



## MANAGEMENT COMPARISON OF WATER-RELATED CHALLENGES IN ASIAN CITIES: THE STUDY CASE OF WATER GOVERNANCE CAPACITY IN BANDUNG



Photo source: Settlements in Bandung. Taken from <http://intisari.grid.id/Intisari-News/Banjir-Melanda-Bandung-Banyak-Perizinan-Yang-Salah-Arah>

**Student:**

Annisa Noyara Rahmasary  
5524008

**Internship Organization:**

KWR Water Cycle Research Institute  
The Netherlands

**Supervisor:**

Prof. Dr. C.J. van Leeuwen  
S.H.A. Koop, MSc.

**Second Reader:**

dr. Carel Dieperink



Universiteit Utrecht



## Acknowledgement

*Alhamdulillah rabbil 'alamin* praise God for bestowing me to conclude this study as the last part of my master program at Utrecht University.

I would like to express my gratitude to both of my supervisors, Prof. Dr. C.J. van Leeuwen and S.H.A. Koop, for their support during the internship and thesis writing process. They trusted me to carry out the research independently while providing me with the utmost guidance and supervision. Under their encouragement, I developed myself to be more confident and critical as a researcher. We proved that poor internet connection was not a problem for communicating since this study was conducted both in The Netherlands, within the Knowledge Management Team at KWR Watercycle Research Institute and in Indonesia, along with the cooperation of Bandung City's government.

I would also like to thank twenty-two interviewees who provided me with data and information for this study. Some of them are Eka Yudhistira, Yayat Yuliana, Deni Riswandani, Hady Moelyono, Muhammad Sapari Dwi Hadian, Dadang Abdul Haris Rosidi, Deti Yulianti, Hangga Dwi Saputra, Enri Damanhuri, Christian Natalie, Prayatni Soewondo, Ayu Sukenjah, Lita Endang, Beta Paramita, and Tulus Subiedo. Also, I truly appreciate the cooperation from the members of Earth Hour Bandung and RT 3 RW 2 Cijawura subdistrict.

Personally, I owe an enormous thankfulness to LPDP (Indonesia Endowment Fund for Education) for enabling me of pursuing my dreams in the Netherlands.

Lastly, I must extend my gratitude to my family and friends for their unending love and supports during the whole master program. The results of this study are dedicated to them.

## Summary

In 2050, the urban population will comprise 86% and 67% inhabitants of the developed and developing countries, respectively (UNDESA, 2012). Population growth and urbanisation pose multifaceted challenges in cities, including water and sanitation. Inadequate water governance exacerbates these urban water challenges. Cities in developing countries often exhibit worse conditions due to larger governance gaps in their Integrated Water Resources Management (IWRM) practices. The City Blueprint® Approach can be used to identify the challenges, assess the performance, and provide options for improving urban water management. The approach comprises of three different frameworks: (a) the Trends and Pressures Framework (TPF), (b) the City Blueprint Framework (CBF), and (c) the Governance Capacity Framework (GCF).

The application of TPF and CBF in Bandung and Jakarta provided an overview of challenges and priorities of urban water management for each city. The two cities have similar social pressures coming from high urbanisation rates and low education rates, next to high pressures from flood risk and water scarcity. These pressures resulted in their Urban Water Cycle Service (UWCS) performance which focuses on the improvement of basic water services, particularly for wastewater and solid waste treatment.

In order to recognize the gaps and opportunities in the water governance, Bandung was selected to be assessed using the GCF. The city was analysed for the five water-related challenges: flooding, water scarcity, solid waste treatment, wastewater treatment, and urban heat island. The results showed several points of improvement: 1) Alleviate the monitoring and evaluation systems; 2) Improve the statutory compliance; 3) Benefit the interaction between the stakeholders; and 4) Utilize the supports from the regional and national governments. Bandung scores the highest in solid waste treatment, which is also relevant to the flooding challenge (i.e. due to drainage clogging).

The study of Bandung is relevant for the four developing Asian cities (i.e. Ahmedabad, Ho Chi Minh City, Jakarta, and Manila) since they can learn from each other as they face similar problems. The analysis of Bandung's governance capacity demonstrated that the presence of the agents of change in the government bodies could trigger changes in the science-policy interaction. The communication between the relevant stakeholders is expected to alleviate the utilization of practical science for policies.

It appears that cities with low Blue City Index (i.e. BCI of 0-2 or *cities lacking basic water services and wasteful cities*) have a large percentage of slum population compared to cities with higher BCIs. The role of civil societies who speak on behalf of the marginalized groups was highlighted. While the governance gaps still exist, the results from The City Blueprint® Approach can be used to bridge these gaps by communicating the available information to all relevant stakeholders.

# Table of Contents

Acknowledgement.....	2
Summary.....	3
Table of Contents .....	4
List of Figures.....	6
List of Tables .....	7
List of Abbreviations .....	8
1. Introduction .....	9
1.1. Urbanisation in the context of global water challenge .....	9
1.2. Problem Definition .....	10
1.2.1. The impact of urban water challenges on the society.....	10
1.2.2. Scientific understanding of urban water governance.....	11
1.3. Aim.....	14
1.4. Research Questions .....	15
2. Theoretical Framework.....	16
2.1. Urban Water Management.....	16
2.2. IWRM and Water Governance.....	16
2.3. The five water-related challenges in Bandung .....	17
3. Materials and Methods .....	19
3.1. Data Collection.....	19
3.2. Data Analysis.....	22
4. Results.....	23
4.1. The overview of water management challenges in Bandung and Jakarta .....	23
4.1.1. The trends and pressures analysis of Bandung and Jakarta.....	23
4.1.2. The city blueprints of Bandung and Jakarta .....	24
4.2. Points of improvements for Bandung’s governance capacity .....	27
4.2.1. The governance capacity analysis of Bandung.....	27
4.2.2. Recommendations for Bandung.....	36
4.3. Comparison of trends and pressures and city blueprints in six Asian cities.....	38

4.4. Learning good water governance from the study of Bandung .....	41
5. Discussion .....	43
5.1 Limitation of the methods and reliability of the results .....	43
5.2 Solid waste and wastewater challenges in an expanding city .....	43
5.3 The significance of slum population .....	45
5.4 The trend of community movement to enhance urban water governance .....	47
5.5 Water governance challenge in Asian developing countries.....	48
6. Conclusions .....	50
References .....	51
Appendix I The Stakeholder Analysis.....	57
Appendix II Governance Capacity Framework .....	60
Appendix III Justification Document of GCF Result .....	88

## List of Figures

Figure 1	The multi-level governance framework (OECD, 2015a).....	10
Figure 2	The different colours represent three categories of pressures (blue= social, green= environmental, and red= financial) in a city (Koop & van Leeuwen, 2016) .....	12
Figure 3	The BCI (Koop & van Leeuwen, 2015b) .....	13
Figure 4	The GCF result of Quito based on 26 qualitative semi-structured interviews (Schreurs et al., 2017) .....	14
Figure 5	Administrative borders of regions (cities and regencies) in the province of West Java. The area of Bandung City is highlighted in pink and pointed by the arrow (Tarigan et al., 2016).....	17
Figure 6	City Blueprint of Bandung based on 25 performance indicators. The range of scores varies from 0 (centre of the circle; low performance) to 10 (periphery of the circle; high performance). Further methodological details are provided in (Koop & van Leeuwen, 2015a).....	24
Figure 7	City Blueprint of Jakarta based on 25 performance indicators. The range of scores varies from 0 (centre of the circle; low performance) to 10 (periphery of the circle; high performance). Further methodological details are provided elsewhere in (Koop & van Leeuwen, 2015a) .....	25
Figure 8	Spider diagram of Bandung’s governance indicators for the flood risk challenge.....	27
Figure 9	Overview of Bandung’s governance conditions for the flood risk challenge .....	28
Figure 10	Spider diagram of Bandung’s governance indicators for water scarcity.....	29
Figure 11	Overview of Bandung’s governance conditions for water scarcity .....	29
Figure 12	Spider diagram of Bandung’s governance indicators for the solid waste treatment challenge.....	31
Figure 13	Overview of Bandung’s governance conditions for the solid waste treatment challenge .	31
Figure 14	Spider diagram of Bandung’s governance indicators for wastewater treatment.....	33
Figure 15	Overview of Bandung’s governance conditions for wastewater treatment .....	33
Figure 16	Spider diagram of Bandung’s governance indicators for the UHI challenge.....	35
Figure 17	Overview of Bandung’s governance conditions for the UHI challenge .....	35
Figure 18	Graphic view of City Blueprint Ahmedabad, HCMC, Manila, and Seoul .....	39
Figure 19	The Trends and Pressures Index of 62 municipalities in 32 countries. The location of six TPI values for the six Asian cities are highlighted in the red boxes.....	40
Figure 20	The Blue City Index of 62 municipalities in 32 countries. BCI values for the six Asian cities are highlighted in green.....	40
Figure 21	The Blue City Index of 61 municipalities in 32 countries. Cities in countries with slum population of >10% are highlighted in red.....	46

## List of Tables

Table 1	The changing paradigms of managing water resources in Indonesia (Fulazzaky, 2014) ...	11
Table 2	Brief description of each water-related challenge in Bandung.....	17
Table 3	The 18 indicators (and sub-indicators) for TPF application (EIP Water, 2016a) .....	19
Table 4	The 25 indicators from seven different categories for the CBF application (EIP Water, 2016b).....	20
Table 5	The 27 indicators from nine different conditions for the GCF (EIP Water, 2016c) .....	20
Table 6	Stakeholder categories and functionalities for the five water-related challenges in Bandung .....	21
Table 7	Summary of trends and pressures indicators' scores for Bandung and Jakarta .....	23
Table 8	Summary of governance capacity indicators' scores for Bandung.....	37
Table 9	Comparison of trends and pressures indicators' scores for the six cities .....	38
Table 10	The urban population in six Asian cities .....	43
Table 11	The feasibility comparison between recycling and composting treatment (Gupta et al., 2015; Zurbrügg et al., 2012) .....	44
Table 12	The percentage of urban population living in slum in 2014.....	46

## List of Abbreviations

BCI	Blue City Index
BECA	Bandung's Environment and Cleanliness Agency <i>Dinas Lingkungan Hidup dan Kebersihan (DLHK Bandung)</i>
BPWA	Bandung's Public Work Agency <i>Dinas Pekerjaan Umum (DPU Bandung)</i>
BSHALPA	Bandung's Settlements, Housing Area, Land, and Parks Agency <i>Dinas Pemukiman, Kawasan Perumahan, Pertanahan, dan Pertamanan (DPKP3 Bandung)</i>
CBF	City Blueprint Framework
CBS	Community-Based Sanitation
CRBC	Citarum River Basin Council <i>Balai Besar Wilayah Sungai (BBWS) Citarum</i>
GC	Governance Condition
GCF	Governance Capacity Framework
HCMC	Ho Chi Minh City
IAMCG	Indonesian Agency of Meteorology, Climatology, and Geophysics <i>Badan Meteorologi, Klimatologi, dan Geofisika Indonesia (BMKG Indonesia)</i>
IPTDE	Innovation Program of Territoriality Development and Empowerment <i>Program Inovasi Pembangunan dan Pemberdayaan Kewilayahan (PIPPK)</i>
IWRM	Integrated Water Resources Management
MSW	Municipal Solid Waste
NAC	National Activity Centre Pusat Kegiatan Nasional
ND-GAIN	Notre Dame Global Adaptation Initiative
OECD	Organisation for Economic Co-operation and Development
PDK	PD Kebersihan
RAP – ACC	Regional Action Plan - Adaptation toward Climate Change <i>Rencana Aksi Daerah - Adaptasi Perubahan Iklim (RAD-API)</i>
RWH	Rainwater Harvesting
TPF	Trends and Pressures Framework
TPI	Trends and Pressure Index
UHI	Urban Heat Island
UWCS	Urban Water Cycle Service
WMFPS	Waste Management and Final Processing Site <i>Tempat Pengelolaan dan Pemrosesan Akhir Sampah (TPPAS)</i>
WRMCT	Water Resource Management Coordination Team <i>Tim Koordinasi Pengelolaan Sumber Daya Air (TKPSDA)</i>
WWTP	Wastewater Treatment Plant

# 1. Introduction

## 1.1. Urbanisation in the context of global water challenge

The growing population of the world drives the higher urbanisation rates. By 2050, the urban resident will account up to 86% and 67% of the population in developed and developing countries, respectively (UNDESA, 2012). The number of megacities (population >10 million) in the world is projected to be around 37 in 2025 while three-quarters of large cities (population 5-10 million) in 2025 will be located in the developing countries (UNDESA, 2012). This brisk movement into the urban areas brings challenges that relate to the cities' dynamic such as housing, occupation, and environmental issues. The latest UN Habitat conference in Quito, Ecuador, on October 2016 (Schreurs, Koop, & van Leeuwen, 2017) resulted in the draft of the New Urban Agenda. It aims for implementing the transformative commitments to support cities' potential to achieve the future urban development (Birch, 2016; UN-Habitat, 2016). The pressing issue comes from cities in the developing countries due to their high rates of population and urbanisation's growth. Moreover, their vulnerability gets threatened from the strengthening impacts of climate change (Koop & van Leeuwen, 2016).

The growth in cities needs to be supported by the capability to provide the needs of its citizens, including water. While the urban water challenges are often associated with water supply, sanitation, stormwater and waste management; flooding and virtual water use become more relevant in the recent decades. These challenges stem from the inadequacy of the local government to regulate the demographic transition (Varis, Biswas, Tortajada, & Lundqvist, 2006). The Organisation for Economic Co-operation and Development (OECD) shares this same value by acknowledging that water crises are often primarily governance crises (OECD, 2015a). According to the OECD, urban water governance is about "doing things right" when managing *too much*, *too little* and *too polluted* water in cities and their hinterland (OECD, 2015b). Good water governance needs to adapt to changing circumstances and levels of risk so that future generations will not inherit poor decision making and implementation.

Like most developing countries, Indonesia has the characteristic of fast-growing urban areas that reinforces the challenges in the urban water governance. While the country has only one megacity, i.e. Jakarta, the expansion of other large and medium cities such as Medan, Surabaya, and Bandung also exhibit urban's classic issues. These issues include substandard settlements (slums) and disparities in basic water service and sanitation (Nastiti et al., 2013). Bandung advanced its economic growth by 7,83% per year in latest decades. This development not only attracts people and investments from other areas but also causes an emerging challenge to ensure the quality of life of its citizens (Tarigan et al., 2016). Similarly, Jakarta faces a rapid urban development. In the early 1980s, the government attempted to create a planning policy to govern the expansion, but it failed when the urbanisation is further driven by the economic bubble and prevalent policies (Douglass, 2010). Although these socioeconomic factors trigger the urbanisation, the impacts mostly result in environmental problems (Firman, 2009).

## 1.2. Problem Definition

### 1.2.1. The impact of urban water challenges on the society

Integrated Water Resources Management (IWRM) is practiced internationally to approach an multidisciplinary and multi-jurisdictional water issues (Sun et al., 2015). A good IWRM practice demands an interaction among the water-actors that is elaborated by the term *water governance*. The Global Water Partnership adopted the definition of *governance* by the United Nations Development Programme (UNDP). It resulted in the main idea of water governance that brings all stakeholder (i.e. government, the private sector, civil society, and pressure groups) to contribute their ideas, state their priorities, exercise their rights, comply their obligations, and discuss their differences on water management (Rogers, Hall, Van de Meene, Brown, & Farrelly, 2003). The complicated relationship between these stakeholders may result in insufficient interaction leading to governance gaps. Hence, the OECD developed an analytical framework for identifying and bridging these gaps (Figure 1).

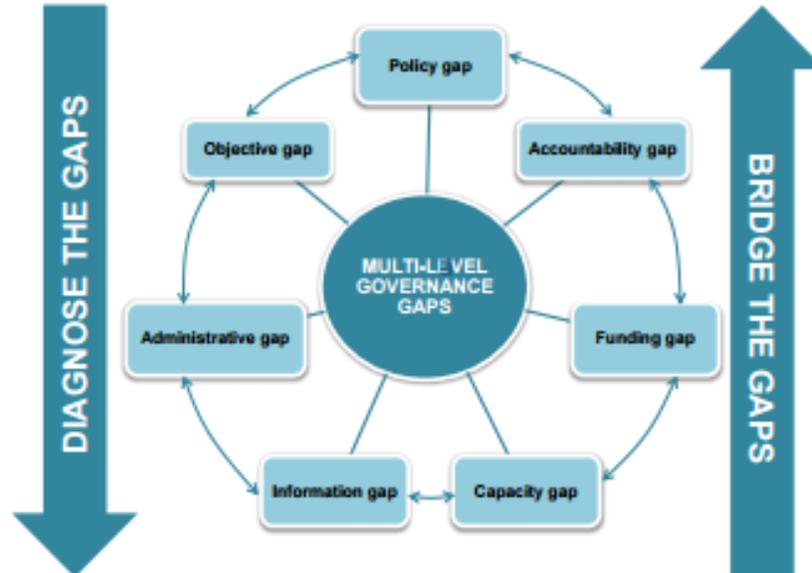


Figure 1 The multi-level governance framework (OECD, 2015a)

The governance issue is long-knowingly recognized as the core problem of the city and water management in Indonesia (Akanda & Hossain, 2012; Fulazzaky, 2014; Varis, 2006). Although the paradigms have changed in the last four decades (Table 1), the objective to proceeded IWRM is limited by the communities' unawareness about this issue and the lack of government capacity to enforce the policies (Fulazzaky, 2014). In cities, these limitations become crucial due to their relevancy with the cities' expansion and the citizen's wellbeing. For instance, the 2007's flooding in Jakarta resulted in approximately US\$ 450 million economic cost and displaced around 340 000 people (Douglass, 2010), whereas the worst seasonal flood in Bandung was stagnant for 2-4 weeks and caused a temporary evacuation (Tarigan et al., 2016).

**Table 1 The changing paradigms of managing water resources in Indonesia (Fulazzaky, 2014)**

Elements	Old (1971–1998) and new (1998–present) paradigms and their implications in water resources management			
	Old Paradigms	Implication	New Paradigms	Implication
Governance regime	Autocracy	Strong leadership character	Democracy	Participative leadership
Administrative rule	Centralization	Concentration on national administration	Decentralization	Domination by district and provincial administrations
Decision-making process	Top down	All decisions made based on administrator interests	Bottom up	All decisions made based on stakeholders aspiration
Budgetary system	Government allocation	Financial sources from debts offering by international institutions funding and government budget	Water users sharing participation	Financial sources from water users and water polluters pay principles and government budget
Role of water in regional development	Supporting factor	Risks to environmental imbalance	Limiting factor	Priority on water balance consideration
Management responsibility	Regional authority	Regionally economic development interests	River basin and regional authority	Sustainable development interests
Role of government in construction	Provider	Risks of corruption due to power authority	Enabler	Capacity building needs for strengthening government administration
Project setting up orientation	Partial approach	Regionally (or personally) economic development interests basis	Integrated approach	Environmental sustainability interests basis
Project interest	Supremacy instruction	To increase personal popularity	People aspiration	To solve water-related problems
Project preparation	Based on short term planning	Approved based on personal/local interests	Based on master plan	Approved based on comprehensive study

Another concern is related to the drinking water availability for the citizens. In 2012, the regional drinking water company of Bandung was connected to approximately half of the city’s population (Tarigan et al., 2016), whereas Jakarta’s piped water was distributed to >70% of its population (Winarso, 2010). The overall water network in Jakarta is underperformed due to the poor condition of its infrastructure (e.g. pipelines, sewerage) that cause leakage (Varis et al., 2006). Moreover, the water quality in Jakarta depends on an inadequate wastewater treatment plant (WWTP) using aerated lagoons (Varis et al., 2006). Likewise, the domestic wastewater in Bandung is only processed through the centralized WWTP using stabilization pond (Tirtawening, 2012).

### 1.2.2. Scientific understanding of urban water governance

The performance of IWRM practices in Indonesia is limitedly evaluated despite its popularity. A suitable framework is needed to understand what went right or wrong during the implementation and learn from other best practices. The study of good water governance is critical since large cities in Indonesia are still growing. However, there is only limited scientific understanding to address the water governance although the general opinion acknowledges it as the core problem. The recent article from Fulazzaky (2014) characterized three main governance challenges to develop future IWRM in Indonesia as enabling environment, institutional frameworks, and management instrument. Hence, this study is expected to contribute further insight of water governance in Indonesian cities and of the broader context in developing Asian cities.

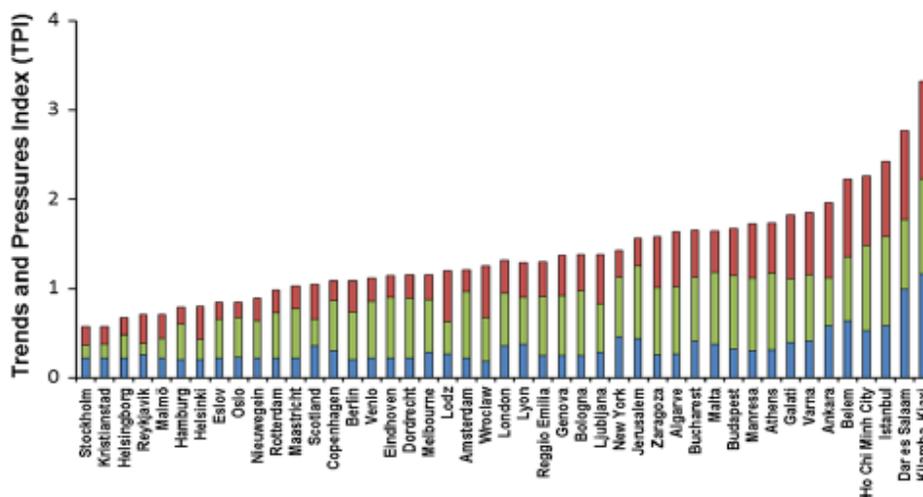
One way to approach these challenges comes with introducing the concept of *governance capacity* defined by (Koop et al., 2017b) as follows:

*the key set of governance conditions that should be developed to enable change that will be effective in finding dynamic solutions for governance challenges of water, waste, and climate change in cities.*

To improve its water governance capacity, a city requires a better understanding of their strengths, weaknesses, potentials, and threats. The City Blueprint® Approach is one of the diagnosis tools that could provide this support for the city. KWR Watercycle Research Institute endorses the development of The City Blueprint® Approach by Prof. Dr. C.J. van Leeuwen, i.e. this study’s main frameworks, and its implementation in the last four years (C. J. Van Leeuwen, Koop, & Sjerps, 2016). The approach is comprised of three complementary frameworks. The main challenges of cities are assessed with the Trends and Pressures Framework (TPF). How cities manage their water cycle is done with the City Blueprint Framework (CBF). Where cities can improve their water governance is done with the Governance Capacity Framework (GCF). By participating in the approach, a city could obtain 1) quick interactive scan of their water cycle, 2) access to other cities’ best practices, and 3) recognition in an international platform (Koop & van Leeuwen, 2016).

### *The Trends and Pressure Framework*

The 18 indicators of TPF cover the existing pressures from social, environmental, and financial categories (Koop & van Leeuwen, 2016). The result of this framework is presented as Trends and Pressure Index (TPI), the arithmetic mean of the indicators indexed between 0 (no concern) to 4 (great concern). The result highlights the sectors that need more recognition for achieving a sustainable practice. Although the social, financial, and environmental settings in cities are unique, the previous studies show the trend that most of the northwestern European cities have an overall low score while the Mediterranean and eastern European cities have a moderate one. The trend also exhibits that cities in the developing countries outside Europe have high TPIs (Figure 2) (Koop & van Leeuwen, 2016).



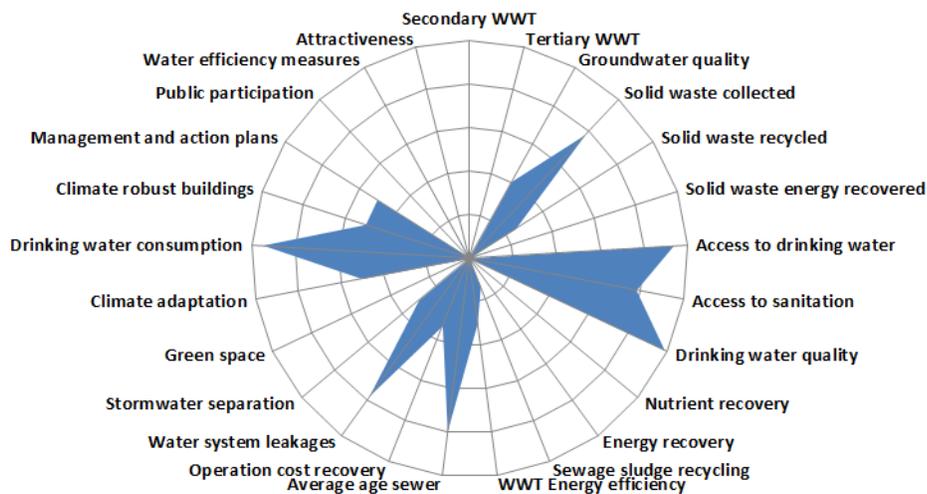
**Figure 2** The different colours represent three categories of pressures (blue= social, green= environmental, and red= financial) in a city (Koop & van Leeuwen, 2016)

The indicators within the framework had been improved to suit a better measurement of IWRM performance. The TPF’s main focus is mapping the trends priorities. This way, an arid region with

limited water availability can perform adequate IWRM when it capable of managing the water resource efficiently (Koop & van Leeuwen, 2015).

### *The City Blueprint Framework*

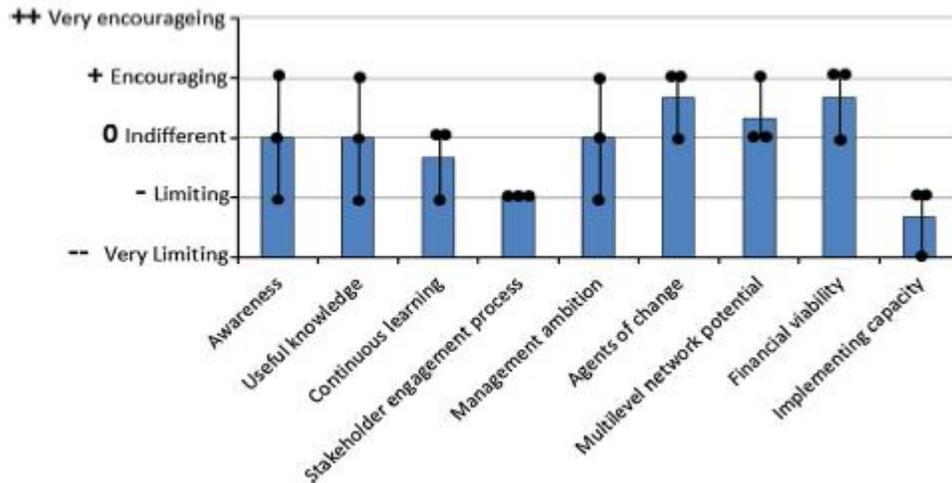
As the main part of the approach, CBF was meant to build the baseline assessment for the sustainability of Urban Water Cycle Service (UWCS; Van Leeuwen et al., 2016). The 25 indicators from seven different categories (Figure 3) are scored on a scale from 0 (very poor performance) to 10 (excellent performance). The result of CBF is presented in the form of Blue City Index (BCI), the arithmetic mean of the measured indicators. In general, the previous cities assessment proved that successful UWCS could be attained using a longer term investment and integration solution for co-benefit advantages with other sectors (e.g. solid waste, ICT, and transportation) (Koop & Van Leeuwen 2015b; Van Leeuwen et al., 2016). Improvements had been applied to the CBF for a better contribution of the indicators to the scoring. Due to the redundancy and lack of focus in IWRM, seven indicators had been added and the calculation method had been changed (Koop & van Leeuwen, 2015b). The newer BCI has a high positive correlation with Notre Dame Global Adaptation Index (ND-GAIN) climate readiness index, the Environmental Awareness Index (EAI), and the World Bank governance (Koop & van Leeuwen, 2015a).



**Figure 3 The BCI (Koop & van Leeuwen, 2015b)**

### *The Governance Capacity Framework*

The previous studies concluded that the governance aspect is crucial for a sustainable IWRM. Therefore, a complementary framework has been developed to understand the key enabling governance conditions that determine the governance capacity of cities to address challenges of water, waste and climate change. The GCF encompasses three dimensions (knowing, wanting, and enabling) with each three key conditions (Figure 4; Schreurs et al., 2017) and 27 indicators, three for each condition. The result for this framework is done by a Likert scale scoring (Koop et al., 2017b).



**Figure 4** The GCF result of Quito based on 26 qualitative semi-structured interviews (Schreurs et al., 2017)

The officials in Bandung approved the application of this approach to provide them with scientific information about city and water management. This understanding is needed to achieve their target as a *smart city* in the context of Global Smart City and Community Coalition (GSC3) with the focus on clean drinking water, waste management, electric power capacity, and the residential environment sectors (GSC3, n.d.). The City Blueprint offers the opportunity to learn from other cities as it initiated a learning alliance of European cities for sharing best practice of UWCS (Koop & van Leeuwen, 2015). Meanwhile, Jakarta was chosen as study area as the follow-up action from the latest UN Habitat Conference in Quito. The Human City Coalition initiated by Akzo planned to launch a project in Jakarta’s slum area (HCC, n.d.). This study contributes to the project as a preliminary study.

### 1.3. Aim

The aforementioned issues show that Indonesian cities face the frequent *too much*, *too little*, and *too polluted* water challenges. These challenges contribute significantly to the cities’ longevity while the main drivers, urbanisation and climate change, are not yet tackled. Although the government is familiar with these issues, the practice of urban water governance is still in the process of learning and adapting. This study provides the overview of the existing water-related challenges in the selected city along with its potential to manage the challenges using IWRM principals. The term *urban water challenges* covers flooding, clean water distribution, solid waste, and wastewater management. The impending challenge of urban heat island (UHI) is also included to demonstrate the impact of climate change. The City Blueprint® Approach is capable of identifying the challenges, assess the performance, and attempt to suggest the possible measures for improving the urban water management. In addition, the results from the study case of Bandung and Jakarta are used in the comparison of the water-related management in other cities in Asia. It aims to contribute the understanding of urban water challenges in developing Asian cities in scientific context.

## 1.4. Research Questions

*What are the gaps and opportunities for the large Indonesian cities to improve their capacity to manage and govern the long-term challenges of too much, too little, and too polluted water and how it adds usable knowledge of urban water challenges in Asian cities?*

The following sub-questions (SQ) are posed to assist the process of answering the main research question:

- SQ1: What are the main water management challenges and priorities of Integrated Water Resource Management in Bandung and Jakarta?
- SQ2: What are the most essential points of improvement for the city of Bandung to improve its capacity to govern challenges of too much, too little and too polluted water?
- SQ3: What key elements attain from the results comparison of the six large cities those had been assessed in Asia?
- SQ4: How can the result of Bandung be used to trigger a long-term science-policy interaction?

## 2. Theoretical Framework

### 2.1. Urban Water Management

The term *urban water management* represent the three long-term challenges by encompassing both water use efficiency and flooding issue. The water use efficiency explores the water supply chain including its conservation and efficiency improvement. Solid waste and wastewater treatment come into management scheme since the water quality also affects its efficiency (Bai, Zhou, Zhao, & Yu, 2017). Meanwhile, the water infrastructure plays an important role concerning the flood, inundation, and pollution risk in the urban area which often deteriorates the surface water quality and disturbs the cities' activities (Varis et al., 2006).

The trend of water consumption in the last five decades promotes water use and water scarcity as the urgent challenges for cities. The largest part that constitutes the global water consumption comes from agriculture while domestic and municipal account for less 10% of water demand. Nevertheless, this small percentage could be a problem if it is wrongly managed (Koop & van Leeuwen, 2016). Attaining a good practice of urban water management task is carried by the existing water utilities that often regulate UWCS from water capture, treatment, distribution, sewage collection, and disposal (González-Gómez & Ángel, 2008).

### 2.2. IWRM and Water Governance

The IWRM that people recognize nowadays had evolved over decades to communicate the complexity of water management. While IWRM has various interpretations, it consistently highlights the word 'integration' that requires the cooperation between the relevant 'actors.' Its implementation sometimes leads to confusion due to its broad and complex facets (Grigg, 2008). In some cases, such as Tanzania 1991's and Sri Lanka 2000's water policies, IWRM's misleading practice even worsened the state of water resource management in the area (Giordano & Shah, 2014) due to the misunderstanding and different perceptions among the involved stakeholders. Over the years, the institutional barriers rise as the main issue for achieving the 'integration' component. Hence, the concept of water governance is now closely followed the implementation of IWRM.

Historically, the promotion of IWRM in Southeast Asia started since the Mekong Agreement in 1995. Since then, the national governments in the region, including Indonesia, had tried to incorporate the practice by reforming the water policies to accommodate a participatory approach (Fulazzaky, 2014). This effort shows that the authority understands the importance of good water governance although the outcome was not always successful. As mentioned before, the issue with water governance remains in the existing gaps (Figure 1). Supposedly, water governance should represent the governance response which is very context dependent (OECD, 2015a).

