-
	5.3 Cohesive policy	0
6. Agents of change	6. General	+
	6.1 Entrepreneurial	0
	6.2 Collaborative	+
	6.3 Visionary	+

EPMAPS, the drinking water authority in Quito, has a reputation of being one of the best, not only of the country of Ecuador, but also on a regional level. Together with the drinking water authority in Cuenca, which with around 700,000 inhabitants is the third biggest city in Ecuador, they can be seen as the best in the country. One interview respondent from a civil society organization also mentioned that regionally they can probably compete with Medellin in Colombia, which is also known for its high quality service in comparison to the rest of Latin America. One of the main reasons mentioned was that EPMAPS has the basic operational issues under control, that is routine. This enables them to focus on the broader picture, which for example a few years ago has enabled them to set up a new department, the *Gerencia Ambiental* (Environmental Management), that focuses on how to make the company more sustainable, whereas other water companies, with lower capacities, are just solving the day-to-day problems. One of the reasons why this might be the case is because the internal organization of the company is rather strong. A very clear organic structure has been constructed in which the names of all departments are given and the hierarchy is very clear, also in the sense of who has to report to who. When asked whether they thought if the responsibilities were clearly defined and divided, all authorities interviewed answered positively. Moreover, when asked whether they were aware of the responsibility of others, again everybody answered positively. This is the merit of this organizational structure in which everything on this area is determined, as is also illustrated by the answer of this respondent from EPMAPS on the question about awareness of the responsibility of others:

[1] This is especially for evaluations within the EPMAPS enterprise. The score is lower when other stakeholders are taken into account.

"Absolutely. Because of that same document, everybody in the company is, I think. If I need anything, I read the document and the structure we have and I know who I have to talk to." (Female authority respondent, 45 years old)

For such a structure to work, there have to be actors on top of the diagram that can carry a whole department, or in the case of the *Gerencia General*, a whole company. It was greatly acknowledged by all the respondents interviewed that EPMAPS had such agents of change that could issue such leadership. Also in situations where different departments had to work together, there was sufficient capacity to forge these collaborations between people. This however, only applies to the leadership that is present within EPMAPS. When taking the entire water network into account, the characteristics in governance condition 6. (*Agents of* change) would be scored neutral, earlier than the + that it received now.

It was already mentioned that the company has a relatively new department of environmental management, which enables the institution to also work on sustainability of the company and questions of broader environmental problemacy. Indeed, EPMAPS is a company that has a clear vision on the goals it wants to reach. The fact that, next to the *Plan Maestro* which issues long-term goals and visions at least until the year 2040 (and which is revised every 5 years), the company also has these plans on shorter- and mid-terms such as 5, 10 and 20 years from now. And these plans and goals are to be called ambitious, or as an interview respondent from EPMAPS put it: *"you know, in water issues, you cannot be not ambitious. You <u>have</u> to make sure that the population will have the adequate supply in the future."* On the one hand, a large-scale project such as the *Proyecto Ríos Orientales* is undertaken, which should yet again provide the DMQ with a great deal of extra water for the future. These kinds of large-scale projects are aimed at obtaining water from the eastern and western mountain ranges around Quito, or even through watershed transfers that come from 100 KM away (or more). On the other hand however, a certain realism is also visible in these plans as the company has a clear policy that projects are not allowed to be carried out when there is no financial viability or support. The project and the responsible executives would simply not get the authorization. This enables the enterprise to reach the earlier mentioned 95% of the goals that are set every year. All of this leads to characteristic 5.1 (*Ambitious and realistic goals*) being scored with a +.

It can however be said of EPMAPS and of more governmental and non-governmental institutions in Quito and Ecuador that there is little cohesion between their operations. Also during the interviews the cohesion between different aspects of the policy fields that have to do with environmental problemacy and wicked water problems was regularly reported as weak. One respondent from a civil society organization mentioned that these different policy fields are *"all on their own island."* In some respects however, from the viewpoint of EPMAPS there have been improvements with more collaborations with the academic field and research, although these collaborations were later reversed due to lacking financial foundations. At the moment, the main investment in research that is done by EPMAPS is the possibility they offer to students to do an internship with the enterprise and then write their

thesis as a part of that. Nevertheless, several authorities mentioned that a new department of planning, innovation and development had been initiated, although this has not been very long ago.

However, to come back to the cohesion between different policy fields, in the words of another respondent from a civil society organization:

"The ministry of environment is not working together with the national secretariat of water (SenAgua) and there is no policy to force them to either. Right now, they are just working separately every day." (female respondent from a civil society organization, 33 years old).

And this is also reflected in the fact that EPMAPS has dismissed the cooperations they had with universities and instead started a research and development department of their own, as this was a cheaper alternative than hiring external parties to do this research. It reinforces their strong internal structure. However, weaker relations with other organizations outside EPMAPS can be an unwanted side-effect, which is also visible in the methods the enterprise uses for their evaluations. As was mentioned before, the goals and visions that are set are ambitious and realistic, and the company has the capacity to pursue these ambitious and realistic long-term goals as well. For most departments, the progression in these goals and objectives is evaluated every month, while some of the bigger departments evaluate less frequent. All the information that is produced by these evaluations is gathered by the general directory of the company and structured. On the basis of this information, then, recommendations to all separate departments are formulated in order to make the working procedures of the departments align better with the goals and objectives that were set for them. This is again another proof that the organization within the drinking water company is functioning rather well. However, the problem of vulnerability to drinking water scarcity is not solved by the drinking water authority alone, as also social, climatological, chemical and political factors need to be taken into account, of which the expertise might lay more with other stakeholders. In order to be able to work together with these other stakeholders, the company will need more openness and cooperative power, as the score for characteristic 3.3 (*cross-stakeholder capacity building*) is low. These collaborations between different organizations are dealt with in the next section.

5.3 The civil society organizations

In table 6, the indicators from the GCAF that are particularly relevant to the role of the civil society organizations in Quito have been listed again. The most important among these indicators are highlighted in the remainder of this section. One side note here is that not the full governance conditions (i.e. stakeholder engagement process and multi-level network potential each with three characteristics) are listed here, since the other three characteristics that were part of these two governance conditions were subject to a critical review and are therefore treated in section 6.2 which deals with the optimalization of the GCAF for the specific context of Quito.

Table 6: results for the governance conditions 4 and 7

4. Stakeholder engagement process	4.1 Inclusiveness	-
7. Multi-level network potential	7.1 Room to manoeuvre	0
	7.2 Clear division of responsibilities	0

It is evident that Quito is a fortunate city, in the sense that the metropolitan district has a public enterprise (which counts as an autonomous wing of the municipality of Quito) that focuses itself fully on drinking water. There is a lot of capacity present in the city on this area that other cities in the Andes and in Latin America do not have. However, in the words of an interview respondent from the authorities, they are also always looking for rooms to improve themselves on. The analysis of governance capacities has pointed out that the external cooperative power of the company (i.e. the strength of their collaborations with other companies, institutions and stakeholders) is one of them. However, this is also related to a deficiency in an efficiently functioning cooperative climate within the water network of the DMQ. Interviews with authorities said a lot about this issue. When for example asked whether there were any other stakeholders involved in their evaluations, the most heard answer was either *SenAgua* (the national water secretariat), the mayor, or other departments of the municipality of Quito. However, when for example asked in what way they had contact or a collaboration with researchers or universities, it was stated that the contact was just one way, and that *"they just come here and we explain to them our projects."* Similarly, when asked how he perceived knowledge exchange with other organizations, another authority respondent stated that improvement was needed on this area in the form of an agreement or a letter of understanding of some sort, which should serve as a way to foster communication and therefore cooperation between different organizations. Especially with the goal of structuring the information regarding issues that have to do with or affect EPMAPS, as well as INAMHI, as well as FONAG, in order for these organizations to *"know exactly which information they have to provide, and which information is being used and for which purposes."*

Hence, relations that the enterprise has with a variety of other organizations (other than political organs, such as the municipality that they are part of or the water authority on the national level) are not very strong. Besides that, one respondent from EPMAPS indicated that the procedures they are involved in together with *SenAgua* or the *Ministerio del Ambiente* (Ministry of Environment) can sometimes be very slow, bureaucratic and take a lot of time. When asked whether this ever led to situations of conflict, this same respondent mentioned the following:

"It's not a very high level of conflict. Only about the details. Things like, you have to go to a meeting, and then the next meeting is next month, and then you have to ask the judicial department, etcetera." (male authority respondent, 61 years old).

Consequently, collaborations with external organizations are not very widespread, while the collaborations EPMAPS does have with several political institutions apparently do

not always work very smoothly. Apart from an institution like FONAG, EPMAPS is close to being the only stakeholder with sufficient capacity to operate on such a large scale as they do. Moreover, as was mentioned in section 3.2, FONAG is a fund that was set up with the idea to conserve and protect the water sources and reservoirs in the mountain ranges around the city of Quito. Their mission is to do this for the entire metropolitan district and for *all* water uses, hence not only for drinking water. It has however been indicated that the fund operates mainly on contributions that they receive from several parties, of which EPMAPS at this point accounts for 90%. Besides the fact that this might have an influence on the priorities that FONAG can set, or the limits to those priorities, this also leads to a situation in which, firstly, FONAG becomes highly dependent on the contributions they get from EPMAPS, and secondly, for themselves they will not be able to fulfil their own mission completely (of protecting the water sources for *all* water users) as they will most of the time have to give priority to drinking water. A respondent from within FONAG also stated that there has been other funding, for example from foreign aid from the USA, although now the USA have put their foreign aid to Ecuador on-hold as a result of Ecuador's more recent foreign policy (see also section 1.2.4). Moreover, it also seems rather difficult to attract new funding, especially in times of an economic crisis. And besides that even now, while in the past there have been times that EPMAPS was trying to defend the dominant position they had in the funding board of FONAG, now attempts are being undertaken to make sure that donors and priorities become more diversified. Nevertheless, at this point the situation is the way it is.

As a result of this situation, there is no real stakeholder present in the field that can look critically to EPMAPS and their actions *and* which also has the means and the capacity to bring this critical attitude into practice. FONAG is one party that can have some influence, although they cannot operate fully independently from EPMAPS. Regarding this situation and the questions and points that were put forward and came out of the interviews, both characteristic 4.1 (*Inclusiveness*) and (as was already mentioned) characteristic 3.3 (*cross-stakeholder capacity building*) scored a -. The governance capacity of multi-level network potential, then, is one with several faces. When looking at the indicator of clear division of responsibilities (or cooperative power), as was mentioned before, the situation on this area is better inside the drinking water authority than outside. Besides that, when asking authority respondents whether they felt they had adequate time and resources to develop new ideas, the answers that were given were rather indifferent. Sometimes the means were present, sometimes there was too little time and sometimes time and resources were both abundant. All in all, authority respondents argued the situation on this area was good the way it was. However, when asking a similar question (whether they were given enough room to develop new ideas) to respondents from civil society organizations, it was striking that all respondents from FONAG answered this question positively, while respondents from other organizations gave answers that indicated an absence of space for participation. Hence, the extent to which characteristic 7.1 (*Room to manoeuvre*)- which is scored neutral now - is present in Quito is highly dependent on which stakeholders are taken into account. If one would ask a person within either FONAG or EPMAPS the answer may be more positive than when asking other stakeholders, or citizens. In the first section of the next chapter the role of the latter of those two is discussed in more detail.

6. Towards a participative and transparent approach

6.1 The role of the citizens and their relation to the other societal layers

In table 7 the governance characteristics of conditions 1 (*Awareness*), 2 (*Useful* knowledge), 8 (*Financial viability*) and 9 (*Implementing capacity*) are listed again.

Table 7: Results for governance conditions 1, 2, 8 and 9

Indicator	Sub-indicator	Score
1. Awareness	1.1 Community knowledge	-
	1.2 Local support	+
	1.3 Internalization	0
2. Useful Knowledge	2.1 Information availability	+
	2.2 Accessibility	0[2]
	2.3 Cohesion	-
8. Financial viability	8.1 Affordability	+
	8.2 Willingness to pay	+
	8.3 Financial continuation	0
9. Implementing capacity	9.1 Policy instruments	--
	9.2 Legal compliance	-
	9.3 Preparedness	-

It is evident that money plays a clear role in a variety of ways. The drinking water service in Quito is to be called cheap. Examples that were given of the pricing varied from 4 USD per month for a student's house of three people, to a water bill for an entire condominium of 7 USD per month. It can therefore be considered evident that when respondents were asked whether they felt if the drinking water service was affordable (and accessible, for that matter), everybody answered this question positively and characteristic 8.1 (*Affordability*) could be scored with a +. However, the daily per capita drinking water consumption in Quito is a problem (see section 3.2), and one of the most important reasons why this might be is exactly that the service is as cheap as it is. The current pricing, in the words of an interview respondent, *"makes the drinking water very easy to obtain, but maybe even easier to waste."*

Indeed, it was one of the answers that was heard the most that drinking water in Quito is taken for granted by most people. At the same time, it was stated that the largest share of the city's population did not know where the water comes from, or (in the words of respondents from EPMAPS) how increasingly harder the drinking water company had to work to get the water and to provide it to everyone, or that the watershed transfers through which Quito provides itself with water came from further and further outside the city, in turn also making the obtaining of drinking water through such a watershed transfer more

[2] This is certainly not true for all data and highly depends on which stakeholder the data is shared with (see section 4.2).

expensive by the day. Moreover, most people only mainly knew that the water was obtained from *"somewhere in the mountains"* or *"somewhere from a reserve or a tank."* However, that the area around the Cotopaxi volcano, which with its altitude of 5897 metres above sea level could be seen from the city when the weather was clear enough, also accounted for part of the water was largely unknown to people. This is interesting, as many inhabitants in Quito clearly did not have the idea that the water in the city would ever run out, while a possible eruption of the Cotopaxi volcano (which last happened in August 2015) would have the potential to completely turn the situation around. In the case of such an event, it is important to have clear action- and emergency plans ready to in the first place be prepared to deal with the consequences on the expert- and professional level, but also to have a complete city of just over 2 million inhabitants know what to do themselves. Interviews however gave an image that among experts these kinds of plans of action were either unclear or hardly present. Besides that, if existent at all, most of the citizen respondents did not know anything about them. Hence, characteristic 9.3 (*Preparedness*) receives a low – score, as the city's (and country's) short-term reactivity to a natural hazard event like a volcanic eruption can be considered a problematic issue. This was also illustrated when a heavy earthquake with a magnitude of 7.8 took place on the 16th of April 2016. About this, one of the citizen respondents to the interviews stated the following, when asked if she thought it was a realistic thought that within 5 or 10 years from now, Quito could have shortages of water:

"[...] the recent earthquake that we passed was very... it wasn't something that we were prepared for. And we have various volcanoes now that are active. And an eruption of the Cotopaxi would really mean a shortage of water, because most of our water at this point comes from there. There are a few other reserves, the government has invested in these, but they are not working yet and we don't know when they will. And until that happens, for our water we will depend on places high up in the mountains, and that is exactly where the volcanoes are active. So these eruptions can happen any time, and if they happen within 5 to 10 years and the alternative sources are not active and not working, then yes, I do think that we can have a water shortage." (female citizen respondent, 26 years old)

This illustrates two things. First, the capacity to deal with sudden and short-term issues such as an earthquake or a volcanic eruption in the context of the water provision for the city may be considered a problem. Besides that, there is also an issue with (a lack of) awareness among the inhabitants of Quito that, while there are hardly any issues on the long term, the water supply can actually be at risk on the short term if a scenario passes of the calibre of the earthquake that happened in April 2016. To tackle this awareness problem, it might prove useful to implement certain policies that have the ability to steer the behaviour of people on areas like that of drinking water consumption. Indeed, instruments like subsidies and incentives have the advantage that while they can reduce drinking water consumption among people, they can also have the positive side-effect that people start thinking about their water use more. In Quito however, the drinking water consumption is not only high for Andean understanding, but has also risen slightly in the past years, as around 2009 the average consumption per capita was 197 litres per day instead of the present 201 litres per day

(Boselli et al. 2010). This slight increase was also confirmed by an interview respondent from EPMAPS. Consequently, characteristic 9.1 (*Policy instruments*) received a low score, as the policy instruments are of poor quality and might indeed even have the effect of promoting unsustainable behaviour instead of discouraging it (see annex 4). Indeed, also other interview respondents from all three societal layers and all stakeholder categories defined stated that there was still a great deal of room for improvement. Especially in the tariff structure, in terms of more differentiations and distinctions between quantities of water use as well as between income and neighbourhoods. Nevertheless, at this point the only distinction to be found in the tariff structure is one between the residential, commercial and industrial consumption of the drinking water, and within the residential consumption a different tariff if a household consumes more than 10 or 20 cubic metres per month respectively. However, the differences in pricing between the categories (residential/commercial/industrial) are presumably not in accordance with the actual differences in consumption between these categories, and for households it is relatively easy to stay in the first category of consumption every month (see sections 7.1.5 and 7.3 for more details and recommendations for changes).

Also the will to reconstruct these structures is far from absent, since characteristic 8.2 (*willingness to pay*) scored high across the different stakeholder categories. However, the interview sample had a higher educated interviewee bias, and willingness to pay is presumably higher amongst this group of higher educated respondents. Besides the gap in the tariff structure, also characteristic 9.2 (*legal compliance*) scored low. Policies to restrict the use of water above a certain quantity or, for that matter, restrictions on the use of certain substances that might end up in the environment later on are existent in Quito, but hardly implemented due to a lack of capacity to enforce them. Enforcing these kinds of policies more often and more strictly, could together with revising the tariff structure help to generate extra sources of income that could be used to make new money available for new projects, and therefore increase the score for characteristic 8.3 (*financial continuation*). This characteristic is scored neutral as there is no reason to assume that regarding the existing projects a financial emergency situation is likely to happen. However, a clear bottleneck is signalled in the fact that the municipality of Quito has given priority to the construction of a metro network throughout the entire city of Quito, with the direct consequence that there is no money available for the construction of for example a tertiary wastewater treatment plant. Hence, Quito has to set their priorities because there are not enough financial means available to carry out all projects at the same time.

