Stakeholder Engagement in Sustainable Urban Water Management in the Accra Metropolis, Ghana

By

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Declaration

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Abstract

Over the last two decades, the Accra metropolis has experienced rapid population, urbanisation and economic growth that threatened the sustainable management of water and sanitation systems to deliver efficient services. Guided by the political ecology theory, this study explores the water system dynamics in Accra by examining the web of factors that rendered previous water management approach inadequate and prompted the search for an alternative way. The transdisciplinary research (TDR) process was adopted as the overarching research approach for this study. Fundamental to the operationalisation of the TDR process was the establishment of a learning platform that brought together diverse stakeholders for dialogue and deliberations on water issues in the metropolis. At the learning platform, an assemblage of research methods, including focus groups, dialogue, one-on-one consultation and surveys were used. Additional data were gathered from literature and national documents including reports, plans and strategies. The study showed that the Government of Ghana (GoG), overwhelmed by the mounting challenges and the declining capacity of water institutions to manage the water system began the water privatisation process to reform the water sector in 2005. A 5-year (2006 – 2011) Management Contract was signed between the government and a private entity, Aqua Viten Rand Limited (AVRL) to implement interventions that would help establish a financially self-sufficient urban water system capable of achieving at least five outcomes – improved water governance, efficient water supply, increased water coverage and access, reduced non-revenue water (NRW), and reduced water-related health risks. The analysis showed that interventions under Private Sector Management (PSM) fell short of fully achieving the desired outcomes. Based on the poor outcomes, a decision was made by the government to return urban water management to public ownership at the end of the contract period (2011). To kick-start a new public management regime, a new framework called the Water Sector Strategic Development Plan (WSSDP) was developed to guide the vision of providing sustainable access to clean water and basic sanitation for all urban citizens by 2025. Under this framework, the water managers in Accra implemented interventions inspired by the Sustainable Urban Water Management (SUWM) approach. Overall, the implementation of interventions under the WSSDP has been described as encouraging with considerable improvements in potable water volume supplied, water governance, and growing attention to sewage and wastewater management through public-private-partnerships. However, several areas that required further attention included addressing NRW, wastewater treatment and ecosystem integrity, among others. To address the gaps, a framework that defines the overall goal, key objectives and five interventions are presented. The interventions included - reducing unaccounted-for water (UFW), cost recovery and tariff adjustment, public participation and awareness campaign, expansion of water treatment capacity, and rehabilitation of wastewater treatment plants. Given the limited financial resources, water managers may need to identify the most cost-effective option with maximum benefits. Based on the benefit-cost analysis, the study concludes that investments in cost recovery and water tariffs adjustment could generate maximum benefits at the lowest cost than the remaining interventions in the long term. Sustainable financing of the urban water system would require improved cost recovery from water consumers. Tariff increases are inevitable, however, consideration for targeted lifeline tariffs and subsidies to low-income residents could make cost recovery acceptable and realistic.

Opsomming

Die Accra-metropool het die afgelope twee dekades vinnige bevolking, verstedeliking en ekonomiese groei beleef wat die volhoubare bestuur van water- en sanitasie-stelsels bedreig om doeltreffende dienste te lewer. Gelei deur die politieke ekologie-teorie, ondersoek hierdie studie die dinamika van waterstelsel in Accra deur die web te ondersoek van faktore wat die vorige waterbestuursbenadering onvoldoende gemaak het en die soeke na 'n alternatiewe manier gevra het. Die proses van transdissiplinêre navorsing (TDR) is aangeneem as die oorkoepelende navorsingsbenadering vir hierdie studie. Fundamenteel vir die operasionalisering van die TDR-proses was die daarstelling van 'n leerplatform wat verskillende belanghebbendes bymekaar gebring het vir dialoog en beraadslaging oor waterkwessies in die metropool. Op die leerplatform is 'n samestelling van navorsingsmetodes, insluitend fokusgroepe, dialoog, konsultasie en opnames, gebruik. Bykomende gegewens is versamel uit literatuur en nasionale dokumente, insluitend verslae, planne en strategieë. Die studie het getoon dat die regering van Ghana (GoG), oorweldig deur die toenemende uitdagings en die dalende kapasiteit van waterinstellings om die waterstelsel te bestuur, die privatiseringsproses vir die hervat van die watersektor in 2005 begin het. 'N Bestuurskontrak van vyf jaar (2006 - 2011) is tussen die regering en 'n privaat entiteit, Aqua Viten Rand Beperk (AVRL), onderteken om intervensies te implementeer wat sal help om 'n finansieel selfversorgende stedelike waterstelsel te vestig wat ten minste vyf uitkomste kan bereik - verbeterde bestuur van water, doeltreffende watervoorsiening, verhoogde waterdekking en -toegang, verminderde nie-omsetwater (NRW) en verminderde waterverwante gesondheidsrisiko's. Die ontleding het getoon dat intervensies onder die privaatsektorbestuur (PSM) nie daarin slaag om die gewenste uitkomste te bereik nie. Op grond van die swak uitkomste, is die regering deur die regering besluit om aan die einde van die kontrakperiode (2011) die bestuur van stedelike water na openbare besit terug te gee. Om 'n nuwe openbare bestuursregime te begin, is 'n nuwe raamwerk genaamd die Watersektor Strategiese Ontwikkelingsplan (WSSDP) ontwikkel om die visie van volhoubare toegang tot skoon water en basiese sanitasie vir alle stedelike burgers teen 2025 te lei. die waterbestuurders in Accra het ingrypings geïnspireer wat geïnspireer is deur die Volhoubare Stedelike Waterbestuur (SUWM) -benadering. In die algemeen is die implementering van ingrypings onder die WSSDP beskryf as bemoedigend met aansienlike verbeterings in die hoeveelheid drinkwater wat voorsien is, die bestuur van water, en toenemende aandag aan riool- en afvalwaterbestuur deur openbare-privaat-vennootskappe. Verskeie gebiede wat verdere aandag benodig het, was onder andere die aanspreek van NRW, afvalwaterbehandeling en die integriteit van die ekosisteem. Om die leemtes aan te spreek, word 'n raamwerk aangebied wat die algehele doelwit, sleuteldoelwitte en vyf intervensies definieer. Die intervensies het ingesluit - vermindering van onverklaarbare water (UFW), kosteverhaling en tariefaanpassing, openbare deelname en bewusmakingsveldtog, uitbreiding van die waterbehandelingskapasiteit en rehabilitasie van afvalwaterbehandelingsaanlegte. Gegewe die beperkte finansiële hulpbronne, sal waterbestuurders moontlik die mees koste-effektiewe opsie met die maksimum voordele moet identifiseer. Op grond van die voordeel-koste-analise, kom die studie tot die gevolgtrekking dat beleggings in die verhaling van koste en die aanpassing van watertariewe maksimum voordele teen die laagste koste as die oorblywende intervensies op die langtermyn kan lewer. Volhoubare finansiering van die stedelike waterstelsel sal verbeterde kosteverbetering van waterverbruikers verg. Tariefverhogings is onvermydelik, maar die inagneming van geteikende

lewensduurstariewe en subsidies aan inwoners met 'n lae inkomste kan kosteverhaling aanvaarbaar en realisties maak.

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List of Acronyms

AfDB`	African Development Bank
AMA	Accra Metropolitan Assembly
ASIP	Accra Sewerage Improvement Project
AVRL	Aqua Vitens Rand Limited
BOD	Biochemical Oxygen Demand
CFU	Colony Forming Units
COD	Chemical Oxygen Demand
CONIWAS	Coalition of NGOs in Water and Sanitation
CSIR	Council for Scientific and Industrial Research
CSO	Civil Society Organisation
CWSA	Community Water and Sanitation Agency
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organisation
GAMA	Greater Accra Metropolitan Assembly
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GPRS	Growth and Poverty Reduction Strategy
GoG	Government of Ghana
GSS	Ghana Statistical Service
GWCL	Ghana Water Company Limited
GWP	Global Water Partnership
GWSC	Ghana Water and Sewage Corporation
HSD	Hydrological Services Department
ISODEC	Integrated Social Development Center
IMF	International Monetary Fund
IUWM	Integrated Urban Water Management
IWMI	International Water Management Institute
IWRM	Integrated Water Resource Management
LWBs	Local Water Boards
Mm^3	Million Cubic Meter
MLP	Multi-Level Perspective
MMAs	Metropolitan/Municipal Assemblies
MLG	Ministry of Local Government
MOFEP	Ministry of Finance and Economic Planning
MRH	Ministry of Roads and Highways
MSWR	Ministry of Sanitation and Water Resources
NADMO	National Disaster Management Organisation
NCAP	National Coalition Against Privatisation of Water

NDPC	National Development Planning Commission
NLLAP	National Level Learning Alliance Platform
NWP	National Water Policy
PPMED	Policy, Planning, Monitoring & Evaluation Division
PURC	Public Utility Regulatory Commission
PSM	Private Sector Management
RCN	Resource Centre Network
SCADA	Supervisory Control and Data Acquisition System
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa
SUWM	Sustainable Urban Water Management
SWITCH	Sustainable Water Improves Tomorrow's Cities Health
TBL	Triple Bottom Line
UASB	Up-flow Anaerobic Sludge-Blanket
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UN DESA	United Nations, Department of Economic and Social Affairs
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WHO	World Health Organisation
WRC	Water Resources Commission
WSMP	Water and Sanitation Monitoring Programme
WSSDP	Water Sector Strategic Development Plan
WTA	Water Tankers Association

Chapter 1: Introduction

1.1 Background

The development and management of urban water resources have become strategically important, not only because of the Sustainable Development Goal on Water (SDG 6) but also due to water's growing significance in the dynamic relationships between human development, economic growth and the environment. In rising cities in the developing south, the focus on intensifying economic development coupled with the rapid urban population growth raises concerns about the growing water demand and the capacity of existing water systems to address the water challenges arising from the current development trajectory (Jacobsen, Webster & Vairavamoorthy, 2012).