### 2.3. The five water-related challenges in Bandung

While this study obtained the data and information for the trends, pressures, and performances of Jakarta and Bandung, in-depth research was conducted in the latter city. Bandung is the city of the third largest urban population of Indonesia with 2,5 million registered residents (Tarigan et al., 2016). The city acts as the capital of West Java Province and the centre of Greater Bandung or Bandung Metropolitan Area (BMA), which is comprised of Bandung City, Cimahi City, Bandung Regency, and West Bandung Regency (Figure 5). The selected area for the GCF analysis is Bandung City, which is referred as *Bandung* throughout the report.



Figure 5 Administrative borders of regions (cities and regencies) in the province of West Java. The area of Bandung City is highlighted in pink and pointed by the arrow (Tarigan et al., 2016)

The GCF framework had defined the five recurrent urban water challenges that demand such good water governance due to their long-term, complex, and uncertain risks (Koop et al., 2017b). These five water-related challenges are flooding, water scarcity, solid waste treatment, wastewater treatment, and urban heat island (UHI). These interrelated challenges (Table 2) are occurring in Bandung with different level of understanding by the relevant stakeholder.

Table 2 Brief description of each water-related challenge in Bandung

Challenges	Description
Flooding	The flood challenge in Bandung has received more attention in recent years due to the increasing frequency of the flood events. It should be underlined that the term 'flood' is known to the citizens of Bandung as <i>banjir cileuncang</i> , i.e. an event of inundation due to rain intensity that exceeds the capacity of the city drainage.
Water scarcity	Drinking water is generally available in Bandung all year long since the city has the annual precipitation of 1700 mm (Abidin et al., 2013). A specific context of water scarcity challenge in Bandung is

	defined by the uneven distribution of drinking water which is managed by the regional drinking water company.
Solid waste treatment	The challenge with solid waste treatment causes the blockage of drainage channels by that exacerbates the risk of flooding (Tarigan et al., 2016). More importantly, solid waste treatment in Bandung is a hot topic due to the state of the city's final disposal site that is near-expired.
Wastewater treatment	The same authority that regulates the drinking water also manages the centralized wastewater treatment in Bandung. The service coverage of this centralized system is still limited (Tirtawening, 2012). Meanwhile the popular means to treat the water are using the septic tanks or direct discharge to the environment.
Urban heat island (UHI)	Since Bandung lies between mountains ranges, its average diurnal temperature is lower than other expanding cities in Indonesia. While UHI-related studies are short in the country, Bandung is often chosen as the study area along with Jakarta, Bogor, and other high-populated cities.

The thirty districts (*kecamatan*) in Bandung comprise the administrative area of the city (Bappeda, 2011). Each of these districts has several sub-districts (*kelurahan*) those consisted of a number of neighbourhoods (i.e. a cluster of 100-500 households). The current Bandung's mayor, Ridwan Kamil, endorses the roles of these lower administrative levels by distributing responsibilities of managing their territories. In the following chapters, the term '*territorialities*' refers to sub-district level that is given such authorities.

### 3. Materials and Methods

The methodology that is used in this research had been defined, i.e. The City Blueprint® Approach. In practice, the TPF, CBF, and GCF were applied to assess Bandung while only TPF and CBF analysis were conducted for Jakarta.

#### 3.1. Data Collection

In the preliminary study for TPF and CBF application, an extensive literature study was conducted to identify each indicator and sub-indicators in Table 2 and 3. The prerequisite data for most of the indicators could be found in open access websites, for example, the CIA, World Bank, and WHO. For the TPF, the used data was on national level hence the same data were utilized for both Bandung and Jakarta. Some of the TPF indicators required a literature study specific for the subject, such as salinization, flood risk, and land subsidence (EIP Water, 2016c). The relevant scientific articles were obtained using Scopus and Google Scholar by inputting key phrases such as *land subsidence risk in Bandung, Jakarta sewerage system, and peak discharge of the Citarum River*.

**Table 3 The 18 indicators (and sub-indicators) for TPF application (EIP Water, 2016a)**

Categories	Indicators	Sub-indicators
Social pressures	1 Urbanization rate	
	2 Burden of disease	
	3 Education rate	
	4 Political instability	
Environmental pressures	5 Flooding	Urban drainage flood
		River peak discharges
		Sea level rise
		Land subsidence
6 Water scarcity	7 Water quality	Fresh water scarcity
		Groundwater scarcity
		Salinization and seawater intrusion
8 Heat risk	9 Economic pressure	Surface water quality
		Biodiversity
Financial pressures	10 Unemployment rate	Heat island effect
		11 Poverty rate

The CBF used city-level data and information obtained from scientific articles and local sources (government agencies, utilities, or news). The regional or national data were used to provide a quantitative assessment when there is no exact value available to assign the data to the indicator’s scale. The website of EIP Water provides public documents as the guideline for completing the assessment for each indicator (EIP Water, 2016a, 2016b).

**Table 4 The 25 indicators from seven different categories for the CBF application (EIP Water, 2016b)**

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

Meanwhile, the GCF was only carried out for the city of Bandung. The analysis was applied for the five recurring urban water challenges as mentioned by Koop et al. (2017b): flooding, water scarcity, wastewater treatment, solid waste treatment, and urban heat island. These points represent the classic challenges of *too much*, *too little*, and *too polluted* water. The data collection for the GCF was a combination of policy documents analysis and interviews with relevant stakeholders who are authorized to give feedback for the final scoring (Koop et al., 2017b) for each indicator in Table 5.

**Table 5 The 27 indicators from nine different conditions for the GCF (EIP Water, 2016c)**

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

The stakeholder and network analysis was the first step of GCF’s data collection. It started from identifying stakeholders, differentiating and categorizing stakeholders, to investigating relationships between stakeholders (Reed et al., 2009). The whole process of stakeholders analysis was based on literature review, expert opinions, and snowballing. The last two means were conducted by reaching expert (i.e. Bandung’s officials and researchers) via email (Appendix I). During the field research, additional information was added to the analysis from the earlier conducted interviews. Consequently, four categories of stakeholders were defined (Table 6).

In total, twenty-two interviews were carried out in Bandung. Four interviews with different categories of stakeholders were available for the five water-related challenges. Two short interviews were added with the main authority for Bandung’s urban planning (i.e. Bappeda) and the Environmental Agency of West Java Province. The interviews questions were mainly compiled based on the pre-defined questions from EIP Water website (Appendix II, EIP Water, 2016c).

**Table 6 Stakeholder categories and functionalities for the five water-related challenges in Bandung**

	<b>Flooding</b>	<b>Water scarcity</b>	<b>Solid waste treatment</b>	<b>Wastewater treatment</b>	<b>UHI</b>
<b>Authorities</b> (governmental agencies) – regulator – implementer – evaluator	- DPWA (implementer) - CRBC (regulator and implementer)	- Tirtawening (municipal owned company) - BSHALPA (regulator and implementer)	- PDK (municipal owned company) - BECA (regulator, implementer, and evaluator)	- Tirtawening (municipal owned company) - BSHALPA (regulator and implementer)	- BSHALPA (regulator and implementer) - BECA (regulator, implementer, and evaluator)
<b>Private sector*</b> Service and technology suppliers	N/A	N/A	N/A	N/A	N/A
<b>Academia</b>	Researchers from Bandung Institute of Technology and RDI	Researchers from Padjadjaran University	Researchers from ITB (Bandung Institute of Technology)	Researchers from Bandung Institute of Technology	Researchers from UPI (Indonesia University of Education)
<b>Civil society</b> – NGOs – Local communities	Elingan	Jagaseke	Greeneration	Local community in RW 02 of Cijawura sub-district	Earth Hour Bandung

\*Some of the private stakeholders (e.g. bottled water companies) had been contacted for interviews but none of them responded

A coding system was used to incorporate the interview results in this report. Each of the interviewees was given a code name according to the water-related challenge. Interviews with stakeholders from flooding challenge were labelled as FL01, FL02, FL03, and FL04. Correspondingly, interviews for water scarcity, solid waste treatment, wastewater treatment, and UHI challenges were coded as WS, SW, WW, and UH (Appendix III). The interview results were used to determine the final GCF scores in data analysis. In addition, informative remarks from the interviewee could be found throughout the result and discussion chapters of this study.

### **3.2. Data Analysis**

In general, the data analysis was performed in the following procedure. Firstly, the preliminary results of TPF and CBF were validated by the local stakeholders. The officials in Bandung supported the data completion and validation since the research was fully known by the city-level government. Secondly, these officials also helped with the validation of others interviews. Besides the pre-defined questions for GCF analysis, additional questions were asked to crosscheck the information obtained from previous interviews. A total of twenty-two interviews were used to construct the final score of each GCF's indicator for the five water-related challenges, where the justification document is available as Appendix III. Lastly, these final scores were sent to the interviewees so that they could provide constructive feedback, argumentation, or additional literature.

## 4. Results

### 4.1. The overview of water management challenges in Bandung and Jakarta

#### 4.1.1. The trends and pressures analysis of Bandung and Jakarta

The term trends and pressures in this analysis (Table 6) refers to the fact that the (local) government is barely able to change the underlying reason behind their current performances (Koop & van Leeuwen, 2015a; Schreurs et al., 2017). Both Bandung and Jakarta face high environmental pressures. Jakarta is located in a very vulnerable delta which is recurrently used as the study case of a sinking city with an average land subsidence rate of 75-100 mm/yr (Erkens et al., 2015). While the Bandung Basin lies 650-700 m above sea level amongst 2.400 m volcanic highlands, the city's vulnerability is exacerbated by land subsidence which on average occurred at the rate of 8 cm/year (Abidin et al., 2013).

**Table 7 Summary of trends and pressures indicators' scores for Bandung and Jakarta**

Categories	Indicator/Subindicator	Bandung	Jakarta
Social pressures	1.Urbanisation rate	2.9	2.9
	2.Burden of disease	1	1
	3.Education rate	2.8	2.8
	4.Political instability	2.5	2.5
Environmental pressure	5 Flood Risk	(3)	(4)
	5.1 Urban drainage flood	4	4
	5.2.Sea level rise	0	4
	5.3.River peak discharges	3	4
	5.4.Land subsidence	4	4
	6 Water Scarcity	(2.3)	(3.7)
	6.1.Freshwater scarcity (national)	3	3
	6.2.Groundwater scarcity	4	4
	6.3.Salinization and/or seawater intrusion	0	4
	7. Water Quality	(1)	(1)
Financial pressures	7.1.Surface water quality (national)	1.5	1.5
	7.2.Biodiversity	0.8	0.8
	8.Heat island effect	4	4
	9.Economic pressure	3.8	3.8
	10.Unemployment rate	1.5	1.5
	11.Poverty rate	1.5	1.5
	12.Inflation rate	2.1	2.1

	No concern		Low concern		Medium concern		Concern		Great concern
--	------------	--	-------------	--	----------------	--	---------	--	---------------

The social and financial pressures of both cities come from the ongoing mega-urbanisation in Jakarta and Bandung regions driven by the high economic activities in the past three decades (Firman, 2009). Greater pressure trails both cities since their urban population growth exceeded 3% per year in the 2010s (Tarigan et al., 2016; Winarso, 2010), and are higher than the national average (i.e. 2,69%). The urbanisation contributes significantly to the expansion of the slum population in the cities, as Bandung and Jakarta are entitled the highest rank in cities with the highest proportion of slum dwellers (Tarigan et al., 2016). Although the incoming population is attracted by the seemingly high opportunity to alleviate their economic stability, it sometimes fires back due to the significant disparities that exist in

large cities (Winarso, 2010). This is reflected in the indicators such as education rate, political instability, economic pressure, unemployment rate, and poverty rate (Table 7). This rapid development eventually aggravates the environmental challenges, including urban water management, in particular when the cities are least equipped (UN-Habitat, 2011; Varis, 2006).

#### 4.1.2. The city blueprints of Bandung and Jakarta

The result of CBF analysis provides a baseline assessment of a city’s UWCS management with the expectation that it will support the future planning of the city (van Leeuwen et al., 2016). Using the 25 indicators as shown in Figures 6 and 7, a general impression can be obtained of existing UWCS sustainability for the cities of Bandung and Jakarta. The two cities have Blue City Index (BCI) scores of 2.6 and 2.0, respectively, where the BCI theoretically varies from 0 to 10. It puts them among other cities with low BCIs such as Belem (Brazil), Quito (Ecuador), and Bucharest (Romania).

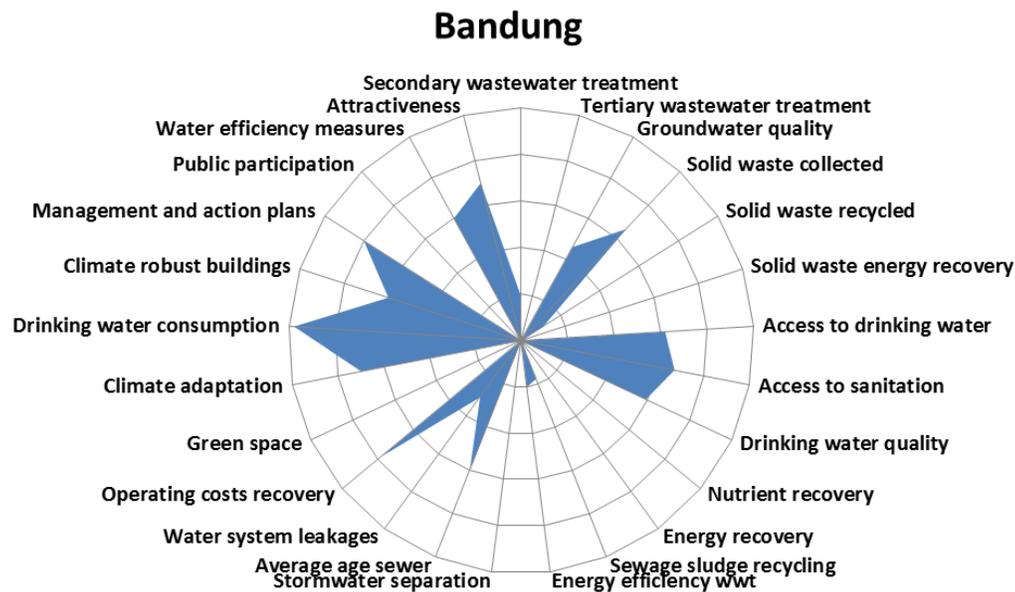
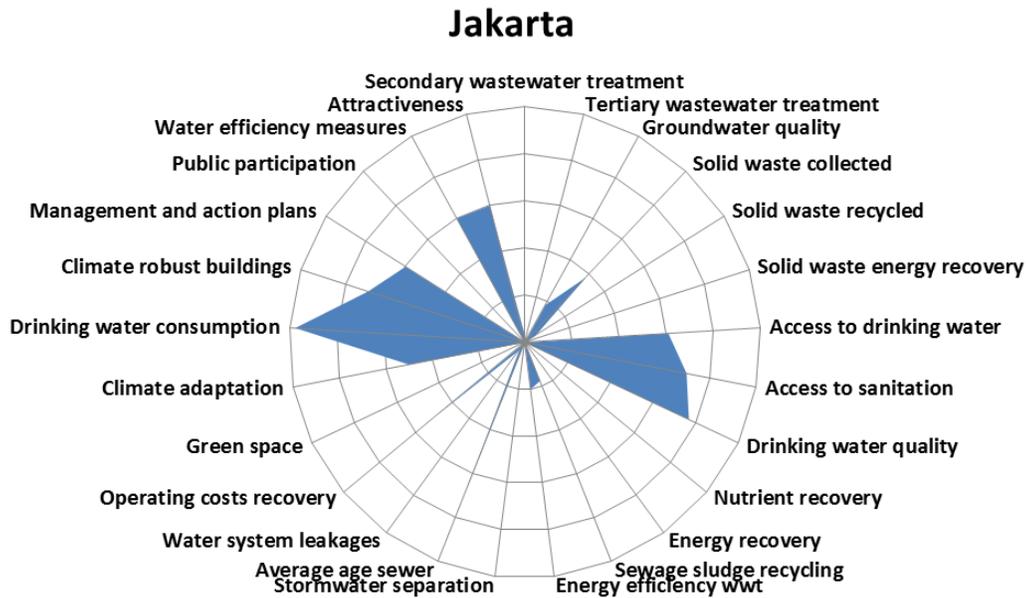


Figure 6 City Blueprint of Bandung based on 25 performance indicators. The range of scores varies from 0 (centre of the circle; low performance) to 10 (periphery of the circle; high performance). Further methodological details are provided in (Koop & van Leeuwen, 2015a)



**Figure 7 City Blueprint of Jakarta based on 25 performance indicators. The range of scores varies from 0 (centre of the circle; low performance) to 10 (periphery of the circle; high performance). Further methodological details are provided elsewhere in (Koop & van Leeuwen, 2015a)**

Water quality in both cities still depends on the ability of self-purification in waterbodies such as rivers and aquifers. This notion had been embedded for so long in the country where only about 11 cities have sewerage with average coverage of around 5% of the city population (ADB, 2013). A centralized system that connects wastewater from houses to the WWTP is rather difficult to be implemented. It is delimited by the lack of available land within the city, in addition to high cost, high energy, and skilled personnel requirements (Hendrawan et al., 2013). Septic tanks are widely used for treating blackwater while greywater and wastewater from the population without septic tanks are discharged directly into the river (OECD, 2016).

Although the score of basic water services for Bandung and Jakarta are among the highest, their water supply providers have not been able to serve the whole city's population. Tirtawening, Bandung's drinking water company, covers 62% of the city population (OECD, 2016) while the combination of Palyja and Aetra, Jakarta's drinking water companies, results in service coverage ratio of 61%. A lower percentage of the population use tap water for their consumption since people supply themselves with bottled water provided by the drinking water company or, primarily, by private companies who utilize the groundwater reservoir. In Jakarta, 39,6% citizens use tap water for cooking while the rest utilize artesian wells (36%), bottled or refilled water (15,3%), and surface or rainwater (7,62%; Elyda, 2016).

Meanwhile, the characteristic of Municipal Solid Waste (MSW) in the cities are dominated by organic 'wet' waste. No incinerator exists in Indonesia. Several initiations to build large incinerators in Bandung are opposed by many parties since it is claimed to be less efficient for the city's waste composition (Dipa, 2014). The trend with solid waste recycling is rising, but it fails to significantly

address the root problem of waste generation in the city. With the current waste composition, composting seems the better measure to treat the solid waste (Zurbrügg et al., 2012).

Compared to the other cities in Indonesia, the sewerage system in Bandung and Jakarta are in relatively good condition. However, the combined sewer network covers a very limited area in the cities, and there is no refurbishment or additional installation since it was built 20-35 years ago (Prihandrijanti & Firdayati, 2011). The low score in water system leakage (i.e. 35% in Bandung and 48% in Jakarta) is caused by both physical and commercial leakages (i.e. lost water even before reaching the customer, Non-Revenue Water, NRW). The water supply company has the difficulties in differentiating the percentages of water lost due to low operation and maintenance capabilities (poor performing devices) or due to commercial reasons such as water theft, low meter accuracy, and errors in meter-reading (Moersidik et al., 2015). The government covers the cost of infrastructure development for basic water service. Depends on the significance, it could be the local, regional, or national government. The high cost of sustainable measures demands additional financial support which usually comes from private sectors, both local and international.

Since Bandung and Jakarta are largely affected by the impacts of climate change, the cities' government had exerted several instruments to promote climate change adaptation. With the current trend of community's movement, there is a rising awareness of climate change impacting the public's life. Some communities, such as Earth Hour and Greeneration, promote new habits to act 'healthier' such as reducing food waste, abandoning the use of plastic bags, also saving electricity and water (SW04; UH04). At the same time, the city accommodates climate change adaptation by introducing more green spaces in the city. However, the current shares of 12,15% and 14,94% green area in Bandung and Jakarta (Diskamtam, 2015; Martiyanti, 2016) do not even comply with the Indonesia Spatial Planning Act No 26/2007 that requires a minimum of 30%. In recent years, both cities added more urban parks as a public space. However, these new utilities tend to focus on the aesthetic and social value for the city whereas the function to cope with climate change is not so much prioritized (UH02).

IWRM practice in Indonesia develops in a positive direction. A river basin territory in Indonesia is called *wilayah sungai* which enclose the outer boundaries of a drainage basin regardless of the administrative borders (Fulazzaky, 2014). This factor facilitates the implementation of IWRM in several river basins. Some of these basins have formed working groups (i.e. Water Resource Management Coordination Team, WRMCT) covering both upstream and downstream areas, including Citarum and Ciliwung basins in Bandung and Jakarta (ADB, 2016). Although according to The World Bank's Governance Indicator *Rule of Law*, the public participation for Indonesia is categorized as zero, the rising trend of community involvement in larger cities has the potential to improve public participation. The initiators of these communities are usually the youth. These young generations actively promote their objectives and at the same time assist a transboundary environment education to the public (Suharko, 2015).

## 4.2. Points of improvements for Bandung’s governance capacity

### 4.2.1. The governance capacity analysis of Bandung

#### *Flooding*

The relevant stakeholders began to recognize that the root of flooding lies in spatial planning, where past developments in Bandung have transformed Bandung's retention areas into paved and impermeable areas with high runoff-coefficients (FL03; FL04). The citizens of Bandung have a basic knowledge of the drivers, risks, and impacts of flood events and, as a consequence, there is moderate awareness about flood risks. However, there is no significant change in attitude and behaviour of local communities. In particular, their poor collection of solid waste often causes drainage channels to clog (FL01; FL03). The agents of change within the citizens help the government's duty to educate the people in flood adaptation and mitigation. Bandung Mayor's incentive to establish IPTDE (Innovation Program of Territoriality Development and Empowerment) also initiated a change in public attitude (FL01). The availability of data and information helps all stakeholders to better understand flooding issues, especially the information about flood-prone areas. The current monitoring and evaluation systems are still fragmented. Hence, the potential knowledge from these systems has not been fully utilized. The integration of these fragmented systems might facilitate more adequate flood risk management in the future. The monitoring of potential flood events in Bandung is limited by using weather forecasts by IAMCG (Indonesian Agency of Meteorology, Climatology, and Geophysics) as well as the visual inspection by officers in upstream areas and CCTV (Closed Circuit Television) network spreads in the city (FL01). The citizens can contribute to the monitoring via the city's social media channels. A good monitoring effort is demonstrated by the Citarum’s WRMCT. This institution consists of representatives from various relevant stakeholders who interact regularly (FL02; FL04).

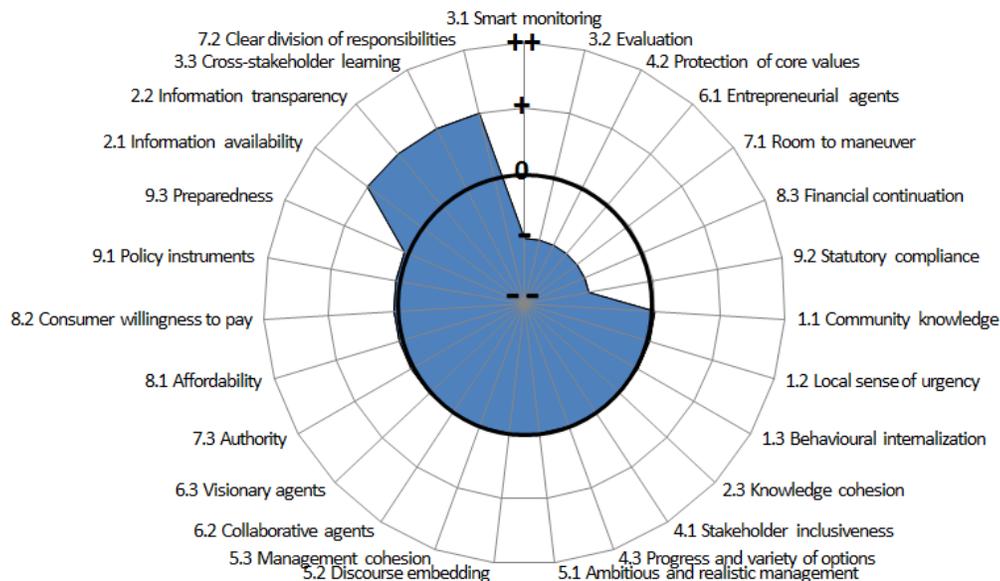
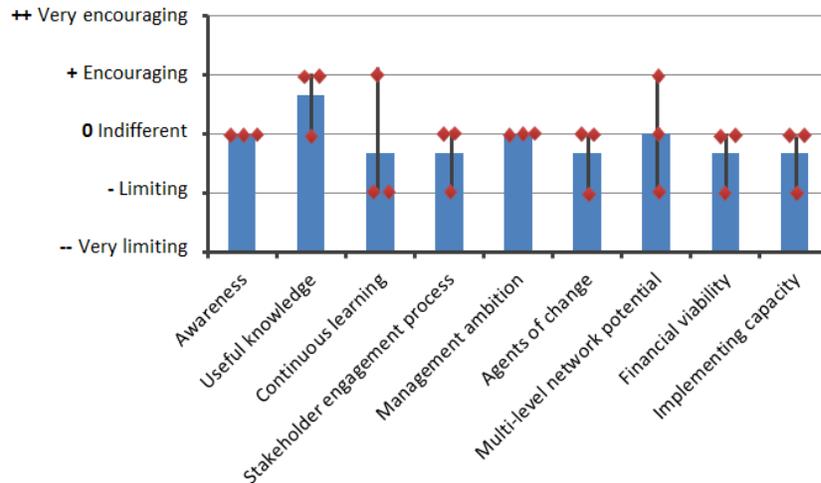


Figure 8 Spider diagram of Bandung’s governance indicators for the flood risk challenge



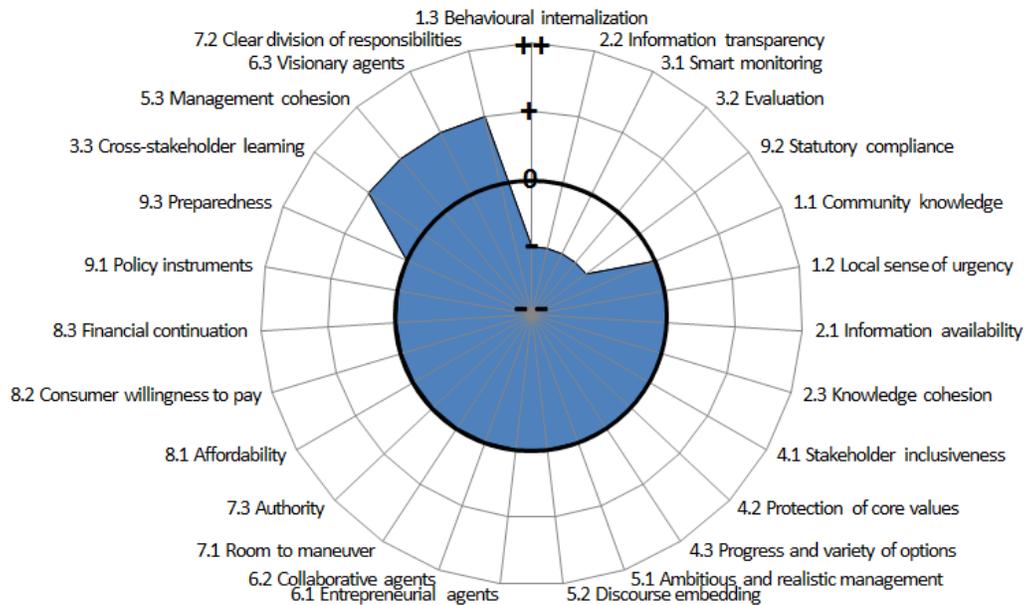
**Figure 9 Overview of Bandung's governance conditions for the flood risk challenge**

Various stakeholders are involved in the planning and implementation of flood risk management policies. However, the limited engagement of some communities lead to the implementation of governmental programs (mainly physical work) which can unintentionally harm their rights (e.g. place to live) (FL02; FL04). The development of flooding infrastructures is still the focus of Bandung's Public Works Agency (BPWA) for flood management solutions. Other efforts, including Rain Water Harvesting (RWH), infiltration wells, and biopores, are conducted by BECA (Bandung's Environment and Cleanliness Agency), CRBC (Citarum River Basin Council), and various communities (FL02, FL04). There is a clear division of responsibility for flood mitigation in Bandung, as can be inferred from Bappeda's (Bandung Planning Agency) master plan (Bappeda, 2011; 2013). However, the roles of responsible city's agencies and local agents of change are limited by the interests of higher hierarchies at provincial and national levels, since Bandung is chosen as one of the National Activity Centres or NACs (Bappeda, 2011; 2013; FL01). Innovative collaborations are started to deal with flooding challenges, although the management's objectives are short term and following the rule of *business as usual*. The source of financial support will only contribute to conventional flood management. Bandung is financially capable to invest in flood risk management due to their internal sources (tax revenues) and external sources (the Special Allocation Fund from national government), but these sources are not yet fully utilized to address flooding challenge (FL03). On the other hand, strengthening the implementation of policy instruments needs to be emphasized considering the current weak legal system and statutory compliance. The low adherence can be seen from the deviation of development provisions in the city, for example land use ratio for the buildings that worsen the retention ability of the city of Bandung (FL02; FL03). With the current conditions, the preparedness of Bandung in facing flood disasters is in the initial level of 'learning by doing'. The current preparedness procedures still underestimate the impact of floods on various aspects.

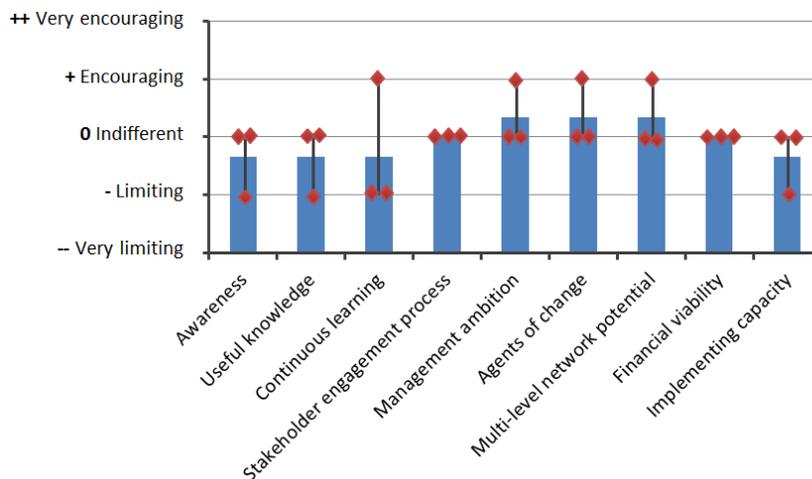
#### *Water Scarcity*

Water scarcity in Bandung is mainly caused by a poor performance of the water supply system. The citizens do not consider water shortage as an urgent problem because they are already familiar with this limitation (WS01). The public complains to the government when the water is very scarce

(especially during the dry season; WS02). Drinking water management is done by Tirtawening, a municipally owned drinking water company. At present, Tirtawening has a drinking water distribution system that covers about half of the city's population. The population that is not connected to the Tirtawening's water pipelines tap clean water from independent wells (*sumur pantek*). BSHALPA (Bandung's Settlements, Housing Area, Land, and Parks Agency) has a program to distribute clean water (non-piped) to the community.



**Figure 10 Spider diagram of Bandung's governance indicators for water scarcity**



**Figure 11 Overview of Bandung's governance conditions for water scarcity**

The quantity of surface water in Bandung is sufficient for the needs of the city, but the water quality is very poor (Bappeda, 2014). The groundwater availability is sufficient for the future population

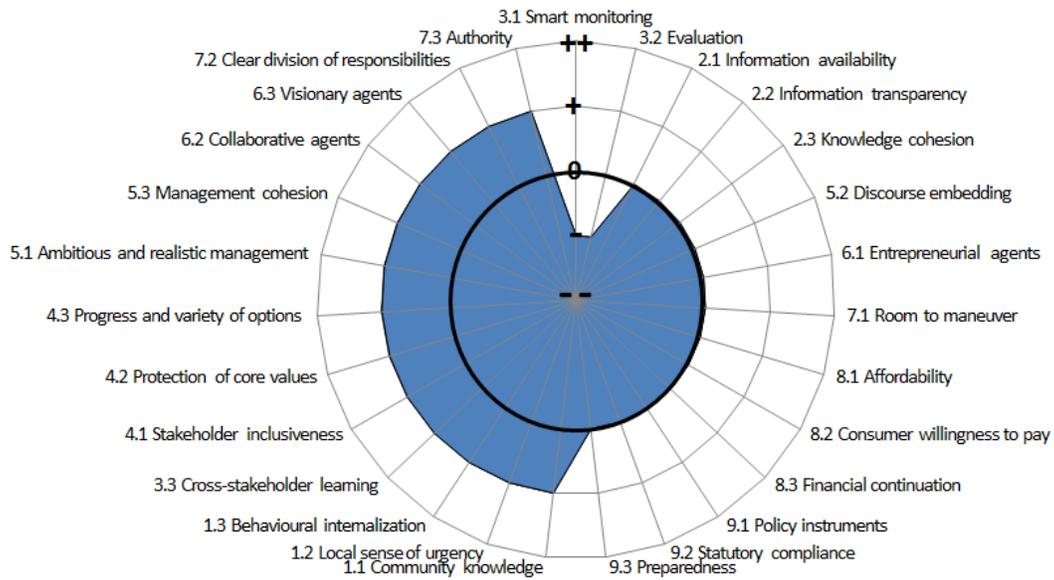
although there are already some critical points in the shallow unconfined and deep confined aquifers (Bappeda, 2014; WS03). Some stakeholders (e.g. Tirtawening, researchers) own information and data related to the water supply, but they are not yet integrated and utilized for securing water provision (WS03; WS04). Although public participation regarding the piped water supply appears to be limited, the provision of clean water in the settlements (coordinated by BSHALPA) involves local citizens who help with the maintenance of water supply installations. Bandung has a water and sanitation working group where the members (e.g. Tirtawening, BSHALPA, BPWA) discuss water management issues, especially in achieving the universal target in 2019 (WS01; WS02). The universal entails 100% of the population served by clean water, 0% slum areas, and 100% of the population have access to sanitation. Hence, the management ambitions are currently focused on improving the basic water services.