It was pointed out earlier in this section that a large part of the problem of future vulnerability to drinking water scarcity can in Quito be assigned to the factor of the awareness of citizens, and that if this awareness would be improved it would already become much easier to provide a counterweight to this vulnerability. This would potentially make it an attractive idea to explore which role citizens can play in improving the governance capacities, by creating a more accessible climate of participation. Indeed, while not one respondent from the expert side gave the impression that he or she was not aware of what could possibly happen on this area (leading to characteristic 1.2 (*Local support*) being scored with a +), almost all respondents (citizens as well as experts) also indicated that the opposite was true

for most of the population of Quito (leading to characteristic 1.1 (*community knowledge*) to be scored with a -). As characteristic 1.3 (*Internalization*) means the extent to which actors have incorporated sustainable behaviour in their daily patterns for *both experts and citizens*, where internalization of sustainable behaviour is considered high (+) for the first and low (-) for the latter, this characteristic is scored neutral. According to one citizen respondent however, also among citizens awareness and consciousness have greatly increased in the past 10 to 20 years, especially as a result of people that have been able to study abroad and to take back new knowledge from there to Ecuador about natural resources and the necessity of taking care of them. However, other respondents from the authority side as well as from the organization side argued that creating awareness about problems that are not directly visible for people seems difficult. One example that was given was that the reason why there was an absence of wastewater treatment in the city and why the plans to build a tertiary wastewater treatment plant were not given priority, was that all the untreated wastewater eventually ended up either in the river Machángara or the San Pedro, which were both rivers that flowed outside the city and only through places where just a marginal part of the population could see (and smell) them. Similarly, several citizen respondents mentioned that many Ecuadorians do not have a mindset that is very much aimed at what could happen in the future, or in the words of one of these respondents, *"we just wait until the problem is there and then we start fixing it."*

To try and find a solution to these challenges, from the initiative of EPMAPS, as well as from that of FONAG, campaigns have been issued to create more awareness about these matters among the population of Quito. One of the ways in which this is done is by visiting schools, and, as another respondent from EPMAPS indicated, visits of these same school children to the water treatment plants of EPMAPS are being organized. During these visits, these children are then explained about the importance of water, about the dangers of pollution and water wasting and the important role that these children can play in the future in this respect. It has however not been clarified if all the schools in Quito have been reached with these actions or just a part of them. Besides that, in a direct sense of the word, these kinds of visits to the schools and from the schools to the treatment plants only reach the children that are aged under 18. Hence, the part of the population that is not in school anymore is only reached indirectly and possibly also not fully. Respondents from EPMAPS indicated that there were also widespread campaigns issued among these older parts of the population. However, no specific descriptions were given on what these campaigns consisted of. Besides that, when asking these same citizens themselves, most of them had never seen or heard of such a campaign. Some other respondents did state that they did know some of these campaigns, but that they did not take place on a regular basis and that they were not as widespread as was being stated by authorities. Besides that, apparently the campaigns were also not very effective, as one respondent stated that the campaigns were personally not moving her to think: *"wow. I really have to change my behaviour!"*

Hence, apparently there is a mismatch between the perceptions of experts and citizens, in the sense of what the first group says they do and what the second group says they notice of it. Moreover, when asking respondents whether they thought it was good or helpful to ask citizens when evaluating policies the majority answered positively. However, when asking

respondents from the citizen categories and from organizations if they thought it would ever happen, the majority considered it unlikely. Similarly, when asking respondents from the citizen categories whether they felt if they were given enough options in how they wanted to participate, hardly anybody answered affirmatively. Yet, when asked whether they would want to participate in subsequent stages (in whatever way possible), everybody did. This suggests that the construction of a participative climate is problematic in Quito, although one can also not know for sure that if such a participative climate would be there everybody would indeed start to participate more (and an experiment would have to be carried out to find out). However, the fact that there is a gap on this area seems in so far confirmed.

6.2 Optimalization of the GCAF for the specific context of Quito

As the GCAF-approach has never been applied to a Latin American or Andean city before, it was necessary that during the research process the used indicators were reviewed and tested on applicability to the local context. Essentially, this meant that the indicators that assessed governance capacities in Quito were in turn also assessed themselves on their intrinsic relevance to the place-specific situation. In order to translate this into a researchable assignment, the third research question, which dealt with how the GCAF could be optimized and operationalized in order to adequately assess governance capacities in Quito (see methodology section 2.1), was developed. Consequently, some indicators would have to be excluded from the framework, while the process of data collection would also lead to the addition of new indicators. In summary, results obtained from the interviews showed that there were no indicators that were absolutely not applicable to the specific local context of Quito, although there were three that deserve to be highlighted because they were subject to discussion. These indicators are shown in table 8 and shortly discussed after. The section then proceeds by proposing three additions to the GCAF, of which the rationale is mainly based on the WIGO report (WIN, 2016): transparency, accountability and anti-corruption.

Table 8: governance characteristics subject to discussion

4. Stakeholder engagement process	4.2 Protection of core values	-
	4.3 Progress and choice variety	-
7. Multi-level network potential	7.3 Authority	+

During the research process, two main things that were evident came up and these were issues that kept coming back. First, the climate of water governance in Quito is characterized by an apparent lack of channels through which stakeholders could issue their voice. As was explained in section 5.3, there is already no strong collaborative connection between stakeholders on the long term, but it should equally importantly be mentioned that participation on the short-term, of the type of providing ideas, brainstorming sessions,

organizing discussion and debate evenings, etc., are also hardly present. This is not to say that EPMAPS, the municipality of Quito and other relevant leading institutions would reject the possibility or utility of these kinds of events. However, it can in so far be determined that clear and constructive channels of communication to organize them are next to absent. To the GCAF characteristics 4.2 (*Protection of core values)*, 4.3 (*Progress and choice variety*) and 7.3 (*Authority*) therefore applies more or less the same statement: as there are not that many stakeholders working together, one could argue that the governance climate is rather one-sided and thus choices and differing values are not factors that are applicable to the Quito context. Taking characteristic 4.2 (*Protection of core values*) as an example, if there is a central institution that has most of the decision-making power, there are not many core values of other stakeholders that have a voice during the decision making process. More specifically, when arguing that the status quo (with EPMAPS and FONAG as the only stakeholders with large capacity) is the only possible situation, logically there are no core values to be harmed as the core values of the organizations in question do not significantly differ. However, in reality it is rather unlikely that these two institutions are the only institutions that have the *potential* to participate. Hence, in reality, it is also likely that there are many stakeholders (such as small firms, citizens, etc.) whose core values are actually harmed, while we do not know about them because they are not taken into account in the first place. Similarly, progress and choice variety is a factor that may be present in the institutions that are already 'on top of the pyramid,' while many stakeholders that have much smaller capacities may actually be severely limited in this respect. Finally, in a governance climate such as that of Quito, it may not necessarily be surprising that the indicator of (political) authority scored a + in the assessment. After all, if you ask somebody whether there is enough authority to overcome conflicting interest, the answer will always be positive if there are few parties involved that have different interests in the first place. Or in the words of the interview respondent from FONAG cited earlier, when talking about the fact that 90% of the contributions to the funding board of FONAG came from EPMAPS, *"if you have the absolute majority and if there are important decisions to be taken, if they then want they can just push through any decision that they want."* However, if there is a lack of clear channels of communication to the public and a climate of participation, it remains questionable whether the situation is one that fosters credibility, and ultimately, progression.

On the area of participation in general, there is much more potential present in Ecuador than is being utilized at this point. Indeed, the relations between the Ecuadorian governmental institutions and all actors that have the potential to participate (the civil society) under the rule of the current president, Rafael Correa, are to be called interesting yet complex. In a World Bank report dealing with the period of time before Correa became president, Klapper (2007) stated that, as a result of a growing disillusionment with the state and with the process of democracy (i.e. also corruption), the civil society has gained a more vocal role in governance issues in the country. More accountability and transparency from the state was demanded, as well as better opportunities to engage in public policy making and monitor state actions. One way in which the civil society has managed to fulfil this demand is by utilization of social mobilizations. However, these social mobilizations have also created decreased levels of trust between state and civil society, as they lack constructive channels of dialogue

and negotiation between the state and civil society. This has in turn also caused a lack of receptiveness of the state to respond to peaceful civil demands. In other words, civil society organizations in Ecuador have especially gained a clearer voice, but this has (apart from the grown influence of a great deal of the indigenous movements in Ecuador) hardly led to effective engagement of these organizations into governance processes. Moreover, a weak culture of transparency and a weak judicial system further reinforced the impossibility to negotiate with the state through constructive channels (Klapper, 2007). President Correa promised he would improve these channels and with that the relation and possibility to engagement between state and civil society. However, what he has done is create these channels of negotiation through the introduction of more bureaucracy, which secondarily functions as an instrument of control and regulation (Ortiz, 2015).

Hence, Correa's wish to create a platform of participating civil society organizations has actually had the perverse effect that organizations at times are not fully free in what they are doing and saying. This hampers collaboration between organizations and political institutions. The difficult relation that the Ecuadorian government has with the civil society (organizations as well as citizens in general) is also reflected in the urban local context of Quito. A possible lack of transparency may further reinforce this issue (and the danger of feelings of mistrust that could possibly originate from it), as was also discussed in the interviews several times. One citizen respondent stated the following when asked whether she would accept a price increase if that would mean that additional benefits were created:

"*If they would also really realize those projects, then yes. Otherwise not. [...] At this moment, I would just not know. It's just not transparent. They tell you a lot of things, but in reality most of them are just not happening. And of those things the citizens just don't believe most of it and they just don't trust the government anymore. They for example raise the taxes a lot for a lot of things that are not really necessary, or for things that the people don't even know about.*" (female university student respondent – 28 years old).

Another citizen respondent indicated that there were especially always plans, but that "*at the end of the day, you don't know if they have done it."* This male respondent indicated that in the end everything is more written on paper and that it is not enough to be able to say as a citizen that the water problems are really being taken care of. Besides that, he stated that especially administrations should also be reformed as it was absolutely impossible to know what the money was spent on. Several respondents from EPMAPS mentioned that there was a law in Ecuador that obliges organizations to be transparent in everything that they do and also to publish transparency reports. EPMAPS as well as the municipality of Quito have also done this on their websites (AguaQuito, 2016; Municipio de Quito, 2016b). However, it is apparently still difficult for citizens to get to know what is being done on these areas and what projects are being carried out. Though it can be a point of discussion whether this is a consequence of citizens not being able to find the information (for example due to not having access to the internet), or of not being willing to search for the information. *Or* of the fact that

people do not trust what governmental institutions are doing in the first place, which is also illustrated by the words from the same citizen respondent as cited earlier:

"They do something [...] but when they have 100 000 m^3 of water to treat, they don't treat 100% of the water. They may treat 40% and then they throw it away and say: "yeah. We have done something." [...] I mean, [...] if you have your room, and it's a total mess, and you take a pair of socks and clean it up, and then you say: "my room is clean. I fixed it." I think it is kind of the same thing." (male citizen respondent, 40 years old).

Hence, transparency is as an essential governance element that needs improvement in Quito. Moreover, the respondent from within FONAG who was already cited several times in this report for example stated that one of the goals that he set for himself when he took the job was to increase the effectiveness of the investments, by connecting economic and hydrologic information, and by means of a more efficient use of the existing sources that could provide Quito with more water in critical periods, with the possible consequence that a new project to uncover a new source or a new basin could be postponed. However, one of the necessities to also reach this goal, next to more openness and transparency, is also an improvement in accountability and an improvement in documentation of information on a variety of issues, such as finances. This respondent also indicated that this was still much needed in Quito and in Ecuador as a whole. Improvement on these fields would in turn be able to facilitate participation (as more information would become more readily available for citizens and all stakeholders, in turn also leading to higher scores of the characteristics 2.1 (*information availability*), 2.2 (*Accessibility*) and 2.3 (*Cohesion*)), and the implementation of anti-corruption initiatives. The necessity of these principles, as derived from the WIGO-report (WIN, 2016) might also be applicable to a wide variety of other local contexts. It is therefore proposed to add a new tenth condition to the GCAF: GC. 10. (*Integrity*). This condition in turn consists of three characteristics: 10.1 (*Transparency*), 10.2 (*Accountability*) and 10.3 (*Anti-corruption*). The most important function of these new characteristics should be to facilitate participation through the creation of an environment of trust between different governance layers (WIN, 2016). In this way, more efficient collaborations between stakeholders, governmental institutions and citizens should be forged easier and on a bigger scale.

7. Conclusion

7.1 Discussion of the results

7.1.1 Limitations to the CBF results

The most important thing that should be born in mind about the CBF assessment, as well as for the GCAF, is that they are both snapshots of a particular moment and that the performances and scores change over time. Moreover, with regards to the population characteristics of education and the neighbourhood, the used sample for the interviews was

not fully representative for the city of Quito. Besides that, there could be biases on other aspects such as income and ethnicity. Due to the lack of reliable data regarding income distributions it has been left out as a decisive factor. Also ethnicity has not been taken into account as there are no clear signs of significant differences between ethnic groups (see chapter 1.2.4). Discrimination- and inequality issues are more recognizable between rural-urban regions and less evident within the city of Quito (Sánchez, 2005). Moreover, if at all present, processes of discrimination are mainly related to marginal position of the indigenous population compared to the other four ethnic groups identified (Sánchez, 2005), although these indigenous groups have gained a much more prominent and vocal role in politics in Ecuador in recent years (Becker, 2011).

The neighbourhoods in the South of the city were under-represented which limited the insight in place- or neighbourhood-specific differences in thinking about water challenges. Similarly, the sample contained an educational bias, as all respondents had either a university or PhD background. With more time and means, it would have been useful to conduct interviews among the less educated population in order to investigate differences in perception regarding water challenges since the public education and awareness has been identified as one of the major problems. Moreover, a larger sample (e.g. N>30 in each of the 4 identified population groups) would have been needed in order to classify the used interview sample as representative for the entire city. It would be interesting if a follow-up research, in about 10 years, is carried out. In the first place to make the research more extensive by accurately including all relevant population characteristics, but also to monitor progression.

As the research was carried out in a Non-European city, there were more data limitations that had to be resolved. Sometimes proxies have been made that were based on less accurate data that was available. Furthermore, the City Blueprint assessment has only worked with publically available data as much as possible to ensure transparency and reliability. In the case that the scores could not be backed up by up to date public data sources, data retrieved from personal meetings with key persons within EPMAPS, EMGIRS and INAMHI had to be used. The validity of this data is less easy to check. In order to maximise the validity, transparency and reproducibility, contact details are provided for each indicator score (see Annex 1). Finally, the research has aimed to work with specific city data as much as possible. However, as data on this scale level was sometimes unavailable, national data had to be used. In this case, accuracy tends to be altered in countries with a high variety between different cities, since an average is given of the entire country. Also of a country that holds extreme outliers (Koop & Van Leeuwen, 2015a).

7.1.2 Indicators for which public data was unavailable

As was mentioned in section 7.1.1 some of the indicators that were part of the CBF, the TPF and the GCAF had to be scored while there was no central database of information available for scoring these indicators. In these cases the research had to work with proxies. Proxies have been used for the indicators urban drainage flooding, groundwater quality and heat island effects. Urban drainage flooding for example, is a measure of the risk of flooding expressed as

a percentage of the urban soil that is sealed (Koop & Van Leeuwen, 2015c). Where a city has much sealed soil covered with impermeable asphalt, concrete and roofs, rainwater will have less chance of infiltrating in the ground and therefore increase the risk of flooding. There were no sound and consistent documents that could be found in which there was clear data about land use in the DMQ (and therefore soil sealing). The overview that Huang et al. (2007) had given of several spatial metrics of 77 cities globally including Quito, provided the knowledge that Quito had an open space ratio of around 13%, which was just below the average of the 77 cities assessed (also see section 3.1). It can be argued that a lower open space ratio means that a larger share of the soil is sealed, but the share of urban soil that is sealed is in turn dependent on more factors than only the open space ratio. This makes open space ratio an inaccurate proxy for urban soil sealing.

The urban heat island effects indicator consists of two factors: **(1)** the predicted number of combined tropical nights (>20 °C) and hot days (>35 °C) in the period of 2071 – 2100 and **(2)** the share of green and blue area in the urban centre of Quito (Koop & Van Leeuwen, 2015c). For both of these factors no accurate public data was available for Quito. For the first of these two, a prediction of maximum temperatures in the year 2080, provided by *INAMHI*, was used. This was a prediction for the area around the Antisana volcano, approximately 70 KM southeast of Quito. For the city of Quito, such a long-term projection was not available. The area around the volcano is situated in a similar landscape and at an altitude which is just a little higher than Quito. Despite the fact that an expert interview respondent stated that the climatologic variability even within the Andean highlands and between different sources that provide water for the city of Quito can be rather big, this projection can still serve as a comparison. It showed that the highest average day temperature in the future would be 18.51 °C in November 2080 (see figure 4). This means that also during the night, at least in this projection, temperatures will not rise above 20 °C either. It was therefore safe to assume that the number of combined tropical nights and hot days in the period of 2071 – 2100 in Quito is 0. However, this cannot be considered satisfactory, since a sound scoring of this part of the indicator would require a prediction specifically for Quito.

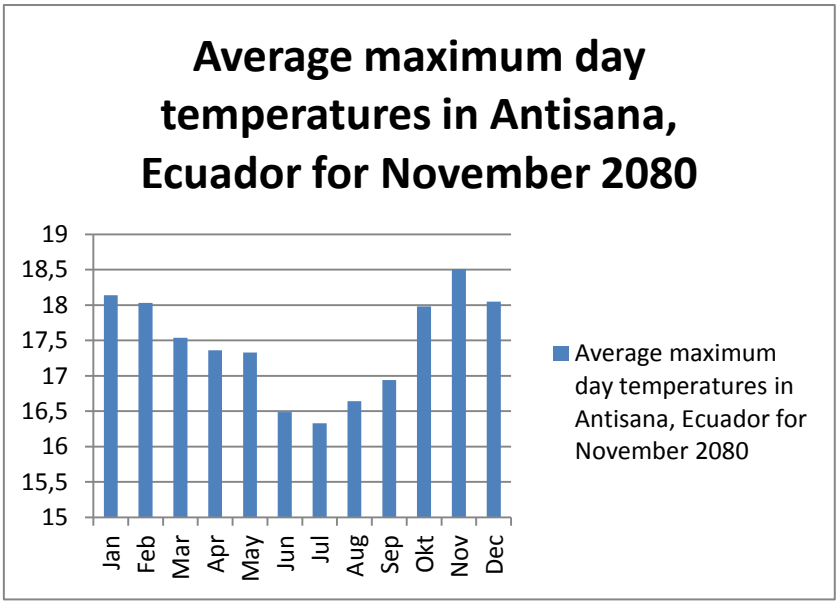

Figure 4: projection of average maximum day temperatures for Antisana, Ecuador, in the year 2080 (extracted from: *INAMHI*, Quito)

For the share of green and blue area in Quito, a calculation of the surface areas of the parks in Quito was used. It was determined that this surface area is 7.45 KM^2 (see also annex 1), and this is 6.01% of the entire urban centre, which is 124 KM^2. However, the share of green and blue area includes more than only parks. Sports and leisure facilities and agricultural areas can be considered part of it as well (Koop & Van Leeuwen, 2015c), and for that matter, also strips of grass alongside a road can for example be counted. It is evident therefore, that while the available data is not satisfactory to give an accurate estimation, the percentage of green and blue area will be higher than 6%. It is however impossible to know the exact percentage. This feeds the importance of publically available monitoring data regarding the share of green and blue areas in Quito. The same goes for groundwater quality, as the data that was used was not publically available but retrieved in accordance with a contact person from EPMAPS. For groundwater quality in Quito there is no central database where all the scores and sample tests are registered. When requesting the data, a document was provided that showed sample tests on a large number of substances and on four different points in time. The *norms* for groundwater quality were however not included and these had to be retrieved from a constitutional document that was provided later. This document however contained groundwater quality norms for only part of the substances that were given in the first document. Hence, the indicator has been scored, but cannot be considered optimally accurate because of the given reasons. This is also a good example of why governance characteristic 2.3 (*Cohesion*) received a low score, as there is a clear gap in the cohesion between the different data sources that are available.