Since the 1970s, the approach to urban water management has been shaped by a 'conventional water management approach' (usually referred to as the 'conventional approach') that has tended to favour large-scale, centralised, and mechanised water and drainage systems. These systems comprised buried and above-ground infrastructure networks that aimed at supplying potable water and protecting public health (Farrelly & Brown, 2011). Such systems were capital intensive and were rarely designed to take into account the ecological implications for water supplies over the long-term (Brierley & Fryirs, 2008). This paradigm has also often been characterised by an uncoordinated institutional framework premised on a sector-based or "silo" approach to urban water management (Brown, Keath & Wong, 2008). In many ways, it contributed to fragmented and overlapping responsibilities between various water institutions, limited stakeholder/actor engagement and the lack of long-term integrated water resources planning (Novotny, 2008).

There is a widely accepted realisation that the conventional approach is no longer appropriate for dealing with the challenge of providing high-quality water supply and sanitation services in light of the rapid expansion of the urban population, economic growth, extreme climatic events and environmental degradation (Brown & Farrelly, 2009; Hurlimann & Wilson, 2018; Jalilov, Kefi, Kumar, Masago & Mishra, 2018; Marlow, Moglia, Cook & Beale, 2013). The intent of this study is, therefore, to explore an alternative approach to the conventional approach using a case study of the water system in Accra, Ghana.

Several bodies of literature now exist that emphasise the need for an alternative to the conventional approach. Generally referred to as Sustainable Urban Water Management (SUWM), this approach provides an alternative way of understanding urban water problems because it has been developed by its proponents to integrate a broader range of factors than the conventional approach (Brown & Farrelly, 2009; Marlow, Moglia, Cook & Beale, 2013; van de Meene, Brown & Farrelly, 2011). The SUWM approach is grounded within an emerging paradigm that promotes the integrated management of urban water use, wastewater and stormwater to achieve improved water use efficiency, enhance equitable water allocation and access, and reduce the impact of water use on the environment through wastewater recovery and stormwater re-use

(Bos & Brown, 2012; Butler, Ward, Sweetapple, Astaraie-Imani, Diao, Farmani & Fu, 2017; Moglia, Cook & Beale, 2013). For proponents of SUWM, it helped to identify ways to sustainably manage urban water resources as a *total water cycle*. By doing so, the approach allowed water managers to take into account existing complexities and interconnections between different sectors (water supply, sewage, drainage, stormwater, environmental protection, etc.) and aspects of urban water management (engineering, governance, environment, economics, etc.) (Jalilov, Kefi, Kumar, Masago & Mishra, 2018: 3).

Underlying the SUWM approach is the premise that water is integral to the functioning and survival of cities and therefore, it needs to be a focus of the transition towards sustainable cities. The SUWM is seen as alternative to the conventional approach because the latter viewed water management as following a single pathway from supply to consumption and then to disposal while SUWM insisted that water can be reclaimed and reused multiple times, cascading from higher to lower quality (Hurlimann & Wilson, 2018; Jalilov, Kefi, Kumar, Masago & Mishra, 2018). The conventional approach presented water supply, wastewater and stormwater as separate systems to be managed separately by different entities. All three systems were, in turn, separated from urban planning and development (Closas, Schuring & Rodriguez, 2012; Jacobsen, Webster & Vairavamoorthy, 2012). In some developing cities, stakeholders realised that the approach to separately managing these systems might not have yielded the best results (Closas, Schuring & Rodriguez, 2012; Jacobsen, Webster & Vairavamoorthy, 2012).

In the Accra Metropolitan Area (henceforth, Accra metropolis), policymakers recognise that improved water supply and sanitation services are essential catalysts for economic development and necessary response to the increased demand created by rapid urban population growth. With a population of about 2.5 million people, the Accra metropolis is Ghana's primary economic hub (Gillespie, 2016). Since 2000, the city has experienced rapid urbanisation and extensive economic growth along with a massive amount of waste generated. In combination, these episodes are putting an enormous strain on existing water and sanitation systems as well as in the distribution of water supply to various parts of the metropolis (Oduro, Adamtey & Ocloo, 2015).

Underneath this booming economy lies a vulnerable city faced with multiple challenges, including water scarcity, flooding, pollution, and climate change impact among others that threaten the sustainable future of adequate water supply and access, proper stormwater drainage and an effective wastewater treatment system (Gillespie, 2016; Grant & Oteng-Ababio, 2016; Oteng-Ababio, Smout & Yankson, 2017a). The magnitude of growth, the rapid spread of informal settlements (slums), and residential expansion beyond the boundaries of the metropolis have created new dynamics in urban water consumption and flow patterns that overwhelm the existing water systems and its ability to deliver efficient and effective water and sanitation services. Also reflective in the metropolis is a case of spatial production that is characterised by urban disparity and inequality brought about through uneven urban growth, poor urban planning, and a lack of implementation of the strategic plan (Engstrom, Sandborn, Qin, Burgdorfer, Stow, Weeks & Graesser,

2015; Weeks, Hill & Stoler, 2013). These patterns continue to ensure that allocation of resources like water favour well-structured and well-planned neighbourhoods connected to the reticulation system.

Guided by the political ecology theory, this study focuses on how interactions among social, economic, political and environmental realities in the Accra metropolis have complicated water management problems, prompting the call for alternative ways of dealing with complex water problems. In the last decade, political ecology has provided a useful lens for understanding the fundamental interrelationships between human, urban, and natural systems (Boelens, Hoogesteger, Swyngedouw, Vos & Wester, 2016; Delgado-Ramos, 2015; Rusca, Boakye-Ansah, Loftus, Ferrero & van der Zaag, 2017). The current urban set up in the Accra metropolis in terms of population, economic development, urban expansion, and environmental consideration depicts an entrenched unevenness, which tends to create social and ecological injustice. The political ecology perspective emphasises the need for a shift towards fair social access to environmental resources.

The political ecology viewpoint is premised on the notion "that any tug on the strands of the global web of human-environment linkages reverberates throughout the system" and that changes in the environment are due to humanity's influence on nature as well as nature's impact on humankind (Escobar, 2010; Robbins, 2012: 5). Using the lens provided by political ecology theory, the interactions and dynamics of urban water systems that facilitated water management transitions from public to private sector control in the Accra metropolis are examined. The interactions between political, social, environmental, economic realities that influence changes in the urban water system are also explored. In the process, both beneficiaries and losers of water services delivery as a result of the power dynamics that shaped urban water management are identified.

1.2 Defining and structuring the research problem

The concentration of urban population and economic activities have turned the Accra metropolis into an epicentre of water politics and contestation for access among diverse water users. As the city continues to expand and grow economically, there is a strong tendency towards increased water demand and thus increased environmental risks associated with water abstraction and wastewater disposal. Several issues of concern arise from the water extraction, water supply and wastewater system management in the city. For example:

- Water demand has exceeded the supply: The Accra metropolis has a water supply deficit due to excessive water losses and increased water demand. The current water supply to the metropolis is estimated to be 553,846 m^3/day (Ghana Water Company Limited (GWCL), 2017). With 50 per cent of this lost through leakages, the pressure to meet the growing water demand will have a have serious implications for the already fragile water system.

- Inadequate investment and weak revenue mobilisation mechanism: There is lack of capacity for comprehensive revenue mobilisation in water service delivery thereby resulting in regular financial losses and deficits (Amankwaa, Owusu, Owusu & Eshun, 2014).
- The Accra metropolis and its environs continue to grapple with high levels of pollution in rivers and water bodies that supply freshwater to the water systems (Acquaah & Carboo, 2015). Uncontrolled mining activities, reduced discharge of untreated wastewater, and agrochemical usage in farming activities along waterways, among others account for severe water pollution while increasing the cost of water treatment and production processes.
- The volume of non-revenue water (NRW) has remained consistently very high: An average of 50 per cent of treated water produced cannot be accounted for due to physical and economic losses (GWCL, 2015; Harris, Rodina, Luker, Darkwah & Goldin, 2016). The factors contributing to physical water losses include serious leaks, bursts and overflows from the reservoirs. Factors that account for economic water loss include inaccurate meter readings, poor data recordings, ineffective revenue collection mechanism and illegal connections. Together, they account for the high volume of water unaccounted for or lost.
- The city continues to struggle with flood events due to lack of flood control systems: The poorly planned drainage system and the absence of flood control systems expose the Accra metropolis to regular flooding events throughout the rainy season (Amoako & Boamah, 2015; Frick-Trzebitzky, 2017; Korah & Cobbinah, 2019). Also, changes in rainfall pattern towards more intense storms lead to an increased risk of flooding with implications on the social well-being and the economy. For example, the metropolis experienced its worst flooding in 2015 when a heavy rainstorm contributed to a massive explosion at a gas station claiming 152 lives and destroying properties worth millions of dollars (Asumadu-Sarkodie, Owusu & Jayaweera, 2015). The National Disaster Management Organisation of Ghana (NADMO) estimates that over the last decade, the cost of the flood damage management has increased from US$ 2 million to US$ 4 million per flood event (ibid).
- Fragmented water management sector in the Accra metropolis: Different institutions manage water, sanitation and environmental protection separately without effective coordination among these institutions.