Researchers and lecturers of the universities in Bandung act as the agents of change. They have led several pilot projects such as RWH and mini water treatment plant. Some communities, such as Jagaseke, work together to conserve natural springs that are sufficient as clean water source for the surrounding population (WS04). Tirtawening and BSHALPA have begun to adapt these ideas, although they are still in the exploratory stage. With the division of responsibilities between piped and non-piped water, governmental agencies have recognized the potential innovative collaborations with new actors. Nevertheless, the current implementation of (unconventional) new ideas is hampered by the community's financial capacity and policy instruments (WS02; WS03). As Tirtawening customers, some people still have low payment compliance for every month (WS02). The Government of Bandung has allocated funds for low-income society to improve access to clean water. The city has several financial sources (e.g. Tirtawening's revenue, loans from commercial banks, grants from the national government) to meet the basic water services (Bappeda, 2014; WS02). On the other hand, the legal instruments to protect clean water sources within the city are not yet synchronized with other sectors. It results in the absence of a deterrent effect for the polluters and groundwater exploiters (WS03). Bandung's preparedness to clean water scarcity is relatively sufficient with the clear division of responsibilities and roles for the relevant government agencies. However, the procedures and workflows are not disseminated properly to the public. At the same time, the public does not feel concerned about the preparedness since they consider the government to be responsible for providing water for the city in any situation (WS04).

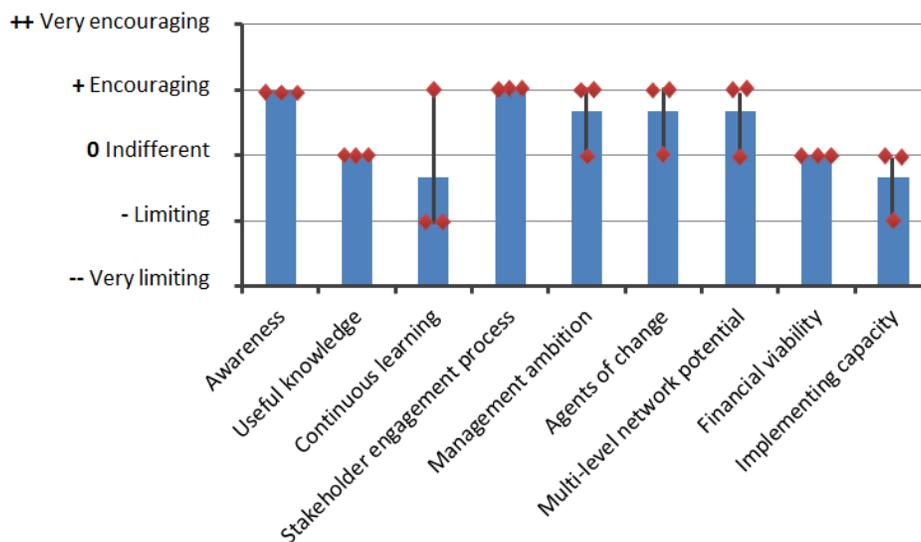
#### *Solid Waste Treatment*

Solid waste is a popular issue in Bandung due to the sentiment of the people who are traumatized by Leuwigajah disaster (a landfill avalanche with 156 toll death) in 2005. This tragedy became the tipping point of public awareness related to solid waste management. Compared to the other four challenges, solid waste management has the highest GCF score. It can be attributed to the active participation of various communities in socializing the new mind set of sustainable waste management (SW01; SW04). Earlier this year, BECA became the regulator for solid waste management in Bandung (based on the new organization structure and working procedure). It puts BECA in a higher position than *PD Kebersihan* (PDK), the solid waste manager (operator), who managed every aspects related to solid waste until last year (SW02; SW03; SW04). At present, government of Bandung is working on long-

term targets to reduce the waste that must be transported to open-dumping disposal sites. This is done by promoting decentralized waste processing near its source (SW01). This year, BECA began implementing programs based on the Solid Waste Master Plan that was formulated since 2012 by BECA-appointed consultants with input and supervising from researchers and territorialities (BECA, 2014; SW01).



**Figure 12 Spider diagram of Bandung's governance indicators for the solid waste treatment challenge**



**Figure 13 Overview of Bandung's governance conditions for the solid waste treatment challenge**

Although the citizens of Bandung have adequate knowledge about solid waste treatment, it has not been observed in the overall change in behaviour (SW03, SW04). The incremental change only results in low rates of recycling and, especially, composting, as solid waste in Bandung is mostly organic. The availability of data and information about solid waste in Bandung is insufficient for exploration of

innovations in waste treatment. The existing data and information are tailored to the needs of the general public which made these data and information are insufficient for research and evaluation (SW03). Implementation of monitoring is very poor so that the evaluation of the current results cannot provide any evidence of real progress (SW03; SW04).

The city is now following a long-term ambition that by 2030, 70% of the waste will be processed within the city and 30% will be transported to the disposal site (BECA, 2014; SW01). To achieve this target, the government needs to coordinate various relevant stakeholders. Coordination between the local operators requires an unobstructed flow of procedures (SW01; SW03). BECA and PDK have planned to engage IPTDE teams and local officers (*petugas roda*) in each territoriality also the scavengers (*pemulung*) to increase the coverage area of solid waste collection and transportation. Bandung requires the program to synchronize with other sectors and regions (e.g. Bandung Regency, West Bandung Regency, Cimahi City, and Sumedang City). It is primarily related to the Waste Management and Final Processing Site (WMFPS) in Legok Nangka which is a newly planned site for the Greater Bandung region. The province officials have an important role in the WMFPS planning since they manage many aspects from land acquisition to financial support (SW01). The financial performance of PDK was previously stagnant (even declining) and needed to be revitalized (SW03). The appointment of BECA as the regulator is expected to alleviate the financial burden of PDK since BECA has broader access to provincial budgets (through municipal government; SW04).

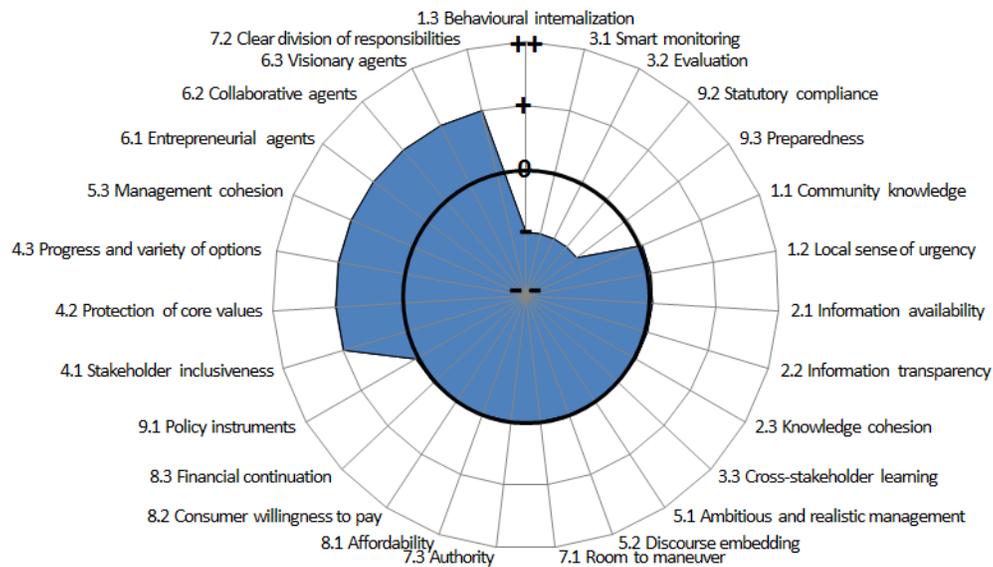
The fundamental challenge for Bandung is to change the public mind set about solid waste. Solid waste is considered as dirty (garbage) that has no value, and should be transported immediately to disposal sites (SW01; SW04). This mind set is reflected in the (financial) willingness to spend more funds in maintaining the cleanliness of their living area but opposing financial support to solid waste treatment programs such as making a simple composting unit in their backyard (SW03). The legal instruments in Bandung regarding solid waste management are sufficient. Social media trends contribute to enforcement using social sanction for the violators (e.g. people who are caught illegally dumping solid waste will get his/her picture taken and be circulated on internet) (SW02; SW04). Bandung has an adequate (binding) legal instrument for conventional waste treatment, but there is a lack of social implementation of instruments (SW04). On the other hand, no policy instrument further promotes the idea of recycling and composting. The element of uncertainties has not been integrated for Bandung's preparedness which until now is still using the open dumping method in the final disposal site.

#### *Waste Water Treatment*

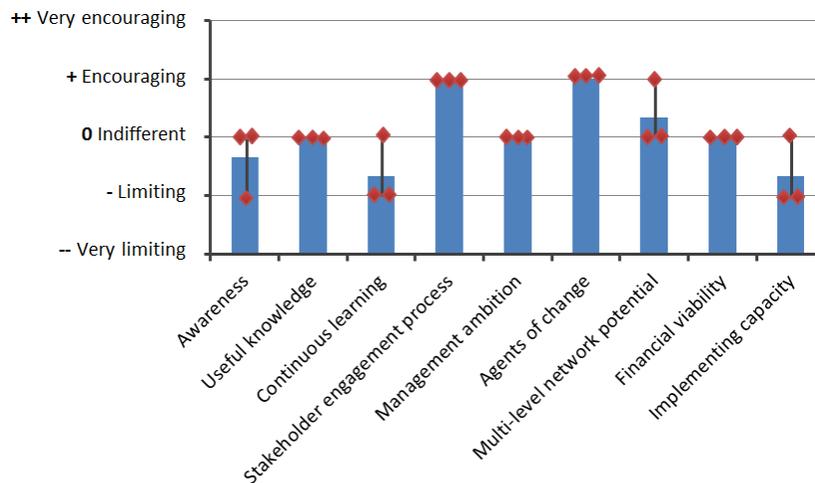
In general, wastewater treatment in Indonesia is carried out on-site, using septic tanks. Several cities have a centralized system with a treatment plant, including Bojongsoang WWTP in Bandung but its service area is limited. The issue of wastewater in Bandung has been on the government agenda given the universal target of 2019 to improve community access to sanitation (WW01). Unfortunately, the citizens are not concerned about wastewater issues although they are faced with the risks of untreated wastewater (WW04). In the last three years, the presence of *Sanimas*, a community-based sanitation (CBS) program, has successfully engaged some of the society members to pay attention to

their domestic wastewater treatment. Nevertheless, changes in the attitude of the community are still based on external factors such as raising the river water quality (the end channel for wastewater disposal) and improving their environment's aesthetic (WW04).

The availability of data and information on wastewater management are sufficient for small-scale independent program of designing WWTP installations (WW03). More detailed data (e.g. water quality parameters) are claimed to be available at BECA in the city and province levels. However, the access to these data involves a complicated bureaucracy. Bandung does not have an adequate monitoring system so that the evaluation of WWTP (both central and communal) and sewer networks cannot be done in detail (WW02). WWTP monitoring is mainly carried out using visual inspection, i.e. water clarity. The central Ministry of Public Works has recently compiled the centralized WWTP performance indicator to improve the effectiveness of wastewater performance evaluation (WW02).



**Figure 14 Spider diagram of Bandung's governance indicators for wastewater treatment**



**Figure 15 Overview of Bandung's governance conditions for wastewater treatment**

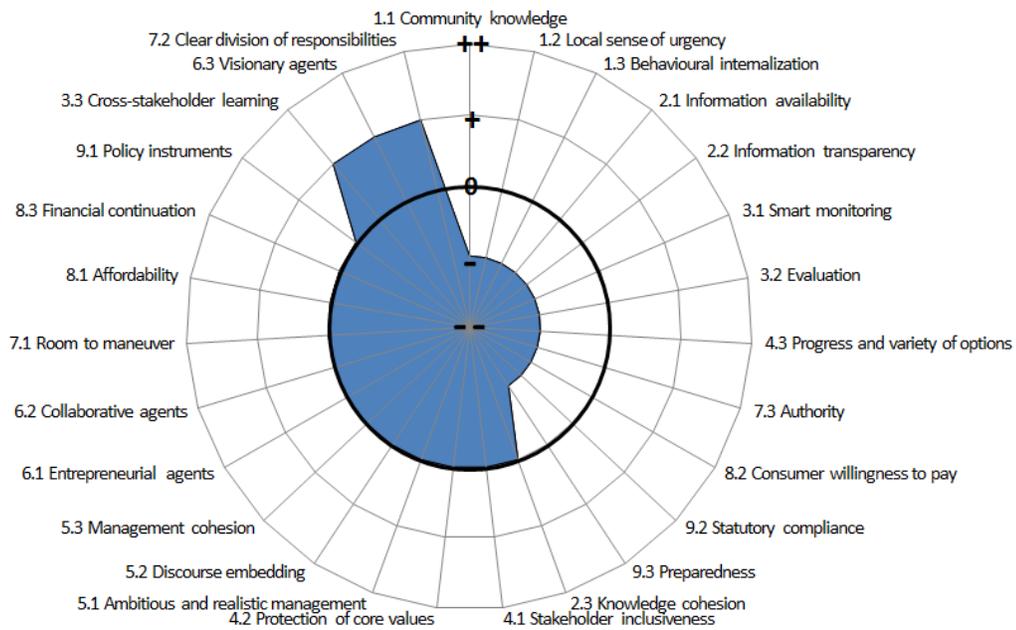
The stakeholder inclusivity in wastewater treatment is different in two settings. First are the Tirtawening customers (who also manage wastewater service in Bandung) and second are the citizens without access to improved sanitation. Tirtawening customers connect their wastewater pipeline (from toilet and bathroom) to the nearest Tirtawening sewerage that leads to Bojongsoang WWTP. Subscribed customers who do not have the pipeline connection but own septic tanks use the service of WC/toilet suction trucks from Tirtawening, although sometimes they do not know their rights and use paid private services instead (WW01; WW02). This blackwater will be delivered to the disposal points within the city which are also connected to Bojongsoang. These subscribed customers are not actively involved in wastewater management. Besides the efforts to increase the number of domestic and private wastewater connections (e.g. hotels and restaurants), Tirtawening also has a special program that eliminates wastewater connection fees for eligible families (i.e. low-income society). At the same time, the development of the Sanimas program indicates strong involvement of local people (WW03; WW04). Sanimas receives financial support from the public and private partnerships. Although this practice is ideal by utilizing local potential (with the help of government's facilitator), the number of connections to each communal WWTP is limited to a range of 100 households (WW01). This is rather insignificant compared to the total Bandung's population, considering the project is only entering the fourth year in 2017 with the completed communal WWTP in 14 locations (BSHALPA, 2016). The Sanimas program also exposed the presence of agents of change among the citizens who enlighten the local people about the importance of wastewater treatment. Some of them even proposed the ideas for the design of communal WWTP (WW04).

Currently, the main agenda of Bandung, included in the universal target of 2019, is the provision of basic sanitation services for its citizens. The distribution of responsibilities for wastewater treatment is similar to the provision of drinking water where Tirtawening and BSHALPA have similar programs to help the low-income society. The main challenge of installing WWTPs is the availability of unoccupied land in such densely populated areas (WW01; WW02). This is important because the conventional wastewater treatment applied in Indonesia requires such considerable land area. The low public awareness of wastewater treatment has an effect on the financial capacity and legal compliance of the society. Treating wastewater is not a priority of the household budget of most families in Bandung (WW03; WW04). The government of Bandung has access to several provincial and national funds for the implementation of basic water services, next to alternative sources of financing such as international grants (WW01). Likewise in water scarcity challenge, regulations and policies in wastewater collection and treatment are fragmented so that no effective penalties or incentives can support the achievement of future ambitions. The city prepares for this future wastewater challenge by a refurbishing plan on Bojongsoang WWTP (WW02), but it is still based on a *business as usual* scenario without the integration of uncertainties.

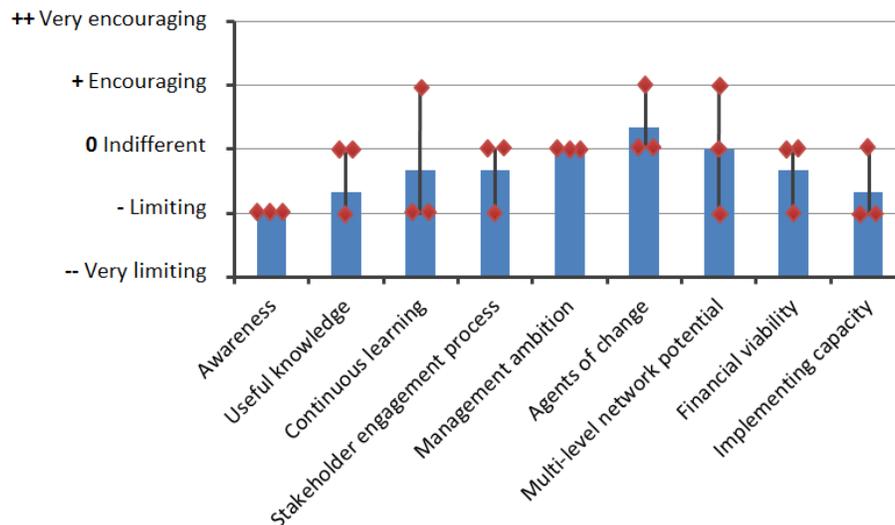
#### *Urban Heat Island*

UHI in Indonesia is not considered to be an issue. The term itself is used by researchers but is less known to the general public (UH03). Therefore, the UHI issue in this study extends its scope to adaptation to climate change including energy resource efficiency and green space utilization (UH01). With this wider coverage, the public awareness indicator seems fragmented with some citizens joining

communities as agent of change (UH01; UH04). The availability of technical data and information of UHI-related and climate adaptation research is limited. The scattered knowledge of climate change adaptation in some institutions has been cultivated in a structured way, in particular to complete the formulation of Regional Action Plan - Adaptation toward Climate Change (RAP-ACC) (UH01), while UHI knowledge is available as research results (UH03). Monitoring and evaluation procedures are still very minimal, for example, emissions testing by BECA and quality monitoring of green space by BSHALPA (UH01; UH02). The existence of Bandung's RAP-ACC, which was completed in April 2017, demonstrates the efforts of the city government (i.e. Bappeda) to document and harmonize the climate change adaptation actions.



**Figure 16 Spider diagram of Bandung's governance indicators for the UHI challenge**



**Figure 17 Overview of Bandung's governance conditions for the UHI challenge**

RAP-ACC is the result of various stakeholders interactions related to climate adaptation, including government agencies (Bappeda, BECA, BPWA, Transportation Agency, and Tourism Agency), researchers (Centre for Climate Risk and Opportunity Management, CCROM), and some private parties. RAP-ACC result contains the city's climate profile and vulnerability map (up to district level) which is used as the base for adaptation options for priority villages within Bandung (CCROM, 2017). While UHI challenge is not addressed directly in RAP-ACC, government programs in arranging the city structure, especially slum areas, may mitigate the UHI effect (Paramita & Fukuda, 2014; UH03). These programs include the development plan of *apartemen rakyat* (people's apartment) and *rumah deret* (houses in rows) by BSHALPA (UH02; UH03). Based on the research, the pattern and layout of the building, as well as the materials used in the building can be modified to reduce the effect of UHI in Bandung. It will be more useful than relying only on the increase of green space that intersects with the urban development plans (UH03). Some of the government's planning shows the low level of public influence on the issue. Due to the ineffectiveness of city arrangement's implementation, some residents in the area even showed resistance (UH03).

The government's ambition to tackle UHI challenge in Bandung has started although the used title is urban spatial arrangement or climate change adaptation (UH03; UH04). The main purpose of this program is still the improvement of basic services for the citizens (i.e. housing). The agents of change have realized the importance of developing certain attitudes in addressing climate change (UH04). The role and sharing of responsibilities among government agencies are relatively clear and, as a consequence, the exploration of cooperation is now growing. However, this process requires the help of a stronger authority and policy instruments or governance arrangements to attract more people to work together. It includes increasing the willingness of citizens to support the mitigation efforts financially. Strong authority needs to be followed by the formulation of comprehensive regulations. At present, the regulatory instruments on UHI and climate change are based on the national decree (issued by the ministry) and several city scale regulations (UH01; UH03; UH04). The preparedness for climate change impact of Bandung is adequately addressed in the RAP-ACC. However, since UHI is not addressed directly in the document, the preparedness for the UHI challenge is rather limited.

#### **4.2.2. Recommendations for Bandung**

Based on the CBF results, Bandung was expected to score relatively high in solid waste treatment while most improvement is needed for wastewater treatment. The GCF analysis result showcases the existing governance conditions (GCs) of the city which can be used to comprehend in on which aspects the city needs to focus. Table 8 shows that the highest score is indeed retained by the GCs for solid waste treatment, while the lowest score is displayed by addressing UHI. The stakeholders in Bandung seemed to realize that solid waste management is crucial also to reduce the cause of flooding in the city (i.e. due to drainage clogging). At the same time, wastewater treatment shows an unforeseen result where it scores higher than expected.

On one hand, Bandung should improve its *continuous learning* GC, where the indicators of *smart monitoring* and *evaluation* are indicated (-) very limiting in all challenges. Likewise, indicator of

*statutory compliance* is limiting *implementing capacity* GC. On the other hand, indicators of *cross-stakeholder learning* and *clear division of responsibilities* encourage Bandung to be a collaborative city to address the challenges.

**Table 8 Summary of governance capacity indicators' scores for Bandung**

	Flood risk	Water scarcity	Solid waste treatment	Wastewater treatment	UHI
1.1 Community knowledge	0	0	+	0	-
1.2 Local sense of urgency	0	0	+	0	-
1.3 Behavioural internalization	0	-	+	-	-
2.1 Information availability	+	0	0	0	-
2.2 Information transparency	+	-	0	0	-
2.3 Knowledge cohesion	0	0	0	0	0
3.1 Smart monitoring	-	-	-	-	-
3.2 Evaluation	-	-	-	-	-
3.3 Cross-stakeholder learning	+	+	+	0	+
4.1 Stakeholder inclusiveness	0	0	+	+	0
4.2 Protection of core values	-	0	+	+	0
4.3 Progress and variety of options	0	0	+	+	-
5.1 Ambitious and realistic management	0	0	+	0	0
5.2 Discourse embedding	0	0	0	0	0
5.3 Management cohesion	0	+	+	0	0
6.1 Entrepreneurial agents	-	0	0	+	0
6.2 Collaborative agents	0	0	+	+	0
6.3 Visionary agents	0	+	+	+	+
7.1 Room to maneuver	-	0	0	0	0
7.2 Clear division of responsibilities	+	+	+	+	+
7.3 Authority	0	0	+	0	-
8.1 Affordability	0	0	0	0	0
8.2 Consumer willingness to pay	0	0	0	0	-
8.3 Financial continuation	-	0	0	0	0
9.1 Policy instruments	0	0	0	0	0
9.2 Statutory compliance	-	-	-	-	-
9.3 Preparedness	0	0	0	-	-
Average score	1,89	1,96	2,37	2,07	1,67

The flooding challenge in Bandung can be cultivated by developing a better use of data and information and by improving learning from various stakeholders. Special attention is required for monitoring and evaluation procedures in program implementation, as well as a more efficient use of policy instruments improvement to better handle flood mitigation. Similarly, water scarcity in Bandung can be approached using cross-stakeholder learning by better exploring roles and expertise. Sharing knowledge and practice will improve access to drinking water for all citizens, as this is currently the main concern of water scarcity.

Solid waste treatment also needs to develop monitoring and evaluation methods for observing progress of the programs' implementation. The current levels of awareness and public participation should be utilized to succeed relevant programs such as waste separation, waste recycling, and waste-to-energy by composting. In the long run, it is also important to address the challenge from its very source, i.e. reducing the amount of solid waste that is being produced. This can be done by replacing the packaging material of used products and educating the society to implement zero food waste in their houses.

Both wastewater treatment and UHI challenges in Bandung are currently not listed as priority within the government agenda. However, the GCF analysis shows that Bandung has the potential for sustainable wastewater management if the CBS programs can be more encouraged. Further efforts are needed to change the public perspective on wastewater management. At the same time, the government is expected to realize the importance of monitoring and evaluation of a program in achieving management ambitions. The UHI challenge in Bandung is supported by the presence of agents of change who realize the importance of preparing cities in mitigating UHI effects, and in a broader scope, climate change adaptation. A clear division of tasks in government agencies is also expected to support the management ambition of Bandung.

### 4.3. Comparison of trends and pressures and city blueprints in six Asian cities

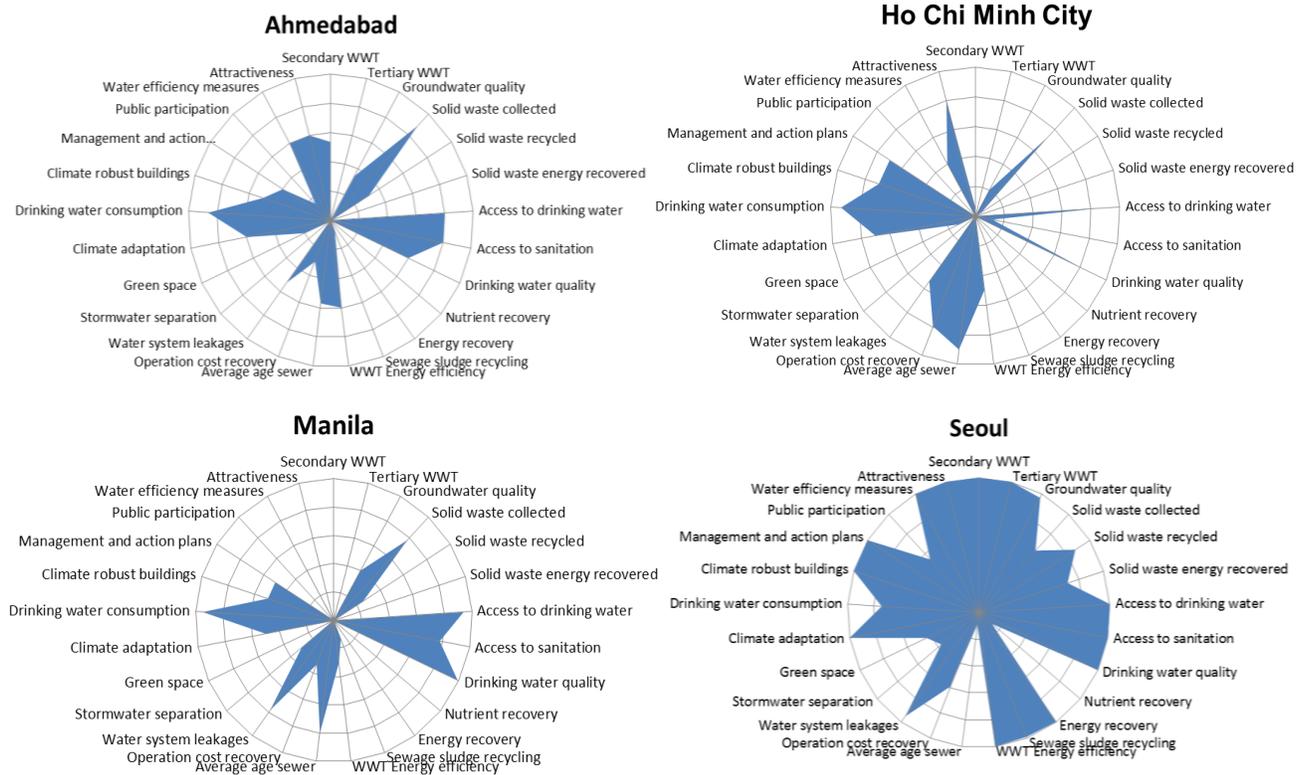
From 62 municipalities in 32 different countries that had been assessed by The City Blueprint® Approach, six of them are located in the Asia region. Besides Bandung and Jakarta, TPF and CBF analyses were conducted for Ahmedabad (India), Ho Chi Minh City (HCMC, Vietnam), Manila (Philippines), and Seoul (South Korea). Table 9 shows that similar trends and pressures are present in different cities in Asia except for Seoul. Five cities face social pressures, particularly coming from the high urbanisation rates, environmental pressure from flooding and heat risk, and financial pressures from the low average GDP and high inflation rates. Meanwhile, Seoul, as the capital city of South Korea only faces *freshwater scarcity* but its average *water scarcity* indicator still results in a medium concern.

**Table 9 Comparison of trends and pressures indicators' scores for the six cities**

Categories	Indicator	Ahmedabad	Bandung	Ho Chi Minh City	Jakarta	Manila	Seoul
Social pressure	Urbanisation rate	3	3	3	3	2	1
	Burden of disease	2	1	1	1	2	0
	Education rate	2	3	1	3	3	0
	Political instability	3	2	2	2	3	2
Environmental pressures	Water scarcity	4	2	2	3	3	2
	Freshwater scarcity	4	1	1	1	2	4
	Groundwater scarcity	4	4	1	4	4	1
	Salinization & seawater intrusion	3	0	3	4	4	0

	Flood risk	2	3	4	4	4	1
	Urban drainage flood	4	4	4	4	4	2
	Sea level rise	0	0	4	4	4	0
	River peak discharges	2	3	4	4	4	0
	flood risk due to subsidence	1	4	4	4	4	0
	Water quality	2	1	1	1	1	1
	Surface water quality	2	1	1	1	0	1
	Biodiversity	1	1	1	1	1	1
	Heat risk	4	4	4	4	4	2
Financial pressure	Economic pressure	3	4	4	4	4	2
	Unemployment rate	0	2	0	2	2	0
	Poverty rate	2	2	3	2	2	0
	Inflation rate	3	3	2	3	1	0
SCORE		2,4	2,4	2,2	2,6	2,5	0,9

	No concern		Low concern		Medium concern		Concern		Great concern
--	------------	--	-------------	--	----------------	--	---------	--	---------------



**Figure 18 Graphic view of City Blueprint Ahmedabad, HCMC, Manila, and Seoul**

Figure 6, 7, and 18 show the spider diagrams (City Blueprints) of six Asian cities. Likewise in the TPF analyses for five Asian cities show comparable performance over seven CBF categories. In particular,

five cities have a similar score in *climate robustness* with relatively low *drinking water consumption* and adequate management of climate adaptation *plans and actions*. There are also differences such as high solid waste generation in Jakarta and low access to sanitation in Manila. HCMC has the highest scores in the *infrastructure* category, notably with the newer installation of the sewerage network. Ahmedabad's performance on solid waste and wastewater treatment also stands out among the five cities. Meanwhile, Seoul performs better in water management compared to the other five Asian cities. Seoul can still improve in two fields: *nutrient recovery* and maintenance as measured by the *average age of the sewer*.