Besides these three, many indicators (of which examples are drinking water quality, access to drinking water, access to sanitation, water system leakages, among others) have in this study been scored on the basis of information that was retrieved personally in accordance

with a key person within EPMAPS. These data were either not public or difficult to access. For Quito, but also for other cities, this has the general potential of harming transparency and impede research. It is very important to make sure that the data of the three indicators that have worked with proxies during this study will become available in the future. Especially for the share of green and blue areas, as this is a sub-topic of climate change that deserves more attention.

7.1.3 Access to drinking water and sanitation in Quito

There is some discussion about the high access coverages for drinking water that came out of the CBF analysis as being 98.55%. This seems a high percentage. However, as the population of the DMQ is about 2.24 million people (INEC, 2010b), the absolute population that lacks access to drinking water is about 32,000 people. However, statements regarding the *percentage* sometimes varied between estimations from 1.5% (according to official figures given by the authorities) to 20% (which is the equivalent of 300,000 and 400,000 people that lack access to drinking water). The fact that these percentages are so divergent emphasizes the need for peer-reviewed open source data and more transparency. A key requirement of transparency is that there is free and easy public access to relevant, reliable and *consistent* data and information (WIN, 2016). As estimates of the percentage of people lacking access to drinking water are so divergent, the available data cannot be considered as such.

An important element in the opportunities to resolve wicked water challenges involves a solid collaboration between different governance layers (Graham et al., 2003; Huitema et al., 2009). However, in a situation where a drinking water authority profiles itself as a company which is doing an extremely good job, while there are other people also on the expert level that state that these figures should be reviewed as critically as possible, it is advised to EPMAPS to (besides publishing their access coverages for the whole city): also publish these in absolute population numbers *and* publish smaller compartments of these numbers along lines of for example income, neighbourhood and differentiating between the rural and urban parts of the DMQ. This is important for getting a clearer image of the situation and to create an image that is more credible. More accurate and reliable information provision is needed to establish an environment of trust between different governance layers and to facilitate the exchange of information. Given that the percentages provided by people from different organizations are strongly inconsistent, this environment of trust is currently not present.

7.1.4 Drinking water consumption in Quito: excessively high, or subject to relativity?

Drinking water consumption in Quito can be seen as a problem. If the residential, commercial and industrial consumption together stays as much as it is now and adequate action is not undertaken, Quito can face problems with supplying potable water to all its inhabitants in the future. Quito sees its drinking water consumption of little over 200 litres per capita per day as

something that has to be reduced. However, for indicator 20 (*Drinking water consumption*) of the CBF Quito did receive a score of 8.7. The main reason for this is that the score for the indicator is calculated as relative to all other cities assessed until now. From those cities the city with the highest drinking water consumption is Kiev in The Ukraine with a consumption of 728.8 litres per capita per day (Koop & Van Leeuwen, 2015c), over 3,5 times as much as Quito. In figure 5, the drinking water consumption in Quito is compared to the drinking water consumption in a number of other cities. Besides that, the amount of non-revenue water (water that is consumed while it is not paid for) is included here, while this is not included in the score for indicator 20 (*Drinking water consumption*). All data is extracted from IB-net (2016), which at this point (for Quito) does not give data more recent than the year 2010. Hence, whereas the data on drinking water consumption that has been used for the indicator score of the CBF Analysis is from 2016, in this table the figure from 2010 is used, in order to make it resemble with the data on non-revenue water from the same year.

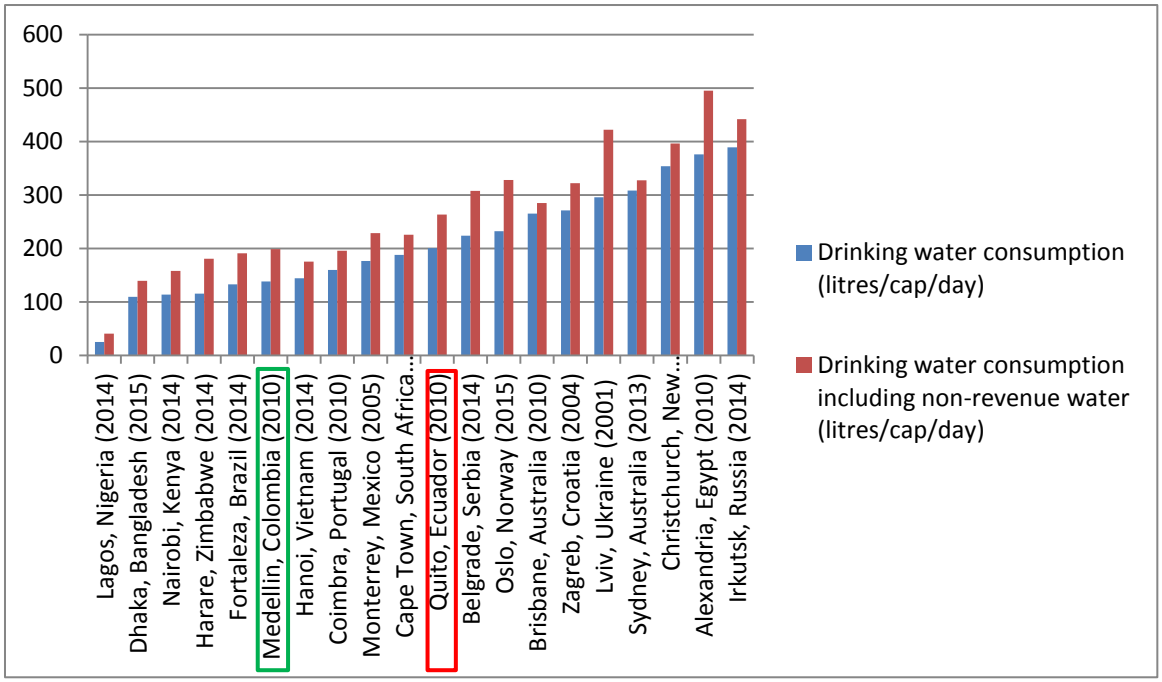

Figure 5: Drinking water consumption and non-revenue water statistics for 20 cities in Latin America, Europe, Africa, Asia, Australia and New Zealand (Extracted from: IB-Net, 2016).

It has been mentioned several times that the drinking water consumption in Quito is high in comparison to other places in the Andean highlands. Indeed, when looking at the other Andean city in the table, Medellín in Colombia, their consumption is only two thirds of that of Quito. Besides Medellín, there are several other cities elsewhere in Latin America, Africa and Asia where the daily drinking water consumption is lower. Hence, for a city in the global south Quito indeed has an excessively high drinking water consumption. On the other hand however, there are grounds to place the excessiveness of the consumption in Quito in perspective, as there are several places in for example Russia, Egypt and New Zealand that

have a daily drinking water consumption which is almost the double of that of Quito. Moreover, as was mentioned earlier, with Kiev in The Ukraine having a consumption of more than 3.5 times that of Quito, it should come as no surprise that the score that Quito receives for the indicator in the CBF analysis (as this is calculated as relative to all the other cities assessed until now) is actually rather high. And finally, all European places in the table except one (Coimbra in Portugal) have a higher drinking water consumption than Quito. As more than half of the cities that are assessed for the CBF until now are European, it can be said that there is also a European bias in the formula for Indicator 20 (*Drinking water consumption*), making it more likely for Quito to get a higher score. This European bias is important to mention in general as well, as this discussion also illustrates the need for more research on this area in Latin America, other continents in the global south, but maybe even the most: specifically in cities in the Andean highlands, such as Medellín, Bogotá, La Paz, Cuzco and Cuenca. Not only would these cities also be able to benefit from a City Blueprint Analysis made of their city, but also in the light of city-to-city learning a city like Quito would especially be able to gain from this study, if the same research with the same indicators would be carried out in these other cities in the Andean highlands, on similar altitudes, with similar populations and population growths, and with comparable climatic conditions.

7.1.5 Revising the current tariff structure

The interviews conducted as part of this study made it evident that the tariff structure for the drinking water in Quito should be revised. In the current structure there already is a distinction between residential, commercial and industrial use of the water. For each of these categories respectively the cost of drinking water is 40, 55 and 62 cents per cubic metre. Moreover, for the residential consumption the tariff is only applicable if a consumer stays in the lowest category of consumption, which is between 0 and 10 cubic metres per month. Separate tariffs are then charged for households that consume either between 10 or 20 cubic metres in a month, or more than 20 cubic metres[3]. However, the average drinking water consumption per capita is 201 litres per day, or roughly 6 cubic metres per month. An interview respondent from FONAG suggested that in the future about 1,5 times the total amount of the water that is consumed now would have to be available for double the population. This would mean that the daily per capita drinking water consumption would have to be brought back to around 150 litres per day, or 4,5 cubic metres per month (which is for all types of users together). In order to provide an efficient incentive to reduce drinking water consumption therefore, the boundaries between different classifications of consumption should be well lower than 10 and 20 cubic metres per month.

Besides that, it should be born in mind that the residential consumption is much less than the industrial and commercial consumption. Another respondent from EPMAPS stated that the residential drinking water consumption is *"actually a very marginal part of the income of the drinking water company."* In turn, this was confirmed by a respondent from a

[3] All information about the tariff structure has been obtained from 2 separate interview respondents within EPMAPS

civil society organization stating that *"the majority of the population, 60% or maybe 70%, just consumes what they can pay for, and that is not necessarily a lot. So the reason why our consumption is that high, is not because the people use that much, it is because small segments of the population and companies use that much."* Indeed, going back to the example of the water bill of $4 per month for three people that was given in section 6.1, this would (in this particular household) mean a per capita consumption of only 3.33 cubic metres per month. This example was given by a respondent who was slightly embarrassed by the fact that she sometimes took showers of around 20 minutes or more, and does therefore *not* illustrate a case of exceptionally low water consumption. Apparently, then, there are still factors in play that double the average drinking water consumption for all categories, meaning that these factors individually have to be on a consumption of at least 9 cubic metres a month (300 litres a day) or more. The differences in tariffs for residential use (40 cents) and commercial (55 cents) and industrial use (62 cents) may therefore not be proportionate to the actual differences in water consumption between these categories.

However, in order to determine which tariffs are actually best applicable, more detailed research will need to be done on exact amounts of per capita drinking water consumption per separate category. Finally, the extent to which all these changes are legally possible also needs to be investigated. There is a national directive in Ecuador that obliges local water authorities to keep their drinking water tariff social and the possibility to deviate from this national line and make an exception for the local context of Quito, or to include income as a factor of differentiation in the tariff structure and charge different tariffs for different income segments, are suggestions for further research that need to be considered.

7.1.6 Integrity in water governance

Before this study, the GCAF was inexperienced for the South-American context and therefore had to be adjusted to fit the local context. As discussed in section 6.2, for Quito this did not result in the exclusion of any indicator. However, it did lead to a critical review of the GCAF characteristics 4.2 (*Protection of core values)*, 4.3 (*Progress and choice variety*) and 7.3 (*Authority*), as these all had to do with the suggestion that there were multiple actors in play, therefore multiple values to be protected, multiple choices to be made and finally many conflicting interests to be overcome before important decisions could be taken. Due to the centralist character of water governance in Quito however, it can be argued that these characteristics were either present with a low score or less relevant. The GCAF has until now mainly been constructed on the basis of literature and practical examples from western contexts, of which the nature has generally proven to **(a)** be more democratic than that of Quito and **(b)** have a greater diversity of different stakeholders on different scale levels. The situation in Quito is therefore a very useful addition to the discussion, as it offers a new perspective on how the GCAF could be used in cities and countries that have a similar governance system and political economy as Quito and Ecuador.

As new additions to the GCAF, it was also already discussed in section 6.2 that GC. 10 (*integrity*) can be added to the framework as the new condition, which in turn consists of

the characteristics 10.1 (*transparency*), 10.2 (*accountability*) and 10.3 (*anti-corruption*). This is based on the WIGO-report (2016), which addressed the four basic pillars of integrity in the water sector: transparency, accountability, participation (together known as the TAP principles) and anti-corruption (WIN, 2016). In the new governance condition however, participation is left out as a characteristic since it is already largely covered by the characteristics of GC. 4 (*Stakeholder engagement process*). In order to address the characteristics of this new condition successfully, it is especially of importance to create solid and effective monitoring and evaluation systems. If this basis is realized, this provides the possibility for institutions and individuals to be held accountable for their decisions and actions regarding water resources. This in turn depends for a great deal on what is monitored, who is doing the monitoring (and their credentials) and how the monitoring is carried out, evaluated and reported. At the local level, participation is key. Local people need to be given a voice, also in the sense that they can choose or refuse to support the monitoring process. When functioning adequately, such a system (in combination with independent activities by the media and governmental and non-governmental institutions), can effectively make sure illicit practices and unethical decisions are uncovered and eradicated, and increase the status of the water sector and its reputation in the eyes of the public (WIN, 2016). Hence, it fosters the creation of an environment of trust between the water sector and the consumers of the water. And while it is *unlikely* that all countries in the world miss all four of these principles, it is in turn much more *likely* that a bigger part of the countries misses at least one. This is supported by the many examples of countries to which (the absence of) these principles (is) are applicable in practice, that are provided in the WIGO-report (2016) and come from all over the world: Colombia, Brazil, Kenya, Ghana, Nepal, among others.

It can hardly be stated that either of these principles can have negative consequences, apart from the fact that, in the case of transparency and accountability, it almost inevitably leads to the introduction of more bureaucracy. Participation, similarly, always carries the risk of fragmentation and loss of surveyability (see also: Huitema et al., 2009). However, whenever managed and organized well, participation can be a major improvement to the water governance climate of any city. Moreover, an absence of each one of these four pillars has the potential to lead to an unfair and unjust manner of managing resources that should in principal be available to all:

"International agencies, governments, private companies, local authorities and communities spend hundreds of billions of dollars each year on infrastructure and water services. But their efforts are not keeping pace with the demand for water uses, in part due to abuse of resources, resulting in slower development and polluted environments." (WIN, 2016: p. 23).

In other words, as long as there is corruption (or any other form of absence of transparency that hampers an equitable division of resources) in the water sector, the pace of the sustainability of development may be not even half as high as it could or should be. Or framed slightly differently:

"The main victims of corruption are the poor and powerless: women, children and the landless. However, in the end, corruption and a lack of integrity are harmful for all: both the victims of corruption and those who are corrupt. Ultimately, when resources are wasted and the environment is damaged, everybody loses." (WIN, 2016: p. 24).

Finally, for the broader field of urban water governance these results mean that the assumption that the global water crisis is predominantly a governance crisis (OECD, 2016) seems confirmed. Also in the specific context of Quito parallels can be drawn between the (absence of) the principles of water integrity that are given in the WIGO-report (2016). While by no means stating that it is the case in Quito, it is evident that especially so-called State-Owned Enterprises (or SOEs, like for example EPMAPS in Quito) require special attention in the implementation of anti-corruption initiatives, as they are soft targets for political interference and corruption. This makes it even more important that (not only in Quito, but everywhere) execution reports and policy decisions are made public and monitored by independent oversight bodies (WIN, 2016). It is also in this specific context of Quito clearly visible that the problems posed as a result of the CBF and the TPF analyses cannot simply be solved by applying measures that only take into account the technological nature of the problem itself. To adequately resolve these limitations the multifaceted character of wicked water problems and of climate change governance should be taken into account, and the nature of solutions offered should equally be sought in the political, technological, economical and social milieus, among others. Also the need to create a solid collaboration and environment of trust between different governance layers which resembles with a great deal of the theories that were discussed in sections 1.2.2 and 1.2.3 (Horelli et al., 2013; Verhoeven & Tonkens, 2011; Corfee-Morlot et al., 2009), has been widely discussed in the light of the specific context of Quito, but also determined as being hardly present. A final suggestion for further research therefore, is the question of how to create such an environment in Quito, in which accordingly all four principles of the WIGO-report (WIN, 2016) are visible, along with concrete points of action to improve the city's stakeholder engagement process.

7.2 Conclusion

This research was carried out to answer the following research question:

"What are the opportunities and limitations of the Integrated Water Resources Management (IWRM) in Quito, Ecuador and how can the main limitations best be resolved?"

The first step in answering this question was to identify the current main bottlenecks of Quito's IWRM using the CBF and the TPF. The assessments revealed that Quito has two main points of concern: **1)** its absence of wastewater treatment (along with an absence of financial means to solve this) and **2)** its vulnerability to drinking water scarcity. At present, almost 100% of the DMQ population has access to drinking water. However, while solid long-term strategies to prevent water shortages are in progress, on the short term a large part of the water supply is obtained from the area around the active Cotopaxi volcano, which last

erupted in 2015. In the case of such a sudden event happening again, Quito might be cut off from part of its water supply and may be potentially at risk if no alternative water resources and infrastructure is available. As emergency action plans, quick exchange of information and efficient cooperation between different stakeholders are limited and sometimes non-existing, Quito's population could be at large risk. Moreover, the city's population is expected to have doubled by 2050 leading to increased dependency on a highly vulnerable water supply.

The second step, was to look for opportunities to address the most important bottlenecks found in the City Blueprint assessment. It was found that the relation between EPMAPS and the consumers of the drinking water is problematic and that the limited involvement of citizens can be considered a water governance gap. Moreover, awareness among and collaborations between professionals from EPMAPS are relatively widespread, while more awareness for drinking water conservation among the population of Quito needs to be created, for example by adjusting the tariffs more in proportion to water use. However, along with legal compliance and the stakeholder engagement process, this most urgently needs the most improvement.

The third step was to assess the governance capacity of Quito's drinking water system and its identified vulnerabilities. As the GCAF lacks experiences regarding the South-American context, the framework was improved based on the assessment of Quito. It was found that transparency, accountability, participation and anti-corruption were important for building governance capacity needed to address the challenges of drinking water in Quito. A stable and integer environment in which feelings of distrust between different governance layers and stakeholders are reduced by increased transparency and accountability, will in turn lead to more willingness to participate (by citizens *and* experts). Furthermore, anti-corruption initiatives can be considered an additional necessity that is not specifically linked to the assessment of Quito (as corruption is found in many different places and sectors in the world), but nevertheless is a precondition for integrity in general. However, initiatives to bring these four pillars into practice are hardly present. These need to be improved, as the fewer the supply side shows willingness to change their behaviour in a more open and collaborative way, the unlikelier it is that changes on the consumer side will happen.