The Accra metropolis faces an arduous task to transform its urban water system into one that is among other things reliable and financially self-sufficient to address multiple challenges. The decision to reform the water sector dated back to the early 1990s when the government realised that interventions under the conventional management approach were gradually becoming inadequate to address the multiple challenges emerging from the water service delivery (Adombire, 2007; Amankwaa, Owusu, Owusu & Eshun, 2014). However, it was not until between 2006 and 2011 that a series of fiscal, regulatory and institutional reforms were implemented with the aim to establish a financially viable water system and to

improve urban water governance. This period (2006-2011) marked the transition from public to private sector management (PSM).

1.3 Motivation for the study

In 2005, the Government of Ghana (GoG) decided to privatise the urban water sector to address the declining public-sector funding, poor water service quality and inefficiency of the water utility, GWCL. The privatisation of the urban water sector resulted in water reforms that targeted implementation of interventions, namely institutional arrangement, tariff adjustments, infrastructural expansion, subsidy removal, and decentralisation of the sanitation and water sector. The transition from public water management to PSM was intended to improve water services delivery to the urban poor and help establish long-term financial viability and stability of the GWCL (World Bank, 2004). This transition process also led to the formulation of the National Water Policy (NWP) in 2007, which aimed to guide the development of water resources in Ghana (Government of Ghana, 2007).

In 2005, the GoG signed a 5-year Management Contract with a private entity, Aqua Viten Rand Limited (AVRL) following a period of competitive bidding. This new entity took over the management of water production, supply and distribution to the Accra metropolis. It also became responsible for water revenue mobilisation. The AVRL officially commenced operation in 2006 amidst agitation among various stakeholders who opposed this new arrangement. Nonetheless, the AVRL saw through the implementation of the 5-year contract, which ended in 2011.

The era of PSM came to an end following the decision of the GoG not to renew the 5-year management contract under the private sector water reform in 2011. At the end of the contract period, the management of urban water returned to the public (government) control. As part of the return to public water management, the government in consultation with other stakeholders developed a new framework for the implementation of interventions that can support the achievement of sustainable water supply and sanitation for all people in the country by 2025. The framework, Water Sector Strategic Development Plan (WSSDP) developed in 2012, explicitly outlines the SUWM principles as follows:

"To contribute to the improvement in the living standards of Ghanaians through increased access to and use of safe water, sanitation and hygiene and sustainable management of water resources." WSSDP, 2014, P.16

The WSSDP has been implemented in the Accra metropolis since 2012 under public water management. Following the decision not to renew the management contract of the AVRL, coupled with the return to public water management, expectations grew as the WSSDP was deemed comprehensive enough to address the limitations of the PSM and to achieve the government's vision of ensuring sustainable water and

sanitation for all urban residents by 2025. Details of the outcomes of the WSSDP will be presented in Chapter 6.

The study aims to investigate these water management transitions in the Accra metropolis by conducting transdisciplinary research (TDR) in collaboration with water stakeholders (described in detail in Chapter 3). The study is based on the premise that the multiplicity of water problems in a city like Accra demands a scientific inquiry that integrates basic knowledge with applied knowledge while moving beyond disciplinary fields. Transdisciplinary research is interdisciplinary research that gets co-produced with social partners. When interdisciplinary research is conducted jointly with practitioners and other key stakeholders to generate new knowledge supportive of efforts to find real-world solutions, then this can be referred to as transdisciplinary research. This is why this study embraces the TDR approach. According to Brandt et al. (2013), TDR provides for a reflexive research process by establishing a collaborative platform between researchers and stakeholders to address societal problems while building a mutual learning process.

The application of the TDR process for this research was inspired by a similar experience from the northern part of Ghana between 2009 and 2011 when the researcher undertook a study on small water reservoirs and dams for agricultural development and climate change adaptation. This research involved an interdisciplinary group of researchers that worked with both rural and urban communities to co-examine the status of small dams and reservoirs as vital resources for agriculture, livelihood and climate change adaptation in northern Ghana. The goal was to co-produce sustainable solutions for redesigning and managing small dams and reservoirs to support dry season irrigated vegetable farming and livestock production. The research scientists comprised a team of ten experts: sociologists (2), irrigation engineers (2), land and water management experts (2), surveyors (2) and agricultural economists (2). The need to address the intertwined nature of the problems informed the establishment of this diverse team. Such intertwined issues included the politics of small dams and reservoir development, dysfunctional dams, low performance, the short lifespan of dams and reservoirs, low productivity and market access. The study sought to present a holistic view of the different challenges that affect the performance of small dams and reservoirs.

An essential part of this study was the preliminary engagements with the various stakeholders from the northern region including officials from the Metropolitan, Municipal and District Assemblies (MMDAs), the Ministry of Food and Agriculture (MoFA), Irrigation Development Authority (IDA), representatives of farmers and livestock cooperatives, and traditional chiefs. A multi-stakeholder forum that brought together all the different stakeholders for a reflexive session, to interact and to iron out their differences was organised in January 2009. At this forum, deliberations led to the identification of the factors that limited the potential of the small dams and reservoirs to achieve maximum productivity. Prior to the multi-stakeholder forum, separate consultations were carried out with the officials of the MoFA, IDA, MDAs,

the leaders of the dams and reservoir communities as well as representatives of crop and livestock farmers. From these activities, it was established that there were limitations in technical and management capacities of both implementers and beneficiary communities of the small dams and reservoirs projects. Part of the reason behind the low performance of the dams and reservoirs was that there was a lack of comprehensive consultation with local beneficiary communities about the suitability of these dams for the specific needs of specific populations. These communities argued that they did not receive any formal training or technical skills on the management and maintenance of these facilities.

Further engagement with these communities revealed that for areas where irrigated agriculture was the main occupation, the absence of a market for vegetables proved to be a disincentive for effective management and sustainability of the small dams and reservoirs. The research also revealed that community preferences for water use for irrigated agriculture or livestock watering determined the use of infrastructure irrespective of the actual design – irrigation dam or just a reservoir. For example, in communities where livestock production was the main livelihood activity, irrigation infrastructure was hardly used and irrigation dams have become "white elephants".

Through the research, we were able to achieve four significant outcomes (Acheampong, Ozor & Sekyi-Annan, 2014; Venot, de Fraiture & Acheampong, 2012):

(1) redesigned sustainable small dams and reservoirs that explicitly take into account the preferences of water users (small dams for vegetable farming or reservoirs for livestock watering) in the various communities;
(2) increased transparency and enhanced coordination among the different stakeholders involved in the development, use and management of small dams or reservoirs;
(3) improved the sense of ownership of small dams and small reservoirs for crop and livestock production; and
(4) improved market access for produce from irrigated fields by establishing linkages with trader cooperatives in the south of the country

Building a team of research scientists working with local communities on this project revealed the synergies with on-site practical knowledge and experience of user communities to understand the real problems and define customised water management solutions for the various communities in the northern region of Ghana. Through this research, we were also able to transcend the "silo" working style of the project related institutions and included communities thereby paving the way for effective collaboration among government institutions, beneficiary communities and the research team in the implementation of recommendations and outcomes of the project.

I bring the experience from the previous research to this study by employing the TDR process to explore the multiplicity of issues arising from the management of water supply, stormwater and wastewater in the Accra metropolis. Through this process, it is expected that the engagement with the various stakeholders

would yield valuable input, exchange views and improve learning among stakeholders to generate the knowledge and practices that could support the implementation of sustainable strategies in the metropolis.

Using the TDR process to explore urban water management in the Accra metropolis created an opportunity for the stakeholders to deepen their understanding of the dynamics of urban water problems, considering the diversity of existing realities and scientific perceptions of urban water problems. It also helped me to understand the various perspectives of each actor in the urban water space in terms of the divergent framings of existing problems in water management in the city of Accra. As a researcher, I was initially inclined to follow the traditional approach of conducting surveys. However, the application of the TDR process enabled me to gain a much deeper understanding of urban water problems from the various stakeholders' viewpoints. It also helped me shift my stance towards a demand-driven approach to the framing of the real water problems in the Accra metropolis expressed by the stakeholders involved in the TDR process.

Based on the deliberations among various participants on the learning platform, four research questions were defined as follows:

- What are the key challenges confronting water management practice in the Accra metropolis?
- To what extent did interventions under the PSM in the Accra metropolis help achieve sustainable outcomes?
- To what extent did the WSSDP improve upon the outcomes of the interventions under the PSM?
- What measures could be taken to help water managers think of new ways of managing water systems efficiently in the Accra metropolis?

1.4 Research objectives

The overall aim of the study is to explore the dynamics of water management in the Accra metropolis, delving into the web of challenges, realities and factors that render the current management practices inadequate, thus prompting calls for more sustainable management solutions. Based on this analysis, the study proposes a viable pathway for water management. An essential aspect of this study is working with different stakeholders, including academics, researchers, users, and practitioners in the water sector to co-define the research objectives as follows:

- To analyse the water management practices and transitions in the Accra metropolis
- To evaluate the water management interventions implemented as part of the private sector water reforms
- To examine the development and implementation of WSSDP in the Accra metropolis
- To propose a framework that could help support of a suitable water management planning in the Accra metropolis.