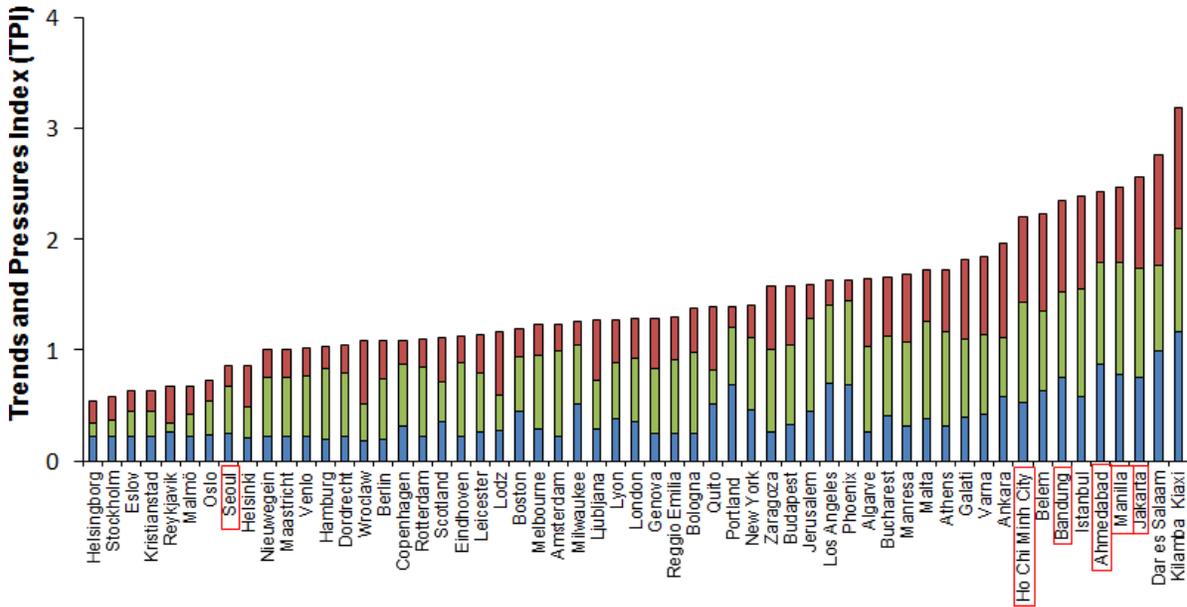


Figure 19 The Trends and Pressures Index of 62 municipalities in 32 countries. The location of six TPI values for the six Asian cities are highlighted in the red boxes

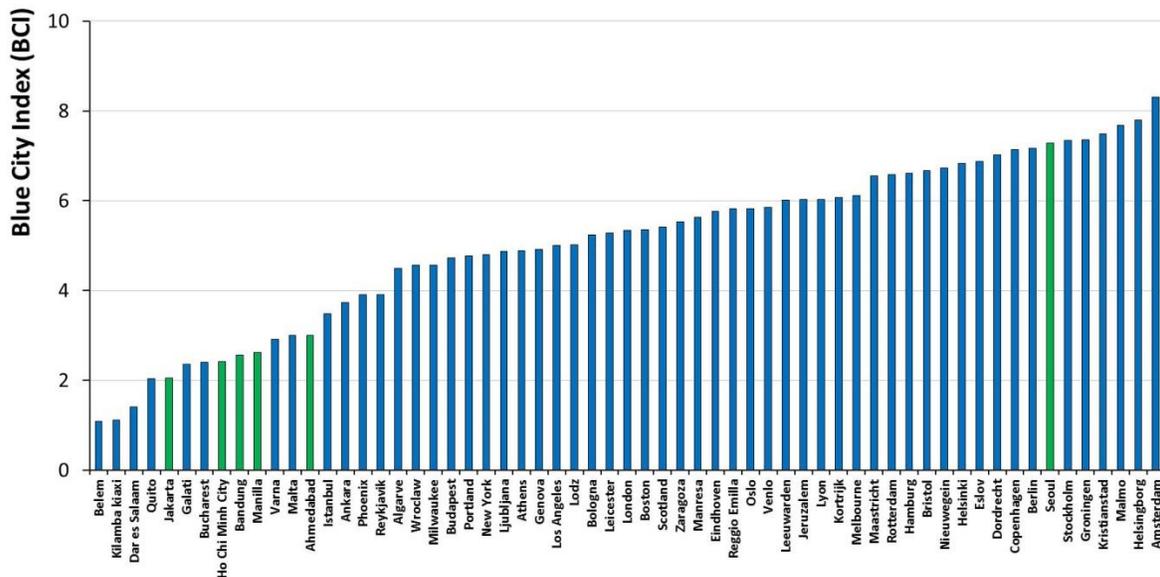


Figure 20 The Blue City Index of 62 municipalities in 32 countries. BCI values for the six Asian cities are highlighted in green

A more global comparison shown in Figure 19 displays that the five Asian cities are clustered within the group of municipalities with high TPIs, whereas Seoul has a similar TPI as Helsinki (Finland) and BCI as Stockholm (Sweden). A comparable cluster is shown by the global overview of BCI scores of the 62 municipalities where the five Asian cities are grouped in the category of cities with high TPI and low BCI scores. These two scores are negatively correlated. In general, municipalities with high trends and pressures scores usually have low BCI scores most probably because they face more constraints and challenges in attaining good water management (Koop & van Leeuwen, 2015a).

The comparison allows Asian cities to identify what they can learn from each other. Ahmedabad performs better in solid waste and wastewater treatment compared to other Asian cities with similar TPI scores. The MSW composition of India is similar to Bandung and Jakarta and consists of 40-60% of organic waste (Gupta, Yadav, & Kumar, 2015). India applies different methods of treating its organic MSW including composting, vermi-composting (using worms to turn organic waste to nutrient rich soil), and the production of biogas (using anaerobic digestion to produce methane and manure from organic waste) (Gupta et al., 2015). Nevertheless, Ahmedabad's main reason to score high in *solid waste collected* is due to the low generation of solid waste compared to European cities. The high score of wastewater treatment in Ahmedabad is also ambiguous since a large proportion of the citizens still lack access to drinking water and sanitation (Koop et al., 2017a). These reasons are comparable to the five Asian cities. Their high scores in some CBF indicators are mainly due to lower scores of the European cities based range used in the score calculation.

The global BCI score overview shows that Seoul is the best performing Asian city (Figure 20). By looking at the TPI scores (Figure 19), it is reasonable to state that that Seoul can achieve such high BCI score because of the relatively low financial, social and environmental pressures compared to other Asian cities. Governance capacities may also be low in these cities, next to their high social and financial pressures. These aspects may limit the efforts that could be exerted by countries, regions and municipalities to improve water management. The result of TPF and CBF analysis in the five cities (Ahmedabad, Bandung, HCMC, Jakarta, and Manila) align with the findings of regional challenges mentioned by (Koop & van Leeuwen, 2016) where Southeast Asia's socio-economic changes put high pressures on the environment. Seoul, on the other hand, displays similar characteristics to OECD countries. In fact, South Korea is an OECD Member State. Water-related policy in South Korea had been dynamically adjusted by ongoing political and economic discussions and arguments between different actors (Hwang, 2017).

#### **4.4. Learning good water governance from the study of Bandung**

Table 8 shows that Bandung's opportunities to improve its water governance are supported by stakeholder learning initiated by the agents of change and a clear division of roles and responsibilities. This general idea is seen most clearly from the solid waste treatment challenge. The masterplan for solid waste treatment is currently the only official document that realistically incorporates the role of diverse stakeholders in the management's bigger picture. Eventually, Bandung may also need to redefine their authorities. Although the city has distinguished institutional roles in each challenge, the

city is still lacking enforcement authorities. The sole institution that is able to impose sanctions towards the violators of prevailing law and regulation is *Satpol PP*, the municipal police.

In the meantime, some unconventional measures were taken to increase the statutory compliance of the public. Besides social sanctions through social media that is widely used, a bureaucracy measure was applied by a leader in one territoriality in the Greater Bandung region who will serve its community only when they practice waste separation (personal communication with West Java Province's Environmental Agency). This type of measures is suitable for a smaller population, and the result is normally for a shorter term effect. Larger populations (e.g. a city's population) usually demonstrates a socio-institutional inertia which hampers the widespread support to implement changes into a new direction (Pihkala, Harmaakorpi, & Pekkarinen, 2007). Institutional inertia is also responsible for prolonging the response toward policy innovation. In a country that applies decentralization, the command powers (e.g. to implement policies) from higher authorities are sometimes lessened at lower levels (Harries & Penning-Rowsell, 2011). In Indonesia, this inertia is promoted by the practice of city officials' rotation from one agencies to another.

Using the result of The City Blueprint®, a transformation process of Bandung is expected to take place. This could be the first step to trigger a long-term science-policy interaction. Although the GCF results shows that cross-stakeholder learning is present for almost all challenges, the available knowledge as the outcome of research has not been fully utilized by the local government. The government usually funds pilot projects, but a long-term implementation of an (unconventional) innovation takes an extra effort. This aspect can be observed from several *indifferent* and *limiting* scores in *progress and variety of options*. From the GCF result, it is also inferred that two indicators of *multi-level network potential GC* (i.e. *room to maneuver* and *authority*) scores mostly indifferent. These two indicators are scored that way since the implementing unit for measures regarding the five water-related challenges is usually a government body. Although decentralization provides lower administrative levels with some degrees of freedom, they are still confined by the central influence. This influence is present as a rigid bureaucracy, which can hamper the ability of local officials to apply innovative measures or policies in their area.

Nevertheless, this can be changed with the help of agents of change within the government bodies. In this very case, Bandung is one example of a city where its major is a technocrat instead of a bureaucrat with a common political career. During his period, the number of government projects which involved researchers is rising. The presence of others agents of change in the city agencies also assist in this improvement, as can be seen in the areas of solid waste and wastewater treatment. A close relationship between the stakeholders is expected to alleviate the government's effort to utilize usable science for policies. Intense communication builds an iteration between the knowledge producer and its target groups (i.e. groups who will apply and get affected by the policy measures) that will enhance the efficiency and usability of the produced knowledge (Dilling & Lemos, 2011). As mentioned by Schreurs et al. (2017), the complexity of the five wicked water challenges in the city asks for an iterative process to improve the state of GCs for attaining the long-term ambitions.

## 5. Discussion

### 5.1 Limitation of the methods and reliability of the results

The main objective of TPF and CBF analysis are mapping the city's challenges and current performance of the measures. However, due to the globally scarce availability of city level data, some indicator are scored with national data which may limit the assessment's accuracy (Koop & van Leeuwen, 2015b). This decision was taken to improve the prospect of city-to-city learning. In a written report, city-specific features can be discussed, for example by relating the indicator of trends and pressures to the city performances.

While the scoring for TPF and CBF analysis is straightforward, the procedure on translating the gathered interview results into GCF scores is amenable. The answers from the interviewees are inferred to determine which one of five likert-type scoring (Appendix II) that suits the indicator the most. To make this study reproducible, a justification report is compiled with a brief explanation for each indicator for each of the five challenges (Appendix III). Based on this reason, the selection of interviewees categories was important to cover the general idea of the GCs in the city. Therefore a stakeholder analysis was conducted in the earlier phase which resulted in the categorisation of government bodies (authorities), private sector, academia, and civil society (Appendix I). However, this study is not able to encompass the perspective from the privates. Several companies and individuals had been contacted during the desk and field research in Bandung, but none of them responded to cooperate. In the justification, the context on private business is provided by the other stakeholders view regarding the matter. At the same time, Tirtawening and PDK are municipal owned companies of which their performances have been assessed based on the profits. This serves an opportunity to understand a part of private's stakes in the urban water challenge.

### 5.2 Solid waste and wastewater challenges in an expanding city

The result of the CBF analyses in the previous chapter shows that five Asian cities can clearly improve in the areas of solid waste and wastewater treatment. It is aligned with the finding in Koop & van Leeuwen (2016) that generalize the water, waste, and climate challenges in Southeast Asian countries. Major improvements are needed regarding their solid waste treatment and water infrastructure. With such large population (Table 10), some of these urban areas still rely on the environment's ability to maintain its own quality. The long embedded discourse in the local society supports the *dilute and dispersed mentality* where people discharge their solid waste and wastewater directly into the environment (e.g. landfill sites and rivers).

**Table 10 The urban population in six Asian cities**

City	Population	Reference
Ahmedabad	7,34 million	Koop et al. (2017a)
Bandung	2,5 million	Tarigan et al. (2016)
Ho Chi Minh City	7,79 million	van Leeuwen, Dan, & Dieperink (2016)
Jakarta	9,8 million	UNDESA (2012)
Manila	11,9 million	UNDESA (2012)
Seoul	9,7 million	UNDESA (2012)

In developing Asian cities, the largest percentage of their MSW ends in a landfill-type disposal site which is considered as the most economical method (Gupta et al., 2015). Landfilling often refers to an open dumping uncontrolled disposal method, which sometimes lacks proper support to prevent leaching or emissions of pollutants from the solid waste piles (Guerrero, Maas, & Hogland, 2013). South Korea used to depend on landfilling but it is promoting the utilization of incineration and recycling. In 2010, 21,6% of their MSW are incinerated and 60,5% are recycled (Min & Rhee, 2014).

Wastewater disposal systems in cities in the developing countries are underdeveloped and include aerated lagoons, septic tanks, and latrines (Varis et al., 2006). The development of WWTPs are taking place globally, but they are unable to keep up with the rapid population growth and urbanization. In Bandung, the difficulty to improve solid waste and wastewater management stems from the embedded public view and confined measures options due to limited resources (e.g. land area and funding). Changing the public view requires a great effort since they are used to the management that unobtrusive, convenient, and requires no significant efforts on their part (Hendrawan et al., 2013). These factors are applicable to other rapidly growing cities, particularly in the developing countries.

**Table 11 The feasibility comparison between recycling and composting treatment (Gupta et al., 2015; Zurbrügg et al., 2012)**

Recycling	Composting
Paper, plastic, and metals are easier to be separated	Reluctance to process organic waste (i.e. kitchen waste)
Low cost technology available	Low cost technology available
Short term process	Long term process
End products are easier to sell	Organic fertilizer has a specific market

In Indonesia, the changes started since the authorities needed to reduce the amount of waste generation that will be disposed in open dumping sites. With the support of a national-level legal instrument (Government Regulation No. 81/2012 about solid waste reduction, reuse, and recycle and Minister of Environment Regulation No 13/2012 about waste banks), waste separation that lead to recycling and composting have been practiced in several cities in Indonesia, including Bandung, Gianyar, Jakarta, and Surabaya (SW04; Dhokhikah, Trihadiningrum, & Sunaryo, 2015; Zurbrügg et al., 2012). The waste banks promote the public willingness to separate their solid waste since they pay the members for their valuable waste (i.e. plastic, metal, paper) (Dhokhikah et al., 2015). Similarly, the rise on the solid waste separation and recycling in other Asian cities are triggered by the presence of poor people who collect recyclable material for living and bigger recycling companies who realize the value of separated solid waste (Guerrero et al., 2013). On the other side, composting is a less popular (Table 11) though the dominant solid waste generation of an expanding city is compostable organic materials. South Korea has a success case of using strict policies to compel its residents to recycle their MSW (i.e. restricted use of disposable products, Volume-Based Waste Fee System, and food waste recycling). In addition, the government also promotes Extended Producer Responsibility (EPR) that invokes producers to consider their products packaging (Min & Rhee, 2014). Nevertheless, the city government still needs to attract financial support for installing and operating city-level composting or recycling units. In the meantime, extra attention should be given to the condition of the final disposal

site where most of these sites are not yet equipped with proper components (e.g. plastic/clay-lined layer) to prevent leachate and landfill (Guerrero et al., 2013).

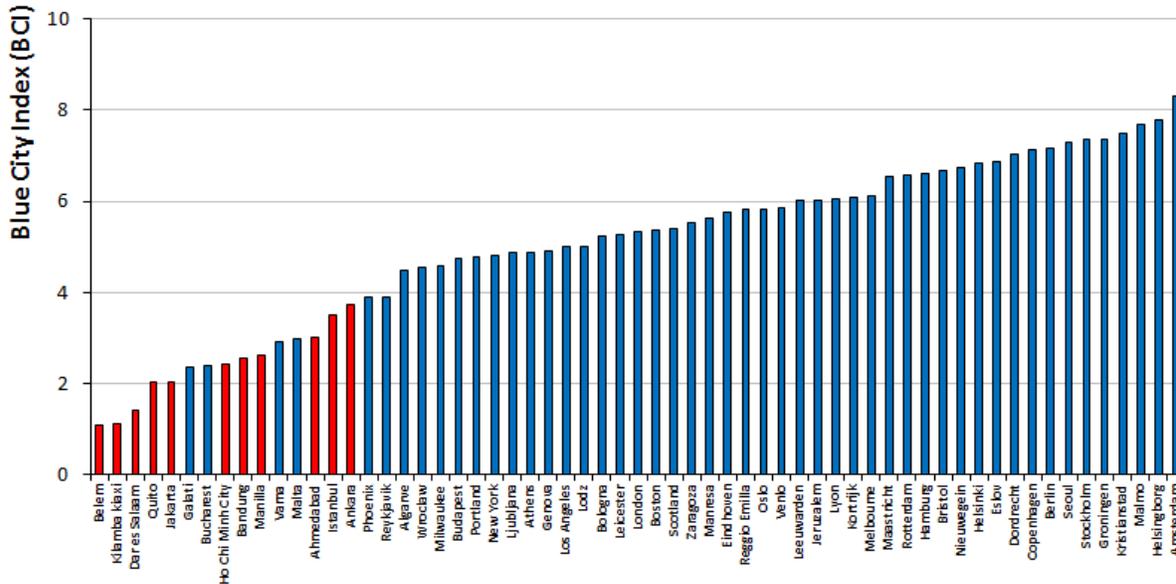
In the recent years, both government and public bodies are more aware of wastewater treatment. The main reason is the visible environmental degradation as well as the emergence of relevant regulations and low-cost sanitation programs with the growing understanding of the benefits of better sanitation and environmental hygiene (Hendrawan et al., 2013). Since then, several WWTPs have been built in Indonesian large cities. However, centralized systems only serve <20% of each city's population and <10% of the national population (ADB, 2013; Hendrawan et al., 2013) with the ongoing quality degradation of the installations (WW02). This off-site centralized treatment has its advantages, particularly when there is a high risk of public health and environmental contamination with uncontrolled on-site treatment using septic tanks or latrines. However, the off-site system relies upon the local regulations, land availability, and financial support. A good drainage network is also required to cover the whole city (Kerstens, Leusbrock, & Zeeman, 2015) and is a very expensive infrastructure (Koop & van Leeuwen, 2016). At the same time, the Indonesian government has introduced the CBS which offers less extensive work and more engagement of the surrounding society. The selected technology to be applied can also be consulted with the locals to embed the *sense of belonging* which expects to increase independent maintenance efforts. Since a CBS unit only covers <100 house connections, the rise in the public willingness to join the program in the future is expected. If the government can promote and assist the practice of CBS programs, it will gain more public interest, even for the slum population, as in the case of Greater Bandung region (Sofyan et al., 2016). Continuous supervision and improvements are needed to ensure the quality of the treatment unit since on-site treatment and CBS systems are known to have comparably low removal efficiencies (Kerstens et al., 2015).

### **5.3 The significance of slum population**

With the current high rates of urbanisation, a recent estimation states that 32,7% of world's population is living in slums (UN-Habitat, 2011). Slum dwellers usually have fewer privileges compared to others. The UN-Habitat defined slum dwellers as the population who live in an area with lack of improved water supply, sanitation, sufficient living area, durable housing, and secure tenure (Varis, 2006). These parts of cities expand with the ongoing urbanisation which results in even more deficiencies of infrastructure and resources. Therefore, slum dwellers are notorious as the most vulnerable members of the society, including in facing climate change impacts (UN-Habitat, 2011). However, slum areas are continuously under-recognised in the discussion of cities' risk and vulnerability (Jamil, 2013). By comparing the percentage of the slum population in cities assessed with The City Blueprint® Approach, an evident relationship is displayed between these populations and the cities' IWRM and climate adaptation performances (Table 12).

**Table 12 The percentage of urban population living in slum in 2014**

City	Country	Slum population	City	Country	Slum population
Belem	Brazil	22,3%	HCMC	Vietnam	27,2%
Kilamba Kiayi	Angola	55,5%	Manila	Philippines	38,3%
Dar es Salaam	Tanzania	50,7%	Ahmedabad	India	29,40%
Quito	Ecuador	36%	Istanbul&Ankara	Turkey	13,00%
Bandung&Jakarta	Indonesia	21,8%			



**Figure 21 The Blue City Index of 61 municipalities in 32 countries. Cities in countries with slum population of >10% are highlighted in red**

The World Bank uses the definition of slum dwellers by the UN Habitat. The data in Table 12 were inferred from The Millennium Development Goals database (The World Bank, n.d.). As shown in Figure 21, the countries with high percentages of slum populations coincide with those with low BCI. At the same time, ND-GAIN website shows that the ten countries with the highest BCI have no slum populations at all in 2015. The slum population indicator is categorized under the health sector that affects the country's vulnerability (ND-GAIN, n.d.). The data of Romania (Galati and Bucharest), Bulgaria (Varna) and Malta are not available in The World Bank or ND-GAIN websites. The slum population in Europe is often associated with Romani people (i.e. gypsies) who live under the poverty line in a substandard and overcrowded house with very limited access to drinking water, sanitation, and electricity. They also have a higher risk of unemployment and stay in school for fewer years (UNDP, n.d.). Many of Romani people are concentrated in Central and Southeastern Europe countries, including Romania and Bulgaria.

Figure 21 shows that the slum population is present in the cities with a BCI score between 0-2 and some with a BCI score between 2-4. Koop & van Leeuwen (2015a) categorized the cities with BCI score of 0-2 as *cities lacking basic water services* where the access of adequate quality of drinking water and

sanitation facilities is insufficient. Meanwhile, cities with BCI score of 2-4 are classified as *wasteful cities* with sufficient basic water services but a lack of wastewater treatment and high flood risk.

This evident connection between slums' percentage and BCI score supports the importance of alleviating the slums' infrastructure to attain better IWRM performance in cities. The effort certainly requires such large financial support while high percentages of slum populations are located in the developing countries. At present, no available method is reliable to accurately estimate the cost needed to fund the measures for slum areas. More importantly, the authorities should review the characteristic of the local slum (e.g. city level) and recognize the local resources for designing the fitting measures (UN-Habitat, 2011). Presumably, some resources will be available from the slum itself since its population in developing countries comprises the largest part of the informal sector that plays a significant role in urban economic development (Jamil, 2013). This review result can help the local authorities to improve the awareness of their problem which may lead to the accurate use of potential external financial support.

Nevertheless, the management of slum population is multidimensional. Besides improving the infrastructure, other aspects also need to be fostered. In several cases, local authorities had attempted to provide the desirable accommodation, but the residents opted to stay (Jamil, 2013). The slum dwellers have the reluctance to be relocated since they are already depended on the current living situation. Some novel approaches have been proposed to the local authorities to increase the engagement level from the residents, including legalising of slum areas (Tarigan et al., 2016). This approach can provide slum dwellers with a *sense of belonging* and security which is aligned with the spirit of NUA from the latest UN Habitat Quito Conference in designing sustainable and inclusive cities (Birch, 2016; HCC, n.d.).

#### **5.4 The trend of community movement to enhance urban water governance**

The GCF result of Bandung features the role of communities as the agents of change to support the management of the city. In Indonesia, these grass-root movements identifies themselves as a civil society (i.e. community) rather than non-government organizations (NGOs) where the latter refers to big and established organisations. The city of Bandung is renowned for its large number yet diverse civil society. It is also one of the pioneer cities in the development of environmental communities along with other large cities in Indonesia (Suharko, 2015) where talents and autonomous financial resources are more concentrated (UN-Habitat, 2011). While four communities (*Elingan, Jagaseke, Greeneration, Earth Hour Bandung*) are interviewed in this study as the representatives for relevant stakeholders, other communities are identified as well. These communities collectively work together, also with the government, to address the five water-related challenges.

Although early environmental movements were inaugurated in the Western industrialized countries, they are now developed as a global effort that deals with diverse environmental issues. These movements conduct environmental actions (e.g. raising awareness and providing relevant information for education) and delve into policy advocacy (Mol, 2009; Suharko, 2015). Despite their practical role

to connect the government, public, and private sector, the scientific literature on this linkage is limited to the specific function of large NGOs which perform advocacy in environment conservation (Suharko, 2015). In the meantime, smaller communities aim for smaller but more accurate targets. Similar characteristics are found in the young global justice activists where it evolves a commitment to horizontal-networked organisations using creative action such as the utilisation of information and communication technologies (ICTs) (Juris & Pleyers, 2009). In other words, such communities are usually more open and collaborative, as observed in the case of Bandung. These communities have the potential to expand the public engagement toward the city's management plan using ICT (i.e. online social media) platforms, also called social digital platforms.

As part of their role as mediator between other stakeholders, these civil societies also represent the interests and core values of marginalized citizens, such as slum dwellers. In large cities where two contrasting images of slums and developed areas coexist, negotiations across different groups of the society and the government are needed. While the communities in Bandung have some degree of freedom to translate these interests into actions (FL03; FL04), the communities in HCMC are somewhat desolated due to the lack of institutional conditions (i.e. the GCs) for development (Mol, 2009). This difference shows that the communities' effort in bridging the interests needs the cooperation from other stakeholders, particularly the government. Supportive authorities will gain benefits to achieve the city's ambitions by collaborating with these communities.

## **5.5 Water governance challenge in Asian developing countries**

Since the enactment of Law No. 7/2004, which is now revoked, Indonesia had implemented IWRM by assigning the function to manage the river basin to a fit-for-purpose group, especially in Java basins. This institutional arrangement is still learning about the trading-off between river basin management and public administration authority (Fulazzaky, 2014). In Bandung, although the GCF analysis result indicates a clear division of roles and responsibilities, it mostly applies to city-level authorities. Whereas some overlaps yet exist between the administrative authorities (e.g. the local government of Bandung) and river basins (e.g. CRBC). The results of the GC analyses also disclose that the government owns the key role to manage its city as can be observed from other stakeholders' dependency on the government's approval. Researchers will most likely produce practical knowledge for the city when they work in a governmental project. Also, the communities mention that government support is needed to coordinate the scattered results using smaller scale approaches. In Bandung and Surabaya cases, the cities' performances very much reflect the initiative of the leaders (i.e. city majors).

According to the constitution, the government of Indonesia is indeed responsible for management of the natural resources for public goods, which is common for Asian developing countries. In Vietnam, the lack of government accountability and transparency contribute to the less integrated strategy and action plan for the nation's water sector (van Leeuwen, Dan, & Dieperink, 2016). Due to this condition, such inevitable gaps may prevail between the government and the other relevant stakeholders. While these challenges are more apparent in the developing countries, these governance gaps are admitted

by the OECD as the core problem of managing the water sector (Figure 1; OECD, 2015a). The GCF analysis was added to The City Blueprint® Approach to address these gaps. The results of the GCF analysis can be used to integrate the governance gaps, barriers, and capacities, to communicate available information for relevant stakeholders, and to comparing practical knowledge amongst cities (Koop et al., 2017b). The definite aim is to disclose such efficient pathways for the cities to improve their capacities in performing urban water management. A range of options is expected to be available as potential pathways since specific and rigid measures will affect the institutional inertia on the longer term. Narrowly defined policies will impede the adaptability of the society in responding to possible changes in the future (Harries & Penning-Rowsell, 2011).

Good water governance should also be capable of avoiding the wrong way of implementing IWRM. In many cases IWRM implementation became the final objective instead of the measure used to achieve sustainable water management. IWRM practices in some regions even blocked the existing opportunity and ignored the real priorities, which worsened the water sector's quality (Giordano & Shah, 2014). Therefore, the identification of background trends and pressures, existing performances, and potential improvements of the overall governance capacity will provide the detailed conditions for a specific area. In addition, The City Blueprint® Approach transparently introduced and communicated the results of many cities. This learning alliance facilitates other cities to do a *reverse engineering* where one could learn from other cities' practices by determining their reasons and methods in completing transformations successfully. The same approach of *reverse engineering* can be applied to learn from the others' failure in managing their major water challenges (Tortajada, 2010). Subsequently, the city is expected to tailor such fit-for-purpose measures on addressing its urban water challenges.

## 6. Conclusions

Population growth and urbanisation increase the percentage of urban dwellers in the world. In cities, it means increasing demands for water and sanitation, next to the uncertainties caused by climate change. While IWRM is known globally to address these challenges, the implementations are sometimes hampered by water governance challenges (OECD, 2015a). This study is designed to depict the urban water challenges in Asian cities along with their potential for improvisation. By selecting the water governance challenges in Bandung (Indonesia), this study answers the following research question: *What are the gaps and opportunities for the large Indonesian cities to improve their capacity to manage and govern the long-term challenges of too much, too little, and too polluted water and how it adds usable knowledge of urban water challenges in Asian cities?*

This study identified the challenges and priorities of urban water management in two large cities in Indonesia. High socio-economic and environmental pressures result in their UWCS management that focuses on improving basic water services. Using the case of Bandung, several points of improvement for water governance capacities were made. In general, the city needs to: 1) Alleviate their monitoring and evaluation systems as the references for many coming decisions; 2) Improve the statutory compliance toward the arranged legislation, policies, and agreements; 3) Further benefit of the interaction between the stakeholders in Bandung; and 4) Utilize the additional supports from the regional and national governments efficiently. Bandung GCs score the highest in solid waste treatment. It is critical since the management of solid waste is very relevant to the flooding in the city.

The study of Bandung is relevant for other four developing Asian cities assessed by The City Blueprint® Approach, i.e. Ahmedabad, HCMC, Jakarta, and Manila. These five cities share similar trends, pressures, and performances which made the cities can opt for and successfully implement similar measures. Nevertheless, translating these results of scientific analyses into practical policies was found as rather complicated due to the socio-institutional inertia. This study revealed that the presence of the agents of changes and the intense communication between stakeholders could trigger changes in the science-policy interaction (Dilling & Lemos, 2011).

The discussion of this study added valuable insight of the significance of slum population toward the solid waste and wastewater management in developing cities. With the main limitations of lacking available land and financial resources, cities need to utilize instruments and policies to change the embedded public view about the management. Accordingly, this study showed that the cities with low BCI have the larger percentage of urban slum population compared to the others. This evident reason calls for global attention for designing sustainable and inclusive cities (Birch, 2016; HCC, n.d.). In this context, the civil society (i.e. community) can represents the interests of marginalized citizens. However, the key role of the city management in developing countries is usually retained with the government. The information from The City Blueprint® Approach is expected to bridge the gaps by communicating the available information to all relevant stakeholders.