7.3 Recommendations to the city of Quito

On the basis of all that has been discussed, this report concludes with the following 12 policy recommendations for the future of a sustainable and climate-adaptive water governance in Quito. The city is recommended to investigate possibilities to implement the following measures:

- Regarding the tariff structure, the differences in costs per cubic metre between the different categories of residential use (40 cents), commercial use (55 cents) and industrial use (62 cents) can well be extended, as it has been shown that the latter two categories may on average use three times as much water as the residential users.
- Similarly, instead of the incentive in the current tariff structure by which residential users have to pay more when they consume more than 10 cubic metres per month, the advice is given to decrease the intervals, resulting in residents starting to pay more

after for example 3, 6, 9 and 12 cubic metres, or after 4, 8 and 12 cubic metres, in order to avoid that one can easily stay in the lowest category of consumption.

- However, in order to avoid that this adjustment leads to a tariff that can no longer be considered social (which is a national law in Ecuador, see section 7.1.5), EPMAPS is also advised to include the income of the residents in the differentiations and charge a higher tariff for residents with a higher income, while charging lower tariffs for residents with lower incomes.
- EPMAPS, *SenAgua* and the *Ministerio del Ambiente* should work together more closely in order to create a more effective legal compliance. This not only restricts the use of large quantities of water or substances that pollute the water, but it also prevents the necessity of new expenditures to repair any damage that is done by harmful actions.
- Recently there have been little investments in research by EPMAPS due to a lack of financial resources. EPMAPS has in turn set up a research department of themselves. However, collaborations with universities could enable EPMAPS to outsource research tasks and use the leftover capacity to invest in another new project.
- Better communication channels and collaborations between different expert organizations should be set up. This in turn should foster information exchange between organizations such as *EPMAPS, FONAG, INAMHI, SenAgua, Ministerio del Ambiente* and municipal spatial planning departments, and also make this exchange more structural and more efficient on the long term.
- Additionally however, these communication channels can then also be used for the quicker exchange of information on the short term and for the communication of action- and emergency plans for the different scenarios in which this is needed. Action can then be undertaken quickly, even when a multitude of organizations (and perhaps also citizens) has to be involved.
- Exchange of knowledge is actually existent on the international level, with other cities in highland areas (i.e. Bogotá, Mexico City). Results have shown that this same exchange of knowledge is hardly present on the national level, while for example the geographical location of Cuenca is also one in the Andean highlands, on a similar altitude and the drinking water authority is equally considered to be on a high level as that of Quito. EPMAPS is therefore recommended to realize more and better collaboration and exchange of knowledge with the drinking water authority in Cuenca.
- To promote transparency and facilitate future research, institutions in Quito (as well as in other cities) should be urged to construct clear, accessible, relevant and consistent central (and public) databases for information on indicators such as the share of green and blue area in the city, predictions of average temperatures in the future, groundwater quality and the share of the urban soil that is sealed.
- More awareness among people could also be created by water rationing. Availability of water could be differentiated between different neighbourhoods, between different times of the day, and with variability between Quito's dry season (roughly from June to September) and the wet season (roughly from October to May), in the sense that there would be more restrictions during dry season and less during rainy season.

- Besides that, a campaign should be issued that explains people *why* things like water rationing and increased tariffs happen. In the future, these campaigns should (unlike now) *take place on a regular basis*, cover all multifaceted elements and characters of climate change (hence, not only water, only solid waste, etc.) and make much more use of the social media and internet instead of only the traditional media, in order to reach as many people as possible.
- Finally, better communication channels should be set up between authorities and citizens, in order to create a situation in which citizens are involved more into political decision-making, are more in a position to give feedback, can participate in for example open discussion evenings and attend meetings of the municipality and of EPMAPS, all with the goal of creating win-win situations from a top-down as well as from a bottom-up perspective, promote transparency and therefore foster an environment of trust and collaboration between the different layers of the population of Quito.

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Annex 1: Operationalization, formulas and scores for the City Blueprint assessment

For the analysis of trends and pressures, the following ordinal classes, expressed as 'degree of concern', have been used: 0–0.5 points (no concern), 0.5–1.5 (little concern), 1.5–2.5 (medium concern), 2.5–3.5 (concern) and 3.5–4 (great concern) – (Koop & Van Leeuwen, 2016).

Social Pressures

Urbanization rate

Percentage of population growth either by birth or migration. The percentages are annually averages per country. Urbanization increases the pressure on integrated water resources management (IWRM) in cities.

Calculation:

The indicator is calculated as follows:

Score urbanization rate = $-0.114\mathbf{X}^2 + 1.3275\mathbf{X} + 0.1611$

Where X is the urbanization rate (%).For urbanization rates lower than 0% the score is also zero and the above formula is not applied.

For Quito:

In Quito urbanization rate is 1.9%, CIA (2016). Therefore:

$\mathbf{X} = 1.9\%$

Score education rate = $-0.114\ (\mathbf{1.9})^2 + 1.3275\ (\mathbf{1.9}) + 0.1611 = \mathbf{2.4}$

Urbanization rate is a concern for Quito.

Scale: National.

Burden of disease

The gap between current health status and an ideal situation where everyone lives into old age, free of disease and disability of population growth either by birth or migration. The indicator measures the age-standardized disability-adjusted life years (DALY) per 100.000 people. DALY is the quantification of premature death, burdens of disease and disability in life years. It is a time-based measure that combines years of life lost due to premature

mortality and years of life lost due to time lived in states of less than full health, e.g. disease, injuries and risk factors (WHO, 2004).

Calculation:

WHO calculation of DALY

Years of premature death: Sum of the number of deaths at each age * [global standard life expectancy for each age – the actual age].

Years lost due to disability: Number of incident cases in that period * average duration of the disease * weight factor.

Years of premature death + Years lost due to disability = DALY

The average DALY per 100.000 people is a strong tool to indicate the burden of disease.

The WHO subdivided these DALY's per 100.000 people into 5 classes. These classes are used to standardize this indicator to a score of 0 to 4 in the CBF analysis as shown below.

DALY per 100.000 people	**Score**
0 – 20.000	0
20.000 – 40.000	1
40.000 – 60.000	2
60.000 – 80.000	3
80.000 <	4

For Quito:

X = 29357 (WHO 2014)

Score is **1.0** point. The burden of disease is a little concern for Quito.

Scale: National.

Education rate

Education rate expressed as percentage of children completing their primary education

Calculation:

The indicator is calculated as follows:

Score education rate = $-10^{-5}\mathbf{X}^3 + 0.0012\mathbf{X}^2 - 0.0426\mathbf{X} + 4.3057$

Where **X** is the education rate (%)

For Quito:

X = 111% (World Bank, 2016d)

$-10^{-5} * \mathbf{(111)}^3 + 0.0012 * \mathbf{(111)}^2 - 0.0426 * \mathbf{(111)} + 4.3057 = \mathbf{0.7}$

Education rate is of little concern for Quito.

Political instability (and absence of violence)

The estimated likelihood that the government will be destabilized or overthrown by violent means such as terrorism and politically-motivated violence of population growth either by birth or migration.

Calculation:

The indicator is calculated as follows:
X = Estimated political stability score

4 – [(**X** – 2.5) / (2.5 – 2.5) × 4] = Score

For Quito:

X = - 0.01 (World Bank 2016a)

4- [(**-0.01**--2.5) / (2.5--2.5) x 4] = **2.0**

Political instability is a medium concern for Quito.

Environmental Pressures

Water scarcity

Indicator 5 consists of three sub-indicators: Fresh water scarcity, Groundwater scarcity, Salinization & seawater intrusion

Fresh water scarcity

The abstracted fresh water as percentage of total renewable resource. This includes surface water and groundwater sources.

The scoring method is in accordance with the European Environmental Agencies classification (OECD, 2004; WRI, 2013).

% of renewable resource abstracted	**Score**
0. –.2	0
2 – 10	1
10 – 20	2
20 – 40	3
>40	4

For Quito:

X = 2.241% (Aquastat 2016)

Score of **1.0** point.

Fresh water scarcity is of little concern for Quito.

Groundwater scarcity

The abstracted groundwater as a percentage of the annual groundwater recharge. This is a measure of the pressure on groundwater resources.

Calculation:

The indicator scoring is in accordance with the classification used by UNESCO.

% abstracted of annual recharge	**Score**
0.- 2	0
2 – 20	1
20- 50	2
50 – 100	3
>100	4

For Quito:

X = between 0 and 2 (Igrac, 2010)

Score of **0.0** points.

Groundwater scarcity is of no concern for Quito.

Salinization & seawater intrusion

Measure of the vulnerability of seawater intrusion and salinization of the soil.

Calculation method:

This indicator score is based on a quick literature check in which seawater and groundwater intrusion are scored as suggested below.

Seawater intrusion

Description	**Score**
No seawater intrusion reported and city not prone to (future) intrusion	0
No seawater intrusion reported and city can experience intrusion in coming century	1
No seawater intrusion reported but city is prone to intrusion in the near future	2
Seawater intrusion reported	3
Seawater intrusion reported and city is particularly prone to intrusion	4

Groundwater salinization

Based on literature studies, here the following scheme is applied to determine a score:

Description	**Score**
No concern	0
Low concern	1
Medium concern	2

Concern	3
Great concern	4

The highest score of both indicators is used as the final score for salinization and seawater intrusion.

For Quito:

X = Score of **0.0** points for seawater intrusion, as well as for soil salinization. Quito is situated at an altitude of 2850m above sea level, so seawater cannot reach the city.

Flood risk

The indicator flood risk consists of 4 sub-indicators: Urban drainage flood, Sea level rise, River peak discharges, Land subsidence.

Urban drainage flooding

Risk of flooding due to intensive rainfall expressed as the share of urban soil that is sealed.

Calculation method:

Sealed soil cover in the city standardized according to the min-max method. The minimum and maximum values are determined by taking the bottom and the top 10% of the 572 European cities assessed. Green and blue areas refer to sports and leisure facilities, agricultural areas, semi-natural areas and wetlands, forests, discontinuous low density urban fabric as a proxy for private gardens and water bodies (EEA, 2012). Lower 10% of all European cities assessed is 31.7%, top 10% has a share impermeable area of 69.6%. Min-max transformation leads to:

(**X** - 31.7)/(69.6 - 31.7) x 4= score

For Quito:

Where a city has much sealed soil covered with impermeable asphalt, concrete and roofs, rainwater will have less chance of infiltrating in the ground and therefore increase the risk of flooding. No public or consistent documents could be found in which there was clear data about land use in the DMQ (and therefore soil sealing). It was chosen to look at the open space ratio of the city of Quito, as analyzed of 77 cities globally (hence including Quito), by

Huang et al. (2007). They indicated that with around 13%, Quito has an open space ratio which is just below the average of the cities assessed. While the open space ratio of a city certainly does not say everything, it can be argued that a lower open space ratio means that a larger share of the soil is sealed. Despite the fact that the share of urban soil that is sealed is dependent on more factors than only the open space ratio, urban drainage flooding can on the basis of this data considered to be a medium concern for Quito.

Sea level rise

Measure of the vulnerability of flooding due to sea level rise. Percentage of the city that would flood with 1 meter sea level rise. Only environmental circumstances are considered. Protection measures such as dikes, dams *etcetera* are not considered (that would be a performance).

Calculation method

In accordance with the European Environmental Agency (2012) the following classification is used to standardize the area being affected by a 1 meter sea level increase without flood protection on a scale from 1 to 5.

Urban area affected (%)	**Score**
0-5	0
6-10	1
11-20	2
21-40	3
41-100	4

For Quito:

X = 0.0%

Quito lies on an altitude of 2850 metres above sea level. Therefore Quito scores **0.0** points for sea level rise meaning that marine flooding is of no concern for the city of Quito.

River peak discharges

Measure for the vulnerability of flooding due to river level rise. Also flash floods from outside the city are included in this indicator. Percentage of the city that would flood with 1

meter river level rise. Only environmental circumstances are considered. Protection measures such as dikes, dams etcetera are not considered (that would be a performance).

Calculation method

In accordance with the European Environmental Agency (2012) the following classification is used to standardize the area being affected by a 1 meter river level increase without flood protection on a scale from 1 to 5.

Urban area affected (%)	**Score**
0-5	0
6-10	1
11-20	2
21-40	3
40-100	4

For Quito:

Majority of the rivers flow outside the metropolitan district of Quito and are situated at a lower altitude than the city itself. The risk of river peak discharges for the city is therefore minimal.
X = Score is **0** points.

River peak discharges are of no concern for Quito.

Land subsidence
Land subsidence increases the risks of river and coastal floods and salt water intrusion. The cause of land subsidence is irrelevant for its impact on flooding.

Calculation method

This score is based on a qualitative assessment according to the following classification:

Score	**Description**
0	No infrastructure damage, no flood risk
1	Low/medium infrastructure damage expected, no major increase in flood risk expected

2	Experienced infrastructure damage and medium infrastructure damage expected or <0.50m subsidence by 2100 in a substantial area of the city.
3	Serious experienced infrastructural damage or < 1m subsidence by 2100 in a substantial area of the city
4	Serious experienced infrastructure damage, Imminent flooding/ < 2m subsidence by 2100 in a substantial area of the city

For Quito:

X = Score is **0.0** points.

See indicator also indicator of river peak discharges: no real infrastructural damage is expected. Score indicator = 0.0 points. Flood risk due to subsidence is of no concern for Quito.

Water quality
Water quality consists of two sub-indicators: Surface water quality, Biodiversity.

Surface water quality
Measure of relative surface water quality. A lower Indicator score is given for better quality.

Calculation method:

A national surface water quality index (WQI) is available as a measure out of 100. Then, the indicator is calculated as follows:

(100 – WQI) / 25 = score

For Quito:

X = 83.4 (EPI 2010)

(100 - **83.4**) / 25 = **0.7**

Surface water quality is of little concern for Quito.

Biodiversity
Measure of the biodiversity of aquatic ecosystems in the city. A low indicator score is given where biodiversity is good.

Calculation method

The calculation is based on national or regional data when city-level data are not available. There are many ways of assessing biodiversity, so there is no globally uniform approach.

For non-EU countries, it is recommended to use data from software called the Environmental Performance Index (EPI), led by Yale University (epi.yale.edu).

The latest 2012 update does not include the relevant parameter called 'Water – impact on ecosystem'. This is available from the 2010 version (see also Indicator 4).

The value is obtained from the Country Profiles.

For Quito:

(**X** = Water (impact on ecosystem) value which is 73.8 points.

Score indicator = $\frac{100-\boldsymbol{X}}{25}$

$\frac{100-[\mathbf{73.8}]}{25}$ = **1.0**

EPI (2010)

Aquatic biodiversity is of little concern to Quito.

Heat risk
Prediction of heat island effects severity on human health

Calculation method

1. Number of combined tropical nights (>20°C) and hot days (>35°C) in the period 2071-2100, where the maximum is set on 50 days. The number is standardized using the following formula:

[Number of combined tropical nights and hot days/50] ×4 = score

2. Percentage of green and blue urban area. Share of green and blue areas is available for all European cities. The EEA city database presents data for of 367 European cities. From these data the average of the lowest 10% is taken as minimum (16%) and the average of the highest 10% is taken as maximum (48%). The percentages for the EU cities are standardized according to the min-max method. For non-European cities percentages for green and blue area are mostly not available. A best estimate is given by comparing this city to a similar European city. It is important for these cities to provide better information on the share of green area.

4 – [(% green and blue area – 16) / (48 – 16) × 4] = score

3. The overall score is the arithmetic average of both standardized scores.

For Quito:

$\mathbf{X}_1$ = 0.0 (INAMHI 2016)

$\mathbf{X}_2$ = 6.01% (own estimation).

To measure the share of green and blue area for European cities, a database is available. For Quito and other Non-European cities however, such a database is unavailable and a best estimate is to be made. The part of the city which is incorporated is only the urban centre. For Quito, this corresponds with approximately 33% of the total urban area and therefore an estimated surface area of 124 KM^2. An estimate was made by looking at a map of Quito on Google Maps. No substantial blue areas were identified in the urban centre. Below, the green areas identified in the urban area of Quito (and their corresponding surface areas) are given.

Park name	**Surface area**	**Reference**
Parque La Carolina	67 hectares	Parques Metropolitanos de Quito, 2015
Parque Metropolitano Guangüiltagua	557 hectares	Parques Metropolitanos de Quito, 2015
Arqueológico Rumipamba Park	43,4 hectares	Parques Metropolitanos de Quito, 2015
Parque La Alameda	6 hectares	In-Quito, n.d.
Parque Itchimbia	54 hectares	Expedia, 2016
Parque El Ejido	14,1 hectares	Skyscrapercity, 2009
Parque Del Arbolito	3,5 hectares (approx. 25% of 'El Ejido')	Skyscrapercity, 2009

This leads to a percentage of 6.01%. The final score for the share of green and blue area is normally calculated by the min-max method, with reference to the EU database. From these data the average of the lowest 10% is taken as minimum (16%) and the average of the highest

10% is taken as maximum (48%). Even in the most optimistic interpretation the percentage of green and blue area in the urban centre of Quito would be lower than the current minimum:

[0 / 50] x 4 = 0

4 - [(**6.01** – 16) / (48 -16) x 4] = 5.24875 which is a maximum score of 4 points

Overall score is **2.0** points.

Heat risk is a medium concern for Quito

Financial Pressures

Economic pressure
Gross Domestic Product (GDP) per head of the population is a measure of the economic power of a country. A low GDP per capita implies a large economic pressure.

Calculation method

The International Monetary Fund (IMF) provides the GDP of a country for all world countries. From these data the average of the lowest 10% is taken as minimum (514.7US$/year) and the average of the highest 10% is taken as maximum (59231.2US$/year). The cities are standardized according to the min-max method.

X = GDP per capita per year (US$)

Score economic pressure = (**X** – 514.7) / (59231.2 – 514.7)*10

For Quito:

X = 8237.7US$/cap/year (IMF 2013)

(**8237.7** – 514.7) / (59231.2 – 514.7)*10 = 3.5

Economic pressure is a concern for Quito.

Unemployment rate

Percentage of population of the total labour force without a job.

Calculation method

Score unemployment rate = $0.0002\mathbf{X}^3 - 0.0173\mathbf{X}^2 + 0.5077\mathbf{X} - 0.8356$

Where X is unemployment rate (%)

For Quito:

X = 4.6% (World Bank 2016b)

$0.0002 * \mathbf{(4.6)}^3 - 0.0173 * \mathbf{(4.6)}^2 + 0.5077 * \mathbf{(4.6)} - 0.8356 = \mathbf{1.2}$
Unemployment rate is of little concern for Quito.

Poverty rate

Percentage of people that is below the poverty line of 2 US$ a day.