1.5 Transdisciplinary research in sustainable urban water management practice

Within the water system of Accra metropolis, multiple stakeholders including experts from different disciplinary backgrounds, such as engineering, chemistry, bacteriology, governance, and administration exist. They work within various sub-systems (water supply system, wastewater system, watershed, and drainage system) to protect water resources, manage water infrastructure or deliver water-related services. Diverse factors, including social, political, institutional, economic, and environmental factors contribute to multiple problems in the water system and this strongly influences the performance of the urban water system.

In the Accra metropolis, stakeholders within the water sector subscribe to the consensus that an alternative approach to water management holds the key to the potential transformation of the urban water system. These stakeholders included the GWCL, Accra Metropolitan Assembly (AMA), Water Resources Commission (WRC), Ministry of Sanitation and Water Resources (MSWR), Water Research Institute (WRI), Coalition of NGOs in Water and Sanitation (CONIWAS), University of Ghana (UG), International Water Management Institute (IWMI) and the Water Users Associations (WUAs). The critical question for the metropolis is as follows: how do we harmonise the different efforts and perspectives of the various water stakeholders and sectors to create a more consensus-driven platform for promoting strategies for urban water management? To deal with such a question, the TDR process was vital for exploring the multi-dimensional interactions among the various aspects (e.g. social, economic, political, institutional, and ecological factors), different stakeholders (e.g. policymakers, utility service provider, regulator agency, and water users) across multiple levels (i.e. local, national, and regional levels).

Instrumental to the TDR process used in this study was the establishment of a learning alliance platform (henceforth learning platform). This learning platform was set up to bring diverse stakeholders from the urban water sector for monthly meetings to engage, discuss and define issues and questions for this study during a 12-month period (July 2015 to June 2016). On each platform, 18 to 20 key representatives (participants) of the various stakeholders participated in discussions on topical water management issues in the Accra metropolis. In all, 12 meetings (one platform per month) on the last Thursday of the month for 12 months, plus two other meetings (preparatory and final platforms) were set up in the Accra metropolis.

Preliminary discussions served as an “icebreaker” and to motivate participants in exchanging relevant information and aligning their experiences and goals to the shared goal of the platform. As a participant at the platform, I also doubled as the facilitator to steer the direction of the process. Participants were encouraged to put aside the conceptual and methodological ideologies of their various disciplines to facilitate a holistic discussion of ideas that can help address the water problems in the metropolis. At the first meeting, the overall status of urban water management in the metropolis was discussed. Based on this discussion, 15 topical water issues in the context of the Accra metropolis were defined and 12 issues were

finally selected for interrogation over 12 months. To sustain patronage, an invitation letter together with the list of identified issues were sent to the various water agencies and related institutions in the metropolis. Details of the learning platforms are presented in Chapter 3.

From experience in the Accra metropolis, the TDR provided a sense of holistic knowing among all stakeholders. It allowed stakeholders to understand the different facets of water problems such as water supply deficits, water pollution, poor wastewater management, poor institutional coordination for water management. Once these facets were understood, the interconnections between them could also be understood, as well as the roles of respective stakeholders to collaborate and find sustainable solutions to the problems. Although the TDR was a challenging process due to the multiple issues and multiple stakeholders involved, it also provided the opportunity to produce an integrated framework for finding the optimal way for sustainable practices in urban water management in Accra.

1.6 Conceptual framework

In figure 1.1, a framework that visualises the conceptual framework of the study is presented. To systematically deal with urban water management, multiple issues and their interactions, at different levels, in the Accra metropolis are discussed. Water management is becoming increasingly complex due to myriad of issues such as water demand pressure from a rapidly growing population and the engagement of multiple stakeholders with different perspectives, interests, and values (Bos & Brown, 2013). Furthermore, water demand for economic growth and ecological functioning has become highly contested amidst limits to water abstraction and use, and the implications for the ecosystem (Barnett & Morse, 2013; Gleick, 2010).

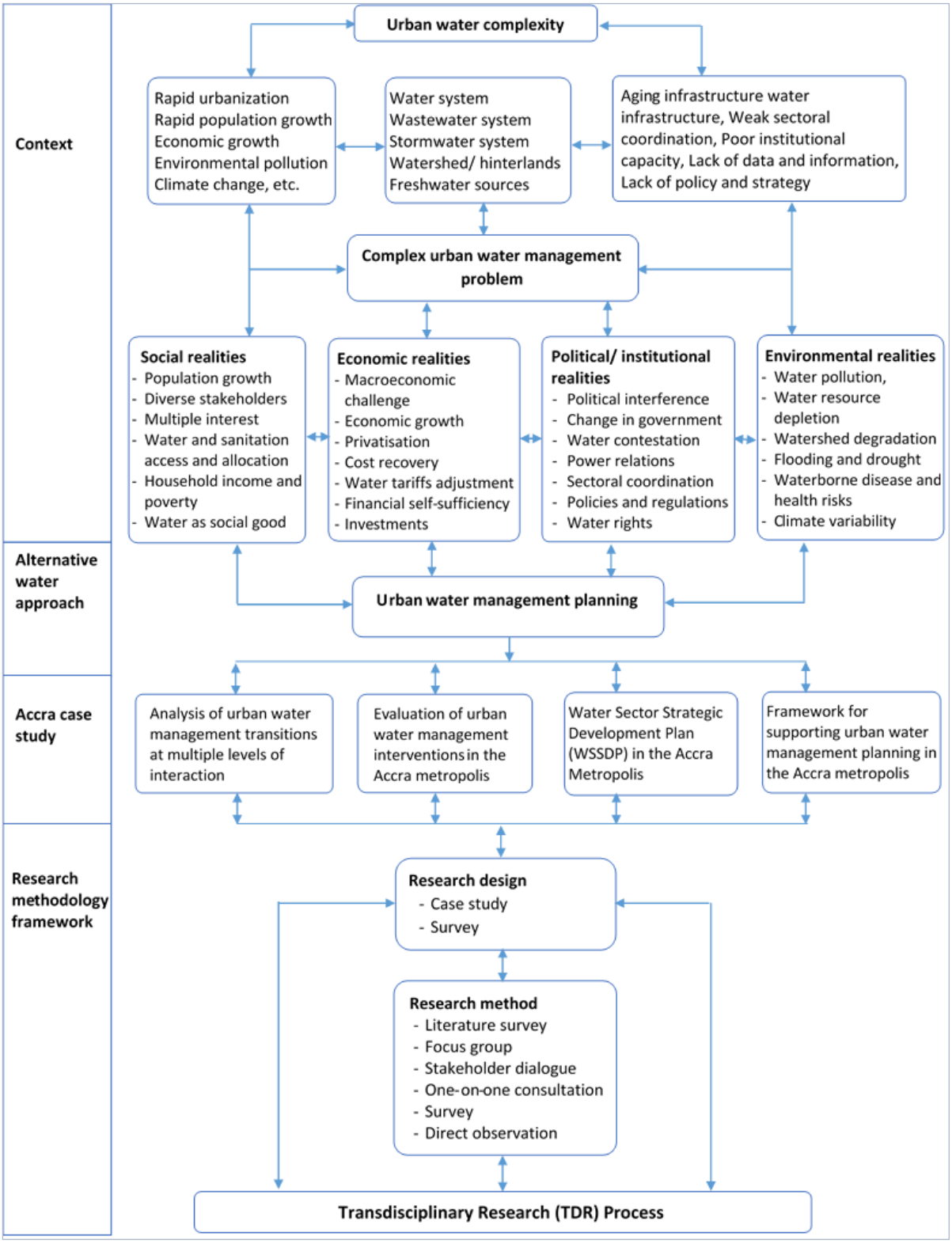

Figure 1.1 Conceptual framework for the study (Author's design)

To pursue sustainable approach to the urban water development and management, it is vital to examine the dynamics of the interactions among political, economic, social, and physical realities that characterise the urban water system (Bos & Brown, 2012; Butler, Ward, Sweetapple, Astaraie-Imani, Diao, Farmani & Fu,

2017; Werbeloff & Brown, 2011). Within the physical reality, there is water in its tangible form, which entails surface water such as rivers, streams and lakes, and groundwater and their behavioural properties. It also includes the physical structures consisting of water system infrastructure, canals, sewage and storm drainage systems that form a critical medium for water abstraction, passage and disposal (Islam & Susskind, 2012). The water system infrastructures are essential for shaping an urban society water supply needs but receive less emphasis because of some portions are often hidden underground and not viewed as part of the city's built landscape (Agudelo-Vera, Leduc, Mels & Rijnaarts, 2012; Oduro, Adamtey & Ocloo, 2015). Treating the physical aspect of the water system as a part of water planning and management helps broaden our understanding of water's role in society and the development of cities (Tvedt & Oestigaard, 2010). The Accra metropolis has an effect on the physical water cycle by altering river flows, as well as the quality and quantity of water supply (Adank, Darteh, Moriarty, Osei-Tutu, Assan & van Rooijen, 2011; Asumadu-Sarkodie, Owusu & Jayaweera, 2015; Owusu, Asumadu-Sarkodie & Ameyo, 2016).