## References

- Abidin, H. Z., Gumilar, I., Andreas, H., Murdohardono, D., & Fukuda, Y. (2013). On causes and impacts of land subsidence in Bandung Basin, Indonesia. *Environmental Earth Sciences*, 68(6), 1545–1553. <https://doi.org/10.1007/s12665-012-1848-z>
- ADB. (2013). *Indonesia Water supply and sanitation sector assessment, strategy and road map*. Metro Manila: Asian Development Bank.
- ADB. (2016). *River Basin Management Planning in Indonesia Policy and Practice*. Metro Manila: Asian Development Bank.
- Akanda, A. S., & Hossain, F. (2012). The climate-water-health nexus in emerging megacities. *Eos*, 93(37), 353–354. <https://doi.org/10.1029/2012EO370001>
- Bai, M., Zhou, S., Zhao, M., & Yu, J. (2017). Water Use Efficiency Improvement against a Backdrop of Expanding City Agglomeration in Developing Countries—A Case Study on Industrial and Agricultural Water Use in the Bohai Bay Region of China. *Water*, 9(2), 89. <https://doi.org/10.3390/w9020089>
- Bappeda. (2011). *Rencana tata ruang wilayah kota Bandung 2011-2031 [Urban spatial planning of Bandung 2011-2031]*. Available on-demand and in Indonesian language only.
- Bappeda. (2013). *Rencana pembangunan jangka menengah daerah kota Bandung 2013-2018 [Regional intermediate-term development plan of Bandung 2013-2018]*. Available on-demand and in Indonesian language only.
- Bappeda. (2014). *RISPAM Kota Bandung [Bandung's Masterplan of Water Supply Provision]*. Available on-demand and in Indonesian language only.
- BECA. (2014). *Laporan masterplan persampahan [The masterplan of solid waste management]*. Available on-demand and in Indonesian language only.
- Birch, E. L. (2016). A Midterm Report: Will Habitat III Make a Difference to the World's Urban Development? *Journal of the American Planning Association*, 82(4), 398–411. <https://doi.org/10.1080/01944363.2016.1216326>
- BSHALPA. (2016). *Mengenal Sanitasi Berbasis Masyarakat Islamic Development Bank (Sanimas-IDB) Kota Bandung [Introducing Community Based Sanitation with Islamic Development Bank (Sanimas-IDB) of Bandung]*. Available on-demand and in Indonesian language only.
- CCROM. (2017). *Draft RAD-API Kota Bandung [The Draft of RAP-ACC for Bandung]*. Available on-demand and in Indonesian language only.
- Dhokhikah, Y., Trihadiningrum, Y., & Sunaryo, S. (2015). Community participation in household solid waste reduction in Surabaya, Indonesia. *Resources, Conservation and Recycling*, 102, 153–162. <https://doi.org/10.1016/j.resconrec.2015.06.013>

- Dilling, L., & Lemos, M. C. (2011). Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. *Global Environmental Change*, 21(2), 680–689. <https://doi.org/10.1016/j.gloenvcha.2010.11.006>
- Dipa, A. (2014, September 1). Bandung govt urged to scrap waste incinerator technology plans. *The Jakarta Post*. Retrieved March 9, 2017 from <http://www.thejakartapost.com/news/2014/09/01/bandung-govt-urged-scrap-waste-incinerator-technology-plans.html>
- Diskamtam. (2015). RTH (ruang terbuka hijau) kota bandung [Green spaces in Bandung City]. Retrieved March 7, 2017, from <http://diskamtam.bandung.go.id/ruang-terbuka-hijau>
- Douglass, M. (2010). Globalization, Mega-projects and the Environment. *Environment and Urbanization ASIA*, 1(1), 45–65. <https://doi.org/10.1177/097542530900100105>
- EIP Water. (2016a). *INDICATORS OF THE CITY BLUEPRINT FRAMEWORK*. Retrieved March 7, 2017 from [http://www.eip-water.eu/City\\_Blueprints](http://www.eip-water.eu/City_Blueprints)
- EIP Water. (2016b). *INDICATORS OF THE GOVERNANCE CAPACITY FRAMEWORK*. Retrieved March 7, 2017 from [http://www.eip-water.eu/City\\_Blueprints](http://www.eip-water.eu/City_Blueprints)
- EIP Water. (2016c). *INDICATORS OF THE TRENDS AND PRESSURES FRAMEWORK*. Retrieved March 7, 2017 from [http://www.eip-water.eu/City\\_Blueprints](http://www.eip-water.eu/City_Blueprints)
- Elyda, C. (2016). Jakartans lacking access to clean water. *The Jakarta Post*. Retrieved March 9, 2017 from <https://www.pressreader.com/indonesia/the-jakarta-post/20161029/281633894786322>
- Erkens, G., Bucx, T., Dam, R., de Lange, G., & Lambert, J. (2015). Sinking coastal cities. *Proceedings of the International Association of Hydrological Sciences*, 372, 189–198. <https://doi.org/10.5194/piahs-372-189-2015>
- Firman, T. (2009). The continuity and change in mega-urbanization in Indonesia: A survey of Jakarta-Bandung Region (JBR) development. *Habitat International*, 33(4), 327–339. <https://doi.org/10.1016/j.habitatint.2008.08.005>
- Fulazzaky, M. (2014). Challenges of Integrated Water Resources Management in Indonesia. *Water*, 6(7), 2000–2020. <https://doi.org/10.3390/w6072000>
- Giordano, M., & Shah, T. (2014). From IWRM back to integrated water resources management. *International Journal of Water Resources Development*, 30(3), 364–376. <https://doi.org/10.1080/07900627.2013.851521>
- González-Gómez, F., & Ángel, M. (2008). Efficiency in the management of urban water services. What have we learned after four decades of research? *Hacienda Pública Española*, 39–67. Retrieved from <http://dialnet.unirioja.es/servlet/articulo?codigo=2870250&info=resumen&idioma=ENG>

- Grigg, N. S. (2008). Integrated water resources management: balancing views and improving practice. *Water International*, 33(3), 279–292. <https://doi.org/10.1080/02508060802272820>
- GSC3. (n.d.). Global Smart City & COmmunity Coalition - Bandung. Retrieved February 14, 2017, from <https://gsc3.city/cities/indonesia/bandung/>
- Guerrero, L. A., Maas, G., & Hogland, W. (2013). Solid waste management challenges for cities in developing countries. *Waste Management*, 33(1), 220–232. <https://doi.org/10.1016/j.wasman.2012.09.008>
- Gupta, N., Yadav, K. K., & Kumar, V. (2015). A review on current status of municipal solid waste management in India. *Journal of Environmental Sciences (China)*, 37, 206–217. <https://doi.org/10.1016/j.jes.2015.01.034>
- Harries, T., & Penning-Rowsell, E. (2011). Victim pressure, institutional inertia and climate change adaptation: The case of flood risk. *Global Environmental Change*, 21(1), 188–197. <https://doi.org/10.1016/j.gloenvcha.2010.09.002>
- HCC. (n.d.). Human Cities Coalition. Retrieved June 20, 2017, from <https://www.humancities.co/>
- Hendrawan, D., Sulistyoweni Widarnako, M., Sarwanto Moersidik, S., & Wahyudi Triweko, R. (2013). Evaluation of centralized WWTP and the need of communal WWTP in supporting community-based sanitation in Indonesia. *European Scientific Journal*, 9(17), 1857–7881.
- Hwang, J.T. (2017). Changing South Korean Water Policy after Political and Economic Liberalisation. *Journal of Contemporary Asia*, 47(2), 225–246. <https://doi.org/10.1080/00472336.2016.1266014>
- Jamil, S. (2013). Connecting the Dots: The Urban Informal Sector and Climate Vulnerabilities in Southeast Asia's Megacities. *NTS Alert*. Retrieved from <http://www.rsis.edu.sg/nts/HTML-Newsletter/Alert/pdf/NTS-Alert-1301.pdf>
- Juris, J. S., & Pleyers, G. H. (2009). Alter-activism: emerging cultures of participation among young global justice activists. *Journal of Youth Studies*, 12(1), 57–75. <https://doi.org/10.1080/13676260802345765>
- Kerstens, S. M., Leusbrock, I., & Zeeman, G. (2015). Feasibility analysis of wastewater and solid waste systems for application in Indonesia. *Science of the Total Environment*, 530–531, 53–65. <https://doi.org/10.1016/j.scitotenv.2015.05.077>
- Koop, S. H. A., Aartsen, M., Goswami, B., Oost, J., Schmidt, C., & van Leeuwen, C. (2017). City blueprint approach: key opportunities for India's urban water challenges. *The Water Digest*, 66–73.
- Koop, S. H. A., & van Leeuwen, C. J. (2015a). Application of the Improved City Blueprint Framework in 45 Municipalities and Regions. *Water Resources Management*, 29(13), 4629–4647. <https://doi.org/10.1007/s11269-015-1079-7>

- Koop, S. H. A., & van Leeuwen, C. J. (2015b). Assessment of the Sustainability of Water Resources Management: A Critical Review of the City Blueprint Approach. *Water Resources Management*, 29(15), 5649–5670. <https://doi.org/10.1007/s11269-015-1139-z>
- Koop, S. H. A., & van Leeuwen, C. J. (2016). The challenges of water, waste and climate change in cities. *Environment, Development and Sustainability*, 1–34. <https://doi.org/10.1007/s10668-016-9760-4>
- Koop, S. H. A., Koetsier, L., Doornhof, A., Reinstra, O., Van Leeuwen, C. J., Brouwer, S., Dieperink, C., & Driessen, P. P. J. (2017). Assessing the Governance Capacity of Cities to Address Challenges of Water, Waste, and Climate Change. *Water Resources Management*, 1-17.
- Martiyanti, E. (2016). RTH di DKI capai 9.896,8 hektare [Green spaces in Jakarta reach 9.896,8 hectares]. Retrieved March 7, 2017, from [http://www.beritajakarta.com/read/37844/RTH\\_di\\_DKI\\_Capai\\_98968\\_Hektare](http://www.beritajakarta.com/read/37844/RTH_di_DKI_Capai_98968_Hektare)
- Min, D. K., & Rhee, S. W. (2014). Management of Municipal Solid Waste in Korea. In A. Pariatamby & M. Tanaka (Eds.), *Municipal Solid Waste Management in Asia and the Pacific Islands* (pp. 173-194). Singapore: Springer.
- Moersidik, S., Arifin, R., Soesila, E., Hartono, D., & Latief, Y. (2015). Project portfolio management to increase PDAM Tirtawening's service coverage area. In C. Brebbia (Ed.), *Water Resources Management VIII* (p. 65). Southampton: WIT Press. <https://doi.org/10.2495/WRM150061>
- Mol, A. P. J. (2009). Environmental governance through information: China and Vietnam. *Singapore Journal of Tropical Geography*, 30(1), 114–129. <https://doi.org/10.1111/j.1467-9493.2008.00358.x>
- Nastiti, A., Primasuri, W. A., Setiani, B., Sudrajat, A., Latifah, I., Roosmini, D., ... Meijerink, S. (2013). WATER AND SANITATION IN URBAN SLUM: A CASE FROM BANDUNG MUNICIPALITY, WEST JAVA, INDONESIA. In *The Second International Conference on Sustainable Infrastructure and Built Environment*. Bandung. Retrieved from <http://repository.uibn.ru.nl/handle/2066/135242>
- ND-GAIN. (n.d.). The Notre Dame Global Adaptation Initiative (ND-GAIN). Retrieved June 20, 2017, from <http://index.gain.org/about>
- OECD. (2015a). OECD Principles on Water Governance. Retrieved February 5, 2017, from <https://www.oecd.org/cfe/regional-policy/OECD-Principles-on-Water-Governance-brochure.pdf>
- OECD. (2015b). *Water and Cities Ensuring Sustainable Futures* (OECD Studi). Paris: OECD Publishing. <https://doi.org/10.1787/9789264230149-en>
- OECD. (2016). *Green Growth in Bandung, Indonesia* (OECD Green). Paris: OECD Publishing. <https://doi.org/http://dx.doi.org/10.1787/9789264264113-en>

- Paramita, B., & Fukuda, H. (2014). Heat intensity of urban built environment in hot humid climate region. *American Journal of Environmental Sciences*, 10(3), 210–218. <https://doi.org/10.3844/ajessp.2014.210.218>
- Pihkala, T., Harmaakorpi, V., & Pekkarinen, S. (2007). The role of dynamic capabilities and social capital in breaking socio-institutional inertia in regional development. *International Journal of Urban and Regional Research*. <https://doi.org/10.1111/j.1468-2427.2007.00757.x>
- Prihandrijanti, M., & Firdayati, M. (2011). Current Situation and Considerations of Domestic Waste-water Treatment Systems for Big Cities in Indonesia (Case Study: Surabaya and Bandung). *Journal of Water Sustainability*, 1(2), 97–104.
- Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H., & Stringer, L. C. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of Environmental Management*, 90(5), 1933–1949. <https://doi.org/10.1016/j.jenvman.2009.01.001>
- Rogers, P., Hall, A. W., Van de Meene, S. J., Brown, R. R., & Farrelly, M. (2003). Effective Water Governance Global Water Partnership Technical Committee (TEC). *Global Environmental Change* (Vol. 21). <https://doi.org/10.1016/j.gloenvcha.2011.04.003>
- Schreurs, E., Koop, S., & van Leeuwen, K. (2017). Application of the City Blueprint Approach to assess the challenges of water management and governance in Quito (Ecuador). *Environment, Development and Sustainability*. <https://doi.org/10.1007/s10668-017-9916-x>
- Sofyan, I., Soewondo, P., Kunaefi, T. D., & Handajani, M. (2016). Community-Managed Decentralized Sanitation in the Greater Bandung Slum Areas. *Asian Journal of Water Environment*, 3(1), 14–31. Retrieved from [www.geneares.org/archive.html](http://www.geneares.org/archive.html)
- Suharko. (2015). The success of youth-oriented environmental NGO: A case study of Koalisi Pemuda Hijau Indonesia. *Asian Social Science*, 11(26), 166–177. <https://doi.org/10.5539/ass.v11n26p166>
- Sun, G., Michelsen, A. M., Sheng, Z., Fang, A. F., Shang, Y., & Zhang, H. (2015). Featured Collection Introduction: Water for Megacities - Challenges and Solutions. *Journal of the American Water Resources Association*, 51(3), 585–588. <https://doi.org/10.1111/1752-1688.12317>
- Tarigan, A. K. M., Sagala, S., Samsura, D. A. A., Fiisabilillah, D. F., Simarmata, H. A., & Nababan, M. (2016). Bandung City, Indonesia. *Cities*, 50, 100–110. <https://doi.org/10.1016/j.cities.2015.09.005>
- The World Bank. (n.d.). Population living in slums (% of urban population). Retrieved June 20, 2017, from <http://data.worldbank.org/indicator/EN.POP.SLUM.UR.ZS>
- Tirtawening. (2012). Cakupan pelayanan air limbah [Wastewater treatment service's coverage]. Retrieved February 5, 2017, from [http://www.pambdg.co.id/new/index.php?option=com\\_content&view=article&id=61&Itemid=76](http://www.pambdg.co.id/new/index.php?option=com_content&view=article&id=61&Itemid=76)

- Tortajada, C. (2010). Water Governance: Some Critical Issues. *International Journal of Water Resources Development*, 26(2), 297–307. <https://doi.org/10.1080/07900621003683298>
- UNDESA. (2012). *World Urbanization Prospects: The 2011 Revision*. New York: United Nations Department of Economic and Social Affairs. <https://doi.org/10.2307/2808041>
- UNDP. (n.d.). Roma data. Retrieved June 20, 2017, from <http://www.eurasia.undp.org/content/rbec/en/home/ourwork/sustainable-development/development-planning-and-inclusive-sustainable-growth/roma-in-central-and-southeast-europe/roma-data.html>
- UN-Habitat. (2011). *Global Report on Human Settlements 2011. Cities and Climate Change*. <https://doi.org/10.1787/9789264091375-en>
- UN-Habitat. (2016). The New Urban Agenda. Retrieved February 5, 2017, from <https://www.habitat3.org/the-new-urban-agenda>
- Van Leeuwen, C. J., Dan, N. P., & Dieperink, C. (2016). The challenges of water governance in Ho Chi Minh City. *Integrated Environmental Assessment and Management*, 12(2), 345–352. <https://doi.org/10.1002/ieam.1664>
- Van Leeuwen, C. J., Koop, S. H. A., & Sjerps, R. M. A. (2016). City Blueprints: baseline assessments of water management and climate change in 45 cities. *Environment, Development and Sustainability*, 18(4), 1113–1128. <https://doi.org/10.1007/s10668-015-9691-5>
- Varis, O. (2006). Megacities, Development and Water. *International Journal of Water Resources Development*, 22(2), 199–225. <https://doi.org/10.1080/07900620600648399>
- Varis, O., Biswas, A. K., Tortajada, C., & Lundqvist, J. (2006). Megacities and Water Management. *International Journal of Water Resources Development*, 22(2), 377–394. <https://doi.org/10.1080/07900620600684550>
- Winarso, H. (2010). Urban Dualism in the Jakarta Metropolitan Area. In A. Sorensen & J. Okata (Eds.), *Megacities: urban form, governance, and sustainability* (pp. 163–191). Springer Science & Business Media.
- Zurbrügg, C., Gfrerer, M., Ashadi, H., Brenner, W., & Küper, D. (2012). Determinants of sustainability in solid waste management - The Gianyar Waste Recovery Project in Indonesia. *Waste Management*, 32(11), 2126–2133. <https://doi.org/10.1016/j.wasman.2012.01.011>

## Appendix I The Stakeholder Analysis

According to Reed et al. (2009), different approaches can be applied to carry out a stakeholder analysis. Either using descriptive, normative, or instrumental rationale, stakeholder analysis process are categorized into three steps mentioned in materials and methods chapter. Reed et al. (2009) represents some methods for each analysis step below:

1. Identify stakeholders
  - Focus group
  - Semi-structured interviews
  - Snowball sampling
2. Categorize stakeholders
  - Analytical (top down)
    - Interest-influences matrices
    - Radicalness
  - Reconstructive (bottom up)
    - Stakeholder led
    - Q method
3. Investigate the relationships
  - Actor linkage matrices
  - Social network analysis
  - Knowledge mapping

In this study, the identification of stakeholders was prepared based on literature review and expert opinion (using communication via email). Likewise, the categorization was made based on the same consideration. During the period of research in Bandung, the first step was to have discussion with the city coordinator (representative of BECA, Ir. Lita Endang S., M.Si.). Bandung was going through institutional change with the new organization structure and working procedure in January 2017. Therefore, many roles and responsibilities of the government agencies were changed. The categories of stakeholders and selection of interviewees (Table 6) were finalized in Bandung with the help of the city coordinator and interviewees.

### Stakeholder identification: list of known stakeholders

No	Stakeholders	Flooding	Water scarcity	Solid waste treatment	Waste-water treatment	UHI	Notes
1	Bandung's Environment and Cleanliness Agency						-Initiator of biopores program -Monitor many parameters, to ensure the environment quality
2	Tirtawening						-Responsible for drinking water system and centralized in the city -Also owns three fecal transportation trucks
3	PD Kebersihan						Responsible for solid waste management
4	Resilience Development Initiative (RDI)						Institution /organization with various focus of research
5	Bandung's Fire and						-Has important role during the event

	Disaster Mitigation Agency						of flooding -Acts as the field coordinator for evacuation during any disaster together with Disaster Mitigation Agency in Province level (Bandung does not have one)
6	Indonesian Center of Research and Development for Water						Institution /organization with various focus of water-related research
7	Bandung's Health Agency						Division of Environmental Health conducts test for drinking water quality
8	Bandung's Public Work Agency						Implementer unit for building infrastructures in the city, including water-related one
9	Bandung's Settlements, Housing Area, Land, and Parks Agency						Responsible for citizens' housing and infrastructure (esp. in low income households)
10	Bappeda (Regional Development Planning Board) - City-level - Province level						The main land use regulator in Bandung
11	Bandung Institute of Governance Studies						Institution /organization with various focus of research
12	Bandung Institute of Technology						Institution /organization with various focus of research
13	Indonesian Center of Groundwater Resources and Environmental Geology						-Groundwater monitoring -Groundwater utilization and exploitation
14	GDKPI						NGO - Reducing plastic waste
15	YPBB						NGO - Zero Waste Lifestyle
16	BRIL. ( <i>Bandung Raya Indah Lestari</i> )						The winner of planned waste-based power plant tender in Gedebage, Bandung
17	Bandung's Integrated Permits Service						Including issuing permission to build something in the city for residential or commercial
18	Bandung's Cemetery and Parks Agency						Green space management*
19	Directorate of Environmental and Geology (under Indonesian Ministry of Energy and Mineral Resources)						-Groundwater monitoring in cooperation with provincial mining agency (e.g. static levels, extraction rate) -Groundwater zoning (recommendation)
20	Cita Citarum Project Implementer (under CRBC)						IWRM based projects in Citarum basin
21	Citarum River Basin						Besides Cita Citarum, the institution

	Council						has other IWRM based projects in Citarum basin
22	Flood Mitigation Task Force (under Bandung's municipality)						Work together with Bandung's Fire and Disaster Mitigation Agency during the event of flooding
23	Indonesian Agency of Meteorology, Climatology, and Geophysics						Measure temperature, precipitation, and other meteorological parameters on daily basis
24	Territorialities						Local people
25	Civil Society Organizations (CSOs)						Representatives of local people
26	CSR programs of commercial/private bussiness						Provide funding for pilot projects (of government or private initiatives)
27	Bottled water companies, water vendors						Provide drinking water in packages
28	Water intensive industries (i.e textiles)						-Usually use groundwater for production -Bigger scale industries are complied to own treatment plants -Medium/small scales industries are less-monitored

### Stakeholders categorization

#### *Authorities* (governmental bodies/agencies)

- regulator
- implementer
- evaluator

#### *Private sector*

- service suppliers
  - officially cooperated with government
  - not officially cooperated with government
- technology suppliers

#### *Academia*

- Research institution
- Universities

#### *Civil society*

- NGOs & CSOs
- Local communities
- Pressure groups
- Media

## Appendix II Governance Capacity Framework

This document provides the method for the application of the Governance Capacity Framework (GCF). It includes the pre-defined questions as the core of interview questions and the likert score chart for each indicator.

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

## Condition 1: Awareness

Awareness refers to the understanding of causes, impact, scale and urgency of the water challenge.

### Indicator 1.1: Community knowledge

**Predefined question:** To what extent is knowledge regarding the current and future risks, impacts, and uncertainties of the water challenge dispersed throughout the community and local stakeholders which may results in their involvement in decision-making and implementation?

<b>++</b>	<b>Balanced awareness</b>	Nearly all members of the community are aware of and understand the actual risks, impacts and uncertainties. The water challenge is addressed the local level. Local communities and stakeholders are familiar with or are involved in the implementation of adaptation measures
<b>+</b>	<b>Overestimation</b>	The community is knowledgeable and recognize the many existing uncertainties. Consequently, they often overestimate the impact and probability of incidents or calamities. The water challenge has been raised at the local political level and policy plan may be co-developed together with local communities
<b>0</b>	<b>Underestimation</b>	Most communities have a basic understanding of the water challenge. However the current risks, impacts and frequencies are often not fully known and underestimated. Future risks, impacts and frequencies are often unknown. Some awareness has been raised amongst or is created by local stakeholders and communities
<b>-</b>	<b>Fragmented knowledge</b>	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
<b>--</b>	<b>Ignorance</b>	The community, local stakeholders and decision-makers are unaware or ignore the water challenge. This is demonstrated by the absence of articles on the issue in newspapers, on websites or action groups addressing the issue

### Five most consulted sources

Van Aalst MK, Cannon T and Burton I (2008) Community level adaptation to climate change: The potential role of participatory community risk assessment. *Glob Environ Chang* 18:165-179

Adger WN, Dessai S, Goulden M, Hulme M, Lorenzoni I, Nelson DR, Naess LO, Wolf J and Wreford A (2009) Are there social limits to adaptation to climate change? *Clim Chang* 93:335-354

Ballard A (2008) *Adaptive Capacity Benchmarking: A Handbook and Toolkit*. Hungerford, UK Berkshire  
Gifford R (2011) *The Dragons of Inaction: Psychological Barriers That Limit Climate Change Mitigation and Adaptation*. *Am Psychol* 66:290-302

Raaijmakers R, Krywkow J and Van Der Veen A (2008) Flood risk perceptions and spatial multi-criteria analysis: An exploratory research for hazard mitigation. *Nat Hazards* 46:307-322

## Indicator 1.2: Local sense of urgency

**Predefined question:** To what extent do actors have a sense of urgency, resulting in widely supported awareness, actions, and policies that address the water challenge?

<b>++</b>	<b>Strong demand for action</b>	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
<b>+</b>	<b>General sense of urgency of long-term sustainability goals</b>	There is increasing understanding of the causes, impacts, scale and urgency of the water challenge. It leads to general sense of urgency of the need for long-term sustainable approaches. However, measures requiring considerable efforts, budget, or substantial change with sometimes uncertain results are often receiving only temporal support. The water challenge is a main theme in local elections
<b>0</b>	<b>Moderate willingness for small changes</b>	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
<b>-</b>	<b>Raising of awareness by small groups</b>	A marginalized group (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
<b>--</b>	<b>Resistance</b>	There is generally no sense of urgency 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

### Five most consulted sources

Marshall NA, Park S, Howden SM, Dowd AB and Jakku ES (2013) Climate change awareness is associated with enhanced adaptive capacity. *Agric Syst* 177:30-34

McCombs M (2004) *Setting the Agenda: The Mass Media and Public Opinion*. Cambridge, UK: Polity Press

O'Connor RE, Bord RJ and Fisher A (1999) Risk perceptions, general environmental beliefs, and willingness to address climate change. *Risk Anal* 19:461-471

Sampei Y and Aoyagi-Usui M (2009) Mass-media coverage, its influence on public awareness of climate-change issues, and implications for Japan's national campaign to reduce greenhouse gas emissions. *Glob Environ Chang* 19:203-212

UNEP (2006) United Nations Environmental Programme. *Raising awareness of climate change. A handbook for government focal points*. Nairobi, Kenya

### Indicator 1.3: Behavioral internalization

**Predefined question:** To what extent do local communities and stakeholders try to understand, react, anticipate and change their behavior in order to contribute to solutions regarding the water challenge?

<b>++</b>	<b>Full internalisation</b>	Because actors are fully aware of the water challenge, their causes, impacts, scale and urgency, the it is integrated into long-term and joint strategy, practices and policies. All actors are encouraged to participate. At this point, the water challenge is integrated into everyday practices and policies
<b>+</b>	<b>Moderate internalisation</b>	Awareness has evolved to mobilization and action. 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 clear strategy, practices and policies
<b>0</b>	<b>Exploration</b>	There is a growing awareness, often as a result of local, exploratory research regarding the causes and solutions of the water challenge. There are only incremental changes in actions, policy and stakeholder's behaviour
<b>-</b>	<b>Recognized as an external pressure</b>	The water challenge is partly recognized, mainly due to external pressure instead of intrinsic motivations. There is no support to investigate its origin or to proceed to action or changing practices
<b>--</b>	<b>Unawareness</b>	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

#### Five most consulted sources

Australian Government. Australian public service commission (2015). Changing behaviour: A public policy perspective. <http://www.apsc.gov.au/publications-and-media/archive/publications-archive/changing-behaviour>

Ballard A (2008) Adaptive Capacity Benchmarking: A Handbook and Toolkit. Hungerford, UK Berkshire

Gifford R (2011) The Dragons of Inaction: Psychological Barriers That Limit Climate Change Mitigation and Adaptation. Am Psychol 66:290-302

Institute for Government. Mindspace the practical guide. Influencing behaviour through public policy. [http://www.instituteforgovernment.org.uk/sites/default/files/publications/MINDSPACE-Practical-guide-final-Web\\_1.pdf](http://www.instituteforgovernment.org.uk/sites/default/files/publications/MINDSPACE-Practical-guide-final-Web_1.pdf)

Manning C (2009) The Psychology of Sustainable Behavior. Tips for empowering people to take environmentally positive action. Minnesota Pollution Control Agency <https://www.pca.state.mn.us/sites/default/files/p-ee1-01.pdf>

## Condition: 2 Useful knowledge

This condition describes the qualities of information with which actors have to engage in decision-making.

### Indicator 2.1: Information availability

**Predefined question:** To what extent is information on the water challenge available, reliable, and based on multiple sources and methods, in order to meet current and future demands so as to reveal information gaps and enhance well-informed decision-making?

<b>++</b>	<b>Comprehensive information enabling long-term integrated policy</b>	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, as well as goals and policies. Furthermore, progress reports on effective implementation can be found
<b>+</b>	<b>Information enhancing integrated long-term thinking</b>	Strong effort is put in providing integrated information from various fragmented sources. Information gaps are identified and attempted to be bridged. This may be clear from extensive documentation on the long-term process. Also citizen knowledge may be taken into account
<b>0</b>	<b>Information fits demand, limited exploratory research</b>	Information on the water challenge is available. Knowledge on understanding or tackling the water challenge is progressing and is produced in a structural way. Knowledge gaps are hardly identified due to lock-in into existing disciplines and policy. This is apparent from the quantity of factual information, but the causes, risks and impacts of long-term processes are lacking behind
<b>-</b>	<b>Information scarcity and limited quality</b>	Limited information is available which 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
<b>--</b>	<b>Lack of information</b>	No information on the water challenge can be found. Or the scarce available information is of poor quality

### Five most consulted sources

Füssel H (2007) Adaptation planning for climate change: Concepts, assessment approaches, and key lessons. *Sustain Sci* 2:265-275

Van Rijswick M, Edelenbos J, Hellegers P, Kok M and Kuks S (2014) Ten building blocks for sustainable water governance: an integrated method to assess the governance of water. *Water Int* 39:5, 725-742

Lemos MC, Kirchhoff CJ and Ramprasad V (2012) Narrowing the climate information usability gap. *Na Clim Change* 2:789-794

Van Leeuwen CJ (2007). Introduction. In: Van Leeuwen, CJ and Vermeire TG (eds) *Risk Assessment of Chemicals. An Introduction*, 2nd edn. Springer, Berlin, 1- 36

Ford JD and King D (2015) A framework for examining adaptation readiness. *Mitigation Adapt Strateg Glob Chang* 20:505-526

## Indicator 2.2: Information transparency

**Predefined question:** To what extent is information on the water challenge accessible and understandable for experts and non-experts, including decision-makers?

<b>++</b>	<b>Easy access to cohesive knowledge</b>	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
<b>+</b>	<b>Sharing of partly cohesive knowledge</b>	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
<b>0</b>	<b>Sharing of very technical knowledge</b>	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
<b>-</b>	<b>Low sharing of fragmented knowledge</b>	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
<b>--</b>	<b>Not transparent and inaccessible knowledge</b>	Information is limitedly available and shared. sharing may be discouraged. The information that is available is difficult to understand. The water challenge is not addressed on local websites

### Five most consulted sources

Hanger S, Pfenninger S, Dryfus M and Patt A (2013) Knowledge and information needs of adaptation policy-makers: a European study. *Reg Environ Change* 13:91-101

Manning C (2009) The Psychology of Sustainable Behavior. Tips for empowering people to take environmentally positive action. Minnesota Pollution Control Agency <https://www.pca.state.mn.us/sites/default/files/p-ee1-01.pdf>

OECD (2015) Organization for Economic Cooperation and Development: OECD Principles on Water Governance. OECD Ministerial Council Meeting. Paris, France

UNDP (2013) United Nations Development Programme. User's guide on Assessing Water Governance. Oslo, Norway

Brown RR and Farrelly MA (2009) Delivering sustainable urban water management: a review of the hurdles we face. *Water Sci Technol* 59:839-846

### Indicator 2.3: Knowledge cohesion

**Predefined question:** To what extent is information cohesive in terms of using, producing and sharing different kinds of information, usage of different methods and integration of short-term targets and long-term goals amongst different policy fields and stakeholders in order to deal with the water challenge?

<b>++</b>	<b>Implementation of cohesive knowledge</b>	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
<b>+</b>	<b>Substantial cohesive knowledge</b>	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
<b>0</b>	<b>Insufficient cohesion between sectors</b>	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
<b>-</b>	<b>Low-cohesive knowledge within sectors</b>	Information that is found is sector specific and information is inconsistent within and between sectors
<b>--</b>	<b>Non-cohesive and contradicting knowledge</b>	A lack of data strongly limits the cohesion between sectors. Information that is found can even be contradictory

#### Five most consulted sources

Hegger D, Lamers M, Van Zeijl-Rozema A and Dieperink C (2012) Conceptualising joint knowledge production in regional climate change adaptation projects: Success conditions and levers for action. *Environ Sci Policy* 18:52-65

Longsdaele KG, Gawith MJ, Johnstone K, Street RB, West CC and Brown AD (2010) Attributes of Well-Adapting Organisations. For the Adaptation Sub-Committee, UK Climate Impact Programme

OECD (2011) Organization for Economic Cooperation and Development: Water Governance in OECD Countries: A Multi-level Approach. OECD Studies on Water. Paris, France

Rowley J (2007) The wisdom hierarchy: Representations of the DIKW hierarchy. *J Inform Sci* 33:163-180

Zins C (2007) Conceptual approaches for defining data, information, and knowledge. *JASIST* 58:479-493

### Condition 3: Continuous learning

Continuous learning and social learning is essential to make water governance more effective. The level of learning differs from refining current management, critical investigation of fundamental beliefs or questioning underlying norms and values.

#### Indicator 3.1: Smart monitoring

**Predefined question:** To what extent is the monitoring of process, progress, and policies able to improve the level of learning (i.e., to enable rapid recognition of alarming situations, identification or clarification of underlying trends)? Or can it even have predictive value?

<b>++</b>	<b>Useful to predict future developments</b>	Monitoring system is adequate in recognizing alarming situations, identifying underlying processes and provides useful information for identifying future developments. Reports of monitoring will display discrepancies between fundamental beliefs and practices. The monitoring is changed in order to act upon these findings by altering the fundamental beliefs. Often regulatory frameworks are changed, new actors are introduced, new risk management approach are used
<b>+</b>	<b>Useful to recognize underlying processes</b>	The abundant monitoring provides sufficient base for recognizing underlying trends, processes and relationships. Reports of monitoring will display discrepancies between assumptions and real process dynamics. Acting upon these findings by altering the underlying assumptions characterizes this level of smart monitoring. Often also system boundaries are re-defined, new analysis approach introduced, priorities are adjusted and new aspects are being examined
<b>0</b>	<b>Quick recognition of alarming situations</b>	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
<b>-</b>	<b>Reliable data but limited coverage</b>	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
<b>--</b>	<b>Irregular, poor quality or absent</b>	There is no system to monitor the water challenge or monitoring is irregular

#### Five most consulted sources

Hinkel J (2011) Indicators of vulnerability and adaptive capacity: Towards a clarification of the science-policy interface. *Glob Environ Chang* 21:198-208

Pahl-Wostl C (2009) A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Glob Environ Chang* 19:354-365

Van Leeuwen CJ (2007) Introduction. In: Van Leeuwen, CJ and Vermeire TG (eds) *Risk Assessment of Chemicals. An Introduction*, 2nd edn. Springer, Berlin, 1- 36

Danilenko A, Van Den Berg C, Macheve B, Moffitt JL (2014). *The IBNET Water Supply and Sanitation Blue Book 2014: The International Benchmarking Network for Water and Sanitation Utilities Databook* 2nd ed. Edition

UNESCO. Monitoring progress in the water sector: A selected set of indicators  
[http://www.unwater.org/downloads/TFIMR\\_Annex\\_FinalReport.pdf](http://www.unwater.org/downloads/TFIMR_Annex_FinalReport.pdf)

### Indicator 3.2: Evaluation

**Predefined question:** To what extent are current policy and implementation continuously assessed and improved, based on the quality of evaluation methods, the frequency of their application, and the level of learning?

<b>++</b>	<b>Exploring the fitness of the paradigm</b>	Frequent and high quality evaluation procedures fully recognize long-term processes. Assumptions are continuously tested by research and monitoring. Evidence for this is found in sources (primarily online documents) that report on the learning process and progress. Uncertainties are explicitly communicated. Also, the current dominant perspective on governance and its guiding principles are questioned
<b>+</b>	<b>Changing assumptions</b>	There is continuous evaluation, hence continuous improvements of technical and policy measures and implementation. Innovative evaluation criteria are used. This is evidenced by reports containing recommendations to review assumptions or explicitly indicating the innovative character of the approach
<b>0</b>	<b>Improving routines</b>	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 short-term character
<b>-</b>	<b>Non-directional evaluation</b>	Evaluation is limited regarding both frequency and quality. Evaluation occurs sometimes, using inconsistent and even ad-hoc criteria. Also the evaluation is not systematic. There is no policy on the performance of evaluations, only the evaluation(s) itself are reported
<b>--</b>	<b>Insufficient evaluation</b>	There is no evaluation of technical or policy measures regarding the water challenge. Otherwise it is not documented

#### Five most consulted sources

Brown R, Ashley R and Farrelly M (2011) Political and Professional Agency Entrapment: An Agenda for Urban Water Research. *Water Resour Manag* 25:4037-4050

Gupta J, Termeer C, Klostermann J, Meijerink S, Van Den Brink M, Jong P, Nooteboom S and Bergsma E (2010) The Adaptive Capacity Wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environ Sci Policy* 13:459-471

Pahl-Wostl C, Tàbara D, Bouwen R, Craps M, Dewulf A, Mostert E, Ridder D and Taillieu T (2008) The importance of social learning and culture for sustainable water management. *Ecol Econ* 64:484-495

Sabatier PA and Weible CM (1999) *Theory of the policy process*. Third edition, Westview press

Termeer CJAM, Dewulf A, Breeman G and Stiller SJ (2015) Governance Capabilities for Dealing Wisely With Wicked Problems. *Adm Soc* 47:680-710

### Indicator 3.3: Cross-stakeholder learning

**Predefined question:** To what extent are stakeholders open to and have the opportunity to interact with other stakeholders and deliberately choose to learn from each other?