Calculation method

Score poverty rate = $-0.0001\mathbf{X}^2 + 0.0404\mathbf{X} + 1.1686$

Where X is poverty rate (% less than 2US$ a day)

For Quito:

X = 5.1% (World Bank 2016e)

$-0.0001 * (\mathbf{5.1})^2 + 0.0404 * (\mathbf{5.1}) + 1.1686 = \mathbf{1.4}$

Poverty rate is of little concern for Quito.

Inflation

Percentage inflation per year. High inflation rates may hamper investments.

Calculation method

Score inflation rate = $0.0025\mathbf{X}^3 - 0.0744\mathbf{X}^2 + 0.8662\mathbf{X} + 0.0389$

Where **X** is the inflation rate (%).

For Quito:

X = 3.6% (World Bank 2016c)

$0.0025 * (\mathbf{4})^3 - 0.0744 * (\mathbf{4})^2 + 0.8662 * (\mathbf{4}) + 0.0389 = \mathbf{2.5}$

Inflation rate is a medium concern for Quito.

City Blueprint

List of City Blueprint indicator scores for Quito

Category	No.	Indicator	Score
I	1	Secondary WWT	0.0
	2	Tertiary WWT	0.0
	3	Groundwater quality	6.0
II	4	Solid waste collected	7.9
	5	Solid waste recycled	0.1
	6	Solid waste energy recovered	0.0
III	7	Access to drinking water	9.9
	8	Access to sanitation	9.3
	9	Drinking water quality	10.0
IV	10	Nutrient recovery	0.0
	11	Energy recovery	0.0
	12	Sewage sludge recycling	0.0
	13	WWT Energy efficiency	0.0
V	14	Average age sewer	1.0
	15	Operation cost recovery	7.9
	16	Water system leakages	4.1
	17	Stormwater separation	0.0
VI	18	Green space	0.0
	19	Climate adaptation	8.0
	20	Drinking water consumption	8.7
	21	Climate robust buildings	4.0
VII	22	Management and action plans	7.0
	23	Public participation	4.2
	24	Water efficiency measures	8.0
	25	Attractiveness	0.0

Categories: I – Water quality, II – Solid waste treatment, III – Basic water services, IV – Wastewater treatment, V – Infrastructure, VI Climate robustness, VII - Governance

I – Water quality

Secondary WWT

Measure of the urban population connected to secondary waste water treatment plants. The focus on secondary treatment is chosen because primary treatment is considered rather insufficient for BOD (biochemical oxygen demand) and nutrient removal.

Definition secondary WWT: Secondary treatment: process generally involving biological treatment with a secondary settlement or other process, with a BOD removal of at least 70% and a COD removal of at least 75% (OECD, 2013).

Calculation

The indicator is calculated as follows:

Indicator 1 = **X** / 10,

Where X is the percentage of population connected to secondary sewage treatment. Assumed that there is only tertiary treatment after secondary treatment has been done.

For Quito:

X = **0.0**%. Wastewater treatment is non-existent in Quito. Plants are under construction but not finished (2016, contact: franklin.palacios@aguaquito.gob.ec)

0.0 / 10 = **0.0**

Tertiary WWT

Measure for the urban population connected to tertiary waste water treatment plants. This treatment step is important for water quality because much nutrients and chemical compounds are removed from the water before it inters the surface water.

Tertiary treatment: Tertiary treatment: treatment of nitrogen or phosphorous or any other pollutants affecting the quality or a specific use of water (microbiological pollution, colour, etc.) (OECD, 2013).

Calculation

The indicator is calculated as follows:

Indicator 2 = **X** / 10,

Where **X** is the percentage of population connected to tertiary sewage treatment.

For Quito:

X = **0.0**%. Wastewater treatment is non-existent in Quito. Plants are under construction but not finished (2016, contact: franklin.palacios@aguaquito.gob.ec)

0.0 / 10 = **0.0**

Groundwater quality

Measure of relative groundwater quality. A lower Indicator score is given for poorer quality.

Calculation

Base the calculation on national or regional data where city-level data are not available.

A limitation is that in any country, city water quality is typically worse than the national average.

For EU countries, data are available to estimate a measure of national groundwater quality. An EU database shows the number of groundwater samples of 'good chemical status' out of a total number of samples.

X = Number of samples of 'good chemical status'

Y = Number of samples of 'poor chemical status'

Indicator 3 = **X** /(X + **Y**)* 10

Note: for non-EU countries, an alternative method should be applied, depending what data is available indicator is calculated as follows:

For Quito:

Score indicator 3:

X = 141

Y = 94

Indicator 3 = **X** / (**X** + **Y**)*10 =

141 / (**141**+ **94**) * 10 = **6.0**

(2015, contact: edgar.pazmino@aguaquito.gob.ec)

II – Solid waste treatment

Solid waste collected

Represents waste collected from households, small commercial activities, office buildings, institutions such as schools and government buildings, and small businesses that threat or dispose of waste at the same used for municipally collected waste (OECD, 2013).

Calculation

The indicator is calculated as follows:

Indicator 4 = [1 – (**X** – 136.4) / (689.2 – 136.4)]* 10,

Where **X** is the kg/cap/year of collected solid waste.

X = 253.47 kg/cap/year of collected solid waste in Quito (2015, contact: pablo.tayupanta@emgirs.gob.ec)

Indicator 4 = [1 - (**253.47** - 136.4) / (689.2 - 136.4)*10] = **7.9**

Solid waste recycled

Percentage of solid waste that is recycled or composted.

Calculation

This indicator represents the percentage of the total collected municipal waste that is recycled or composted. However, when solid waste is used for incineration with energy recovery, it is not possible to also use it for recycling while both practices are sustainable. Therefore the % solid waste that is incinerated is subtracted from the total (100%) of collected municipal waste

to obtain the potential percentage of solid waste that can be recycled (in numerator). Thus this indicator is calculated as shown below.

Indicator 5 = (% recycled or composted) / (100-% used for incineration with energy recovery) * 10

For Quito:

Percentage of solid waste that is recycled or composted: **0.89**% (2015, contact: pablo.tayupanta@emgirs.gob.ec)

Percentage of solid waste that is used for incineration with energy recovery: **0.0**% (2015, contact: pablo.tayupanta@emgirs.gob.ec)

Indicator 5 = **0.89** / (100 - **0**)*10 = **0.1**

Solid waste energy recovered

Percentage of solid waste that is incinerated with energy recovery.

Calculation

This indicator represents the percentage of the total collected municipal waste that incinerated with energy recovery (techniques). However, when solid waste is recycled or composted, it is not possible to also use it for incineration with energy recovery, while both practices are sustainable. Therefore the % solid waste that is recycled or composted is subtracted from the total (100%) of collected municipal waste to obtain the potential percentage of solid waste that can be incinerated with energy recovery (in numerator). Thus this indicator is calculated as shown below

Indicator 6 = (% incinerated with energy recovery) / (100 – % recycled or composted*10

For Quito:

Percentage of solid waste that is incinerated with energy recovery: **0.0**% (2015, contact: pablo.tayupanta@emgirs.gob.ec)

Percentage of solid waste that is recycled or composted: **0.89**% (2015, contact: pablo.tayupanta@emgirs.gob.ec)

Indicator 6= **0.0** / (100 - **0.89**)*10 = **0.0**

III – Basic water services

Access to drinking water

The proportion of the population with access to affordable safe drinking water. A lower Indicator score is given where the percentage is lower.

Calculation

The indicator is calculated as follows:

Indicator 7 = X/10,

Where X is the percentage of total urban population with access to potable drinking water.

For Quito:

X = Percentage (%) of total urban population with access to potable drinking water = **98.55**% (2015)

(contact: max.sotomayor@aguaquito.gob.ec)

Indicator 7 = **98.55** / 10 = **9.9**

Access to sanitation

A measure of the percentage of the population covered by wastewater collection and treatment. A lower Indicator score is given where the percentage is lower.

Calculation

The indicator is calculated as follows:

Indicator 8 = X/10,

Where X is the percentage of total urban population with access to proper sanitation facilities.

For Quito:

X = Percentage (%) of total urban population with access to proper sanitation facilities = **92.73**% (2015, contact: max.sotomayor@aguaquito.gob.ec)

Indicator 8 = **92.73** / 10 = **9.3**

Drinking water quality

A measure of the level of compliance with local drinking water regulations. A lower Indicator score is given where compliance is lower.

Calculation

The indicator is calculated as follows:

Indicator 9 = **X** / 10,

Where X is the percentage of total urban population with access to potable drinking water.

For Quito:

The result is expressed as a percentage of the samples meeting the applicable standards.

X = Total number of samples meeting standards

Y = Total number of samples

99.96% meets Ecuadorian standards in Quito (2016, contact: max.sotomayor@aguaquito.gob.ec).

Indicator 9 = **99.96** / 10 = **10.0**

IV – Wastewater treatment

Nutrient recovery

Measure of the level of nutrient recovery from the wastewater system.

Calculation

A. Wastewater treated with nutrient recovering techniques at the wastewater treatment plants (Mm3 year-1)

B. Total amount of wastewater passing the wastewater treatment plants (Mm3 year-1)

Indicator 10 = [A/B]×[% secondary WWT coverage/100]×10

For Quito:

A = **0.0**

B = **0.0**

Wastewater treatment is non-existent in Quito. Plants are under construction but not finished (2016, contact: franklin.palacios@aguaquito.gob.ec)

Indicator 10 = **0.0**

Energy recovery WWT

Measure of energy recovery from the wastewater system.

Calculation

A) Total volume of wastewater treated with techniques to recover energy (Mm3/year).

B) Total volume of water produced by the city (Mm3/year).

[**A** / **B**]×10 = score

Often only the total volume of wastewater that enters the treatment facilities is known together with wastewater treatment coverage's (% of water going to the treatment facilities). In this case:

C) Total volume of wastewater treated with techniques to recover energy (Mm3/year).

D) Total volume of wastewater treated in wastewater treatment plants (Mm3/year).

Indicator 11 = [**C** / **D**] × [% secondary WWT coverage / 100] ×10,

Indicator 11 = [(**C** / **D)** * (% secondary WWT coverage / 100)] * 10

For Quito:

Indicator 11 = **0.0**

Wastewater treatment is non-existent in Quito. Plants are under construction but not finished (2016, contact: franklin.palacios@aguaquito.gob.ec)

Sewage sludge recycling

A measure of the proportion of sewage sludge recycled or re-used. For example, it may be thermally processed and/or applied in agriculture.

The decision whether or not to apply sewage sludge in agriculture depends on the levels of organic and inorganic micro-contaminants. Often, sewage sludge is contaminated and in many countries it is not allowed to apply sewage sludge in agriculture. Instead, the sludge is burned in waste destruction installations or as biomass in power plants for the generation of electricity.

Calculation

A. Dry weight of sludge produced in wastewater treatment plants serving the city

B. Dry weight of sludge going to landfill

C. Dry weight of sludge thermally processed

D. Dry weight of sludge disposed in agriculture

E. Dry weight of sludge disposed by other means

(As a check, A should = B + C + D +E)

Indicator 12 = [(**C** + **D**) / **A**] × [% secondary WWT coverage / 100]×10

To measure the full potential of nutrient and energy recovery, It is specifically chosen to multiply the first term in the equation above with the percentage of secondary WWT coverage as secondary WWT produces much more sewage sludge than primary WWT.

Indicator12 = [(C + D) / A] x [% secondary WWT coverage / 100] x 10

For Quito:

Indicator 12 = **0.0**

Wastewater treatment is non-existent in Quito. Plants are under construction but not finished (2016, contact: franklin.palacios@aguaquito.gob.ec)

WWT Energy efficiency

A measure of the energy efficiency of the wastewater treatment. A lower Indicator score is given where efficiency measures are more limited.

Calculation

This measure is unlikely to already have a value applied. Instead, apply a self-assessment based on the plans, measures and their implementation to improve the efficiency of wastewater treatment. Self-assessment based on information from public sources (national/regional/local policy document, reports and websites of actors (e.g. water companies, cities, provincial or national authorities).

The following guidance is proposed to make self-assessment score for Indicator 13.

Indicator score	Assessment
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	as 7 plus subsidies are made available to implement the plans
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community
10	as 9 and the activity is in place for = 3 years

For Quito:

Indicator 13 = **0.0**

Wastewater treatment is non-existent in Quito. Plants are under construction but not finished (2016, contact: franklin.palacios@aguaquito.gob.ec)

V – Infrastructure

Average age sewer

The age of the infrastructure for wastewater collection and distribution system is an important measure for the financial state of the UWCS.

Calculation

The average age of the infrastructure is an indication of the commitment to regular system maintenance and replacement. The method compares the average age of the system to an arbitrarily maximum age of 60 years. Moreover, it is assumed that an age of <10 years receives a maximum score since younger systems generally well maintained.

Indicator 14 = (60 – **X**)/(60 – 10)*10

Where **X** is the average age sewer

For Quito:

X = 55

Of 90% of all sewer interceptors in Quito, the construction year is unknown. These all get the maximum age of 60 years. All the other (10%) sewer interceptors are 10 years old or younger. 10 years is however the minimum age to be filled in into the formula. This results in:

X = ((9 * 60) + (1 * 10)) / 10

X = 55

(60 – **X**) / (60 – 10)*10 =

(60 – **55**) / (60-10)*10 = **1.0**

Indicator 14 = **1.0**

More information, contact: diego.paredes@aguaquito.gob.ec

Operating costs recovery (ratio)

Measure of revenue and cost balance of operating costs of water services. A higher ratio means that there is more money available to invest in water services, e.g. infrastructure maintenance or infrastructure separation.

Calculation

Only the operational cost and revenues for Domestic water supply and sanitation services are included.

Operating cost recovery (ratio) = (Total annual operational revenues)/(Total annual operating costs)

Total annual operating costs: Total annual operational expenditures for drinking water

Total annual operational revenues: Total annual income from tariffs and charges for drinking water and sanitation services (US$/year)

Therefore the indicator is calculated as follows:

Indicator 15 = (**X** – 0.33) / (2.34 – 0.33)*10

Where **X** is operating cost recovery (ratio).

For Quito:

Total annual operating costs (US $) = **24 710 046.09**

Total annual operational revenues (US $) = **47 089 381.19**

X = **47 089 381.19** / **24 710 046.09**

X = 1.91

Indicator 15 = (**X** - 0.33) / (2.34 - 0.33)*10

(**1.91** – 0.33) / (2.34 – 0.33)* 10 = 7.9

Indicator 15 = **7.9**

(April 2016, contact: max.sotomayor@aguaquito.gob.ec)

Water system leakages

A measure of the percentage of water lost in the distribution system due to leaks (typically arising from poor maintenance and/or system age).

Calculation

Leakage rates of 50% or more are taken as maximum value and thus scored zero. A best score of 10 is given when the water system leakage is zero.

Indicator 16 = (50 – **X**) / (50 – 0)*10

Where **X** is water system leakages (%).

For Quito:

X = 29.335

Indicator 16 = [(50 - **X**) / 50] *10 = **4.1**

Indicator 16 = 4.1

(April 2016, contact: diego.paredes@aguaquito.gob.ec)

Stormwater separation

A measure of the proportion of the wastewater system for which sanitary sewage and storm water flows are separated. In principal, a separate system is better than a combined system as extreme weather events may lead to sewer overflows into surface water. These sewer overflows are a major source of pollution. Also flooding vulnerability is larger if stormwater separation ratio is low. A lower Indicator score is given where the proportion of combined sewers is greater.

Calculation

A. Total length of combined sewers managed by the utility (km)

B. Total length of stormwater sewers managed by the utility (km)

C. Total length of sanitary sewers managed by the utility (km)

Indicator 17 = [(**B** + **C**) / (**A** + **B** + **C**)]*10

For Quito:

A = 5,295.82

B = 0.0

C = 0.0

Indicator 17 = (0.0 + 0.0) / (5,295.82 + 0.0 + 0.0)* 10 = **0.0**

Indicator 17 = **0.0**

Quito has a combined sewer system, which makes the score for indicator 17 automatically 0.

(May 2016, contact: diego.paredes@aguaquito.gob.ec)

VI – Climate robustness

Green space

Represents the share of green and blue area which is essential to combat the heat island effect in urban areas (area defined as built-up area lying less than 200 meters apart).

Definition of green area (EEA, 2012A): These are green urban areas, sports and leisure facilities, agricultural areas, semi-natural areas and wetlands, forests, discontinuous low density urban fabric as a proxy for private gardens and water bodies.

Calculation

City specific: Numbers are provided in %

Country average: Share of green and blue areas is available for all European cities. The EEA city database presents data for of 367 European cities. From these data the average of the

lowest 10% is taken as minimum (16%) and the average of the highest 10% is taken as maximum (48%). The percentages for the EU cities are standardized according to the min-max method. For non-European cities percentages for green and blue area are mostly not available. A best estimate is given by comparing this city to a similar European city. It is important for these cities to provide better information on the share of green area.

Definition of green Area (EEA 2012): These are green areas, sports and leisure facilities, agricultural areas, semi-natural areas and wetlands, forests, discontinuous low density urban fabric as a proxy for private gardens and water bodies.

Indicator 18 = (**X** – 16)/(48 – 16)*10

Where **X** is the share of blue and green area (%).

For Quito:

X = 6.01%. See also indicator 8 of the analysis of trends and pressures.

Indicator 18 = (**6.01** - 16) / (48 - 16)*10 = - 3.1

Score is negative and thus becomes **0** points.

Climate adaptation

A measure of the level of action taken to adapt to climate change threats. A lower Indicator score is given where actions or commitments are more limited

Calculation

This measure is unlikely to already have a value applied. Instead, apply a self-assessment of the measures and their implementation to protect citizens against flooding and water scarcity related to climate change (e.g. green roofs, rainwater harvesting, safety plans etc.). Self-assessment based on information from public sources (national / regional / local policy document, reports and websites of actors (e.g. water companies, cities, provincial or national authorities).

The following guidance is proposed to make self-assessment score for Indicator 19.

Indicator score	Assessment
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	**as 7 plus subsidies are made available to implement the plans**
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community
10	as 9 and the activity is in place for = 3 years

For Quito:

Climate change adaptation policies in Quito are better and more promising for the future than most other cities in the global south. The city monitors its CO2 emissions and recently adopted a strategy aimed at reducing them. Besides that, policies to reduce energy consumption are in place, public awareness campaigns are organized and attempts are made to block urban deforestation (Boselli et al., 2010). The Quito Strategy for Climate Change (EQCC) was released in February 2008 and formally approved by the Metropolitan Council in October 2009 (Carmin et al., 2012). This strategy is also quite unique in the sense that it is constructed on the city level (ELLA, 2014). Besides that, there is a concrete plan of funds that have been made available for the implementation of the strategies (ELLA, 2013). Quito therefore receives a score of **8.0** points on this indicator, as plans are implemented, clearly communicated to the public, as well as accompanied by subsidies to facilitate this implementation.

Drinking water consumption

Measure of the average annual consumption of water per capita. A lower Indicator score is given where the volume per person is greater.