Concerning social and economic realities, water remains relevant to urban society and economic development and at the same time subject to modification by these elements (Dos Santos, Adams, Neville, Wada, de Sherbinin, Bernhardt & Adamo, 2017). The physical water landscape is always undergoing a form of transformation to meet the multiple demands for economic development and urban society. Thus, social and economic realities tend to influence changes in the physical water landscape in the process of interaction. Water remains in a state of flux not only due to natural variation, precipitation and evaporation patterns, but also the pressure from demand from multiple users. Thus, one of the key focus areas of this study is an understanding of how the diverse stakeholders who use and control water resources characterise the water system. For example, the size of the urban population and households as well as the different categories of urban population (e.g., poor, middle class and wealthy) influence domestic water supply and use. The current water system depicts not only natural and physical landscape conditions, but also society's' effort to control water through the construction of dams, canals, drains, river embankment, storage, pipe network, or recycling plant (Jaeger, Amos, Bigelow, Chang, Conklin, Haggerty, Langpap, Moore, Mote & Nolin, 2017). Such manipulations have changed the direction, location, and the distribution of water in cities. How aware are the diverse stakeholders of this phenomenon and the longer-term consequences, especially if the water system fails to meet the increasing human demands?

Within the political space, institutional arrangements, water markets, water rights and power relations shape urban water systems and water resources management (Chikozho & Kujinga, 2017; Conca & Weinthal, 2018). Here, one can see how policies and regulations influence the supply and allocation of water for different user groups and different purposes. From emerging trends, the declining public-sector funding and capacity constraints in water management have compelled varying forms of PSM arrangements in capital investment, water infrastructure development and management of the water system (Adams, Sambu & Smiley, 2018; Suleiman & Khakee, 2017). Such contractual arrangements involved an agreement between the government and private entities to share management responsibilities for urban water supply and service

delivery. Water managers engaged in PPPs face the dilemma of reconciling the water both as a social good, determined by societal need and water as an economic commodity, determined by the market value and demand (Suleiman & Khakee, 2017). This situation is quite common in the Accra metropolis and other developing cities where poor urban households and informal settlements are prevalent. A crucial role of the urban water manager in the metropolis entails balancing social and economic priorities by making profits for financial self-sufficiency while at the same time delivering affordable water to the poor urban population.

The Accra metropolis presents a mix of socio-economic and environmental conditions that interact within a political space to produce a complex, dynamic system for water supply, sanitation, and wastewater management. It is home to different layers of administrative arrangements from the local to metropolitan and national levels because it serves as the capital for the metropolis and also for the country. These arrangements translate into a fragmented and sectoral institutional functioning within a traditionally centralised system of water service delivery and management. Like many other cities, the metropolis has been experiencing multiple water challenges which are affecting the quantity and regular flow of water supplied. Under the current state of affairs, water stakeholders in the metropolis are of the view that an alternative approach that recognises the complexity of interconnected social, technical, political, and ecological realities and their influence on the water system sustainability is needed.

A significant challenge according to water managers in the Accra metropolis remains how to balance the competing water demands for domestic consumption and economic growth while safeguarding the integrity of the environment and water systems. This growing realisation of the need to define a mix of solutions that can help achieve the balance is what has led to the adoption at the policy level of interventions that reflect the SUWM perspective in this decade. However, just because the interventions defined by the water managers and policymakers have embraced the principles of the SUWM approach, does not mean that the practices have changed. It is much easier to develop new policies than to put them into practice.

1.7 Scope of the study

This study describes and conceptualises a web of interactions between social, economic, political and environmental realities that characterise the urban water system in the Accra metropolis. The interactions and outcomes of these realities tended to influence the direction in urban water management practice but also stimulated the debate around the search for an alternative approach to water management in the metropolis.

The political ecology theory was selected as the most appropriate theoretical framework for this study. This theory addresses the relationships between environmental degradation/ environmental change, and social inequality/ political power relations (Karpouzoglou, Marshall & Mehta, 2018; Lawhon & Murphy, 2012;

Rusca, Boakye-Ansah, Loftus, Ferrero & van der Zaag, 2017). Details of the political ecology theory will be presented in chapter 3.

In addressing the objectives and research questions posed in Section 1.3, a transition dynamics of water management in the Accra metropolis is examined. It provides an analysis of the evolving social, economic, environmental, and political realities that shape urban water management transitions in the Accra metropolis from public sector management to PSM between 2006 and 2011. Using the Multi-Level Perspective (MLP), the interactions at three levels between environmental and social-political dynamics, namely (using the conceptual language of the MLP) the 'regime', 'niche', and 'landscape' levels of the Accra water system are examined. This mode of analysis helps explain the difficulty of the urban water system to successfully manage the delivery of water services under PSM.

The analysis of transition dynamics makes it possible to understand the challenges involved in implementing interventions under the PSM regime. By examining the prevailing conditions and analysing the gap between policy intent and actual practices, stakeholders would gain an in-depth understanding of the limitations of the PSM and identify essential ways for supporting water managers to efficiently plan the sustainable management of water resources under the current public water management regime. Based on an analysis of the outcomes of the PSM, a process for defining a new plan called the WSSDP to support the new era of public water management from private control is also discussed.

Various aspects of the proposed framework for supporting water management planning in the Accra metropolis are elaborated in the study. The qualitative aspects of the learning process remain the main focus but also some quantitative assessments of the outcomes the implemented interventions are analysed. Quantifying the impact and benefits of proposed water management solutions could strengthen the argument for the selection of a specific intervention based on the input cost and the benefits.

1.8 Organisation of the thesis

In Chapter 1, a detailed background and motivation for the research, followed by the research questions and objectives of the study is provided. This chapter also highlighted the rationale and scope of the study and describes the conceptual framing of the subject matter. Chapter 2 starts with a literature review on sustainable development and sustainability concepts, which have inspired the emergence of water management approaches, including the IWRM and SUWM. This chapter zeroes into the urban water sector to review the SUWM approach, which in many ways was inspired by the IWRM approach. In Chapter 3, a description of the methodological approach used for the study is presented. A detailed description and outcomes of the TDR process and the learning platforms are also presented in the same chapter.

In Chapter 4, an analysis of the evolving dynamics and transitions in water management in the Accra metropolis is presented. Using the Multi-Level Perspective (MLP), the three levels of these interactions between environmental and social-political dynamics, namely (using the conceptual language of the MLP)

the ‘regime’, ‘niche’, and ‘landscape’ levels of the Accra urban water system are examined. This mode of analysis helps explain the limited success of water management interventions following the private sector engagement in urban water management between 2006 to 2011. Here, the struggles of government to implement interventions under the private water reform, which was a response to various systemic pressures from external organizations such as the International Monetary Fund (IMF) and the World Bank (landscape actors) are explored. In doing this, the complex interactions among social, economic, technical, and institutional realities and their influence on the adoption of the interventions at the policy level and in practice are unpacked.

In Chapter 5, the water management interventions implemented under the PSM era from 2006 to 2011 are examined. Following unsatisfactory outcomes of the private sector water reforms, a new framework WSSDP to guide the new public sector ownership in water management was developed by the government. A discussion about the process of developing the. WSSDP is presented

In Chapter 6, the implementation of the WSSDP is examined with emphasis on the intervention designed to address the limitations of the PSM. A set of indicators was developed using a process analysis method to measure the extent to which the outcomes of the interventions implemented under this WSSDP were achieved.

Based on this analysis and outcomes in Chapter 6, a framework for supporting the sustainable water management planning in the metropolis is proposed in Chapter 7. The framework defines the overall goal, key objectives and prioritises five interventions derived from a list of interventions identified at the learning platform. It is expected that this will help water managers and policymakers to gain a good understanding of the actions or options to consider in water management planning in the Accra metropolis. Benefit-cost analysis for each intervention is presented to determine the viability of the selected interventions. Chapter 8 presents the summary, conclusions, reflections, and recommendations for further areas of study.

Chapter 2: Literature review

2.1 Introduction

In this section of the various approaches that define the content of the research are explained. The study provides insight into the interpretations of the concepts and approaches drawing from a diverse body of literature with the intent to contribute to the understanding of the SUWM narrative. Before delving into the literature, some essential terminologies used in the study, including 'approach', and 'practice' as well as a distinction between 'water system' and 'water cycle' are defined.

An *approach* is defined as a way, method, procedure, technique, or modus operandi of dealing with something. Concepts can evolve into approaches to manage a situation. For example, SUWM can be considered as an approach that can stimulate the development of strategies to help achieve a set of goals, including improving water efficiency, enhancing water allocation and sustainable water resource use (Hurlimann & Wilson, 2018; Marlow, Moglia, Cook & Beale, 2013).

Practice means the actual implementation, application, or use of an approach or a method in contrast to theories regarding such implementation or application. In the course of the study, it becomes apparent the difficulty in translating water management approaches into practice, which leads to the understanding of why certain approaches have not achieved their desired goals in practice.

A *water system* consists of connected and interdependent components (e.g. rivers, reservoirs, groundwater, watersheds) that function in several different domains (e.g. natural, economic, societal, and political), at various scales (e.g. basin, jurisdictional, transboundary, temporal, and institutional), and at multiple levels (e.g. local, national, and regional) at the same time (Guggino, Rossi & Hendricks, 2012; Islam & Susskind, 2012). The sustainable management of a water system involves understanding the interactions between the components, domains, scales and levels as well as among social, economic, political, and ecological processes that shape water resource availability, supply, and demand in the water system (Cooper, Islam & Susskind, 2015; Fontein, 2008). At the city scale, the *urban water system* consists of sub-systems, including the extraction and production system, collection and distribution system, wastewater and treatment system as well as a stormwater system that operate together to produce and supply clean water and treated wastewater before disposal.