<b>++</b>	<b>Putting cross-stakeholder learning into practice</b>	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 learning programs are in place or may be institutionalized
<b>+</b>	<b>Open for cross-stakeholder learning</b>	Stakeholder interaction is considered valuable and useful for improving policy and implementation. Various initiatives for cross-stakeholder learning have been deployed, yet the translation into practice appears difficult. The programs may not be structural and the learning experience may not be registered and shared
<b>0</b>	<b>Open for stakeholder interaction</b>	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
<b>-</b>	<b>Small coalitions of stakeholders with shared interest</b>	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
<b>--</b>	<b>Closed attitude towards cross-stakeholder learning</b>	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

#### Five most consulted sources

Ansell C and Gash A (2008) Collaborative governance in theory and practice. *J Pub Admin Resear Theor* 18:543-571

Berkes F (2009) Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. *J Environ Manage* 90:1692-1702

EEA (2007) European Environmental Agency. Public participation: Contributing to better water management. Experience from eight case studies across Europe. Report no 3/2014

Muro M and Jeffrey P (2008) A critical review of the theory and application of social learning in participatory natural resource management processes. *J Environ Plan Manage* 51:325-344

Pahl-Wostl C, Craps M, Dewulf A, Mostert E, Tabara D and Taillieu T (2007) Social learning and water resources management. *Ecol Soc* 12

#### Condition 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.

##### Indicator 4.1: Stakeholder inclusiveness

**Predefined question:** To what extent are stakeholders interact in the decision-making process interaction (i.e., are merely informed, are consulted or are actively involved)? Are their engagement processes clear and transparent? Are stakeholders able to speak on behalf of a group and decide on that group's behalf?

<b>++</b>	<b>Transparent involvement of committed partners</b>	All relevant stakeholders are actively involved. The decision-making process and the opportunities for stakeholder engagement are clear. It is characterised by local initiatives specifically focussing on water such as local water associations, contractual arrangements, regular meetings, workshops, focus groups, citizen committees, surveys
<b>+</b>	<b>Timely, over-inclusive and active involvement</b>	Stakeholders are actively involved. It is still unclear how decisions are made and who should be involved at each stage of the process. Often too many stakeholders are involved. Some attendants do not have the mandate to make arrangements. Stakeholder engagement is abundantly done for often overlapping issues
<b>0</b>	<b>Untimely consultation and low influence</b>	Stakeholders are mostly consulted or informed. Decisions are largely made before engaging stakeholders. Frequency and time-period of stakeholder engagement is limited. Engagements are mainly ad hoc consultations where stakeholders have low influence on the end-result
<b>-</b>	<b>Non-inclusive involvement</b>	Not all relevant stakeholders are informed and only sometimes consulted. Procedures for stakeholder participation are unclear. If involved, stakeholders have but little influence
<b>--</b>	<b>Limited supply of information</b>	No stakeholders are included, or their engagement is discouraged. Information cannot be found on the extant decision-making process.

#### Five most consulted sources

EEA (2007) European Environmental Agency. Public participation: Contributing to better water management. Experience from eight case studies across Europe. Report no 3/2014

Glucker A, Driessen PPJ, Kolhoff A and Runhaar HAC (2013) Public participation in environmental impact assessment; why, who and how? Environ Impact Assess Rev 43:104-111

OECD (2015b) Organization for Economic Cooperation and Development: Stakeholder Engagement for Inclusive Water Governance. Paris, France

Van Rijswick M, Edelenbos J, Hellegers P, Kok M and Kuks S (2014) Ten building blocks for sustainable water governance: an integrated method to assess the governance of water. Water Int 39:5, 725-742

Ridder D, Mostert E, and Wolters HA (2005) Learning together to manage together. HarmoniCOP, Osnabrück: University of Osnabrück

## Indicator 4.2: Protection of core values

**Predefined question:** To what extent 1) is commitment focused on the process instead of on early end-results? 2) do stakeholders have the opportunity to be actively involved? 3) are the exit procedures clear and transparent? (All three ensure that stakeholders feel confident that their core values will not be harmed.)

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

### Five most consulted sources

CIS Working Group 2.9 (2003) Common Implementation Strategy for the Water Framework Directive. Guidance document, Luxembourg: Official Publications of the European Communities

OECD (2015a) Organization for Economic Cooperation and Development: OECD Principles on Water Governance. OECD Ministerial Council Meeting. Paris, France

Pahl-Wostl C, Nilsson C, Gupta J and Tockner K (2011) Societal learning needed to face the water challenge. *Ambio*, 40:549-553

Reed MS (2008) Stakeholder participation for environmental management: A literature review. *Biol Conserv* 141:2417-2431

Ridder D, Mostert E, and Wolters HA (2005) Learning together to manage together. HarmoniCOP, Osnabrück: University of Osnabrück

### Indicator 4.3: Progress and variety of options

**Predefined question:** To what extent are procedures clear and realistic, are a variety of alternatives co-created and thereafter selected from, and are decisions made at the end of the process in order to secure continued prospect of gain and thereby cooperative behavior and progress in the engagement process?

<b>++</b>	<b>Active engagement with choice selection at the end of the cooperation</b>	There is active engagement of all relevant stakeholders and clarity of participation procedure and realistic deadlines. The range of alternatives is fully explored and selection of the best alternatives occurs at the end of the process. Reviews of stakeholder meetings provide the alternatives addressed. Stakeholders are engaged throughout the whole process as specified in contractual agreements
<b>+</b>	<b>Active involvement with abundant choice variety</b>	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 with active stakeholder engagement, decisions are taken too early in the process leading to the exclusion of argument and solutions. Hence, decisions may not be fully supported
<b>0</b>	<b>Consultation or short active involvement</b>	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. The suboptimal character of a solution can be observed from evaluations or difference in opinions
<b>-</b>	<b>Rigid procedures limit the scope</b>	Informative and consultative approaches are applied, 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
<b>--</b>	<b>Lack of procedures limit engagement and progress</b>	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

#### Five most consulted sources

Bryson JM, Crosby BC and Stone MM (2006) The design and implementation of cross-sector collaborations: Propositions from the literature. PAR 66:44-55

Pahl-Wostl C (2009) A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. Glob Environ Chang 19:354-365

Ridder D, Mostert E, and Wolters HA (2005) Learning together to manage together. HarmoniCOP, Osnabrück: University of Osnabrück

UNDP (2008) United Nations Development Program: Governance Principles, Institutional Capacity and Quality. New York, USA

Yee S (2010) Stakeholder engagement and public participation in environmental flows and river health assessment. Australia-China Environment Development Partnership. River Health and Environmental Flow in China <http://watercentre.org/portfolio/rhef/attachments/technical-reports/stakeholder-engagement-and-public-participation-in-eflows-and-river-health-assessments>

### Condition 5: Management Ambitions

Policy ambitions assesses if current policy is ambitious, feasible, well-embedded in local context and if it forms a cohesive set of long-term and short-term goals within and across sectors.

#### Indicator 5.1: Ambitious and realistic management

**Predefined question:** To what extent are goals ambitious (i.e., identification of challenges, period of action considered, and comprehensiveness of strategy) and yet realistic (i.e., cohesion of long-term goals and supporting flexible intermittent targets, and the inclusion of uncertainty in policy)?

<b>++</b>	<b>Realistic and ambitious strategy</b>	Policy is based on modern and innovative assessment tools and policy objectives are ambitious. Support is provided by a comprehensive set of intermittent targets, which provide clear and flexible pathways. Assessment tools and scenarios analyses identify tipping points that may be found in policy documents
<b>+</b>	<b>Long-term ambitious goals</b>	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. They often entail a description of the water challenge and need for action
<b>0</b>	<b>Confined realistic goals</b>	There is a confined vision of the water challenge. Ambition are mostly focused on improving the current situation where unchanging conditions are assumed and risk and scenarios analyses are lacking
<b>-</b>	<b>Short-term goals</b>	Actions and goals mention sustainability objectives. Actions and goals are "quick fixes" mainly, not adhering to a long-term vision or sustainable solutions. Uncertainties and risks are largely unknown
<b>--</b>	<b>Short-term, conflicting goals</b>	Goals consider only contemporary water challenges, are short-sighted and lack sustainability objectives. Goals are arbitrary and sometimes conflicting and the character of policy is predominantly reactive

#### Five most consulted sources

Aall C, Groven K and Lindseth G (2007) The scope of action for local climate policy: The case of Norway. *Global Environ Polit* 7:83-101

Biesbroek GR, Swart RJ, Carter TR, Cowan C, Henrichs T, Mela H, Morcecroft MD and D Rey (2010) Europe Adapts to Climate Change: Comparing National Adaptation Strategies. *Glob Environ Chang* 20:440-450

Brown RR and Farrelly MA (2009) Delivering sustainable urban water management: a review of the hurdles we face. *Water Sci Technol* 59:839-846

STOWA (2016) Stichting Toegepast Onderzoek Waterbeheer. Deel 2: Sturen op verandering van aanpak en werkwijze.

Termeer C, Biesbroek R and Van Den Brink M (2012) Institutions for adaptation to climate change: Comparing National Adaptation strategies in Europe. *EPS* 11:41-53

## Indicator 5.2: Discourse embedding

**Predefined question:** To what extent is sustainable policy interwoven in historical, cultural, normative and political context?

<b>++</b>	<b>Embedding of sustainable implementations</b>	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
<b>+</b>	<b>Consensus for sustainable actions</b>	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, the decision-making periods are long as trust relations with new unconventional partners need to be built
<b>0</b>	<b>Low sense of urgency embedded in policy</b>	Current policy fits the local context. 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 short-term policy changes
<b>-</b>	<b>Persistent reluctance and poor embedding</b>	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
<b>--</b>	<b>Policy mismatch</b>	Cultural, historical and political context is largely ignored, leading to arduous policy implementation. Actors may not understand the scope, moral or to whom it applies or how to implement it (total confusion)

### Five most consulted sources

Ambrus M, Gilissen H K and Van Kempen JJH (2014) Public values in water law: A case of substantive fragmentation? *Utrecht Law Review* 10:8–30

Campbell JL (2002) Ideas, politics, and public policy

Hajer M and Versteeg W (2005) A decade of discourse analysis of environmental politics: Achievements, challenges, perspectives. *J Environ Policy Plan* 7:175-184

Schmidt VA (2001) Discourse and the legitimation of economic and social policy change in Europe. In *Globalization and the European Political Economy*, ed. SWeber, 229–72 New York: Columbia Univ. Press

Van Rijswijk M, Edelenbos J, Hellegers P, Kok M and Kuks S (2014) Ten building blocks for sustainable water governance: an integrated method to assess the governance of water. *Water Int* 39:5, 725-742

### Indicator 5.3: Management cohesion

**Predefined question:** To what extent is policy relevant for the water challenge, and coherent regarding 1) geographic and administrative boundaries, and 2) alignment across sectors, government levels, and technical and financial possibilities?

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

#### Five most consulted sources

Corfee-Morlot JL, Kamal-Chaoui MG, Donovan I, Cochran A, Robert A and Teasdale PJ (2009) Cities Climate Change and Multilevel Governance. Environmental Working Papers No. 14, OECD OECD Publishing

Head BW and Alford J (2015) Wicked Problems: Implications for Public Policy and Management. Adm Soc 47:711-739

Lockwood M, Davidson J, Curtis A, Stratford E and Griffith R (2010) Governance principles for natural resource management. Soc Nat Resour 23:986-1001

OECD (2011) Organization for Economic Cooperation and Development: Water Governance in OECD Countries: A Multi-level Approach. OECD Studies on Water. Paris, France

OECD (2015) Organization for Economic Cooperation and Development: OECD Principles on Water Governance. OECD Ministerial Council Meeting. Paris, France

## Condition 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.

### Indicator 6.1: Entrepreneurial

**Predefined question:** To what extent are the entrepreneurial agents of change enabled to gain access to resources, seek and seize opportunities, and have influence on decision-making?

<b>++</b>	<b>Long-term support for entrepreneurship</b>	There is recognition of the need for continuous innovation, hence applied research is enabled that explores future risk management and supports strategy formulation. The experiments yield increased benefits and new insights. This is recognized by other actors, thereby providing access to new resources. Continuous experimentation is secured by long-term and reliable resource allocation
<b>+</b>	<b>Tentative experimental entrepreneurship</b>	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
<b>0</b>	<b>Conventional and risk-averse entrepreneurship</b>	Entrepreneurial agents of change are better able to seize low-risk opportunities. Therefore opportunities for innovative approaches and synergies are hardly pursued. Small changes can be observed
<b>-</b>	<b>Room for short-sighted entrepreneurship</b>	Agents of change struggle to gain access to resources to address imminent water challenges. Windows of opportunity to identify and to act upon perceived risks are limited. Opportunities to address stakeholders with potential access to resources are rarely seized
<b>--</b>	<b>Insufficient entrepreneurship</b>	Ignorance for risk and threats leads to ineffective rigid governance and lack of opportunity for entrepreneurial agents to enable improvements. Moreover, distrust by other actors and potential investors, further decrease access to resources

### Five most consulted sources

Biggs R, Westley FR and Carpenter SR (2010) Navigating the back loop: Fostering social innovation and transformation in ecosystem management. *Ecol Soc* 15:28

Brouwer S, and Biermann F (2011) Towards adaptive management: examining the strategies of policy entrepreneurs in Dutch water management. *Ecol Soc* 16:5

Brouwer S, Huitema D, Biermann F (2009) Towards adaptive management: The strategies of policy entrepreneurs to direct policy change. *Proceedings of the 2009 Amsterdam Conference on the Human Dimensions of Global Environmental Change*

Folke C, Hahn T, Olsson P and Norberg, J (2005) Adaptive governance of social-ecological systems

Head BW and Alford J (2015) Wicked Problems: Implications for Public Policy and Management. *Adm Soc* 47:711-739

## Indicator 6.2: Collaborative

**Predefined question:** To what extent are actors enabled to engage, build trust-collaboration, and connect business, government, and sectors, in order to address the water challenge in an unconventional and comprehensive way?

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

### Five most consulted sources

Emerson K, Nabatchi T and Balogh S (2012) An Integrative Framework for Collaborative Governance. Public Adm Res Theory 22:1-29

Gupta J, Termeer C, Klostermann J, Meijerink S, Van Den Brink M, Jong P, Nootboom S and Bergsma E (2010) The Adaptive Capacity Wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. Environ Sci Policy 13:459-471

Ison R, Collins K, Colvin J, Jiggins J, Roggero PP, Seddaiu G, Steyaert P, Toderi M and Zanolla C (2011) Sustainable Catchment Managing in a Climate Changing World: New Integrative Modalities for Connecting Policy Makers, Scientists and Other Stakeholders. Water Resour Manag 25:3977-3992

Patterson J, Smith C and Bellamy J (2013) Understanding enabling capacities for managing the 'wicked problem' of nonpoint source water pollution in catchments: A conceptual framework. J Environ Manage 128:441-452

Termeer C, Biesbroek R and Van Den Brink M (2012) Institutions for adaptation to climate change: Comparing National Adaptation strategies in Europe. EPS 11:41-53

### Indicator 6.3: Visionary

**Predefined question:** To what extent are actors in the network able to manage and effectively push forward long-term and integrated strategies which are adequately supported by interim targets?

<b>++</b>	<b>Long-term vision supported by short-term targets</b>	Visionary agents of change in different positions and with different backgrounds actively and successfully promote a sustainable and long-term vision regarding the water challenge, that is communicated clearly. Short-term targets fit the long-term visions. There is interest and employment in trend analysis.
<b>+</b>	<b>Long-term vision with flawed communication</b>	There is a clear long-term, integrated and sustainable-oriented vision. There is still some discrepancy between short-term targets and implementation strategies and the long-term vision from visionary agents of change. This means that agents are not always clear in their formulation regarding the effect and impact of envisioned strategies
<b>0</b>	<b>Defense of status quo</b>	The visions of the existing agents of change are limited to promoting the business as usual. They do not oppose nor promote long-term, integrative thinking. Interest or employment in trend analysis is limited
<b>-</b>	<b>Unilateral and short-term vision</b>	There is a unilateral vision regarding the water challenge, which considers a limited groups of actors. The vision often has a short-term focus, with a maximum of 3 to 4 years
<b>--</b>	<b>Deficient sustainability vision and short-term focus</b>	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

#### Five most consulted sources

Boal KB and Hooijberg R (2000) Strategic leadership research: Moving on. *Leadership Quarterly* 11:515-549

Ford JD and King D (2015) A framework for examining adaptation readiness. *Mitigation Adapt Strateg Glob Chang* 20:505-526

Pahl-Wostl C, Nilsson C, Gupta J and Tockner K (2011) Societal learning needed to face the water challenge. *Ambio*, 40:549-553

Schultz L and Fazey I (2009) Effective leadership for adaptive management. *Adaptive Environmental Management: A Practitioner's Guide*. 295-303

Westley F and Mintzberg H (1989) Visionary Leadership and Strategic Management. *SMJ* 10:17-32

## Condition 7: Multi-level network potential

Urban water governance involves a plethora of actors and interests from all levels of government, organizations and (private) stakeholders. For sustainable solutions, working in networks is an essential determinant for effective solutions.

### Indicator 7.1: Room to manoeuvre

**Predefined question:** To what extent do actors have the freedom and opportunity to develop a variety of alternatives and approaches (this includes the possibility of forming ad hoc, fit-for-purpose partnerships that can adequately address existing or emerging issues regarding the water challenge)?

<b>++</b>	<b>Freedom to develop innovative solutions</b>	There is a common and accepted long-term vision for dealing sustainably 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
<b>+</b>	<b>Redundancy to address uncertainty</b>	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
<b>0</b>	<b>Limited room for innovation and collaboration</b>	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
<b>-</b>	<b>Limited autonomy</b>	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
<b>--</b>	<b>Strictly imposed obligations</b>	The actions of stakeholders are strictly controlled and there are rigid short-term targets. Freedom to form new partnerships is strongly limited as actor network composition is fixed and small. There are no resources made available for exploring alternatives that might be more effective or efficient whereas many actors that are affected by the water challenge do not have a voice

### Five most consulted sources

Folke C, Hahn T, Olsson P and Norberg, J (2005) Adaptive governance of social-ecological systems

Gupta J, Termeer C, Klostermann J, Meijerink S, Van Den Brink M, Jong P, Nooteboom S and Bergsma E (2010) The Adaptive Capacity Wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environ Sci Policy* 13:459-471

STOWA (2016) Stichting Toegepast Onderzoek Waterbeheer. Deel 2: Sturen op verandering van aanpak en werkwijze

Stigt R, Driessen PPJ, Spit TJM (2013) Compact City Development and the Challenge of Environmental Policy Integration: A Multi-level Governance Perspective. *Env Pol Gov* 23:221-233

Suhardiman D and Giordano M (2012) Process-focused analysis in transboundary water governance research. *International Environmental Agreements: Politics, Law and Economics* 12:299-308

## Indicator 7.2: Clear division of responsibilities

**Predefined question:** To what extent are responsibilities clearly formulated and allocated, in order to effectively address the water challenge?

<b>++</b>	<b>Dynamic, fit-for-purpose cooperations</b>	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
<b>+</b>	<b>Innovative cooperative strategies</b>	Actors recognize that knowledge and experience are scattered within the local network. Therefore, extra effort is made to bundle the scattered expertise and to reach fit-for-purpose division of clear roles and responsibilities. New cooperation compositions are explored
<b>0</b>	<b>Inflexible division of responsibilities</b>	Responsibilities are divided over a limited set of conventional actors. Opportunities for new cooperation and more effective division of responsibilities are not seized or even recognized. Sometimes conventional actors get more tasks to deal with new water challenges
<b>-</b>	<b>Barriers for effective cooperation</b>	Authorities are fragmentized or they lack interest. Moreover, miscommunication and lack of trust are causes that block effective water governance
<b>--</b>	<b>Unclear division of responsibilities</b>	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

### Five most consulted sources

Mees H (2014) Responsible Climate Change Adaptation - Exploring, analysing and evaluating public and private responsibilities for urban adaptation to climate change. (198 p.)

Mees HLP, Dijk J, Van Soest D, Driessen PPJ, Van Rijswijk MHFMW and Runhaar H (2014) A method for the deliberate and deliberative selection of policy instrument mixes for climate change adaptation. Ecol Soc 19

OECD (2011) Organization for Economic Cooperation and Development: Water Governance in OECD Countries: A Multi-level Approach. OECD Studies on Water. Paris, France

OECD (2015) Organization for Economic Cooperation and Development: OECD Principles on Water Governance. OECD Ministerial Council Meeting. Paris, France

WaterAid (2011) Policy guidelines. Water resource management. A WaterAid in Nepal publication

### Indicator 7.3: Authority

**Predefined question:** To what extent are legitimate forms of power and authority present that enable long-term, integrated and sustainable solutions for the water challenge?

<b>++</b>	<b>Strong well-embedded authority</b>	Long-term, integrated approaches regarding the water challenge are well embedded in policy and regulatory authorities. Authoritative figures receive much support both politically and by society. Their opinions and statements also receive much media attention
<b>+</b>	<b>Stirring authority</b>	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
<b>0</b>	<b>Restricted authority</b>	The water challenge is addressed as long as the status quo is not questioned. Long-term policy visions are limited and new policy mainly needs to fit into existing fragmented structure. This means small (technical) changes are occurring
<b>-</b>	<b>Unfruitful attempts</b>	The water challenge is put forward by individuals or a groups of actors, but there is only little interest which is also fragile due to poor embedding of sustainability principles in current policy mechanisms, interests, and budget allocation. The challenge may have been mentioned in reviews or reports but left unaddressed
<b>--</b>	<b>Powerlessness</b>	The addressing of the water challenge is regularly overruled with contradicting and competing interests and so it is hardly included in policy, regulation or administrative principles

#### Five most consulted sources

Evans B, Joas M, Sundback S and Theobald K (2006) Governing local sustainability. *J Environ Plan Manage* 49:849-867

Gibbs DC, Longhurst J and Braithwaite C (1998) 'Struggling with sustainability': weak and strong interpretations of sustainable development within local authority policy. *Environ Plan A* 30:1351-1365

Huxham C and Vangen S (2005) *Managing to Collaborate: The theory and Practice of Collaborative Advantage*. New York: Routledge

Van Rijswijk M, Edelenbos J, Hellegers P, Kok M and Kuks S (2014) Ten building blocks for sustainable water governance: an integrated method to assess the governance of water. *Water Int* 39:5, 725-742

Wilson E (2006) Adapting to climate change at the local level: The spatial planning response. *Local Environment* 11:609-625

## Condition 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 disproportionately affected.

### Indicator 8.1: Affordability

**Predefined question:** To what extent are water services and climate adaptation measures available and affordable for all citizens, including the poorest?

<b>++</b>	<b>Climate adaptation affordable for all</b>	Programs and policies ensure climate adaptation for everyone. This includes public infrastructure and private property protection. The solidarity principle is clearly percolated in policy and regulation
<b>+</b>	<b>Limited affordability of climate adaptation services</b>	Serious efforts are made to support climate adaptation for everyone, including vulnerable groups. There is often recognition that poor and marginalized groups are disproportionately affected by the water challenge. This is increasingly addressed in policy and regulation
<b>0</b>	<b>Unaffordable climate adaptation</b>	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 such as extreme heat, flooding or water scarcity.
<b>-</b>	<b>Limited affordability of basic water services</b>	A share of the population has serious difficulty to pay for basic water services such as neighbourhoods with low-income or marginalized groups. There is hardly any social safety net regarding water services, let alone for climate adaptation measures
<b>--</b>	<b>Unaffordable basic water services</b>	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

### Five most consulted sources

Dodman D and Satterthwaite D (2008) Institutional capacity, climate change adaptation and the urban poor. IDS Bulletin, 39:67-74

Fankhauser S and Tepic S (2007) Can poor consumers pay for energy and water? An affordability analysis for transition countries. Energy Policy 35:1038-1049

OECD (2011) Organization for Economic Cooperation and Development: Water Governance in OECD Countries: A Multi-level Approach. OECD Studies on Water. Paris, France

Raje DV, Dhobe PS and Deshpande AW (2002) Consumer's willingness to pay more for municipal supplied water: A case study. Ecol Econ 42:391-400

UNDP (2008) United Nations Development Program: Governance Principles, Institutional Capacity and Quality. New York, USA

## Indicator 8.2: Consumer willingness to pay

**Predefined question:** How is expenditure regarding the water challenge perceived by all relevant stakeholders (i.e., is there trust that the money is well-spent)?

<b>++</b>	<b>Willingness to pay for present and future risk reductions</b>	The water challenge is fully comprehended by decision-makers. There is political and public support to allocate substantial financial resources. Also expenditure for non-economic benefits is perceived as important. There is clear agreement on the use of financial principles, such as polluter-pays- and user-pays- or solidarity principle
<b>+</b>	<b>Willingness to pay for provisional adaptation</b>	Due to growing worries about the water challenge, there are windows of opportunity to increase funding. However, the perception of risk does not necessarily coincide with actual risk. Financial principles, such as polluter-pays principle, may be introduced. 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
<b>0</b>	<b>Willingness to pay for business as usual</b>	There is support for the allocation of resources for conventional tasks. There is limited awareness or worries regarding the water challenge. Most actors are unwilling to financially support novel policies beyond the status quo. Generally, there is sufficient trust in local authorities
<b>-</b>	<b>Fragmented willingness to pay</b>	Willingness to pay for measures addressing the water challenges are fragmented and insufficient. The importance and risks are perceived differently by each stakeholder. Generally, their estimates of the cost are substantially lower than the actual costs
<b>--</b>	<b>Mistrust and resistance to financial decisions</b>	There is a high level of mistrust in decision making of resource allocation. At this level financial decisions are based on prestige projects, projects that benefit small groups or specific interests. As expenditures often do not address the actual water challenges, there is a high degree of resistance regarding resource allocation

### Five most consulted sources

Casey JF, Kahn JR and Rivas A (2006) Willingness to pay for improved water service in Manaus, Amazonas, Brazil. *Ecol Econ* 58:365-372

Hensher D, Shore N and Train K (2005) Households' willingness to pay for water service attributes. *Environ Resour Econ* 32:509-531

Marshall GR (2013) Transaction costs, collective action and adaptation in managing complex social-ecological systems. *Ecol Econ* 88:185-194

OECD (2014) Organization for Economic Cooperation and Development: Water Governance in the Netherlands. Fit for the future? OECD Studies on Water, OECD publishing

Whittington D, Briscoe J, Xinming MU and Barron W (1990) Estimating the willingness to pay for water services in developing countries: a case study of the use of contingent valuation surveys in southern Haiti. *Econ Dev Cult Change* 38:293-311

### Indicator 8.3: Financial continuation

**Predefined question:** To what extent do financial arrangements secure long-term, robust policy implementation, continuation, and risk reduction?

<b>++</b>	<b>Long-term financial continuation</b>	There is secured continuous financial support for long-term policy, measures and research regarding the water challenge. These costs are included into baseline funding. Generally, both economic and non-economic benefits are considered and explicitly mentioned
<b>+</b>	<b>Abundant financial support with limited continuation</b>	Abundant financial resources are made available for project based endeavours that are often exploring new solutions but lack long-term resource allocation or institutionalized financial continuation. Hence, long-term implementation is uncertain
<b>0</b>	<b>Financial continuation for basic services</b>	Financial resources are available for singular projects regarding basic services of the water challenge. The allocation of financial resources is based on past trends, current costs of maintenance and incremental path-dependent developments. Costs to deal with future water challenges are often not incorporated. Limited resources are assigned for unforeseen situations or calculated risks
<b>-</b>	<b>Inequitable financial resource allocation</b>	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
<b>--</b>	<b>Lack of financial resources</b>	There are insufficient financial resources available to perform basic tasks regarding the water challenge. Financing is irregular and unpredictable leading to poor policy continuation

#### Five most consulted sources

Adger WN, Arnell NW, and Tompkins EL (2005) Successful adaptation to climate change across scales. *Glob Environ Chang* 15:77-86

Anguelovski I and Carmin J (2011) Something borrowed, everything new: Innovation and institutionalization in urban climate governance. *Curr Opin Environ Sustainability* 3:169-175

Geels FW (2013) The impact of the financial–economic crisis on sustainability transitions: Financial investment, governance and public discourse. *Environ Innov Soc Transit* 6:67-95

Gibbs D, Jonas A and While A (2002) Changing governance structures and the environment: Economy-environment relations at the local and regional scales. *J Environ Policy Plan* 4:123-138

UNEP United Nations Environmental Program (2013) City-level decoupling. Urban resources flows and the governance of infrastructure transition. A report of the working group on cities of the international resource panel

## Condition 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.

### Indicator 9.1: Policy instruments

**Predefined question:** To what extent are policy instruments effectively used (and evaluated), in order to stimulate desired behavior and discourage undesired activities and choices?

<b>++</b>	<b>Effective instruments enhance sustainable transformations</b>	There is much experience with the use of policy instruments. Monitoring results show that the current use of instruments proves to be effective in achieving sustainable behaviour. Continuous evaluation ensures flexibility, adaptive capacity and fit-for-purpose use of policy instruments
<b>+</b>	<b>Profound exploration of sustainability instruments</b>	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
<b>0</b>	<b>Fragmented instrumental use</b>	Policy fields or sectors often have similar goals, but instruments are not coherent and may even contradict. Overall instrumental effectiveness is low and temporary. There is sufficient monitoring and evaluation leading to knowledge and insights in how instruments work and actors are getting a more open attitude towards improvements
<b>-</b>	<b>Unknown impacts of policy instruments</b>	Instruments are being used without knowing or properly investigating their impacts on forehand. The set of instruments actually leads to imbalanced development and inefficiencies that are hardly addressed
<b>--</b>	<b>Instruments enhance unsustainable behavior</b>	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 the counterproductive effects of these policy instruments

### Five most consulted sources

Brown RR and Farrelly MA (2009) Delivering sustainable urban water management: a review of the hurdles we face. *Water Sci Technol* 59:839-846

EEA (2016) European Environment Agency. Urban adaptation to climate change in Europe 2016. Transforming cities in a changing climate. ISSN 1977-8449

Klein RJT, Schipper ELF and Dessai S (2005) Integrating mitigation and adaptation into climate and development policy: Three research questions. *Environ Sci Policy* 8:579-588

Mees HLP, Dijk J, Van Soest D, Driessen PPJ, Van Rijswijk MHFMW and Runhaar H (2014) A method for the deliberate and deliberative selection of policy instrument mixes for climate change adaptation. *Ecol Soc* 19

Müller M and Siebenhüner B (2007) Policy instruments for sustainability-oriented organizational learning. *Business Strategy and the Environment*, 16:232-245

## Indicator 9.2: Statutory compliance

**Pre-defined question:** To what extent is legislation and compliance, well-coordinated, clear and transparent and do stakeholders respect agreements, objectives, and legislation?

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

### Five most consulted sources

Bryson JM, Crosby BC and Stone MM (2006) The design and implementation of cross-sector collaborations: Propositions from the literature. *Public admin review* 66:44-55

Fiorina MP (1982) Legislative choice of regulatory forms: Legal process or administrative process? *Public Choice* 39:33-66

Müller M and Siebenhüner B (2007) Policy instruments for sustainability-oriented organizational learning. *Business Strategy and the Environment*, 16:232-245

Roy AH, Wenger SJ, Fletcher TD, Walsh CJ, Ladson AR, Shuster WD, Thurston HW and Brown RR (2008) Impediments and solutions to sustainable, watershed-scale urban stormwater management: Lessons from Australia and the United States. *Environ Manage* 42:344-359

Van Rijswijk M, Edelenbos J, Hellegers P, Kok M and Kuks S (2014) Ten building blocks for sustainable water governance: an integrated method to assess the governance of water. *Water Int* 39:5, 725-742

### Indicator 9.3: Preparedness

**Predefined question:** To what extent is the city prepared (i.e. there is clear allocation of responsibilities, and clear policies and action plans) for both gradual and sudden uncertain changes and events?