Definition: In this questionnaire we use authorized consumption as defined by the International Water Association (IWA). This is the total volume of metered and/or non-metered water that, during the assessment period (here: 1 year), is taken by registered customers, by the water supplier itself, or by others who are implicitly or explicitly authorized to do so by the water supplier, for residential, commercial, industrial or public purposes. It includes water exported. It is IWA code A14. This is then divided by the city population.

Calculation

The volume is then normalized against maximum and minimum volumes for European cities.

Indicator 20 = [1 – (**X** – 45.2) / (266 – 45.2)]*10

Where **X** is m^3/person/year drinking water consumption.

For Quito:

X = 73.42
(201.14 L/cap/day = 73.4161 m^3/cap/year)

(April 2016, contact: diego.paredes@aguaquito.gob.ec)

Indicator 20 = [1 – (**X** – 45.2) / (266 – 45.2)]*10 =

= [1 – (**73.4161** – 45.2) / (266 – 45.2)]*10 = **8.7**

Climate robust buildings

A measure of whether there is a clear policy for buildings to be robust regarding their contribution to climate change concerns (principally energy use). A lower Indicator score is given where policies are weaker.

Calculation

This measure is unlikely to already have a value applied. Instead, apply a self-assessment based on the plans, measures and their implementation to improve the efficiency of

wastewater treatment. Self-assessment based on information from public sources (national/regional/local policy document, reports and websites of actors (e.g. water companies, cities, provincial or national authorities).

The following guidance is proposed to make self-assessment score for Indicator 21.

Indicator score	Assessment
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	**the topic is addressed in a chapter at the national and local level**
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	as 7 plus subsidies are made available to implement the plans
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community
10	as 9 and the activity is in place for = 3 years

For Quito:

The use of sustainable materials and earning of accompanying certifications has only just initiated in Ecuador and will take some more time to develop (Naranjo, 2015). On the other hand, the Ecuadorian government has been awarded $1.9 million from the Global Environment Facility (GEF) to support a series of energy efficiency projects during 2002-2006, with another US$4.9 million of local co-funding. In 2001, an energy reduction goal of 15% for public buildings had been defined (Van Wie McGrory et al., 2002), although these kinds of goals take a long time to be implemented. In 2010 the city still scored poorly for its eco-buildings policies, which were lacking an environmental code for new buildings or any substantial incentives and awareness campaigns to motivate businesses and households to lower the energy consumption of buildings. Except for small energy-saving schemes in place since 2008, such as using LED light bulbs in city offices, there were no green standards for public buildings in place (Boselli et al., 2010). As this issue is merely described in limited

quantity and not very much addressed in local and national policies, Quito receives a **4.0** as a score on this indicator.

VII – Governance

Management and action plans

A measure of the application of the concept of Integrated Water Resources Management (IWRM) in the city. A lower Indicator score is given where plans and actions are limited. the share of green and blue area which is essential to combat the heat island effect in urban areas (area defined as built-up area lying less than 200 meters apart).

Calculation

This measure is unlikely to already have a value applied. Instead, apply a self-assessment of the measures and their implementation to protect citizens against flooding and water scarcity related to climate change (e.g. green roofs, rainwater harvesting, safety plans etc.). Self-assessment based on information from public sources (national / regional / local policy document, reports and websites of actors (e.g. water companies, cities, provincial or national authorities).

The following guidance is proposed to make self-assessment score for Indicator 22.

Indicator score	**Assessment**
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	**plans are implemented and clearly communicated to the public**
8	as 7 plus subsidies are made available to implement the plans
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community

10	as 9 and the activity is in place for = 3 years

For Quito:

Also integrated water resource management has become a central focus for local and regional governments in Ecuador (Vredeveld, 2008). Quito even uses an online platform in an attempt to facilitate the communication about the plans to the people and wants to actively explore how the civil society can contribute to the city's strategy to combat climate change (Carmin et al., 2013). In addition, Quito is the test case for a pilot project to apply concrete IWRM-principles in the city, as part of the *AguAndes* research project (Pouget et al., 2008). On the other hand however, by 2010 Quito was still one of the few cities in Latin America that failed to enforce water pollution standards and measures on local industries, with the result that residential as well as industrial waste(water) was left untreated, and dumped into the city's two main rivers, Machángara and San Pedro (Boselli et al., 2010). Nevertheless, the management and action plans are there, and despite the fact that they may take time to be executed, Quito receives a **7.0** as a score on this indicator.

Public participation

A measure of share of people involved or doing unpaid work

Calculation

The indicator is calculated as follows (for EU countries):

Indicator 23 = (**X** – 5) / (53 – 5)*10

X = Involvement in voluntary work

For Quito:

According to a World Bank report of a study on national level Ecuadorians on average belong to 1.75 associations. This is 5 to 9 times as much compared to other Latin American countries such as Chile and Costa Rica, although it must be born in mind that membership of civil society organizations is obligatory for certain employment categories in Ecuador. If this non-voluntary membership is excluded, the percentage of public participation is 25% for Ecuador as a country (Klapper, 2007). It should be taken into account however, that this score only includes membership that is purely voluntary. It can be assumed that, in reality, the percentage of public participation in civil society organizations is higher.

X = 25% (Klapper, 2007)

Indicator 23 = (**25** – 5) / (53 – 5)×10 = **4.2**

Water efficiency measures

Measure of the application of water efficiency measures by the range of water users across the city. A lower Indicator score is given where efficiency measures are more limited.

Calculation

This measure is unlikely to already have a value applied. Instead, apply a self-assessment based on the plans, measures and their implementation to improve the efficiency of wastewater treatment. Self-assessment based on information from public sources (national/regional/local policy document, reports and websites of actors (e.g. water companies, cities, provincial or national authorities).

The following guidance is proposed to make self-assessment score for Indicator 24.

Indicator score	**Assessment**
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	**as 7 plus subsidies are made available to implement the plans**
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community
10	as 9 and the activity is in place for = 3 years

For Quito:

In order to battle their issues of water scarcity, Quito is implementing a variety of water efficiency measures such as vegetation maps, climate and forest-fire maps, and watershed models, as well as having analyzed the socioeconomic demographics of the city. The city has also already begun to relocate families living in high-risk areas and to integrate climate impacts into sustainable plans for land use, including slope and hillside management (Baker, 2012). In terms of funding an innovative public-private partnership (FONAG) has been initiated to protect and manage the grassland-covered watersheds above the city. This fund is financed by a 1.25% tax on municipal water in the metropolitan area, supplemented by payments by electrical utilities, donations from private water users and more international as well as domestic donors (Dodman et al., 2009). Finally, this way of working, together with its ways for finding sources for funding is being replicated by some countries near Ecuador, such as Peru and Bolivia, which has resulted in a regional adaptation project of which the three countries are all part (Carmin et al., 2013). The plans are implemented and clearly communicated to the public, and concrete funds have been made available for them, resulting in an **8.0** for Quito as a score on the indicator of water efficiency measures.

Attractiveness

Definition: Examples of cities that attract lot of tourists are Venice, Hamburg and Amsterdam. Water is a dominant feature of those cities. Often the property prices in the vicinity of canals and harbours are much higher than in other parts of the city where the presence of water is not so dominant. Private companies, the owners of the houses, and also the local authorities are often working together to increase the attractiveness of those cities.

Calculation

This measure is unlikely to already have a value applied. Instead, apply a self-assessment of how surface water is supporting the quality of the urban landscape as measured by the community sentiment/well-being within the city. The assessment should be based on information (policy documents, reports or research articles, or documents related to water-related tourism that deal with the sentiment of the citizens. Provide score between 0 (no role) to 10 (water plays a dominating role in the well-being of citizens).

The following guidance is proposed to make self-assessment score for Indicator 25.

Indicator score	Assessment
0	**no information is available on this subject**
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level

5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	as 7 plus subsidies are made available to implement the plans
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community
10	as 9 and the activity is in place for = 3 years

For Quito:

No information is available on this subject, the only exception being a water museum which is situated in Quito. Originally meant to create awareness about the water situation in the city, but mainly visited by tourists, also because of the high entry price. Besides that, no local or national documents were found that deal with this issue. Therefore the indicator receives a score of **0.0** points.

Annex 2: Operationalization of variables for the GCAF

Overview of the Governance Capacity Assessment Framework

Action level	Condition	Characteristic
Knowing	**GC1 Awareness**	GC1.1 Community knowledge GC1.2 Local support GC1.3 Internalization
	GC2 Useful knowledge	GC2.1 Information availability GC2.2 Accessibility GC2.3 Cohesion
Wanting	**GC3 Continuous learning**	GC3.1 Smart monitoring GC3.2 Evaluation GC3.3 Cross-stakeholder capacity building
	GC4 Stakeholder engagement process	GC4.1 Inclusiveness GC4.2 Protection of core values GC4.3 Progress and choice variety
	GC5 Policy ambition	GC5.1 Ambitious and realistic goals GC5.2 Discourse embedding GC5.3 Cohesive policy
	GC6 Agents of change	GC6.1 Entrepreneurial GC6.2 Collaborative GC6.3 Visionary
Enabling	**GC7 Multi-level network potential**	GC7.3 Room to maneuver GC7.3 Clear division of responsibilities GC7.3 Authority
	GC8 Financial viability	GC8.3 Affordability GC8.3 Willingness to pay GC8.3 Financial continuation
	GC9 Implementing capacity	GC9.1 Policy instruments GC9.2 Legal compliance GC9.3 Preparedness

As has been explained in the section 1.2.2 of the theoretical framework, about the perspective of urban governance, the 9 main concepts that form the Governance Capacity Assessment Framework (GCAF) and their main (sub-)dimensions or (sub-)characteristics are defined in this annex. The theoretical framework provided the literary support for the GCAF in a more general sense, or in other words, the rationale for assessing the (adaptive) capacity of urban

water governance systems with the GCAF-methodology. Here, the specific indicators that are used in this research are provided, as well as their definitions and the ways to measure them. Indicators are assessed on a 5 point-scale that runs from a "double minus" (or --) to "double plus" (or ++), where "double minus" corresponds with a certain governance capacity or policy being a very limiting encouragement of the transition towards water-wise cities and climate adaptive cities, and "double plus" corresponds with a certain governance capacity or policy being very encouraging of the transition towards water-wise cities and climate adaptive cities (Koop, 2016 - forthcoming). These indicators were also used to formulate the questions for the interviews. In table 2A, the 9 overarching governance capacities and their definitions are given, while tables 2B until 2J show all the corresponding sub-dimensions or sub-characteristics per overarching governance capacity. In total, there are 27 indicators in this initial GCAF, divided over 9 overarching categories.

Overarching governance capacities

Governance capacity	Definition	References
Awareness	Something that is cognitively and emotionally developed within organizations who are aware of the causes, impact, scale and urgency of climate change for their core business.	Koop (2016 – forthcoming) See also: Alexander Ballard Ltd. (2008)
Useful knowledge	Useful local knowledge and information on how future trends, such as urbanization and climate change, affect the local IWRM-situation of cities and their future prospects.	Koop (2016 – forthcoming) See also: Amundsen et al. (2010)
Continuous learning	Type of knowledge transfer in which constant regular monitoring, evaluation and diagnosis is required for creating preparedness for uncertain and unexpected situations.	Koop (2016 – forthcoming) See also: Pahl-Wostl (2009)
Stakeholder engagement process	The incorporation of as many different relevant groups and parties as possible into the decision-making process, in order to maximize the availability of resources and knowledge, as well as to maximize the opportunity to develop a complete problem	Koop (2016 – forthcoming)

	framing and comprehensive solutions. Engagement consists of two dimensions: inclusiveness, or the opportunity for stakeholders to be involved, and empowerment, or the extent to which stakeholders can influence the outcome of a decision-making.	
Policy ambition	Shaping of local policy approaches in such a way that they are integrated throughout and across governance levels and between organizations, with objectives that are long-term, but with short- and mid-term measurable targets, as well as with the goal of creating a shared narrative and the possibility to resolve conflicts through dialogue and inclusion.	Koop (2016 – forthcoming)
Agents of change	Notion of decision-making responsibility that engages the intrinsic motivation of people, rather than more traditional means of coercion or monetary incentives	Koop (2016 – forthcoming)
Multi-level network potential	Approach to cooperation in which many different stakeholders and institutions with different interests and perspectives are involved. The incorporation of which are essential for tackling water challenges under increasing pressure of climate change and urbanization, as these are problems with high uncertainties, complex relations and many stakeholders involved.	Koop (2016 – forthcoming)
Financial viability	The possibility of continuous financial support of water governance measures by effectively and clearly addressing the costs and benefits of these measures and creating a fair balance between those two and also between revenue and affordability for the poorest in society	Koop (2016 – forthcoming)
Implementing power	Intelligent mixture, that is appropriate for the local context, between policy instruments, legal compliance and the development of action plans, to successfully put a new policy	Koop (2016 – forthcoming)

	in place.	<u>See also:</u> • Müller & Siebenhüner (2007) • Van Rijswick et al. (2014)

<u>Awareness</u>

Characteristic	Definition	References
Community knowledge	Principle that a certain idea, value or belief is made an integral part in one's activities and identity by learning or (unconscious) assimilation and action, at local institutions or organization having to do with IWRM (rather than on an individual level).	Koop (Forthcoming) <u>See also:</u> Alexander Ballard Ltd. (2008)
Local support	Measure of the extent to which the general public (opinion, perception) supports the transition towards more adaptive governance. Coverage of issues in the media or organizations addressing issues in the public sphere can be of strong influence on the shaping of the political agenda	Koop (Forthcoming)
Internalization	Extent is sustainable behaviour per theme part of the community, organizations and institutions within the urban network, by learning assimilation and action?	Koop (Forthcoming)

<u>Useful knowledge</u>

Characteristic	Definition	References
Information	Assessment of whether the knowledge available	Koop (2016 –

availability	covers all relevant sectors, ranging from community knowledge to scientific knowledge, short-term and long-term predictions, and extensive and applicable knowledge regarding alternative solutions. This is necessary to ensure decisions are well-informed.	forthcoming) See also: • Lockwood et al., (2010) • Ford & King (2013) • Van Rijswick et al. (2014)
Cohesion	The conformity of the knowledge available across actors, sectors and administrative layers.	Koop (2016 – forthcoming)
Accessibility	Assessment of whether the knowledge available is effectively shared to all interested and relevant stakeholders.	Koop (2016 – forthcoming)

Continuous learning

Characteristic	Definition	References
Smart monitoring	Assessment of to what extent actions, interactions and outcomes are monitored during the processes of decision making and adaptive governance, if this information is useful and if it is used to improve current management and policy.	Koop (2016 – forthcoming)
Evaluation	Assessment of whether progress and barriers are evaluated so that trends, processes and future challenges can be identified and understood. Or in other words, the consciously and continuously questioning by actors of the whether they 'are doing the right thing.'	Koop (2016 – forthcoming) See also: Pahl-Wostl (2009)
Cross-stakeholder	Assessment of the extent to which interactions between actors occur which facilitate a type of	Koop (2016 – forthcoming)

capacity building	learning, in which not only the justification of a current paradigm is questioned, but also assumptions, key relationships, world views and underlying norms and values.	See also: Pahl-Wostl (2009)

Stakeholder engagement process

Characteristic	Definition	References
Inclusiveness	Measurement of the level to which relevant stakeholders are able to be part of the decision-making process (i.e. inclusiveness), as well as of the transparency of these decisions and decision-making processes.	Koop (2016 – forthcoming) See also: • Lockwood et al. (2010) • Van Rijswick et al. (2014)
Protection of core values	Measurement of the extent to which stakeholders feel confident that their core values will not be harmed, by assessing if commitment is focused on the process instead of the results, if stakeholders have exit possibilities at given moments, and if stakeholders are respected during the process.	Koop (2016 – forthcoming)
Progress and choice variety	Assessment of the variety of alternatives that is produced by all relevant stakeholders, as well as a measurement of the choice selection that is made at the end of the process and whether that ensures cooperative behaviour and optimal choices that can effectively be implemented.	Koop (2016 – forthcoming)

Policy ambition

Characteristic	Definition	References
Ambitious and realistic goals	Measurement of whether goals are ambitious; whether there is a long-term vision in city policies; and if this long-term vision is put effectively into practice by a cohesive package of short-term and intermittent targets.	Koop (2016 – forthcoming)
Discourse embedding	Assessment of the extent to which sustainable policy is included in historical and current policy and the most important institutions.	Koop (2016 – forthcoming)
Cohesive policy	Assessment of the cohesiveness of, on the one hand, policies that shape urban water management which are the water policies itself, and on the other hand, policies that shape urban water management that are related to other related sectors.	Koop (2016 – forthcoming)

Agents of change

Characteristic	Definition	References
Visionary leadership	Assessment of the extent to which there are leaders that envision long-term solutions and steer activities towards results promoting local solutions for water issues and addressing climate adaptation.	Koop (2016 – forthcoming)
Entrepreneurial leadership	Assessment of the extent to which entrepreneurial leaders enable action towards sustainable urban water management and governance.	Koop (2016 – forthcoming)
Collaborative leadership	Assessment of the extent to which collaborative leaders enable coalition forming, which is necessary to enable effective solutions that have the support of all relevant stakeholders.	Koop (2016 – forthcoming)

Multi-level network potential

Characteristic	Definition	References
Room to	Assessment of the extent to which actors in the urban	Koop (2016 –

manoeuvre	water network have the freedom and opportunity to develop a variety of approaches (as this variety is necessary to effectively address complex problems of water governance).	forthcoming)
Clear division of responsibilities	Assessment of the extent to which (water) challenges are or can be addressed by two or more cooperative partnerships. Complex problems of water governance transcend administrative and sectoral boundaries, have to deal with a great deal of uncertainty and variety, and must therefore also be approached as such.	Koop (2016 – forthcoming)
Authority	Assessment of the extent to which issues of urban water governance and climate adaptation are being addressed in existing institutional structures and implemented policy.	Koop (2016 – forthcoming)

Financial viability

Characteristic	Definition	References
Affordability	Assessment of the extent to which the water services and climate change adaptation are affordable.	Koop (2016 – forthcoming)
Willingness to pay	Assessment of how expenditures on water and climate adaptation by policy-makers are perceived by other stakeholders, and whether these expenditures are (according to the other stakeholders) considered transparent and accountable enough to create a trustful environment among stakeholders and policy-makers. This trustful environment is necessary for stakeholders to be encouraged to invest in certain policies.	Koop (2016 – forthcoming) See also: Lockwood et al. (2010)
Financial continuation	Assessment of the extent to which water services are financially secured for the long term.	Koop (2016 – forthcoming)

Implementing capacity

Characteristic	Definition	References
Policy instruments	Measurement of the robustness of policy-measures that are taken to incentivize sustainable action (such as subsidies or emission charges), in terms of the proportion of agency that is left over for certain stakeholders after implementation. In the example of the emission charges, the policy instrument is weak when it is still more profitable for stakeholders to just pay the emission charges instead of reducing their emission. In the example of subsidies, the policy instrument is weak if the subsidies are not enough to persuade stakeholders to undertake more sustainable action.	Koop (2016 – forthcoming)
Legal compliance	Assessment of the extent to which actors comply targets and standards and the extent to which norms are met.	Koop (2016 – forthcoming)
Preparedness	Assessment of the existence and adequacy of action plans and emergency protocols.	Koop (2016 – forthcoming)

Annex 3: Example of interview guide – questions for all stakeholder categories*

***Transcripts of all interviews conducted for all stakeholder categories are available on demand. Please contact: schreurse01@gmail.com**

Before start

Everything you say will be processed anonymously, but if you apart from that wish to not answer any question I ask, you are free in your choice.