The *water cycle*, also referred to as the hydrological cycle, is a global phenomenon that explains the continuous process of water movement on, above and below the earth's surface to the atmosphere through evaporation, rainfall, run-off, condensation, and plant and animal transpiration (Marsalek, Cisneros, Karamouz, Malmquist, Goldenfum & Chocat, 2008). The process involves the exchange of energy as the sun causes water from rivers, oceans, streams, lakes, soil, and plant surfaces to evaporate into the atmosphere, which leads to changes in temperature. Operating at the local scale in a built environment is

the *urban water cycle*, a human-made process of producing clean and safe water for consumption. Typically, the urban water cycle is composed of the following stages, including the extraction and treatment of raw water, water distribution through a pressurised system of pumps, valves, pipes, and storage reservoirs, wastewater collection and treatment. In some cases, at some advanced places, the treated wastewater is reused, thus completing the cycle.

2.2 Sustainable development and sustainability

The need to sustainably manage water is inherently linked to sustainable development due to the significance of water as a prerequisite for development (Russo, Alfredo & Fisher, 2014). Water has been central to the three dimensions of sustainable development (SD) and sustainability, namely economic development, social needs, and environmental limits (United Nation-Water, 2013). Since the launch of the Brundtland Report entitled "*Our Common Future*", the SD concept has become a popular narrative in environmental and development discourse (Brundtland, 1987). This was evident in the discussions at the 1992 UN Conference on Environment and Development in Rio as well as the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg. At the WSSD, global leaders, together with multiple stakeholders, reaffirmed their pledge to implement the SD agenda with a particular focus on addressing poverty issues (Bäckstrand, 2006). Various definitions with varied interpretations of the SD concept have thus emerged. For example, Palmer et al. (2005: 5) defined SD as "development that meets human needs while conserving the earth's life support systems and simultaneously reducing hunger and poverty".

The Brundtland report presented the most widely quoted definition of sustainable development, as "development that meets the needs of the present without compromising the ability of future generations to meet their needs" (Brundtland, 1987: 87). This definition catapulted the SD concept into political maturity, thereby shaping what would eventually be the content and structure of contemporary debates (Blewitt, 2014; Pearce, Barbier & Markandya, 2013). Implicit in the SD agenda has been the need to reduce poverty, enhance social equity, and improve environmental sustainability as we pursue economic growth (Elliott, 2012). A very recent global impact has been the emergence of the Sustainable Development Goals (SDGs), the universal set of goals, targets, and indicators that inform the development agenda and policies of United Nations member states from 2015-2030 (UNDP, 2016).

Fundamental to the SD concept was the recognition that global crises related to the environment, economy, and society were highly interconnected, and there was a need for fundamental changes to address these crises (Adams, 2009; Palsson, Szerszynski, Sörlin, Marks, Avril, Crumley, Hackmann, Holm, Ingram, Kirman & others, 2013). The SD concept reinforced the sustainability paradigm (Bakari, 2014). Ideally, SD aimed towards sustainability to create a better quality of a socially desirable life (fulfilling humanity's physical, cultural, and spiritual needs in an equitable way), economically viable (financially self-sufficient), and ecologically sustainable (maintaining long-term ecosystem viability) system (Sustainable Development Commission, 2009).

The sustainability ideology in the field of environment emphasised the need to maintain a natural resource base for current and future use. Based on the Water 21" project, a research project on sustainable water policy, Mostert (1998) explained this ideology that "the use of renewable resources—such as water—should not exceed the rate of renewal before alternative sources are available, and fundamental ecological processes and structures should be maintained". This definition focused on the needs of people, while other definitions placed emphasis on factors external to society (the environment) and the level of services (e.g., (Bakari, 2014; Butler, Farmani, Fu, Ward, Diao & Astaraie-Imani, 2014). The sustainability notion emphasised water resource perpetuity and compelled water users and managers to rethink current water use for development and its implications for existing water systems and the environment (McNabb, 2017; West, 2018). According to Bakari (2014), traditionally, the sustainability concept was grounded on three pillars, namely:

- Social sustainability - entails the persistence of society to attain sufficient social well-being. Realising social sustainability guarantees the long-term maintenance of the welfare of a community or a nation.
- Environmental sustainability - maintaining a sustainable threshold of natural resources consumption to ensure a balanced ecosystem. The global society needs to ensure a sustainable rate of natural resources use, such as food, energy, material, and water, among others, to live in an environmentally sustainable world.
- Economic sustainability - the obligation of businesses or countries to utilise their resources efficiently and responsibly to operate sustainably and consistently produce an operational profit.

Together, these pillars form the "triple bottom line" (TBL) approach, which sought to establish an optimal balance between the social, economic, and environmental realities of society (Henriques & Richardson, 2013). While the TBL approach represented the functional pillars of sustainability, it paid little attention to the institutional aspects of sustainability. To address this flaw in the TBL approach, Valentin and Spangenberg (2011) introduced the institutional pillar of sustainability in what they labelled the 'prism of sustainability'. This prism comprises four dimensions of sustainability, which include social, economic, environmental, and institutional dimensions (Figure 2.1). De Carvalho et al. (2009) further expounded this approach by distinguishing the institutional dimension into administrative and political aspects, which are inherently linked, but independent of one another and deemed crucial for sustainability.

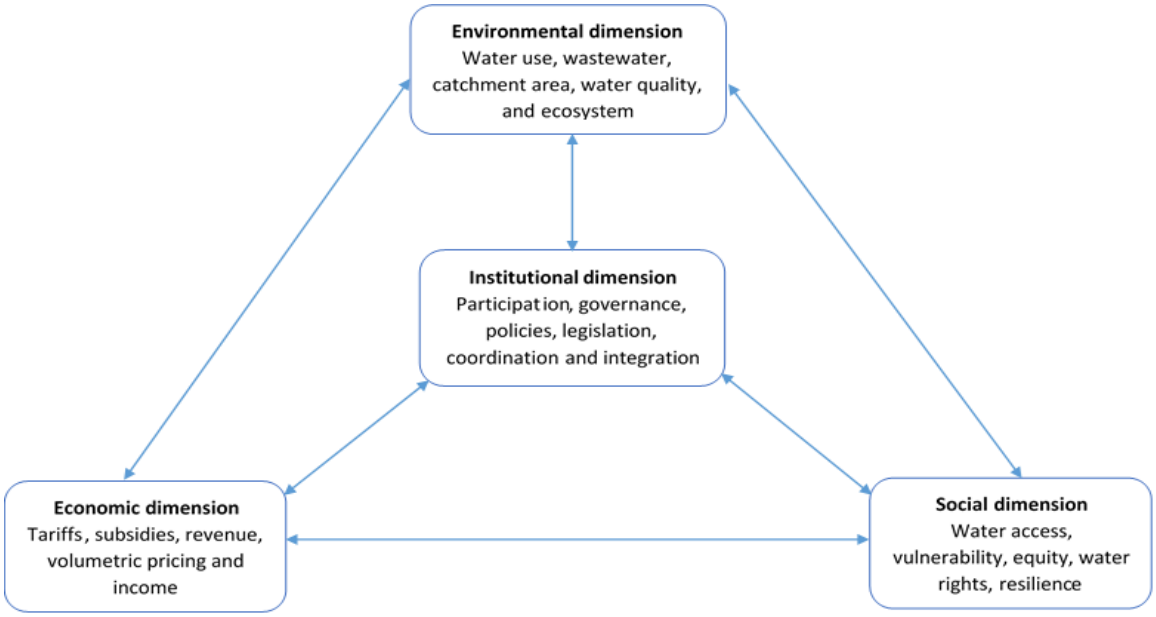

Figure 2.1 The prism of sustainability (Adapted from Valentin and Spangenberg, 2000)

Each dimension of sustainability is defined by relevant indicators which can be quantified to ensure these dimensions of sustainability are more operational and practically meaningful (Behzadian & Kapelan, 2015). For example, for the environment, water use, ecosystem, and wastewater recycled indicators are identified. The economic dimension considers indicators, including average urban water tariff, monthly household income, and poverty level indicators. For the social dimension, the indicators include access to water and vulnerability to disasters, health problems, housing, and unemployment (Carden & Armitage, 2013). Indicators for the institutional dimension include participation, adoption, coordination, and integration. Indicators have proven to be very useful in developing indices and offering valuable information for decision-makers to measure progress towards sustainability goals (Braulio-Gonzalo, Bovea & Ruá, 2015).

The sustainable development and sustainability discourses have somewhat contributed to the search for a new narrative on alternative water management approaches (Russo, Alfredo & Fisher, 2014). In the next section, the emergence of the sustainable water management paradigm is discussed, which reinforces the idea of an alternative approach to the conventional water management paradigm. At the core of this paradigm is the need for sustainable development and sustainability of natural water resources (Russo, Alfredo & Fisher, 2014; Sdiri, Pinho & Ratanatamskul, 2018).