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

#### Five most consulted sources

Allen KM (2006) Community-based disaster preparedness and climate adaptation: Local capacity-building in the Philippines. *Disasters* 30:81-101

Amundsen H, Berglund F and Westskogh H (2010) Overcoming barriers to climate change adaptation-a question of multilevel governance? *Environment and Planning C: Government and Policy*, 28:276-289

Brody SD (2003) Are we learning to make better plans?: A longitudinal analysis of plan quality associated with natural hazards. *J Plann Educ Res* 23:191-201

Evans B, Joas M, Sundback S and Theobald K (2006) Governing local sustainability. *J Environ Plan Manage* 49:849-867

Raaijmakers R, Krywkow J and Van Der Veen A (2008) Flood risk perceptions and spatial multi-criteria analysis: An exploratory research for hazard mitigation. *Nat Hazards* 46:307-322

## Appendix III Justification Document of GCF Result

### Challenge 1: Flooding

Code	FL01	FL02	FL03	FL04	Final
1.1 Community knowledge	0	0	0	0	0
1.2 Local sense of urgency	0	0	0	0	0
1.3 Behavioral internalization	0	0	0	0	0
2.1 Information availability	0	+	+	0	+
2.2 Information transparency	+	0	+	+	+
2.3 Knowledge cohesion	0	0	0	0	0
3.1 Smart monitoring	-	+	x	-	-
3.2 Evaluation	-	0	x	-	-
3.3 Cross-stakeholder learning	+	+	+	0	+
4.1 Stakeholder inclusiveness	0	0	0	+	0
4.2 Protection of core values	0	+	-	-	-
4.3 Progress and variety of options	0	0	0	0	0
5.1 Ambitious and realistic management	0	+	0	0	0
5.2 Discourse embedding	0	+	0	0	0
5.3 Management cohesion	0	+	x	0	0
6.1 Entrepreneurial agents	x	x	x	x	-
6.2 Collaborative agents	0	+	0	0	0
6.3 Visionary agents	0	0	0	0	0
7.1 Room to manoeuver	0	+	-	-	-
7.2 Clear division of responsibilities	+	+	+	+	+
7.3 Authority	0	+	0	0	0
8.1 Affordability	x	x	0	0	0
8.2 Consumer willingness-to-pay	x	x	0	0	0
8.3 Financial continuation	0	+	0	0	-
9.1 Policy instruments	0	x	0	0	0
9.2 Statutory compliance	-	-	-	-	-
9.3 Preparedness	0	0	0	0	0

#### Document references:

Bappeda. (2013). Rencana pembangunan jangka menengah daerah kota Bandung 2013-2018 [Regional intermediate-term development plan of Bandung 2013-2018]. *Available on-demand and in Indonesian language only.*

Bappeda. (2011). Rencana tata ruang wilayah kota Bandung 2011-2031 [Urban spatial planning of Bandung 2011-2031]. *Available on-demand and in Indonesian language only.*

BPWA. (2013). Rencana strategis Dinas Bina Marga dan Pengairan 2013-2018 [Strategic plan of BPWA 2013-2018]. *Available on-demand and in Indonesian language only.*

BPWA. (2016). Rencana kerja Dinas Bina Marga dan Pengairan 2017 [Working plan of BPWA 2017]. *Available on-demand and in Indonesian language only.*

PPID. (2017). Bandung's Information Portal <https://ppid.bandung.go.id/?s=banjir>

There is a tendency that FL02 and FL04 answers scores higher than FL01 and FL03, it is due to their work focus which covers not only in the urban area (Bandung) but the whole Citarum basin. Within Bandung, territoriality (sub-district level government) has a high influence since they interact intensely with the public.

Some stakeholders began to recognize that the root of flood problems lies in the spatial planning, where the development had transformed Bandung's retention area (KBU) into high runoff-coefficients areas. KBU

(Kawasan Bandung Utara, Northern Bandung Region) is not only under the autonomy of each city/regency, but it is a high interest for both provincial and central government (RISPAM doc, Bappeda, 2014). Also, the entire Bandung is determined by the Indonesian government as NAC (Urban Planning Masterplan, Bappeda, 2011-2031). This highlights that there are many parties from different levels of interest are involved in planning the direction of Bandung's development. At the same time, Bandung's Bappeda plans to follow the compact city idea where it promotes green city (dealing with UHI issue), infill and vertical development (flooding issue, and to some extent easier water and waste management) (Urban Planning Masterplan, Bappeda, 2011-2031).

#### 1.1 Community knowledge (0)

All interviewees mentioned that Bandung's citizens have a basic understanding of flood that raises concerns and awareness about this issue. However, the understanding of the uncertainties in the future risk is not present.

#### 1.2 Local sense of urgency (0)

Flood issue is addressed as the main topic in the city's leader election, and it is frequently mentioned in the local news. The government had taken some measures (usually conventional hard-infrastructures) (FL01) while the researchers begin to explore other measures (FL03). As the regular victims, the citizens seem to realize their roles. It can be seen by the growing amount of the flooding-related reports (damage infrastructure, clogged drainage, etc.) by the citizens on the government social media channels (FL01, FL02) and increasing participation in flood socialization/prevention events by the government/communities (FL04).

#### 1.3 Behavioral internalization (0)

Although the public raises their concerns about flood risk (as claimed by FL01,04), a significant/widespread change in attitude is not yet present, especially related to solid waste disposal that often found as the cause of drainage channels clogging (FL02,03).

#### 2.1 Information availability (+)

The availability of data and information helps the understanding of all stakeholders on flood issue (especially the information about flood-prone areas) (FL01, refer to PPID website). The effort to integrate existing information is significant with the accommodation provided by Citarum's WRMCT (FL02). WRMCT has a regular meeting where its members update their knowledge about the happenings in Citarum basin. Researchers also produce flood-related primary data which is open to the public via the universities' libraries (FL03).

#### 2.2 Information transparency (+)

While most of the information about flooding in Bandung's website is understandable for everyone, detailed data about the issue have to be accessed offline (FL01). Anyone could come to BPWA office and request the detailed information as long as the applicant specifies the objective and follows the bureaucracy procedure (FL02,03,04).

#### 2.3 Knowledge cohesion (0)

There are different foci in the existing agencies. BPWA concentrates on the Bandung's flood issues with the drainage clogging, infrastructure materials, etc. (FL01, BPWA documents). On the other side, CRBC (Citarum River Basin Council) works on the bigger scale of flooding that relates to agriculture, replanting vegetation in the upstream areas, etc. (FL02, also refer to Cita-Citarum website <http://www.citarum.org/>). Although these agencies (informally) communicate and work together in regular basis (FL02,04), the knowledge cohesion is still insufficient (FL03).

### 3.1 Smart monitoring (-)

The monitoring of the potential flood event in Bandung is still only using IAMCG's weather forecast, visual inspection by officers in the upstream area, and CCTV network spreads in the city (FL01). Despite its limitation, this system is sometimes able to identify alarming situation, but there are no other purposes aside (e.g. flood prediction) (FL03). A rather good monitoring effort is demonstrated by the Citarum's WRMCT that consists of the representatives from various relevant stakeholders who monitor flood parameters (with undefined methods) and regularly interact (FL02, FL04).

### 3.2 Evaluation (-)

With limited monitoring, there are insufficient data to identify the progress of the flooding management (FL01,03). The evaluation meetings occur in the agencies' internal circle (FL01, BPWA documents). The systematics for evaluations in these agencies are rather unclear, except for CRBC which institutionally more developed than others.

### 3.3 Cross-stakeholder learning (+)

Most of the relevant stakeholders interact via informal communication (especially using Whatsapp groups) where they mainly cooperate practically in the preventive and adaptive measures for the flooding issue (FL01,02). Official framework (i.e. city level working group) where the stakeholders could learn together had been initiated, but due to each agency's tight schedule, the official platform is under-utilized (FL02,03).

### 4.1 Stakeholder inclusiveness (0)

The contribution of the community is still limited and sparse through a scheme called Musrenbang (development planning meeting) that use both top-down and bottom-up approaches (FL01). However, most of the programs were decided beforehand by Bandung's government while the public gives feedbacks later (FL01, BPWA documents).

### 4.2 Protection of core values (-)

Even with the public feedbacks from Musrenbang, there aren't many changes to most of the programs (or any decision) that were decided earlier (FL01). Although any citizen could participate in e-Musrenbang, not everyone has the privileges to be involved in the official meetings in the territorialities. For some cases, the program implementation (particularly physical works) violates the interest or core value of some members of the society (e.g. relocating marginal group without proper consent) (FL02,03). This happening is sometimes signaled by the NGOs via online or printed articles) (FL02,04).

### 4.3 Progress and variety of options (0)

Until now, BPWA focus on the infrastructure development for addressing Bandung's flooding issue (FL01, refer to BPWA & Bappeda documents). Other efforts are RWH, infiltration wells, and biopores (FL02,03). Other official agencies (including BECA and CRBC) also researchers and communities promote these alternative solutions (FL04), but the practice is still limited.

### 5.1 Ambitious and realistic management (0)

The general aim of Bandung's government is reducing the flood prone area within the city (FL01, refer to BPWA & Bappeda documents). The same case applies for the focus of the communities (FL04). Although many researchers had shifted their works to highlight the root of the flood problem (i.e. urban spatial planning), the business as usual situation in Bandung makes these works less interesting (FL03). Only CRBC has a longer term vision on a basin scale. Even so, the translation of this CRBC's vision in Bandung is more complex with many parties expressing high-interest of the city (FL02).

## 5.2 Discourse embedding (0)

The majority of Bandung citizens understand the notion of flooding issue in the city through much socialization conducted by the government (FL02). Nevertheless, the city still needs further effort to promote adaptation practices that support the sustainable approach to the issue of flooding (e.g. RWH and infiltration well) (FL03,04).

## 5.3 Management cohesion (0)

CRBC claimed that the progress on aligning policies and programs within the cities and regencies of Citarum Basin is inclined toward positive progress (FL02). However, it is regarded as ineffective due to the different financial capacities and degrees of authority for each area (e.g. Bandung is given more supports, compared to other cities in Citarum basin, due to its importance) (FL01,04). This very reason also limits the role of Bandung agencies and local agents of change since the interests of higher hierarchy (provincial and national) may intervene with the measures selection for flooding issue (FL01, personal communication with Bappeda).

## 6.1 Entrepreneurial agents (-)

Although no interviewee gives an exact answer about entrepreneurial agents, there is indeed a limited opportunity for anyone to gain resources for addressing flood issue. Most of the pilot projects in the city are initiated by researchers for educational purpose (not exactly fits entrepreneur background) (refer to WS03 – pilot projects on rainwater harvesting and infiltration well).

## 6.2 Collaborative agents (0)

Many collaborative projects (especially from the universities and communities) are applied in the city (FL03,04). Conventional cooperation between the government (BPWA) and other stakeholders are aligned with the city's development (FL01, Bappeda documents). These projects are usually for a shorter term and bound by business as usual objectives.

## 6.3 Visionary agents (0)

The evident implementations of several programs promote the status quo of the city which is now pursuing infrastructure development (FL01,03). Flood challenge is addressed in such way that it will still also attract the investor to the city (FL01, Bappeda documents). Similar to the collaborative agents, the researchers are the one who most familiar with such scenarios other than *business as usual* (FL03). Close interaction between the community and the public reveal that some citizens are actually quite visionary (FL04) although it is not yet accommodated.

## 7.1 Room to manoeuver (-)

Although any stakeholder with sufficient support could propose or conduct projects relates to the flood challenge (FL01), there is an evident difference of entitled freedom among stakeholders (FL03,04). Since CRBC works in basin level, it has the highest level of freedom given by the Ministry of Public Works (FL02). BPWA has less freedom since it mainly acts as implementing unit under the city level government. Other stakeholders obtain even less opportunity to approach unconventional approaches (FL03).

## 7.2 Clear division of responsibilities (+)

All interviewees realize that they need to strengthen their cooperation to achieve such integrated flood management. It can be seen from the intense informal communication among these actors (FL02). Lately, the city develops various working groups that could accommodate these stakeholders to reach fit-for-purpose cooperation in the respective challenges, including flood risk.

### 7.3 Authority (0)

Due to the city's objective to enhance their economic growth (Bappeda documents), existing power and authority in flood management are still definite (FL01,03,04). In the current settings, flooding is frequently addressed by any project designated to Bandung. However, it has not been a top priority to create such firm authority for this water challenge. Again, CRBC has better understanding of the importance of long-term and integrated approaches since it serves in a basin level (FL02).

### 8.1 Affordability (0)

The budget for flood management cost in the city comes from the tax paid by the citizens, and it is able to cover basic protection (from flooding) for most regions within the city (FL03). However, the marginal people always become the most affected groups during the flooding since they live in such vulnerable area (i.e. slums). The government had attempted to renovate their life (e.g. by relocating), but the progress is rather slow (FL03,04).

### 8.2 Consumer willingness-to-pay (0)

Since there is no specific tariff that must be paid by the citizens related to flood management in the city, the willingness to contribute financially could be observed from the commercial sectors (FL03). Some of these companies' practices alter the state of flood risk in the city. Thus, they usually asked for compensation by the city government. As long as it is still profitable, they are agreed to do so (FL03). Also, common people that regularly affected by the flooding are willing to spend their income for better protection (FL04).

### 8.3 Financial continuation (-)

Bandung owns the financial capability from the internal source (taxes from large numbers of local shops, restaurants, factories in the city and local grants) and the external (Special Allocation Fund from the central government) (FL03, 04). While SAF is used mainly by BPWA to building hard infrastructures (FL01), local taxes are not yet fully utilized to address the flooding challenge (FL03). CRBC's financial security is more solid since they are funded by The Ministry of Public Works who cooperates with ADB (FL02). In general, the financial distribution is fragmented within sectors.

### 9.1 Policy instruments (0)

The legal instruments that protect the city from flooding are composed by law and regulation from different sectors (e.g. land use conversion and solid waste management) (FL03). Although the officials realize that these instrument are not yet coherent, they are confined by many interest received by the city (FL01). The government (BECA) conducts socialization and offers incentive for alternative flooding measure (biopores), but the effect is not evident (FL03).

### 9.2 Statutory compliance (-)

Since the legal instruments are still fragmented, such low adherence is observable in the city (FL03,04). For example, the deviation of development provisions (e.g. land use ratio for the buildings) that worsen the retention ability of Bandung (FL02, FL03). This aspect is regularly brought by NGOs/communities in their protest (FL01). Others common violation are related to solid waste treatment. Disposing solid waste in/near the river are known to be the reason of drainage clogging that leads pluvial flooding (FL02,03).

### 9.3 Preparedness (0)

There is clear procedure and action plan in the event of flooding in the city (FL01), although it is based on learning-by-doing method from recurrent events (Bappeda documents). Improvement is needed since the current procedures still underestimate the impact of floods (can be seen from how they called it *cileuncang* – local word for inundation, not flooding) (FL02,03).

## Challenge 2: Water scarcity

Code	WS01	WS02	WS03	WS04	Final
1.1 Community knowledge	0	0	x	0	0
1.2 Local sense of urgency	0	0	x	0	0
1.3 Behavioral internalization	-	0	x	-	-
2.1 Information availability	0	0	0	0	0
2.2 Information transparency	0	-	0	-	-
2.3 Knowledge cohesion	+	+	0	0	0
3.1 Smart monitoring	-	-	-	-	-
3.2 Evaluation	-	-	-	--	-
3.3 Cross-stakeholder learning	+	+	0	+	+
4.1 Stakeholder inclusiveness	+	0	x	0	0
4.2 Protection of core values	0	0	x	0	0
4.3 Progress and variety of options	0	0	0	0	0
5.1 Ambitious and realistic management	0	0	0	0	0
5.2 Discourse embedding	0	0	0	0	0
5.3 Management cohesion	+	+	-	x	+
6.1 Entrepreneurial agents	x	0	x	0	0
6.2 Collaborative agents	0	0	+	0	0
6.3 Visionary agents	+	0	+	0	+
7.1 Room to manoeuvre	0	0	+	0	0
7.2 Clear division of responsibilities	+	0	+	+	+
7.3 Authority	0	0	0	x	0
8.1 Affordability	+	0	x	0	0
8.2 Consumer willingness-to-pay	0	-	x	0	0
8.3 Financial continuation	0	0	x	0	0
9.1 Policy instruments	0	0	0	x	0
9.2 Statutory compliance	0	-	-	x	-
9.3 Preparedness	0	0	0	x	0

### Document references:

Bappeda. (2013). Rencana pembangunan jangka menengah daerah kota Bandung 2013-2018 [Regional intermediate term development plan of Bandung 2013-2018]. *Available on-demand and in Indonesian language only.*

Bappeda. (2011). Rencana tata ruang wilayah kota Bandung 2011-2031 [Urban spatial planning of Bandung 2011-2031]. *Available on-demand and in Indonesian language only.*

Bappeda. (2014). RISPAM Kota Bandung [Bandung's Masterplan of Water Supply Provision]. *Available on-demand and in Indonesian language only.*

Tirtawening. (2013). Business Plan 2013-2017. *Available on-demand and in Indonesian language only.*

The management of drinking water is done by Tirtawening, a municipal-owned drinking water company. It is currently able to serve half of the city's population. The population who are not connected to the PDAM's water pipelines are using independent pump wells (*sumur pantek*). BSHALPA also has a program to increase people's access to water using groundwater well (non-piped) and rainwater harvesting (as pilot projects).

### 1.1 Community knowledge (0)

Bandung citizens do not consider water scarcity as a problem, but they do complain to the government (Tirtawening) if there is no running water in their tap (WS01,02). Nevertheless, the citizens are already familiar with water limitation (i.e. no running water 24h/day in their tap) in particular during dry season (WS04). At the same time, the city government (including Tirtawening), researchers, and concerned

communities are aware of this impending challenge which can be seen from the amount of socialization (on saving water) and research (on alternative water supplies).

#### 1.2 Local sense of urgency (0)

The effort (socialization and research) in raising the public awareness about water is recognized to some extent (WS01,02). Several territorialities are forming local task force to preserve their environment for ensuring high quality groundwater (WS04).

#### 1.3 Behavioral internalization (-)

Since the population are adapted to water scarcity (WS02), the change their behaviour only observable during difficult time (WS01). Moreover, not everyone in the society understand the water scarcity challenge which makes them rather indifferent (WS04).

#### 2.1 Information availability (0)

The government (BSHALPA, Tirtawening) claims that they own the information and data related to the water supply where the respective agencies have R&D department (WS01,02). The produced information is usually related to the potential water resource in the future (Tirtawening, Bappeda documents). However, they are not yet integrated and utilized properly for further research (WS03) or practice purposes (WS04) (e.g. groundwater quality distribution map).

#### 2.2 Information transparency (-)

Most of the data and information from government agency (BSHALPA) and the universities' research are accessible via direct request to their office (WS01) or library (WS03). Meanwhile, detailed data produced by Tirtawening is reserved for internal use only, in particular to improve the company performance (WS02). Researchers usually choose to obtain their primary data, if they cannot obtain the required data from the officials (WS03). On the other hand, communities' practices are sometimes hampered by the lack of information (WS04).

#### 2.3 Knowledge cohesion (0)

There is the city level water and sanitation working group where relevant agencies (e.g. Tirtawening, BSHALPA, BPWA) are involved (WS01,02). Their meetings allow them to improve the city performance, but there is not yet a clear procedure on the knowledge (theory and practical) sharing for external user.

#### 3.1 Smart monitoring (-)

In general, water source monitoring is conducted sparsely by different actors. For example BECA checks river water quality (WS01), researchers monitor water parameters in their specific study area (WS03), while concerned communities sometimes check surface and groundwater quality as well as cleaning the garbage in the drainage channels (WS04). Continuous monitoring is conducted by PDAM which is used for their performance indicator (WS02).

#### 3.2 Evaluation (-)

There is limited practice of evaluation within the relevant agencies. Tirtawening and BSHALPA conduct their monthly evaluation, but it mostly used internally (WS01,02,Tirtawening document). Researchers and communities is given limited opportunity to be involved in the city monitoring-evaluation practice (WS03). Also, since most communities' project are tentative, they do not even have an adequate evaluation for their program (WS04). The score from WS01 and WS02 are representative because their evaluation is based on the findings by their R&D unit and eventually used to improve water provision in the city.

### 3.3 Cross-stakeholder learning (+)

Within the water and sanitation working group, the involved agencies could closely learn from each other (WS01,02). This working group sometimes conduct general meetings that invite researcher and communities although, from a researcher's perspective, the meeting is informative rather than communicative (WS03). Meanwhile, the invited community would share the relevant information to their members to encourage them to be more engaged (WS04).

### 4.1 Stakeholder inclusiveness (0)

Public participation appears to be limited in piped water supply (WS02) since Tirtawening is a company where the public is likely to be a passive party. Meanwhile, water provision in public settlements, coordinated by BSHALPA, involves the local citizens from the early stage of water supply installation (WS01). The agency also shares the maintenance know-how to the public. However, BSHALPA programs are in the minority because more citizens are connected to Tirtawening pipelines, have independent well, or assisted by communities (WS02,04).

### 4.2 Protection of core values (0)

Since water is a basic need for people, most of Bandung's citizens is actively engaged when it is necessary (WS01,02). Alternatives of water provision for public are sometimes identified. For example, applying water filter and installing simple pipelines from a newfound natural spring to the nearest village (WS04). The stakeholder involvement is mainly based on each own interest.

### 4.3 Progress and variety of options (0)

While as a company Tirtawening has a goal to increase their customer numbers, BSHALPA, who provides water for free, also has annual target on water provision (WS01). Both Tirtawening and BSHALPA usually consult their applicant about the detail of the installation and maintenance (WS01,02). However, the progress on searching alternative options (other than pipelines and pumping well) is slow due to the recognized fact that the freshwater quantity in the city is actually adequate for the future (WS03, Bappeda document). This year, BSHALPA starts introducing RWH to the public (WS01) while Jagaseke community works on independent and small scale water sources (WS04).

### 5.1 Ambitious and realistic management (0)

Bandung government recognizes the universal target for 2019 that includes 100% of the population served by clean water, 0% slum areas, and 100% of the population have access to sanitation (WS01,02, Bappeda document). It is referred as 100-0-100 target. Researchers are focusing their work on alternative measures on water provision (WS03) while the communities' works are synced with the universal target, particularly improving access to water (WS04). Hence, the management ambitions are currently focused on improving the basic services of water.

### 5.2 Discourse embedding (0)

Many works are indeed required to attain the 2019 universal target. This target certainly becomes the focus of Bandung's officials though the agreed methods to achieve the target are mostly conventional (WS01,02). With the help of the communities, the number of citizens who understand the challenge is increasing (WS04). Still, there is a looming need to incorporate the future water availability (WS03).

### 5.3 Management cohesion (+)

As mentioned before, there is a water-and-sanitation working group that routinely meet (WS01,02). This platform can also be used to aligned water supply policy with others since an agency could have multiple functions in different sectors. Since the surface water source of Bandung comes from other regions (Bandung Regency and West Bandung Regency), these regions have an agreement and a cooperation

scheme (Bappeda documents). WS03 regards this condition needs to be improved, in particular among the sectors within Bandung itself. However, imbalance development where the resources are spent in one dominant field cannot be proved.

#### 6.1 Entrepreneurial agents (0)

Tirtawening has the opportunity to explore (conventional) innovative cooperation that could be used for increasing water provision (WS02). Meanwhile, communities sometimes come across innovative agents of change within the society. For example, individual who actively search for natural springs that can be used as drinking water source (WS04). However, larger scale impact hasn't been noticed.

#### 6.2 Collaborative agents (0)

Unconventional collaboration are usually initiated by researchers (WS03) since universities and research platforms have broader network (e.g. with foreign institutes). These collaborations are considered exceptional because the city officials still oblige to the status quo of achieving the universal target (WS01,02). The local communities sometimes collaborate with others from outside Bandung (WS04) which is usually in short to mid-term.

#### 6.3 Visionary agents (+)

With the increasing water provision projects (e.g. RWH and horizontal groundwater well) (WS03), there is an increasing potential to secure water availability for Bandung citizens. BSHALPA started to add RWH as their measure to provide free clean water (instead of pumping wells) (WS01). However, alternatives like RWH needs more time to be proved as a reliable water source for the public. Tirtawening still pursues their water coverage target using conventional plans by building more mini water treatment (WS02) while Jagaseke continues to seek for natural springs (WS04).

#### 7.1 Room to manoeuvre (0)

High degree of freedom is only recognized by researchers as they come from knowledge institutions (WS03). Governmental agencies are restricted by their target to solve the current issue (e.g. increasing access to drinking water) using the procedure that has been formulated in their annual working plan (WS01,02,Bappeda documents).

#### 7.2 Clear division of responsibilities (+)

Currently, a clear division of responsibilities are distributed to Tirtawening (piped water) and BSHALPA (non-piped water) (WS01,02,03). While BSHALPA is given more room to cooperate with other agencies, Tirtawening is recognized by the most citizens as the sole responsible institution for water provision (WS02). However, Tirtawening, BSHALPA, and other agencies well-utilize the communication platform which resulted on rather effective roles division. The city government invites the communities like Jagaseke to collaborate in finding alternative water sources (WS04).

#### 7.3 Authority (0)

The current authorities in Bandung are struggling to balance out the water use and the city development (WS03, personal communication with Bappeda). Both Tirtawening and BSHALPA are implementing agencies, meaning that they only have a little authority on enforcing the prevailing law (WS01,02). Most of the regulations that relate to water resources management (e.g. groundwater zoning) are issued by the province government (WS03). This fact restricts the influence of local government to manage their water.

### 8.1 Affordability (0)

There is no cost burdened to the local residents that are supported by BSHALPA, only the customer Tirtawening pays their bill (WS01,02). Even so, there is high rate of arrears which made Tirtawening adjusts the rate for these people. There is a program by BSHALPA to support the marginal group in fulfilling their basic water service (WS01) while Jagaseke community makes effort in providing free water for the community (e.g. RW 9 in Lindung Village, Cidadap District) (WS04).

### 8.2 Consumer willingness-to-pay (0)

For the debt issue with its customer, Tirtawening even use the help from judiciary for the enforcement (WS02). The citizen sometimes has other sources of water (with pipeline water as a secondary). Hence they're not willing to pay in particular when there is less running water in their tap. However, in general, people have the willingness to pay for basic water service. For example, the locals are willing to collect maintenance fee for pumping well provided by BSHALPA's project (WS01). Once the local able to prove that there will be clean water available for them, they are usually willing to invest (WS04). The problem is sometimes the citizens also have a high negligence level.

### 8.3 Financial continuation (0)

For the long-term financial support, Bandung has several sources from (e.g. Tirtawening's revenue, loans from commercial banks, grants from national government) to meet the basic water service by considering Tirtawening's performance as the operator (WS02, Bappeda documents). The grants are given per project, for example, in 2017, Tirtawening plans to install more mini water treatment which made them appeal for fund to the city government (which manage the financial budget from higher territorial level).

### 9.1 Policy instruments (0)

As mentioned in indicator 7.3, the regulation for groundwater zoning is issued by the province government while the city's authorities who monitor its enforcement are lacking (WS03). Meanwhile, policy instrument of urban spatial planning is not yet synced to the water management, although both of them are related. Regardless, the relevant stakeholder considers the current instrument are sufficient to enable the city achieving the target (WS01,02,03). The problem is the presence of strong authority to ensure the enforcement. Tirtawening even offers rewards for anyone who could prove a water-theft (WS02).

### 9.2 Statutory compliance (-)

The fragmented instrument and insufficient monitoring lead to rather low compliance from the public. Tirtawening previously has Non-Revenue Water (NRW) up to >50% (WS02) while the problem with BSHALPA is the negligence of the locals after the aid project ends (WS01). There is also a pressing issue relates to the water quality due to the absence of a deterrent effect for the polluters and groundwater exploiters (WS03).

### 9.3 Preparedness (0)

In the emergency event of water scarcity (e.g. severe draught), Bandung's preparedness has a defined procedure of the clean water distribution by the government (operated by Tirtawening) (WS02). The division of responsibilities and roles for the other relevant agencies (e.g. BECA, BSHALPA, and BPWA) are clear (WS01). However, the procedure and workflow are not disseminated properly to the public. It sometimes results in low public engagement during water scarce situation.

### Challenge 3: Solid waste treatment

Code	SW01	SW02	SW03	SW04	Final
1.1 Community knowledge	+	+	0	+	+
1.2 Local sense of urgency	+	+	+	+	+
1.3 Behavioral internalization	+	+	0	+	+
2.1 Information availability	x	0	-	+	0
2.2 Information transparency	x	+	0	0	0
2.3 Knowledge cohesion	x	0	-	0	0
3.1 Smart monitoring	0	0	-	-	-
3.2 Evaluation	0	0	-	-	-
3.3 Cross-stakeholder learning	+	+	0	+	+
4.1 Stakeholder inclusiveness	++	+	+	+	+
4.2 Protection of core values	+	+	0	+	+
4.3 Progress and variety of options	+	+	+	+	+
5.1 Ambitious and realistic management	+	0	+	+	+
5.2 Discourse embedding	0	0	-	0	0
5.3 Management cohesion	+	+	+	+	+
6.1 Entrepreneurial agents	0	0	0	+	0
6.2 Collaborative agents	+	+	+	+	+
6.3 Visionary agents	+	+	+	+	+
7.1 Room to manoeuvre	0	0	0	0	0
7.2 Clear division of responsibilities	+	+	+	+	+
7.3 Authority	+	+	+	+	+
8.1 Affordability	0	0	0	0	0
8.2 Consumer willingness-to-pay	0	+	0	0	0
8.3 Financial continuation	0	+	0	0	0
9.1 Policy instruments	0	0	0	0	0
9.2 Statutory compliance	-	-	-	-	-
9.3 Preparedness	+	0	0	0	0

Documents reference:

BECA. (2014). Laporan masterplan persampahan [The masterplan of solid waste management]. *Available on-demand and in Indonesian language only.*

Since earlier this year, BECA became the regulator for solid waste management in Bandung. It makes the agency has a higher position than PDK, the solid waste manager (operator).

#### 1.1 Community knowledge (+)

Most of Bandung citizens' understand about the significant risk of solid waste challenge (SW01,02,04). The Leuwigajah disaster (landfill avalanche with 156 toll death) happened more than ten years ago makes people more aware of the solid waste impact and potential calamities. Still, some member of the society (e.g. marginal groups) wouldn't have a comprehensive understanding about the risk (SW03). The city leader often addresses this challenge in his speech which increases even more awareness. BECA claims that the masterplan was compiled by involving the locals (through territorialities' representatives).

#### 1.2 Local sense of urgency (+)

Although not every citizen can be engaged, the active participation of various communities and NGOs results in the increasing understanding of the solid waste challenge in the city. These groups help socializing the new mind set of sustainable management to the public (SW01,04). The new OSWP of Bandung in early 2017 about BECA status and function is one institutional measure to support the

implementation of sustainable solid waste treatment (SW01,02). Previously, PDK has the responsibility for all aspects of solid waste treatment (SW02, SW03, SW04).

### 1.3 Behavioral internalization (+)

With much socialization in recycling and composting domestic solid waste, Bandung is now one of the cities with the highest recycling rate in Java (SW04). However, at the same time, the observation shows that the current behavioural change is not sufficient (e.g. waste is still found in the drainage channel) (SW03). A clear strategy is needed to ensure the effective application of the sustainable practices by the citizens (SW01,02).

### 2.1 Information availability (0)

The data and information about solid waste treatment are available from many sources, such as PPID website (<https://ppid.bandung.go.id/?s=sampah>), Data Portal Bandung (<http://data.bandung.go.id/dataset?q=sampah>), or PDK (SW02,04). As the operator, PDK provides online information in <http://data.bandung.go.id/dataset?q=sampah> and detailed data can be requested offline by coming to the office (SW02). While the available data are sufficient for some types of research, researchers prefer to produce their primary data (SW03). In general, there is a different perception of sufficient data among stakeholders.

### 2.2 Information transparency (0)

Accessible information on PPID and Data Portal are mostly maps, articles/news, and practical matters, which is understandable the public (SW02). The public can better understand the existing information with the help of community effort that circulates info-graphics about solid waste in the social media (SW04). Offline data are more detailed (can be used for research) but researchers usually choose to obtain primary data for PDK's performance (e.g. collected waste's tonnage) to avoid distorted data (SW03).

### 2.3 Knowledge cohesion (0)

Another reason for researchers to obtain their data is due to inconsistency they found about solid waste data (SW03). However, researchers realize that not all stakeholder able to obtain reliable data due to some limitations. Different stakeholders focus on different types of data and information based on their interest (SW04). Although a wide range of data and information are available, they are still scattered around several institutions and organization.

### 3.1 Smart monitoring (-)

The relevant government institutions claim that there is sufficient monitoring conducted for solid waste treatment in the city (SW02). While the monitoring result is used as internal evaluation, it is insufficient for prediction or identification of alarming situation. Moreover, the monitoring is conducted using unclear method (SW03) and is strictly accessible for outsiders (SW03,04).

### 3.2 Evaluation (-)

Similar with monitoring, both BECA and PDK conduct evaluation meetings regularly for internal use (SW01,02). The evaluation usually contributes for improving the current operational aspect (SW02). However, there is an unclear scheme for evaluation, where it is inaccessible for others related stakeholders, i.e. territorialities' solid waste manager, researchers, communities (SW03,04).

### 3.3 Cross-stakeholder learning (+)

Even with the poor implementation of monitoring and evaluation aspects, there is an intense exchange among solid waste stakeholders. Cross-sectors initiatives are developed from informal communication via

several whatsapp of 'solid waste working group' or 'zero waste Bandung' (SW01,04). Two chapters in the solid waste masterplan (i.e. institutional and public participation) are the results of close-interaction among the stakeholders (BECA document). PDK said that they also initiate to open the channel for private cooperation (SW02), but it is not yet documented.

#### 4.1 Stakeholder inclusiveness (+)

As mentioned before, different stakeholders are included in the policy making through constant communication via informal forums (SW01), but there is an unclear procedure (SW04). Both BECA and PDK strive to strengthen the coordination with the local officers (*petugas roda*)/scavengers (*pemulung*) in the territorialities (SW01) since they have direct contact with the citizens (SW03). The coordination is expected to also increase the coverage area of solid waste transportation in the city.

#### 4.2 Protection of core values (+)

BECA claims that they are still targeting to engage more and more territorialities under their coordination (SW01). It is before the responsibilities of PDK to coordinate the commitment of each territoriality (~1500 in total) (SW01,02). With the rising number of engaged public, BECA expected that they can contribute and supervise the progress of the masterplan's targets.

#### 4.3 Progress and variety of options (+)

Bandung's high number in population makes the solid waste manager have difficulties to engage (SW03,04). The already engaged public (via territoriality) and communities are actively contribute to the city's solid waste treatment (e.g. road sweeping, composting and recycling training) (SW01,02). These engagement are not specified in such official documents since BECA and PDK gave the others stakeholder room for alternatives.