Do you have any objection to me recording this interview? (it will be deleted after transcription).

----- *start recording* -----

Can you please state your age, education and the neighbourhood you live in?

Awareness

Community knowledge/stakeholder internalization

Do you think it is a realistic thought that within 5 or 10 years from now Quito could have shortages of water?

Do you think people think about their own water and energy consumption?

Do you think citizens in Quito are aware of possible future issues of water scarcity?

Local/public support

Do you think it is important that people think about their water consumption?

Does possible water scarcity worry you? What aspects worry you the most?

Do you think current measures are adequate, or do you think action is necessary?

Do you think the government is aware of or concerned with the troubles that are there?

Do you think citizens are aware of or concerned with the troubles that are there?

Useful knowledge

Data completeness/Information availability // Accessibility

Do you feel you have sufficient information to achieve your objectives regarding water scarcity prevention?

What data is collected regarding water scarcity prevention? How is that data managed?

Are new technologies of water regulation and prevention of scarcities researched?

How can one access data about water quality and usage?

Is the information about water quality and about methods to prevent water scarcity (for now and for future plans) publically available or communicated to citizens?

Cohesion

How do you perceive knowledge exchange with other organizations?

Continuous learning

Smart monitoring

Would citizens be asked to provide suggestions for improvements?

Does that ever really happen?

Do you think it is helpful for the government or *Agua Quito* to ask citizens when evaluating methods of prevention of water scarcity? Do you think it would ever happen?

Are you, as an organization, ever asked to give your opinion or provide suggestions?

Evaluation

How often are processes/policies evaluated?

What do you consider unacceptable? In terms of water scarcity as well as quality.

Which actors perform an evaluation and is that in turn reviewed also?

How is data from water quality and quantity used to develop policy?

Cross-stakeholder capacity building

Are there any stakeholders involved in an evaluation? If so, which ones?

How do you process cross-stakeholder feedback?

Do you feel that other actors value your perspectives?

Multi-level network potential

Room to manoeuvre

Do you get enough room from the government to find and propose your own ideas and solutions to prevent water scarcity?

Do you feel that you have adequate time and resources to develop new ideas?

To what extent can you act on spotted (unplanned/short-term/sudden) opportunities?

Cooperative power/clear division of responsibilities

Do you feel that responsibilities are clearly defined and divided?

Are you aware of the responsibility of others?

Do you cooperate with a lot of different parties in trying to tackle issues of future water scarcity?

Do you have the impression that the government or *Agua Quito* cooperates with a lot of different parties in trying to tackle the problem?

Have they, for example, ever cooperated with citizens (like you)?

Political power/authority

Is the government approachable and prepared to join collaborations?

Are other large parties approachable and prepared to join collaborations?

Have past collaborations been decisive?

Do you think the current collaboration has enough authority to overcome conflicting interest?

Stakeholder engagement

Openness/inclusiveness

[to affected stakeholders]

Have there been examples in which you (or other citizens) been involved in the decision-making process regarding recent projects? And you as an organization?

Protection of core values

Do you feel that your perspectives are respected?

Progress and choice variety

[Experiences of previous engagement efforts by both initiator and affected]

Do you think there is any progress in the running projects?

How is stakeholder input managed?

Do you feel that you are given sufficient choices in how you want to participate?

Would you, if asked, participate in subsequent stages to give your input? Or not? Why?

Agents of change/leadership

Is there one clear leader, that tries to tackle the problems that are there and in running the projects? Does he show good leadership? Why (not)?

Collaborative leadership

Is there a team or individual that created collaborations at some point in the project?

Entrepreneurial leadership

Is there a team or individual that recognized opportunities at some point in the project?

Visionary leadership

Is there a team or individual that the projects vision?

Are there actors that have the ability to produce and communicate a sustainable vision?

Policy ambition

Ambitious and realistic goals

Is there ambition among the government and other relevant institutions to tackle future issues of water scarcity?

Do you think the goals are realistic?

Is there a long-term vision?

(discourse) embedding

How is the current policy communicated towards citizens?

How are future plans for policies communicated towards citizens?

Do you think the policy fits the local context? How do you think local values and beliefs are incorporated in policy?

Cohesive policy

What do you feel about the cohesiveness between policies? i.e. are policies based on (different facets of) knowledge and are these different fields of knowledge linked to each other?

Financial viability

Affordability

Do you feel like the water service at this point is affordable, for everyone?

Do you feel like adaptation measures that are being (to anticipate on future water scarcity) taken are affordable, for everyone?

Willingness to pay

Are there taxes for water quality, usage and treatment? How high are they?

Do you think current expenditures on these areas are adequate?

Who should pay for new measures?

Do you think, despite extra costs, future water scarcity should be anticipated on and addressed?

Would it be good to invest in measures that regulate water use?

Are you satisfied with current pricing of the existing services to ensure quality and usage?

Would you accept a price increase?

Would you accept a price increase if that means that additional benefits are created? For example the inclusion of a wastewater treatment system, or better measures to ensure water quality (and therefore counter water scarcity)?

Financial continuation

Do you think financial continuation is guaranteed at this moment, when looking at the current plans and projects?

Do you feel that there is adequate financial security to maintain a long-term perspective?

Implementing capacity

Policy instruments

Do you feel that there are sufficient subsidies (positive) or incentives (negative, limits etc.) for regulation of water usage, reduce pollution, increase water quality or other methods to battle future water scarcity? For industries/companies etc., but also for individual households?

Legal compliance

Are there legal restrictions or obligations regarding water usage (e.g. a restriction on the use of water above a certain quantity)? For companies? For individual households?

[if answer an previous question is yes]: how are they monitored and are they enforced regularly? If violations are common, how could that be?

Are there legal restrictions or obligations regarding wastewater risks (e.g. ban on the use of certain substances, to prevent them from ending up in the river/sewer later on?

[if answer an previous question is yes]: how are they monitored and are they enforced regularly? If violations are common, how could that be?

Action plans/preparedness

What further actions can the government *or Agua Quito* take to prevent or improve poor water quality? And to regulate water usage?

Are there implementation plans for long-term projects regarding water quality, usage/scarcity?

Is there an action plan for when water scarcity would actually happen? A plan of emergency of some sort?

General:

Is there anything that has not been covered until now, that you would like to add?

Do you perhaps know other people who would like to participate in a similar interview?

Annex 4: Construction of GCAF-capacity levels

This appendix provides the capacity levels specified for each characteristic into (--) very limiting, (-) limiting, (0) neutral, (+) encouraging and (++) very encouraging the transition towards water-wise and climate adaptive cities

1 Awareness

Awareness refers to the understanding of causes, impact, scale and urgency of wicked water problems. It consists of three dimensions: *community knowledge, local support* and *internalization.*

GC1.1: **Community knowledge**

Ignorance	The community and decision-makers are unaware of the water challenge. This is demonstrated by the absence of articles on the issue in newspapers, on websites or action groups addressing the issue
Fragmented knowledge	Only a small part of the community recognizes the risks related to the water challenge. The most relevant stakeholders, have limited understanding of the water challenge. As a result, the issue is hardly or not addressed at the local governmental level
Underestimation	Most of the community understand the water challenge, However the risks, impacts and frequencies are often not fully known. Future risks, impacts and frequencies are often unknown. Some awareness has been raised at the local level
Overestimation	The community is knowledgeable and recognizes the existing uncertainties. Consequently, they often overestimate the impact and probability of occurrence of incidents or calamities. The water challenge has been raised at the local political level and policy plans are developed, partly as a result of this community knowledge
Balanced awareness	Nearly all members of the community are aware of and understand the actual risks. The community has addressed the water challenge at the local level. It is familiar with or is involved in the implementation of adaptation measures

GC1.2: Local support

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

GC1.3: Internalization

Unawareness	There is unawareness of the water challenge with hardly any understanding of causes and effects or how current practices impact the water challenge, the city or future generations
Recognition mainly by	The water challenge is partly recognized, mainly due to external pressure instead of intrinsic motivations. There is no support to investigate its origin

external pressure	or to proceed to action or change current practices
Exploration	There is a growing awareness, often as a result of local, exploratory research regarding the causes and solutions of the water challenge and the implications of current practices for longer time periods
Moderate internalisation	Awareness has evolved to mobilization. There are various incentives for actors to change current practices and approaches regarding the water challenge. The water challenge, however, is not yet fully integrated into strategy, practices and policies
Full internalisation	Actors are fully aware of the water challenge, their causes, impacts, scale and urgency. The water challenge is integrated into long-term and joint strategy, practices and policies. Other actors are encouraged to participate. At this point, the water challenge is integrated into everyday practices and policies

2 Useful knowledge

This condition describes the qualities of information with which actors have to engage in decision-making. This condition consists of three characteristics, i.e., *information availability*, *accessibility* and *cohesion*.

GC2.1: Information availability

Lack of information	No information on the water challenge can be found. Or the scarce available information is of poor quality
Information scarcity and limited quality	Limited information availability that does not grasp the full extent of the water challenge. In some cases not all information is of sufficient quality to generate a comprehensive overview
Information meets short-term requirements, limited exploratory	Information on the water challenge is available. Knowledge on understanding or tackling the water challenge is progressing and is produced in a structural way, whereas gaps are hardly identified. This is apparent from the quantity of factual information, but the theories on causes

research	and impacts and long-term processes are lacking
Information enhancing integrated long-term thinking	Information on the water challenge is made available from various sources. Information gaps are identified and attempted to bridge. This is clear from extensive documentation on the long-term process. Strong effort is put in integrating fragmented information that is relevant for the water challenge. Not all sustainability pillars may be accounted for. Knowledge from citizens is increasingly taken into account
Comprehensive information enabling long-term integrated policy	A comprehensive and integrated documentation of the issue can be found on local websites and policy papers. It is characterized with adequate information, an integrated description of social, ecological and economic processes regarding the water challenge, and goals and policies. Furthermore, progress reports on effective implementation can be found

GC2.2: Accessibility

Not transparent and inaccessible knowledge	Information is limitedly available and shared. Sometimes sharing is discouraged. Available and accessible information is difficult to understand. The water challenge is not addressed on local websites or mentioned by the local authorities
Low sharing of fragmentized knowledge	Information is sometimes shared with other stakeholders. However, information is inaccessible for most stakeholders. Furthermore, knowledge is often technical and difficult to understand for non-experts. The water challenge may be addressed on local websites or mentioned by local authorities
Sharing of non-communicative specialized knowledge	There are protocols for accessing information; however, it is not readily available. Although information is openly available, it is difficult to access and comprehend because it is very technical. The water challenge is reported on local websites and reports
Sharing of partly cohesive knowledge	All interested stakeholders can access information. Action has been taken to make knowledge increasingly understandable. Still, it is a time-consuming search through a maze of organizations, protocols and databases to abstract

	cohesive knowledge and insights
Sharing of cohesive knowledge enables active citizen engagement	Information is easily accessible on open source information platforms. There are multiple ways of accessing and sharing information. Information is often provided by multiple sources and is understandable for non-experts

GC2.3: Cohesion

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

3 Continuous learning

Continuous learning is essential as it provides stability and guidance in a transition towards adaptive, multi-level governance with respect to the required changes in practice, basic assumptions and fundamental beliefs, world views. Continuous learning is strongly based on the multiple-loop learning theory. This condition consists of the following characteristics: *smart monitoring*, *evaluation*, and *cross-stakeholder capacity building*.

GC3.1: Smart monitoring

Irregular, poor quality or absent	There is no system to monitor the water challenge or monitoring is irregular
Reliable data but limited coverage	Monitoring occurs, however the monitoring system does not cover all facets of the water challenge, with sometimes incomplete description of the progress and processes of technical and policy measures. Monitoring is limited to singular effectiveness or efficiency criteria and cannot identify alarming situations
Quick recognition of alarming situations	Monitoring system covers most relevant aspects. Alarming situations are identified and reported. This leads to improvement of current practices regarding the technical measures. There is only minor notification of societal and ecological effects
Useful to recognize underlying processes	The abundant monitoring provides sufficient base for recognizing underlying trends, processes and relationships. Reports of monitoring will display discrepancies between assumptions and practices. Acting upon these findings by altering the underlying assumptions characterizes the level of smart monitoring. Indicators are a reflection of goals and problem framing, a new set of guiding assumptions, change of boundaries, new system analysis approach, (other) priorities, new aspects (insights)
Useful to predict future developments	Monitoring system is adequate in recognizing alarming situations, identifying underlying processes and provides useful information for identifying future developments. Reports of monitoring will display discrepancies between fundamental beliefs and practices. Acting upon these findings by altering the fundamental beliefs indicates the highest level of learning. Indicators are a transformation of structural context and factors, resulting in: new regulatory frameworks, change of boundary and power structure, new actors in the action arena, new risk management approach etc.

GC3.2: Evaluation

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

GC3.3: Cross-stakeholder capacity building

Closed attitude towards cross-stakeholder learning	There is no contact with other parties, contact may even be discouraged. This is apparent from limited sharing of experience, knowledge and skills. No information is shared outside organisation and sector, nor is external information used
Small coalitions of stakeholders with shared interest	Interaction occurs in small coalitions based on common interests. Opinions of those outside the coalition are generally withheld. Only information for the shared point of view is sought. This is evidenced by the finding of only one perspective regarding the water challenge or few perspectives that are

	supported by means of circle-referencing
Open attitude towards stakeholder interaction	Stakeholders are open to interaction, though not much learning is going on due to the informative character of the interaction. Often, a number of stakeholders, that do not necessarily share interests or opinions, are involved in the decision-making process
Open for cross-stakeholder learning	Stakeholder interaction is considered valuable and useful for improving policy and implementation. Various initiatives for cross-stakeholder capacity building (programs) have been deployed, yet the translation into practice appears difficult. The programs may not be structural and the learning experience may not be registered and shared
Putting cross-stakeholder learning into practice	There is recognition that the water challenge is complex and that cross-stakeholder learning is a precondition for adequate solutions and smooth implementation. This is evidenced by broad support for policy measures and implementation. Moreover, continuous cross-stakeholder capacity building programs are in place and may be even institutionalized

4 Stakeholder engagement process

Stakeholder engagement is required for common problem framing, gaining access to a wide variety of resources and creating general support that is essential for effective policy implementation. Stakeholder engagement consists of three characteristics, i.e., *inclusiveness, protection of core values,* and *progress and choice variety.*

GC4.1 Inclusiveness

Limited information supply	No stakeholders are included, or few. Information cannot be found on the extant decision-making process. Stakeholder engagement may even be discouraged
Non-inclusive information supply	Not all relevant stakeholders are informed and sometimes consulted. Procedure for stakeholder participation is unclear. If involved, stakeholders have but little influence
Untimely consultation and	Stakeholders are mostly consulted or informed. Decisions are largely made before engaging stakeholders. Frequency and time-period of stakeholder

low influence	engagement is limited. Stakeholder engagement is characterised by ad hoc meetings, expert panels, focus groups, shareholding, consultations in regulatory process
Timely, over-inclusive and active involvement	Stakeholders are actively involved. It is still unclear how decisions are made and who should be involved. Often too many stakeholders are involved. Some attendants do not have the mandate to make arrangements. Stakeholder engagement is characterised by broad and specific themed conferences, workshops, surveys, and online-platforms, resulting in abundant and overlapping information regarding the water challenge. This is evidenced by new perspectives on the water challenge, broad knowledge spectrum attending the meetings
Transparent involvement of committed partners	All relevant stakeholders are actively involved. The decision-making process as well as opportunities for stakeholder engagement are clear. Stakeholder engagement is characterised by local initiatives specifically focussing on water such as local water associations, contractual arrangements, regular meetings, assemblies, workshops, focus groups, citizen committees, surveys and hotlines

GC4.2 Protection of core values

Insufficient protection of core values	Because stakeholders are hardly engaged or even informed, core values are being harmed. Implementation and actions may be contested in the form of boycotts, legal implementation obstructions and the invoking of anti-decision support. Other indications of this level are distrust, absence of participation or exits during the decision-making process
Non-inclusive and low influence on results	The majority of stakeholders is engaged, but the level of engagement is low (informative or consultative at best). There is very low influence on the result. Resistance may be invoked, for example on internet platforms and newspapers
Suboptimal protection of core values	Because stakeholders are consulted or actively engaged for short periods, alternatives are insufficiently considered. Influence on end-result is still limited. Decisions comply with the interests of the initiating party primarily. There often is no clear exit strategy at this level in the stakeholder participation process
Requisite for early commitment to	Stakeholders are actively involved and expected to commit themselves to the outcome early in the process. Hence relevant stakeholders may be

output	missing in contractual arrangements as they do not want to commit themselves to decisions to which they have not yet contributed. At this point involved stakeholders have influence on the end-result and therefore the output serves multiple interests
Maximal protection of core values	Stakeholders are actively involved and have large influence on the end result. There are clear exit possibilities and so stakeholders are more committed to the process. The participation opportunities and procedure of implementation are clear. All relevant stakeholders are part of the decision-making process

GC4.3 Progress and choice variety

Lack of procedures limit engagement and progress	The lack of clear procedures hinder stakeholder engagement. This unilateral decision-making limits progress and effectiveness of both decision-making and implementation. It might result in conflicting situations. Often, much resistance can be found online and implementation may be obstruct
Rigid procedures limit the scope	Informative and consultative approaches, according rigid procedures with low flexibility. The period of decision-making is short with a low level of stakeholder engagement. These unilateral decision-making processes may lead to slow and ineffective implementation. The latter can be observed from critique via public channels
Consultation or short active involvement	There is a clear procedure for consultation or short active involvement of stakeholders, but the opportunities to consider all relevant alternatives is insufficient. Decisions are therefore still largely unilateral and solutions suboptimal. Unilateralism serves one interest specifically. The suboptimal character of a solution can become apparent from evaluations or comparisons with similar situations
Active involvement with abundant choice variety	Stakeholders are actively involved and there is sufficient room for elaborating alternatives. Procedures, deadlines and agreements are unclear. There is no or few specification on deadlines in terms of dates. Due to inexperience decisions are taken too early in the process leading to the exclusion of argument and solutions. Decisions may therefore not enjoy full support
Active engagement with choice	There is active engagement of all relevant stakeholders and clarity of participation procedure and realistic deadlines. The range of alternatives is

selection at the end of the cooperation	fully explored and selection of the best alternatives occurs at the end of the process. Reviews of stakeholder meetings provide the alternatives addressed. Stakeholders are engaged throughout the whole process as specified in contractual agreements

5 Policy Ambitions

Policy ambitions assesses if current policy is ambitious, feasible, well-embedded in local context and it forms a cohesive set of long-term and short-term goals within and across sectors. Rules and agreements that are based on shared values and principles are easier to enforce because parties have the strong conviction that they should behave in conformity with the rules. The feasibility of goals depend on the available capacity and resources. Ambitious goals are set that exploit the full potential to tackle the water-related challenge at hand by means of a set of cohesive long-term, mid-term and short-term goals. Policy ambitions consists of three characteristics, i.e., *ambitious and realistic goals, discourse embedding*, and *cohesive policy*.