2.3 Sustainable water management paradigm

The sustainable water management paradigm represented a shift towards the idea of holistic management of water resources. More specifically, efforts toward sustainable water management aimed at improving the water use efficiency, enhance equity in water allocation and sustain environmental (ecological and hydrological) integrity. It formed an integral aspect of sustainable development of water resources with emphasis on managing water issues in line with the sustainability agenda (Russo, Alfredo & Fisher, 2014:

3935). In the sustainable water management agenda, scholars highlighted the need to understand the complexities surrounding current water problems. It was expected that such understanding could help design alternative solutions that could contribute towards multiple goals, including increasing the efficiency in water use and improving social equity while maintaining ample water inflow for ecological and hydrological functioning (Sdiri, Pinho & Ratanatamskul, 2018; UN-Water Decade Programme on Advocacy and Communication (UNW-DPAC), 2015).

2.3.1 Integrated water resources management (IWRM)

As a response to the deepening water management crisis, one of the concepts that emerged from the sustainable water management paradigm was the Integrated Water Resource Management (IWRM) approach. It seemed to have captivated the water community as a viable approach to the sustainable management of water resources. The rise of IWRM to global prominence was regarded by some authors as the climax of decades of deliberations among the water experts at the worldwide arena to develop a holistic package capable of addressing complex water management problems (Giordano & Shah, 2014; Merrey, 2008; Saravanan, McDonald & Mollinga, 2009; Tortajada, 2014). Since then, the concept has become a dominant discourse and has assumed a paradigmatic place in water policies, owing to significant investment and international advocacy by powerful actors such as the World Bank and the United Nations (UN) (Leidel, Niemann & Hagemann, 2012; UN-Water, 2008). Scholars regarded the IWRM approach as a sustainable water management approach that incorporates different competing uses of water and considers the accumulated failures of water management during the hydraulic mission in the mid-20th century (Beveridge & Monsees, 2012; Giordano & Shah, 2014). The often-cited definition of IWRM has been that of the Global Water Partnership (GWP), which viewed IWRM as a "process that promotes the coordinated development and management of water, land and related resources, to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP-TAC, 2000: 22). This definition has been fundamental in shaping the development of the SUWM approach.

2.3.2 Sustainable urban water management (SUWM)

In the urban water context, the IWRM principles have inspired the conceptualisation of the SUWM approach. It is a response to the call for transformative change within the urban water sector with emphasis on a more holistic and integrated way of managing water resources in urban areas for different purposes (Bos & Brown, 2013; Marlow, Moglia, Cook & Beale, 201; van de Meene, Brown & Farrelly, 2011). Proponents of the SUWM advocate for an integrated goal of improving water-use efficiency throughout the urban water system, promoting equitable water allocation and ensuring ecological sustainability at various scales (Bos & Brown, 2013; Farrelly & Brown, 2011; Hurlimann, Wilson & Keele, 2017).

The principles underlying the SUWM approach have also informed multiple concepts applied elsewhere with different names and different acronyms such as Water Sensitive Cities (Wong, Brown & others, 2009)

Integrated Urban Water Management (IUWM) in African cities (Bahri, 2012; Closas, Schuring & Rodriguez, 2012), Water Sensitive Urban Design (WSUD) in Australia or Sustainable Drainage Systems (SUDS) in the UK. Alegre et al. (2013) defined SUWM as the state of acquiring adequate water governance and quality assets to actively establish a water sector that can contribute to urban's social, environmental and economic development to meet both present and future needs without harming the resource base or the environment. SUWM considers the urban water system as a holistic system that is characterised by interconnected components functioning dynamically to deliver multiple goals, including potable water production and supply, wastewater and stormwater management (Bos & Brown, 2013; Marlow, Moglia, Cook & Beale, 2013). Essential to SUWM is the need to foster interaction and cooperation among all stakeholders and institutions in the management process at the city and basin scales.

According to Hurlimann et al. (2017), the SUWM approach is underlined by the sustainability goals– to manage urban water systems to improve water-use efficiency to meet societal and economic water demands, reduce water consumption and losses, and maintain ecological and environmental integrity. The distinctive difference between the IWRM and SUWM lies in the sector of application, the planning unit, and the spatial scale of use. The river basin is the fundamental planning and boundary unit for IWRM, which implies water planning occurs at the river basin scale. The IWRM also accounts for a range of water uses including water for rural households, urban, agricultural, industrial, and hydropower. The SUWM can be regarded as a subcategory of IWRM as it focuses on managing freshwater supply (surface water, groundwater, and desalinated water), wastewater (grey and reclaimed water), and stormwater at the urban scale within the river basin (Hurlimann, Wilson & Keele, 2017, 2017; Jalilov, Kefi, Kumar, Masago & Mishra, 2018).

2.3.3 SUWM as an integrated approach

SUWM represents a way of defining a set of water management interventions or strategies that can allow cities to respond to complex urban water challenges in an integrated manner. It also involves managing water across different institutions and organisations while engaging all of the various stakeholders and water users in the process to achieve sustainability (Bahri, 2012). The SUWM considers the urban water cycle as a whole system with interconnected components that function dynamically to deliver multiple urban services within the river basin (Bahri, 2012; Closas, Schuring & Rodriguez, 2012). These services include, among others, water supply and distribution, wastewater treatment and pollution control, ecosystem protection, and stormwater management (ibid).

Essential to the integrated urban water system is the planning and coordination of individual processes in the system to minimise collected impact and maximise the collective system's efficiency and productivity (Closas, Schuring & Rodriguez, 2012). Urban water management practices with SUWM perspective aims at delivering multi-functional urban water services, which include, but are not limited to, water supply, ecosystem protection, stormwater flow management, wastewater treatment, and water resources allocation among users, including the environment (Grit, Jörg, Steffen & Gerel, 2015). It also acknowledges the

importance of water-use efficiency and economic efficiency, which are highly necessary for the sustainable operation of urban water systems (Bahri, 2012: 6).

The integrated urban water system recognises and aligns with a range of formal (organisations, legislation, and policies) and informal (norms and conventions) institutions that govern water in cities (Bahri, 2012; Grit, Jörg, Steffen & Gerel, 2015). SUWM considers the management of urban water across different agencies and organisations by engaging all stakeholders and users to be part of the process to ensure the sustainability of the process and its outcomes. It takes into account the upstream and downstream issues and incorporates them into planning measures at the basin level (Closas, Schuring & Rodriguez, 2012: 4). Such consideration is essential for sustainable access to water flow considering that upstream activities (such as agriculture) and downstream activities (such as releasing untreated wastewater effluents) can cause stress to the supply system by altering the local hydrological cycle and reducing environmental flows (Jacobsen, Webster & Vairavamoorthy, 2012).

The idea of integrating processes, strategies, stakeholders' views, water use services and various dimensions in the management of urban water underlies the effort by the water community to shift from the conventional approach (old paradigm) towards SUWM approach (Burn, Maheepala & Sharma, 2012; Grit, Jörg, Steffen & Gerel, 2015; Urich & Rauch, 2014). Table 2.1 presents the various characteristics that distinguish the conventional approach from the SUWM approach.

Conventional approach	**SUWM approach**
Water follows a single pathway from supply to consumption and then to disposal.	Water can be reclaimed and reused multiple times, cascading from higher to lower quality.
Water supply, wastewater, and stormwater systems are physically distinct. Institutional integration occurs by historical accident.	Water supply, wastewater, and stormwater systems are purposely linked. Coordinated management can sustain physical and institutional integration.
Large and centralised is better for the collection system and treatment plants.	Small and decentralised, often desirable for collection system and treatment plants.
Wastewater is a nuisance, to be treated and disposed of.	Wastewater is a resource that can be captured and converted to fertiliser.
Stormwater is a nuisance and should be directed away from urban areas as rapidly as possible.	Stormwater is a resource; harvested as a water supply and infiltrates the soil to support aquifers, waterways, and vegetation.
Demand is about quantity. The volume of water required or produced for different end-users is the only parameter relevant to infrastructure choices.	Demand is multifaceted. Infrastructure choice should match the various characteristics of water required or produced for various end-users regarding the quantity, quality, and level of reliability.

Utilities track costs alone and focus on accounting.	Utilities assess all collection of benefits from investment and focus on creating value.
Standard solutions limit complexity; water infrastructure consists of 'hard system' technologies developed by urban water engineers.	Solutions may be diverse and flexible; management strategies and technologies combine 'hard' and 'soft' systems devised by a broad range of experts.
Collaboration equals public relations. Approach other agencies and the public when the approval or pre-chosen solution is required.	Collaboration equals engagement. Enlist other institutions and the public in the search for effective solutions.

Table 2.1 Characteristics of conventional water management and SUWM approach (Adapted from Bahri, 2012; Closas, Schuring & Rodriguez, 2012; Moddemeyer, 2010)

Even though the water system in the Accra metropolis was engineered to fit the conventional approach, the government has reiterated the need for alternatives to water management (Morinville & Harris, 2014; Yates & Harris, 2018). Other stakeholders share the same position to identify new alternatives for water management in the metropolis (Oteng-Ababio, Smout & Yankson, 2017; Suleiman & Cars, 2010; Suleiman & Khakee, 2017). It is these suggestions and responses that have prompted an interest in the kind of interventions associated with the SUWM approach. The advantage of this paradigm is that it advocates the explicit intention to manage water resources as a holistic water cycle to reflect the interconnections between different sectors and services in urban water management. The Accra metropolis adopted resolutions that amount to a commitment to implement the interventions rooted in the principles of the SUWM approach in public water management (Morinville & Harris, 2014; Water Resources Commission, 2012). Water managers and policymakers in the metropolis are believing that the SUWM approach can help them define appropriate interventions that can be implemented to tackle these problems effectively.