#### 5.1 Ambitious and realistic management (+)

Bandung is currently working on long-term targets to reduce the waste that must be transported to the final disposal site by promoting waste processing near its source (decentralization) (SW01,02). In 2030, the city wants to process 70% of the solid waste within the city and transport only the residual waste to the disposal site (BECA document). Although masterplan document states the short, medium, long term target for the zero waste vision, there are challenges from the institutional and public participation aspects that may hamper the progress (SW03). It can be seen from the current progress where there is still insufficient understanding of the new mind set of solid waste treatment in the city (SW04).

#### 5.2 Discourse embedding (0)

One of the main challenge for the city to achieve the zero waste dream comes for the public. There is need to change the public's mind set where now solid waste is considered to have no value (SW01,02). Great effort is also needed to promote the practice of reducing waste, in particular the organic waste, as the biggest solid waste composition (SW03). With the help of many movements in the city, the solid waste awareness is now better incorporated into people's daily life (SW04), at least for no littering and reducing styrofoam/plastic packaging.

#### 5.3 Management cohesion (+)

Bandung requires the program synchronization with other sectors and regions (e.g. Bandung Regency, West Bandung Regency, Cimahi City, and Sumedang City). It is primarily related to WMFPS in Legok Nangka which is a new planned TPA for Greater Bandung region (SW01,03,04). With this new cooperation direction, the management cohesion among Greater Bandung cities and regencies are going to the positive direction (SW02), where before there are several issues regarding solid waste disposal near the city borders (SW03).

### 6.1 Entrepreneurial agents (0)

Several communities that focus on solid waste challenge are also initiating innovative way to deal with the challenge (SW04). They collaborated in a project called BebasSampah (<http://bergerak.bebassampah.id/>) where it aims for zero waste on 2020. One product of the project is the online distribution map of solid waste treatment location (<http://bebassampah.id/>). Nevertheless, this kind of project requires official government (SW01). In general, the changes are small compared to the amount of waste need to be dealt (SW03). Meanwhile PDK has a business unit that plan to expand the possibilities to increase their operational budget (SW02).

### 6.2 Collaborative agents (+)

Similar with the entrepreneurial agent, the local community leads the collaborative initiative in the city (SW01,03,04). Since the new OSWP (Organization Structure and Working Procedure), BECA began to engage more organizations and communities to educate solid waste producer and spread the new mindset about solid waste treatment (SW01,02). BECA, as the appointed regulator of solid waste challenge, had realized the importance to engage every stakeholder to achieve their targets: 100% waste separation on 2019 and 70% waste is processed within the city (and 30% residual waste to final disposal site) in 2030 (SW01, BECA document).

### 6.3 Visionary agents (+)

Such ambitions written in the solid waste masterplan (BECA document) urge a mindset change of Bandung's population. The aim is to change the label of solid waste that is considered dirty and has no value (hence should be transported immediately to final disposal site) into something that people can process themselves (SW01,03). Visionary agents of change are growing in number as can be seen from their online and offline efforts to engage the public (SW01,02,04). Bandung is now the city with highest recycling rate in Indonesia (SW04) but further changes are not yet observable.

### 7.1 Room to manoeuver (0)

All interviewee agreed that even with the current responsibility division of solid waste management, there is still limited freedom received by the implementing units. Although the masterplan had mentioned short, intermediate, and long-term targets, the operators (PDK) and regulator (BECA) are still struggling to achieve the short-term targets (SW03,04). Other stakeholders might have opportunities to initiate inter-sectors collaboration but in general, solutions are sought fragmentally.

### 7.2 Clear division of responsibilities (+)

All interviewee noticed that BECA appointment as the regulator on solid waste management reduces the work responsibility of PDK as the main operator. It is expected that the whole system of solid waste management could be improved by this decision (SW01,02). Since BECA is more connected to other stakeholders, there is growing cooperation that lead to the formation of some fit-for-purpose groups in the city (SW03,04).

### 7.3 Authority (+)

Still with the appointment of BECA as the regulator, the agency is now given the authority to formulate law and regulation (SW01,02). The masterplan document is in the process to be a law product that legitimate all the targets and efforts to achieve it. The pressing issue comes from the situation that the current final disposal site (Sarimukti) will reach its maximum capacity soon (SW03). It urges the government to utilize their power and authority to reduce the solid waste transportation to the final site.

### 8.1 Affordability (0)

All interviewees mentioned that the common Bandung citizens are able to pay for the current solid waste treatment procedure. The tariff is only recently adjusted and still is considered very cheap (SW01,02,03,04). It is made differently depends on the groups of waste producer (domestic, commercial, social, etc). Despite this low tariff, some citizens prefer to dispose their domestic solid waste independently where most of times are not in the designated area.

### 8.2 Consumer willingness-to-pay (0)

Since most people have the mindset to have their environment clean and want their waste to be transported to disposal site as soon as possible (SW04), there is willingness of the community to spend more money (SW03). They even hire additional labor in maintaining the cleanliness of their living area (SW01). However, they are not ready to give financial support for more sustainable programs, such as making a simple composting unit in their backyard (SW03). PDK envisages to have 100% from their customer (since the retribution reception are always lower than it should be), particularly from the commercial sector (SW02). Nevertheless, this effort needs a very solid cooperation from every stakeholder.

### 8.3 Financial continuation (0)

BECA is expected to assist with the financial support for PDK since BECA have the authority to appeal subsidies from the regional government (SW01,03,04). Meanwhile, the main task of PDK is aiming for 100% reception from the compulsory retribution (SW02). In the solid waste masterplan, the financial security are focusing to the subsidy and retribution (BECA document) while PDK plans to expand their business unit (SW02).

### 9.1 Policy instruments (0)

All interviewees agreed that the legal instruments in Bandung pertinent to solid waste treatment are sufficient. As an addition, social media trend contributes to the enforcement using social sanction for the violators (e.g. people who are caught littering will get his/her picture taken, and it will be circulated on the internet). Compare to other challenges, Bandung has city-level legal instrument about solid waste management (e.g. Regional Regulation No. 17/2012 on reducing plastic bag use).

### 9.2 Statutory compliance (-)

With the current instruments and enforcement efforts, the compliance of public is rather low (SW01,04). The social sanction mentioned above popular (and effective) from time to time. The government needs to explore this potential since it is rather effective although it is not as written law and regulations (SW03). The problem also lies in the lack of power and authority within Bandung for the enforcement (SW01,02).

### 9.3 Preparedness (0)

Despite the previous landfill disaster, Bandung preparedness for the future solid waste treatment relies on a conventional procedure (SW02,04). The city receive support from the province government with the regional final disposal site. Although BECA regards it will be adequate for the future (SW02), it will be possible only if the short and intermediate term are achieved (SW03). Also, this future disposal site is still using the principle of open dumping, that hasn't fully integrate the uncertainties.

#### Challenge 4: Wastewater treatment

Code	WW01	WW02	WW03	WW04	Final
1.1 Community knowledge	-	0	0	-	0
1.2 Local sense of urgency	0	0	0	0	0
1.3 Behavioral internalization	-	-	-	-	-
2.1 Information availability	+	0	0	0	0
2.2 Information transparency	0	0	x	0	0
2.3 Knowledge cohesion	0	0	0	+	0
3.1 Smart monitoring	-	-	-	-	-
3.2 Evaluation	-	-	x	0	-
3.3 Cross-stakeholder learning	+	0	0	+	0
4.1 Stakeholder inclusiveness	+	0	+	++	+
4.2 Protection of core values	+	0	+	++	+
4.3 Progress and variety of options	++	-	++	++	+
5.1 Ambitious and realistic management	0	0	0	0	0
5.2 Discourse embedding	0	0	0	0	0
5.3 Management cohesion	+	+	+	x	+
6.1 Entrepreneurial agents	x	+	+	+	+
6.2 Collaborative agents	+	+	+	+	+
6.3 Visionary agents	+	+	+	+	+
7.1 Room to manoeuvre	0	0	0	0	0
7.2 Clear division of responsibilities	++	+	+	++	+
7.3 Authority	0	0	0	0	0
8.1 Affordability	0	0	x	0	0
8.2 Consumer willingness-to-pay	0	0	0	-	0
8.3 Financial continuation	0	0	0	0	0
9.1 Policy instruments	0	0	0	0	0
9.2 Statutory compliance	-	-	x	-	-
9.3 Preparedness	-	-	-	-	-

Bappeda. (2013). Rencana pembangunan jangka menengah daerah kota Bandung 2013-2018 [Regional intermediate term development plan of Bandung 2013-2018]. *Available on-demand and in Indonesian language only.*

Bappeda. (2014). RISPAM Kota Bandung [Bandung's Masterplan of Water Supply Provision]. *Available on-demand and in Indonesian language only.*

Irman, Joy. (2013). Landasan Hukum Pengelolaan Air Limbah [Legal Framework of Wastewater Treatment in Indonesia] <https://www.slideshare.net/metrosanita/modul-1-1-landasan-hukum-pengelolaan-air-limbah>

BCHALPA. (2016). Mengenal Sanitasi Berbasis Masyarakat Islamic Development Bank (Sanimas-IDB) Kota Bandung [Introducing Community Based Sanitation with Islamic Development Bank (Sanimas-IDB) of Bandung]. *Available on-demand and in Indonesian language only.*

Likewise drinking water management, wastewater treatment falls under the responsibility of Tirtawening, a municipal owned drinking water company who regulate the wastewater pipelines system and Bojongsoang WWTP. The population who are not connected to the Tirtawening system usually install on-site septic tanks which will eventually be transported to Bojongsoang. Still, the practice to discharge domestic wastewater directly to the river is common. There is a newly built septage treatment plant in Kiara Condong which is built to observe the efficiency of centralized blackwater treatment. The main reason that hampers the development of any offsite wastewater treatment facility is the difficulty to find a proper land area, especially in a dense and crowded neighbourhood.

### 1.1 Community knowledge (0)

Although the public are mostly ignored the issue (WW04), the government (the most relevant stakeholder who is entitled to regulate wastewater treatment aspect) is knowledgeable (WW01,02). With frequent socialization and project related to wastewater offered by the government, the percentages of Bandung citizens who are aware of wastewater challenge are increasing.

### 1.2 Local sense of urgency (0)

Unfortunately, the citizens are not concerned about wastewater challenge even it occurs in their living area (WW04). There is a growing sense of urgency about wastewater management since the last three years with the presence of programs such as Sanimas (CBS program) (WW01,04) and Tirtawening project for low-income society (WW02). These projects have successfully engaged some of the society members to pay attention to their domestic wastewater management.

### 1.3 Behavioral internalization (-)

All interviewee agreed that external pressure is still one of the main reasons which made the awareness about wastewater is growing. With the frequent updates on environmental quality standard, Bandung is required to follow the regulations (WW01,02), in particular, with the on-going degradation of water quality of Citarum River. The behavioural changes shown by the citizens are usually caused by an obligatory instruction from the government to raise the river water quality (the end channel for wastewater disposal). Either, the citizens want to improve their environment's aesthetic (WW04).

### 2.1 Information availability (0)

The availability of data and information on wastewater treatment are sufficient for a small-scale independent program in designing of WWTP installations (WW04). Most of the information is available offline in some organizations such as BSHALPA (with the documentation of Sanimas program), Tirtawening (WW01,02). More detailed data (e.g. water quality parameters) is available at BECA of city and provincial level (WW01) and the universities library (WW03).

### 2.2 Information transparency (0)

Accessing offline data can be done by requesting the datasets to the organizations' office. There will be procedures and bureaucracy that needs to follow (WW01,02). For Sanimas project, the public can obtain (and understand) the data rather easier with the help of the project's facilitator (WW01,04) due to the technical language that is used in the documents.

### 2.3 Knowledge cohesion (0)

For projects which are supported by (government) facilitators, the data and information are coherent and complete (WW04). In general, the data owner indeed sustained their projects' documentation for several period (WW01,02). However, the shared knowledge is limited compared to what they obtained. The relevant institution also uses water and sanitation working group as sharing platform (WW01,02,03).

### 3.1 Smart monitoring (-)

Some monitoring procedures are conducted by Tirtawening, in particular, to check their infrastructure (e.g. pipeline) and to ensure their outflow water quality (WW02). BSHALPA, as Sanimas program initiator, conducts monitoring in the projects area and educates the local to be able to monitor the communal WWTP by themselves (WW01,04). The Nevertheless, the current monitoring procedures are not sufficient to improve the level of learning. It is mainly conducted to check the progress of their programs.

### 3.2 Evaluation (-)

The lack of monitoring contributes to the limited evaluation for wastewater challenge. Existing evaluation in each institution are usually used internally (WW01,02). The methods for technical evaluation are not yet defined. For example, Bojongsoang WWTP's outflow quality is checked only using visual inspection (i.e. water clarity) while laboratory checks are conducted once a while (WW02). The Ministry of Public Works recently compiled performance indicators for wastewater treatment in the country. It is expected to improve the evaluation's contribution to the level of learning.

### 3.3 Cross-stakeholder learning (0)

There is a high-quality level of interaction among the stakeholders involved in Sanimas project where the public work closely with their facilitator (WW01,04). However, only small percentages of Bandung's population are engaged to Sanimas program. Its applicants' (the territorialities) must appeal BSHALPA to be selected. Meanwhile, in general, most citizens receive knowledge about wastewater challenge through government's socialization and empowerment (WW02,03).

### 4.1 Stakeholder inclusiveness (+)

There is very transparent and active interaction between the involved parties in the Sanimas program (WW01,04). However, the project's significance is not experienced by the rest of the city where Tirtawening customers are not actively interested in their wastewater treatment process (WW02). Tirtawening and BSHALPA have public socialization programs to engage more people to treat wastewater properly (by direct connection to Bojongsoang WWTP, communal WWTP or septic tanks) (WW02).

### 4.2 Protection of core values (+)

Again, Sanimas initiator and recipient gave a high score for the indicator since they have intense communication with a high level of learning during at least one year project's period (WW01,04). Others programs related to wastewater treatment are usually started with an initial meeting to inform and request the commitment from the target audience (WW02). It sometimes results on the disengagement because of public hesitation to commit.

### 4.3 Progress and variety of options(+)

The progress on Sanimas program indicates strong involvement of the locals from the beginning (WWTP planning process) until the unit installation (WW01, WW04). The locals are given the choice to propose their own design (WW04). Nevertheless, the selection of the area for Sanimas program is decided by BSHALPA (i.e. territorialities could propose their area as to be included, but the selection is based on a preliminary study). Meanwhile, Tirtawening will only continue their wastewater program with the public after commitment statement to avoid resistance (WW02).

### 5.1 Ambitious and realistic management (0)

Similar to the water scarcity challenge, the main target of Bandung government is encapsulated in the universal target in 2019 (WW01,02). BSHALPA and Tirtawening are both focus on providing proper sanitation access for the population. It includes engaging more people to be more concerned about their wastewater treatment (UH03,04).

### 5.2 Discourse embedding (0)

Although the current ambition to have proper sanitation fits the local context, the public is rather indifferent about their wastewater. The city officials, including BSHALPA and Tirtawening, also universities conduct public's information session to make better understanding about the challenge (WW01,02,03). Particularly for low and mid income families, they are usually reluctant about the issue, but after a series a socializations, they are able to comprehend (WW04).

### 5.3 Management cohesion (0)

There is very limited synchronization from Bandung's government with the adjacent area. The alignment of policies is still focusing on flood and solid waste challenges (WW01). Bandung is also one of several cities in Indonesia who owns a centralized WWTP (WW02). It results in frequent interaction between Bandung and The Ministry of Public Works to observe and improve the WWTP performance (WW02).

### 6.1 Entrepreneurial agents (+)

Although still limited in numbers, entrepreneurial agents of changes are recognized during Sanimas projects (WW03,04). Since the project gives such degree of freedom, the agents of change can utilize this chance. In several areas, communal WWTP are combined with public spaces that benefitted the adjacent neighbourhood (WW04, Sanimas presentation). The business unit of Tirtawening also identify opportunities on selling bottled water (WW02).

### 6.2 Collaborative agents (+)

Bandung's government recognizes the opportunity to collaborate with the province & national government also private fundings for Sanimas Project (WW01,03). Some of the private funding comes from Islamic Development Bank (IDB) and Australian Aid (BSHALPA documents). Tirtawening also cooperates with Australian government for a project to increase house connections to Bojongsoang WWTP's pipelines (WW02). Also, the public enthusiasm to register their area for communal WWTP projects are growing since 2014 (WW01,04).

### 6.3 Visionary agents (+)

All the interviewees mentioned that their agencies/organizations had realized the significance of wastewater treatment before discharging it to the environment. They are acting as the visionary agents of change in the society by conducting events and socialization about it. Among Bandung citizens, the agents of change enlighten the locals about wastewater treatment where some of them even have ideas about the design of communal WWTP (WW04). Still, improvements are needed to make the dissemination of long-term vision works effectively.

### 7.1 Room to manoeuvre (0)

Similar to other challenges, the governmental agencies usually have somewhat limited freedom to propose a new approach to their predefined task (WW01). Even with Sanimas program, that seems unconventional, the actors are only given limited time-frame (a year) to complete the project (WW03,04). Tirtawening has slightly higher freedom where they have several partnerships, but most of these are aimed at technical solution (WW02).

### 7.2 Clear division of responsibilities (+)

While Sanimas program is on the rise these last three years, the targets indeed seem satisfied with the result (WW04). BSHALPA considers their work are fit-for-purpose (WW01) but the amount of their projects, compared to the total city population, are very small. Still, these different actors recognize the need to incorporate all available expertise, in particular using the platform of water and sanitation working group. Similar to water scarcity challenge, both Tirtawening and BSHALPA have similar programs to assist the marginal groups. Both of them also cooperate with new actors (e.g. Australian government) (WW01,02, BSHALPA documents).

### 7.3 Authority (0)

All interviewee agreed that although the progress that improves the sanitation access in the city are now taking place, Bandung's government still has restricted authority. As mentioned before, Tirtawening and

BSHALPA are implementing units, the regulations are formulated by the higher level authority (province and national) (WW02,03).

#### 8.1 Affordability (0)

Although not all the members of society can afford basic wastewater service (WW02), the government provides this service for free (via Sanimas and Tirtawening program for low-income citizens) (WW01,02). While Sanimas program supports the use of communal WWTP (WW01,04), Tirtawening eliminates wastewater connection fees for eligible families (MBR, Low Income Society) (WW02).

#### 8.2 Consumer willingness-to-pay (0)

In general, the population, especially with low income, have a low willingness-to-pay for even basic wastewater service (WW04). It is due to the low public awareness of wastewater issue which made wastewater treatment is not included as the top priorities of most Bandung families' household budget (WW03). However, the government (via Tirtawening and BSHALPA) allocate their budget to help with the connection fees (WW01,02). The public still has trust on the government regarding this aspect.

#### 8.3 Financial continuation (0)

Both Sanimas and Tirtawening program for low-income family receives financial support from public and private partnerships (WW01,02). Particularly for Sanimas project, there is an annual evaluation of its performance (BSHALPA document) that determine the budget for the project in the next term (WW01,04). The provincial and national budgets are also made available for the implementation of basic water services (WW03) where the city government could appeal for this.

#### 9.1 Policy instruments (0)

Most of the policy instruments related to wastewater treatment in Indonesia are covered under law and regulations about environment quality standard (WW01,02) There are several ministerial decrees and technical notes from Indonesian National Standard (SNI) about how to safely discharge wastewater to the environment (Irman, 2013). There will be a new set of regulations to promote wastewater management in regional scope, after around five years in progress (WW03). Still, the instruments imposition is not fully effective, in particular, because the lack of monitoring for the many inter-sectors users discharge their wastewater (e.g. domestic, factories, and commercials).

#### 9.2 Statutory compliance (-)

Similar with willingness-to-pay, low public awareness of wastewater issue causes low legal compliance. The percentages of the population who discharge their wastewater directly to the river are still high (WW02,04). Even houses with septic tank are not all connected to the WWTP. The city needs more authorities to monitor wastewater disposal (other than BECA who is responsible for monitoring environment quality) (WW01,02).

#### 9.3 Preparedness (-)

The city prepares for the future wastewater challenge by refurbishing plan on Bojongsoang WWTP (WW02). Tirtawening (as the WWTP operator) plans to improve the water quality of the outflow since there is new regulation on environmental quality standard. The preparedness of Bandung in dealing with wastewater related disasters (compiled by Bappeda) is based its strategy with the risk from business as usual scenario but still hasn't integrated the factor of uncertainties (Bappeda documents).

### Challenge 5: Urban Heat Island

Code	UH01	UH02	UH03	UH04	Final
1.1 Community knowledge	-	-	-	-	-
1.2 Local sense of urgency	-	-	-	-	-
1.3 Behavioral internalization	-	-	-	-	-
2.1 Information availability	-	-	-	-	-
2.2 Information transparency	0	x	-	-	-
2.3 Knowledge cohesion	0	x	0	0	0
3.1 Smart monitoring	-	-	-	-	-
3.2 Evaluation	-	x	x	-	-
3.3 Cross-stakeholder learning	+	+	+	+	+
4.1 Stakeholder inclusiveness	0	x	0	0	0
4.2 Protection of core values	0	x	x	0	0
4.3 Progress and variety of options	0	x	-	x	-
5.1 Ambitious and realistic management	0	x	0	x	0
5.2 Discourse embedding	0	0	-	0	0
5.3 Management cohesion	0	0	x	x	0
6.1 Entrepreneurial agents	x	x	0	+	0
6.2 Collaborative agents	0	x	x	0	0
6.3 Visionary agents	+	x	x	+	+
7.1 Room to manoeuver	0	x	x	0	0
7.2 Clear division of responsibilities	+	x	+	x	+
7.3 Authority	-	-	-	x	-
8.1 Affordability	0	x	0	x	0
8.2 Consumer willingness-to-pay	-	x	-	-	-
8.3 Financial continuation	x	x	0	x	0
9.1 Policy instruments	x	0	0	x	0
9.2 Statutory compliance	0	x	-	0	-
9.3 Preparedness	-	x	-	-	-

CCROM. (2017). Draft RAD-API Kota Bandung [The Draft of RAP-ACC for Bandung]. *Available on-demand and in Indonesian language only.*

Paramita, B., & Fukuda, H. (2014). Heat intensity of urban built environment in hot humid climate region. *Am. J. Environ. Sci*, 10, 210-219.

Urban heat island (UHI) in Indonesia is not a popular issue. Even the term itself is only regularly used by researchers group and is less familiar to the public (UH03). The UHI issue in this study extends its scope to adaptation to climate change including energy resource efficiency and green space utilization (UH01).

#### 1.1 Community knowledge (-)

All interviewee agree that UHI is not recognized as a widespread issue in Bandung. While the term UHI is used mainly by researchers (UH03), the public could relate with the explanation of UHI's character. Climate change adaptation is better understood by the majority of the stakeholders, in particular by using terms such as urban green space and energy use efficiency (UH01,03,04). Nevertheless, public awareness of the challenge is fragmented where knowledgeable citizens are those who joined environment based communities.

#### 1.2 Local sense of urgency (-)

Since UHI issue is noticed by the researchers, they attempt to incorporate the factors into the government programs (UH03). The government is originally had programs related to climate change adaptation

(UH01). Although it is not directly mentioned, these programs (later known as part of RAC-APP) also address UHI challenge to some extent.

### 1.3 Behavioral internalization (-)

With the limited knowledge and awareness among the citizens, UHI is recognized as the increase of average air temperature (esp. using a local term '*hareudang*') (UH03). Rising trend in the temperature is more known as the effect of climate change (UH01). Hence, the behavioural change, such as conserving water and energy, reducing waste, and using public transportation, are perceived as climate change adaptation (UH04).

### 2.1 Information availability (-)

The availability of data and information about UHI is limited in the technical aspects. The common data are temperature profiles of the city which is related to the city's structure (UH03). Other data and information are related to climate change adaptation including about air pollution, energy production, and solid waste treatment (UH01,02,04).

### 2.2 Information transparency (-)

With the limited available data for UHI challenge, the sharing procedure is also restricted between researchers and data owner, which is IAMCG (UH03) where these detailed temperature profile data are usually not free. Other data and information which more relevant for climate change adaptation are kept by BECA (UH01).

### 2.3 Knowledge cohesion (0)

Although the information transparency is rather confined, it will be available for other once it is used for research (UH03). Researchers who also work as government-consultants usually share their findings. Meanwhile, climate change adaptation information is in better state with the coordination of many institutions (Bappeda, BECA, and other agencies including Public Works, Transportation, Tourism) who contribute to RAP-ACC (UH01, personal communication with Bappeda, RAP-ACC document).

### 3.1 Smart monitoring (-)

Since the monitoring for UHI challenge is mainly related to the temperature, it is primarily conducted by the IAMCG. However, there is no procedure on sharing the detailed and continuous data yet. Other temperature monitoring is conducted by researchers (UH03). For climate change adaptation, the monitoring is done by some institutions including DPKP3 who monitors the green space quality (not the quantity) (UH02) and BECA who conducts vehicle emission test routinely (UH01). Communities only monitor via exchanging news and articles informally (UH04). These efforts are not sufficient to identify alarming situation.

### 3.2 Evaluation (-)

With the existing monitoring procedures, the evaluation result is not yet fully utilized for improving the future policy and implementation. Regular evaluations are conducted by BECA as the main agency that responsible to monitor the city's environmental quality (UH01). Earth Hour Bandung as one BECA partner to promote climate change awareness has an informal internal evaluation in addition to annual evaluation with BECA (UH04).

### 3.3 Cross-stakeholder learning (+)

The completion of RAP-ACC in April 2017 demonstrates the efforts of the city government (Bappeda) to document and harmonize the necessary actions (UH01, Bappeda personal communication). All interviewees mentioned that the government (via BECA) had engaged more and more organizations and

learned from each other (i.e. the interaction is not only informative). UHI challenge is addressed at the same time by improving learning for climate change adaptation. Moreover, some researchers are involved in government's projects for slum settlement (UH03).

#### 4.1 Stakeholder inclusiveness (0)

It is mentioned before that RAP-ACC completion shows the result of various stakeholders' interaction (UH01). Although the interactions between government agencies are clear and contribute a lot to the document, the target (i.e. Bandung citizens) are not involved closely in the formulation (UH03,04). The public already works on their climate-related programs, while the city expects that RAP-ACC could improve the efficiency. Meanwhile, sharing sessions to engage the people living in slum area are still limited (UH03).

#### 4.2 Protection of core values (0)

Climate change related government programs such as reducing emission, waste, and energy use are relatively well-received by the public with positive feedback from the public (usually written in the government's social media) (UH01,04). However, larger projects (which are more pertinent to the city development but have significant effect to UHI/climate change) have such low public influence which leads to disengagement or sometimes resistance (UH03).

#### 4.3 Progress and variety of options (-)

Popular programs such as water and energy conservation are supported by many people due to its simplicity. The measures are related to everyday's life where people do not need to invest much to the process (UH01). Meanwhile, larger programs, such as slum rearrangement, encounter resistance and critic from the public since the relevant decisions are mostly unilateral. The uncooperative population also hamper the implementation (UH03).

#### 5.1 Ambitious and realistic management (0)

Bandung's ambition to tackle UHI challenge in Bandung had been incorporated in the city planning targets (Bappeda documents). It is not yet referred directly on the documents but the measures to make Bandung to be more compact yet sustainable also consider the city's temperature profile (UH03). Climate change adaptation for Bandung has not based on any legal framework yet but BECA has regular targets as their performance indicator for climate proofing the city (UH01). In general, the main objective of the city is still the improvement of basic services for the citizens.

#### 5.2 Discourse embedding (0)

The current measures taken by the city government suits the local norms and contexts (UH01). It can be seen from the growing support from the public, although they have not understood the comprehensive knowledge of climate change's risk and uncertainties (UH02,04). At the same time, Bandung officials also attempt to conduct a series of socialization for slum rearrangement which it mainly aims to alleviate the locals' quality of life. Although the general reception is neutral, some slum areas are detached (even resist) due to slow progress of the government (UH03).

#### 5.3 Management cohesion (0)

There are only a few efforts to synchronize the adaptation measures of Bandung with its adjacent area. In the recent years, the city is focused on the completion of RAP-ACC, which is also made to synchronize the adaptation with national instruction (UH01). Most climate adaptation measures in the city are also done to follow with the national requirement, e.g. minimum area of green space should be 30% of the urban area (UH02).

### 6.1 Entrepreneurial agents (0)

Local communities such as Earth Hour are trained to have fundraising in their events (UH04). It works for them since Earth Hour has become a *brand* and it is endorsed by an international platform (WWF). Researchers, whose work directly relates to the UHI challenge, usually support the government projects (i.e. designing new settlements) (UH03).

### 6.2 Collaborative agents (0)

The collaboration projects in Bandung exist mostly among conventional actors: government agencies, researchers, and sometimes communities (UH01). For example, the joint project to formulate RAP-ACC and the development plan of *apartemen rakyat* (people's apartment) and *rumah deret* (houses in rows). Communities like Earth Hour Bandung are helping with engaging more to the public and educating them about climate change (e.g. water saving, solid waste recycling, and energy efficiency) (UH04). These do not directly address the UHI challenge but aim for the vision on climate change adaptation.

### 6.3 Visionary agents (+)

Similar to other challenges, the visionary agents in Bandung have recognized the importance of developing certain attitudes in facing climate change impact (UH01,04). There are increasing public events that highlight the adaptation aspect, which is meant to raise public awareness. However, clear strategies (and targets) on this matter are not yet formulated.

### 7.1 Room to manoeuvre (0)

Bandung's government grants BECA the freedom to tackle climate change issues using their methods. Since many aspects are connected to climate change, BECA has to cooperate with other agencies (Bappeda, Public Works, Transportation, Tourism, etc) (UH01). Nevertheless, this collaboration is still on the level of formulating a future plan. Cooperation with communities (e.g. *Bandung Bijak Energi*) is confined to such short-term targets (UH04).

### 7.2 Clear division of responsibilities (+)

The division of roles and sharing of responsibilities among government agencies are clear with the planning coordinator being Bappeda and the implementing coordinator being BECA (UH01, personal communication with Bappeda). With the finalization of RAP-ACC, the progress on climate-proofing Bandung can be improved. The city government is exploring cooperation with researchers and platforms such as Green Building Council Indonesia (GBCI) (UH03).

### 7.3 Authority (-)

Compared to other challenges, UHI (even in a broader sense, climate change adaptation) are not yet on the priority list of Bandung. Indeed, there is growing awareness among citizens while city officials also support the publication of this challenge (UH01). However, no defined authority can enable an integrated solution for this challenge. Bandung follows the law issued by the national government (UH03), with no plan on arranging its own regulation, which is possible considering BECA is now a regulatory agency.

### 8.1 Affordability (0)

In general, Bandung has to deal with unaffordable climate adaptation, especially for the UHI challenge. Conventional measures such as a car's catalytic converter are not yet used by the majority of citizens (UH01). On a larger scale, compared to Jakarta, Bandung still has no building that obtains a *green certificate* from GBCI (UH03). As one measure to manage the urban space, the city now owns five apartments for low-income families, which is also reducing the UHI effect compared to previous slum housing.

composition (UH03). Nevertheless, these five apartments contribute only a little on reducing the city's temperature.

#### 8.2 Consumer willingness-to-pay (-)

There is fragmented willingness of the citizens to spend their income for climate change adaptation. Likewise, the case with car's catalytic converter, a large part of the population (e.g. students from outside the city, families just above the poverty line) prefers to live in a *cheap house* in the densely populated area. These overcrowd settlement that scattered around Bandung apparently has higher average temperature compared to its surrounding area (UH03; Paramita & Fukuda, 2014).

#### 8.3 Financial continuation (0)

Although there is no special budget allocated for climate change adaptation, Bandung could make use the available budget (from the city, province, and national government) to achieve the universal 2019 target of 0% slum area (UH03, personal communication with Bappeda). Managing slum settlements in the city will affect the diurnal temperature in the city (UH03; Paramita & Fukuda, 2014).

#### 9.1 Policy instruments (0)

The policy instruments on UHI and climate change adaptation in the city are based on the national decree (issued by the ministry) and several Bandung's regulations (UH02,03). The city level instruments usually address specific issues, such as green building and plastic bag use (UH02). Meanwhile, the national regulations refer to city's obligation (such as the minimum green space area). These regulations are scattered among different sectors. There is also need to consider UHI challenge into the urban spatial plan (UH03).

#### 9.2 Statutory compliance (-)

There is moderate compliance of the city level regulation which controls the behaviour of individual (or small group of people) (e.g. obeying car emission standard, reducing plastic bag use, conserving energy) (UH01,04). Based on BECA monitoring, the amount of citizens who comply these regulations are increasing. More pressing issue come from the city's spatial plan where many infringements occur. It is mainly related to the city's structure that affects the city's temperature profile (UH03).

#### 9.3 Preparedness (-)

Bappeda just had finished the formulation of RAP-ACC which covers identification of climate change impact for the city and integrating the climate change adaptation to the regional agenda (UH01). RAP-ACC result contains the city's climate profile and vulnerability map (up to district level) which is used as the base for adaptation options for priority villages within Bandung. However, UHI issue is not addressed directly in RAP-ACC, only the city's temperature profile is explained. Hence, although there is a strategy for climate change impact, the preparedness for UHI challenge is rather limited.