GC5.1 Ambitious and realistic goals

Short-term, conflicting goals	Goals consider only contemporary water challenges and are short-sighted. Goals lack sustainability objectives. Goals are arbitrary and sometimes conflicting, causing reoccurring issues. Character of policy is predominantly reactive
Short-term goals	Actions and goals are better coordinated. Actions and goals are "quick fixes" mainly, not adhering to a long-term vision or sustainable solutions. Uncertainties and risks are largely unknown
Confined realistic goals	There is a confined vision regarding the water challenge. Its ambition is predominantly focused on improving the current situation where predictability, unchanging conditions, is assumed. Evidence is the lack of risk assessments and scenarios
Long-term ambitious goals	There is a long-term vision that incorporates uncertainty. However, it is not supported by a comprehensive set of short-term targets. Hence, achievements and realistic targets are difficult to measure or estimate. Visions are often found online as an organisation's strategy. These visions often entail a description of the water challenge or outlook as motivation

	for the approach of the organisation
Realistic, ambitious strategy	Policy is based on modern and innovative assessment tools and policy objectives are ambitious. Support is provided by a comprehensive set of intermittent targets, which provide a clear and flexible pathway. Hence, assessment tools, scenarios and tipping points must be specified in documents

GC5.2 Discourse embedding

Unsuitable policy and implementation	Cultural, historical and political context and history is largely ignored, leading to arduous policy implementation. Actors may not understand the scope or moral of the policy or may not understand to whom it applies or where to start the implementation (confusion)
Persistent reluctance and poor embedding	Actors feel reluctant to execute current policy as it conflicts with their norms and values. Policy hardly takes the local context and existing discourses into account. And the policy does not correspond with societal demands. This may lead to distrust between actors, inefficient use of resources and ineffective overall implementation
Problem framing and embedding	Current policy fits the local context, but hardly improve the city's adaptability to the water challenge. The water challenge is increasingly identified, framed and interwoven into local discourse, but the disregard of uncertainty prevents a sense of urgency that is necessary to adopt adequate adaptation measures. Decision making often results in very compromised small changes that fit into the current short-term policy focus
Consensus for sustainable actions	There is a consensus that adaptation is required, but substantial effort is necessary as there is little experience in addressing the water challenge in a long-term integrated approach. Furthermore, opposing interests and problem framing need to be solved. This is evidenced by long decision-making periods, often trust relations with new unconventional partners need to be built
Embedding of sustainable implementations	Local context is used smartly to accelerate policy implementation. Innovations are subdivided into suitable phases which are more acceptable and effectively enables sustainable practices. Effective policy implementation is enabled by a general consensus that long-term integrated policy is needed to address the water challenge and deal with uncertainty

GC5.3 Cohesive policy

Incompatible policies	Policies between and within sectors are strongly fragmented and conflicting. This is evidenced by contradicting objectives and the squandering use of resources
Opposing sectoral policies	Overall water and climate adaptation policy is characterised by fragmentation and imbalance between sectors. The majority of resources is spent on the dominant policy field and overlap between sectors lead to inefficient use of resources
Fragmented policies	Policy is fragmented and based on sector's specific scope and opportunities for co-benefits are not explored. However, effort is made to balance the resource allocation between sectors
Overlapping comprehensive policies	There is cross-boundary coordination between policy fields to address water challenges. Policies are comprehensive, but have not yet resulted in a broad thematic multi-sectoral approach. Efforts to harmonize different sectors are evident from employee – functions or assignments and protocols
Cohesive synergetic policies	Policies are coherent and comprehensive within and between sectors. There is an overarching vision resulting in smooth cooperation. Goals are unitedly formulated, evaluated and revised to adapt to new challenges. This is evidenced by thematic approaches instead of sectoral, many inter-sectoral meetings, interdisciplinary reports and cohesiveness in goals and strategies formulated

6 Agents of change

In order to drive change, agents of change are required to show direction, motivate others to follow and mobilize the resources required. Agents of change consists of *entrepreneurial, collaborative* and *visionary agents.*

GC6.1 Entrepreneurial

Insufficient	Ignorance for risk and threats leads to ineffective rigid governance and

entrepreneurship	lack of opportunity for entrepreneurial agents to enable improvements. Moreover, distrust by other actors and potential investors, further decrease access to resources
Room for short-sighted entrepreneurship	Agents of change struggle to gain access to sufficient resources to address imminent or short-term water challenges. Risks are often not acknowledged. Windows of opportunity to identify and to act upon perceived risks are limited. Opportunities to address stakeholders with potential access to resources are rarely seized
Conventional and risk-averse entrepreneurship	Entrepreneurial agents of change are better able to seize low-risk opportunities. Therefore opportunities for innovative approaches and synergies are not pursued. Small changes can be recognized
Tentative experimental entrepreneurship	There is a growing understanding of the water challenge's uncertainty, complexity and need for innovative approaches that entail a certain level of risk. Tentative experimental projects set in but are paid by conventional resources. Projects are small-scale pilots
Long-term support for entrepreneurship	There is recognition of the need for continuous innovation, hence applied research is enabled that explores future risk management and supports strategy formulation. The experiments yield increased benefits and new insights. This is recognized by other actors, thereby providing access to new resources. Continuous experimentation is supported by long-term and reliable resource allocation

GC6.2 Collaborative

Lack of collaborative agents	Collaboration is discouraged, because there is a very strong hierarchical structure or even personal interest. There is distrust between stakeholders and the willingness and opportunity to initiate collaboration are limited
Insufficient opportunity for collaborative agents to set up collaboration	There is insufficient opportunity for agents of change to go beyond conventional collaboration. The current collaborations are deemed sufficient to deal with the water challenge whereas the vision limited
Agent are enabled to enhance	Traditional coalitions are preserved to maintain status quo. There is trust within these coalitions. There is limited space to create new collaborations

conventional collaboration	(including new composition of actors). If new collaboration occurs solutions are still mostly sectoral and short- to mid-term
Agents of change push for collaboration between new stakeholders	There is an understanding that wicked water challenges require long-term, integrated solutions. Hence, wide-spread collaborations between a variety of stakeholders and sectors are being established. New collaborations with unconventional actors, result, more and more, in valuable new insights and effective networks
Agents of change strongly enhances wide-spread synergetic collaboration	There is ongoing build-up of productive and synergetic collaborations. Facilitators may even be administered to coordinate this through mediation and authority. There is a conception of the ideal collaboration composition

GC6.3 Visionary

Deficient sustainability vision and short-term thinking	There is a lack of visionary agents that promote change towards a long-term, sustainable vision regarding the water challenge. Diverging expectations and objectives of stakeholders are the result. This may be evidenced by indecisiveness or even conflicts. Long-term and integrative initiatives may also be blocked
Unilateral and short-term vision	There is a unilateral vision regarding the water challenge, which benefits only a small groups of actors. The vision often has a short-term focus, with a maximum of 3 to 4 years
Defense of status quo	The visions of the existing agents of change are limited to promoting the business as usual. They do not oppose nor promote long-term, integrative thinking. There is probably no attention to or employment in trend analysis
Long-term vision with flawed communication	There is a clear long-term vision that considers the interests of most sectors and stakeholders. There is still some discrepancy between short-term targets and implementation strategies on the one hand and the long-term vision from visionary agents of change on the other hand. This means that agents are not always clear in their formulation regarding the effect and impact of envisioned strategy
Long-term vision supported by	Visionary agents of change in different positions and with different backgrounds actively and successfully promote a sustainable and tong-term

short-term targets receiving much approval	vision regarding the water challenge, that is communicated clearly throughout the entire multi-level network. Short-term targets seamlessly fit the long-term vision. There is employment in trend analysis and these actors are consulted. There are sectoral and inter-sectoral meetings to formulate short-term targets to support long-term goals

7 Multi-level network potential

Urban governance involves a plethora of actors and interests from all levels of government, organizations and (private) stakeholders. For sustainable solutions, working in networks is inevitable. To exploit the full potential of progression networks need a certain level of autonomy, legitimacy and authority. Multi-level network potential consists of three characteristics, i.e., *room to manoeuvre, clear division of responsibilities*, and *authority*.

GC7.1 Room to manoeuvre

Strictly imposed obligations	The actions of stakeholders are strictly controlled and there are rigid short-term targets. Freedom to form ad hoc fit-for-purpose partnerships is strongly limited. Actor network composition is fixed and small. There are no resources made available for exploring alternatives that might be more effective or efficient whereas many actors that are affected by the water challenge do not have a voice
Limited autonomy	Only a few actors receive some degree of freedom, there are limited opportunities to develop alternatives, and there is hardly any opportunity to form partnerships with unconventional actors
Limited room for innovation and collaboration	Actors are given the means to perform predefined tasks for dealing with problems that are framed with a narrow, short-term and technical-oriented scope. There is limited room to deviate. Solutions are sought in own sectoral field and expertise
Redundancy to address uncertainty	There is recognition that a high degree of freedom is necessary to deal with complex situations in the form of experiments and looking for new unconventional collaborations. There is a dynamic mix of cooperative partnerships and a redundant set of diverging alternative solutions. A clear overall vision to steer research is however lacking

Freedom to develop innovative solutions	There is a common and accepted long-term vision for dealing sustainable with the water challenge. Within the boundaries of this vision, actors are given the freedom to develop novel and diverse approaches and partnerships, resulting in continuous improvements and exploration. These partnerships are most likely institutionalized

GC7.2 Clear division of responsibilities

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

GC7.3 Authority

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

8 Financial viability

Sufficient financial resources are crucial for good water governance. Willingness to pay for water challenge adaptation services is important to gain access to reliable funding for long-term programs. At the same time, water and climate adaptation services need to be affordable for everyone including poor people or people being disproportionally affected. This condition consists of three characteristics, i.e., *affordability, willingness to pay* and *financial continuation*.

GC8.1 Affordability

Unaffordable basic water services	Basic water services are not affordable or even available for a substantial part of the population. This may be due to inefficient or obsolete infrastructure, mismanagement or extreme poverty
Limited affordability of basic water services	A share of the population has serious difficulty to pay for basic water services including neighbourhoods with low-income or marginalized groups. There is hardly any social safety net regarding water services, let alone for climate adaptation measures
Unaffordable climate adaptation	Basic water services are affordable for the vast majority of the populations, however poor people and marginalized communities have much difficulty to afford climate adaptation measures to protect themselves against impacts of extreme heat, flooding or water scarcity. Sometimes, priority is given to the economic relevance of climate adaptation measures instead of access to climate adaptation services for everyone
Limited affordable climate adaptation	Serious efforts are made to support climate adaptation for everyone, including vulnerable groups. There is recognition that poor and marginalized communities are disproportionately affected by effects of climate change. Human rights and equity principles are embraced and fully recognized. This is increasingly reflected in policy and regulation
Climate adaptation affordable for all	There are programs and policies that ensure climate adaptation for everyone. This includes both public infrastructure and private property protection. The solidarity principle clearly percolates in policy and regulation

GC8.2 Willingness to pay

Mistrust and resistance to financial decisions	There is a high level of mistrust in decision making regarding resource allocation. At this level financial decisions are based on prestige projects, projects that benefit a small group of actors or assist limited interests. As expenditures often do not address the actual urban water challenges, there is a high degree of resistance regarding resource allocation
Fragmented willingness to pay	Willingness to pay for measures addressing water challenges is fragmented and insufficient. The importance and risk of the water challenge is perceived differently by the stakeholders. This may be clear from media

	attention given to the water challenge. Generally, the perceived required investments to address the water challenge in substantially lower than the actual costs
Willingness to pay for business as usual	There is support for the allocation of resources for conventional tasks. There is limited awareness or worries on the water challenge and imposed future threats. Most people (both public or stakeholders are unwilling to financially support novel policies regarding the water challenge. There is sufficient trust in local authorities
Willingness to pay for provisional adaptation	Due to growing worries about challenges, there are windows of opportunity to increase funding for certain aspects regarding the water challenge. However, the perception of risk does not necessarily coincide with actual risk. Financial principles, such as polluter-pays principle, may be introduced. However due to inexperience, implementation is often flawed. Focus groups decide on priority aspects regarding the water challenge, but there is confusion regarding the extent and magnitude of the water challenge
Willingness to pay for present and future risk implementation	The water challenges are fully comprehended by decision-makers. There is political and public support to allocate substantial financial resources to address the challenges. Also expenditure for non-economic benefits is perceived as important. There is clear agreement on the use of financial principles, such as polluter-pays-, user-pays- or solidarity principle in policy implementation

GC8.3 Financial continuation

Lack of financial resources	There are insufficient financial resources available to perform basic tasks regarding the water challenge. Financing is irregular and unpredictable leading to poor policy continuation
Inequitable financial resources allocation	There are potential resources available to perform basic management tasks regarding the water challenge, but they are difficult to access, are distributed rather randomly and lack continuity. No clear criteria can be found on the resource allocation. Resources allocation is ad hoc and considers only short-time horizons
Financial continuation for	Financial resources are available for singular projects of basic services, that do not necessarily adjoin. The allocation of financial resources is based on

basic services	past trends, current costs of maintenance and incremental path-dependent development. A tool for this is a cost-benefit-analysis. Costs to deal with future water challenges are not incorporated. Limited resources are assigned for unforeseen situations or calculated risks.
Abundant financial support with limited continuation	Abundant financial resources are made available for project based endeavours that often lack long-term resource allocation or institutionalized financial continuation. Hence, long-term implementation is uncertain
Long-term financial continuation	There is secured continuous financial support for long-term climate adaptation policy, measures and research regarding the water challenge. These costs are included into baseline funding. Both economic and non-economic benefits are considered and explicitly mentioned using comparison tools

9 Implementing capacity

Implementing capacity is about the effectiveness of policy instruments with respect to the water challenge. Part of the effectiveness is also due to the level of compliance to policy and regulation and the familiarity with (calamity) action plans.

GC9.1 Policy instruments

Instruments enhance unsustainable behaviour	Policy instruments may enhance unwanted or even damaging behaviour that opposes sustainability principles, e.g., discount for higher water use stimulates spilling and inefficiency. There is hardly any monitoring that can be used to evaluate or reveal the counterproductive effects of these policy instruments. Unsustainable behaviour can be intentional
Unknown impacts of policy instruments	Instruments are being used without knowing or properly investigating their impacts on forehand. The set of instruments actually leads to imbalanced development and inefficiencies. During the implementation, a persistent belief in the effectiveness of the instruments blocks learning or the recognition that the instruments do not have the intended results

Fragmented instrumental use	Policy fields or sectors often have similar goals, but instruments are not coherent and may even contradict. Overall instrumental effectiveness is low and temporary. There is sufficient monitoring and evaluation leading to knowledge and insights in how instruments work. Actors are open to look for improvements in the use of policy instruments
Profound exploration of sustainability instruments	Instruments to implement principles such as full cost-recovery and polluter-pays principle, serve as an incentive to internalize sustainable behaviour. The use of various instruments is explorative and therefore not yet optimized and efficient. The use of instruments is dynamic. There are a lot of simultaneous or successive changes and insights
Effective instruments enhance sustainable transformations	There is much experience with the use of policy instruments. Monitoring results show that the current use of instruments proves to be effective in achieving sustainable behaviour amongst almost all actors. Continuous evaluation ensures flexibility, adaptive capacity and fit-for-purpose use of policy instruments

GC9.2 Legal compliance

Poor compliance due to unclear legislation	Legislation and responsibilities are unclear, incomplete or inaccessible leading to poor legal compliance by most actors. If legislation is present it enjoys poor legitimacy. Actors operate independently in small groups. Fraudulent activities take place
Moderate compliance to incomplete legislation	The division of responsibilities of executive and controlling tasks is still unclear. Legislation is incomplete meaning that certain gaps can be misused. This stimulates autocratic behaviour. There is loss of trust in local authorities due to inconsistent enforcement typically signalled by unions or NGO's
Strict compliance to fragmentized legislation	The water sector is still fragmented, but complies strictly to well-defined fragmentized policies, regulations and agreements. Flexibility, innovations and realization of ambitious goals are limited. An activity may be penalized multiple times in different direct and indirect ways due to poor coordination and unclear divisions of roles and responsibilities
Flexible	New ambitious policies, agreements and legislations are being explored

compliance to ambitious explorations	in a "learning-by-doing" fashion. Most actors are willing to comply. Some targets may be unrealistic and requires flexibility. At this level frontrunners of the long-term climate adaptive water policies can be recognized
Good compliance to effective sustainable legislation	Legislation is ambitious and effective. There is much experience with developing and implementing sustainable policy. Short-term targets and long-term goals are well integrated leading to realistic implementation. There is a good relationship among local authorities and stakeholders based on dialogues. Implementation of policies and technical innovations succeed quite rapidly

GC9.3 Preparedness

Poor preparedness	There are hardly any action plans for dealing with (future) calamities, uncertainties and existing risks. The city is highly vulnerable. No disaster plans or resilience plans can be found
Limited preparedness	Action plans are responsive to recent calamities and ad hoc. Actual probabilities and impacts of risks are not well understood. Action plans are still unclear. Reports should be found on how the water sector dealt with recent calamities, as well as evaluation reviews
Low awareness of preparation strategies	Based on past experiences, there are action plans. Actions required are clear but awareness of existing action plans or the division of tasks is limited. The plans are not sufficient to deal with imminent calamities and gradually increasing pressures. There is recognition of the need for action plans, yet the development of action plans does not cover all water-related threats and challenges. Damage is almost always greater than expected or prepared for
Fragmented preparedness	A wide range of threats is considered in action plans. Maybe over-abundant. Plans are proactive and follow the precautionary principle. Awareness of risks is high, but action plans are scattered and non-cohesive. They may be independent or made independently by various actors. Allocation of resources, staff and training may therefore be ambiguous
Comprehensive preparedness	Long-term plans are flexible by bundling different risks, impacts and worst case scenarios. The action plans for calamities are clearly communicated, co-created and regularly rehearsed by all relevant

	stakeholders. The required materials and staff are available on short-term notice in order to be able to respond adequately. Evaluations on the rehearsals or reviews on dealing with calamities are available