2.3.4 Principles underlying SUWM

Several scholars assert that a combination of principles underlies the SUWM that describe it as a flexible and adaptive mechanism for optimising the management of urban water system and water resources (Box 2.1) (Hurlimann, Wilson & Keele, 2017; Jalilov, Kefi, Kumar, Masago & Mishra, 2018). Nonetheless, others argue that such an all-inclusive nature and flexibility of alternative approach such as the SUWM tend to make it politically attractive and a "convenient target of opportunity" (Grigg, 2011, 2014; Hurlimann, Wilson & Keele, 2017; Marlow, Moglia, Cook & Beale, 2013). SUWM is not a cast-on-stone approach or a methodology per se, but it is a way of thinking about bringing multiple solutions or interventions together to address urban water issues within a specific context. In some cases, some of the solutions may not come directly from the water sector but another sector. For example, implementing a new building code or housing regulation can help improve the functioning of the storm drainage system and improve water use

efficiency while compelling the water utility provider to make provision for water supply to areas with low pipe network coverage.

Key Principles of SUWM

- SUWM reiterates the value of alternative water sources.
- SUWM encourages the use of "fit-for-purpose" water sources, in terms of quality and quantity.
- SUWM regards the process of water extraction, production, supply, wastewater recycling, and disposal as a component of the same water management cycle.
- SUWM targets the protection, conservation and use of water resources at its source (seeking high quality and quantity).
- SUWM is conscious of water use by non-urban users in the river basin.
- SUWM seeks to align formal institutions (organisations, legislation, and policies) and informal practices (norms and traditions) that govern urban water.
- SUWM recognises the relationships among water resources, infrastructure and urban planning.
- SUWM pursues multiple goals - economic efficiency, social equity, and environmental sustainability.
- SUWM encourages participation by all water and water-related stakeholders.

Box 2.1 Underlying principles of SUWM (adapted from Closas, Schuring & Rodriguez, 2012)

The SUWM idea calls for greater emphasis on the investment in water infrastructure technologies and strategic options that would improve water efficiency, increase wastewater recycling and reuse, enhance equitable water allocation and encourage circular water flow instead of linear flow (van der Hoek, Struker & De Danschutter, 2017). This idea provides the opportunity for water managers and professionals to understand the social, economic, political and ecological realities and interactions that affect the urban water management, water and wastewater flow, and linkages between the water system and the hinterland (Jalilov, Kefi, Kumar, Masago & Mishra, 2018). Such a comprehensive task for water managers and professionals can be challenging as it requires balancing multiple goals, including improving economic gains (efficiency and productivity) and social equity while enhancing environmental and ecosystem integrity. The study emphasises that there is no one-size-fits-all model for implementing the SUWM approach; instead, it is about adapting a mix of principles to the local context based on existing water problems. The expectation is that even the smallest intervention can contribute to a more significant impact due to the linkages between the various components of the urban water cycle. For example, the introduction of an effective detection and monitoring system for water supply in the system could end up reducing water losses while increasing water savings significantly.

2.3.5 Interventions for SUWM

The improvement of urban water security, sanitation and sustainability of the ecosystem in the long-term calls for a holistic approach, which among other things recognises the linkage between urban planning and

development, water supply, sanitation, and well-functioning ecological system. This requires the implementation of a mix of options for SUWM, some of which have been successful in addressing urban water problems:

2.3.5.1 Encouraging behavioural change

A significant hurdle remains to change the behavioural patterns of water users regarding water conservation and consumption. Several studies of attributed water use inefficiencies to the misconception some people have about water as a free resource with unlimited access (Gilg & Barr, 2006; Jorgensen, Graymore & O'Toole, 2009; Xue, Hong, Dong & Mak, 2017). Cities can achieve significant water savings without implementing technical interventions if they can change the behavioural pattern of water users, in particular, domestic water users. Awareness creation, advocacy and sensitisation can encourage water users to alter their behaviour towards water use by saving water through the reduction of water consumption and losses. Education and awareness creation on the socio-economic and environmental benefits of efficient use of water can help water users to value water as a commodity like oil and gas so that it can be used reasonably without being wasted.

2.3.5.2 Leakages reduction and active leakage management

Water leakages contribute to a significant loss of potable water that occur in the distribution network of the cities' water system. Leakages that arise in the distribution network between the point of supply and point of consumption are often challenging to deal with, in particular, in cities in developing countries where there are limited technologies and automated systems to detect water leakages (Closas, Schuring & Rodriguez, 2012). A transition from reactive to active management practices, such as advance leakage detection system to detect leakages, replacement of water mains, pressure reduction in the pipe network, which can reduce water loss in the system. Under the Sustainable Water Management in the City of the Future (SWITCH) program, the establishment of a Supervisory Control and Data Acquisition System (SCADA), linked to a Geographic Information System and simulation model to monitor water flows and pressures in Zaragoza Municipality, Spain, provided an effective solution to water leakages and losses (Howe & Mitchell, 2011).

2.3.5.3 Rainwater harvesting

Rainwater harvesting is gradually becoming a standard sustainable option for the provision of additional water supply sources of many urban households in developing cities. Several studies have demonstrated that rainwater harvesting can provide a useful and reliable water source for a variety of water uses, including urban agriculture, landscaping and flushing toilets. In Beijing, rainwater harvesting for greenhouse agriculture production proved to be economically beneficial as it reduced the water supply cost and increased the volume of available water for irrigation (Howe, Vairavamoorthy & van der Steen, 2011). Rainwater harvesting ponds served as storage ponds for irrigation in the greenhouse and also for creating humid conditions for mushroom production (ibid)

2.3.5.4 Wastewater and sanitation management

A sustainable approach to wastewater management is the recycling of wastewater or greywater for reuse. Proponents of SUWM approach see wastewater not as a waste but as a valuable resource, which, when managed efficiently with technologies, can provide an additional source of water supply. China has successfully installed about 300 functional decentralised wastewater reclamation systems that are producing 50,000 – 60,000 m^3 / day of secondary quality water used for landscape irrigation, toilet flushing, street cleaning and car washing (Howe, Vairavamoorthy & van der Steen, 2011; World Bank, 2016).

2.3.5.5 Urine collection and use

The conversion of urine into organic fertiliser provides a significant option for closing the urban water cycle loop. In the Accra metropolis, research has shown the potential of urine conversion into manure as an essential source of nutrients for urban agriculture (Amoah, Adamtey & Cofie, 2017; Amoah, Drechsel, Henseler & Abaidoo, 2007; Cofie, Olugbenga & Amoah, 2010). A study by Cofie et al. (2010) on 14 public urinals in the Central Business District of the metropolis showed that approximately 7.3 m^3 of urine was generated daily. This translated into an annual production of roughly 2000 m^3 of urine. In terms of nitrogen alone, this volume represents 6.6 tonnes of plant-available nitrogen. When managed well, this could be a significant source of fertiliser for urban agriculture and a substitute for highly-priced inorganic fertilisers in the metropolis. The collection and conversion of urine to fertilisers for urban agriculture can present a win-win situation for actors involved in urban water management. Entrepreneurs engaged in urine collection and conversion may have a guaranteed business, urban farmers can have a reliable supply of affordable organic fertiliser while the Metropolitan Assembly could be relieved of the pollution burden associated with open urine disposal.

2.3.5.6 Urban agriculture

Agriculture in green spaces in the Accra metropolis has increased significantly due to the economic benefits and also the demand for vegetables produced from this venture (Antwi-Agyei & Ensink, 2016; Mackay, 2018; Obosu-Mensah, 2018). The estimated annual income per farmer practising irrigated agriculture in the metropolis ranges between US$480 and US$690 (Danso, Hope & Drechsel, 2014). Farmers undertaking year-round agriculture have relied heavily on pipe water and untreated wastewater flowing in rivers for their irrigation needs. The growing scarcity of rainfall and pipe water shortage means farmers have to rely more on raw sewage. The prospects of using treated wastewater for irrigated urban agriculture seems to have generated both research and political interests as the authorities respond to the call for reduced pipe water demand for non-consumptive usage or non-drinking purposes. For the metropolis, water actors have the opportunity to establish a strong linkage between treated wastewater use and irrigated agriculture for health, economic and environmental benefits. For instance, if taken serious, irrigated agriculture could

generate substantial profit from the sale of vegetables (which is in very high demand in the city), enough to contribute to the cost of wastewater treatment and thereby address water pollution issues

2.3.5.7 Stormwater management

Within the integrated framework SUWM, an essential aspect of stormwater management is the linkages between the volume of rainfall that flows through the city, the current infrastructure (natural and artificial) through which precipitation flows and the water bodies that serve as reservoirs to receive stormwater. Management structures in developing cities like the Accra metropolis are rarely set up for an integrated approach to stormwater management (Closas, Schuring & Rodriguez, 2012; Howe, Vairavamoorthy & van der Steen, 2011). Many buildings and structures have been constructed illegally at unapproved sites, including wetlands and waterways in the metropolis. Infrastructure such as housing, roads and utilities are some of the components of urban development that shape stormwater management, but these components usually operate independently. This raises the level of risk of unintended consequences of one venture on another venture. In many areas of the metropolis, the construction of residential houses in wetlands and waterways tended to alter the stormwater flow and increase the intensity of runoff which in turn contribute to severe erosion, flooding and collapse of structures. Urban infrastructural planning in the metropolis has not fully integrated the development and management of stormwater. As a result, Accra continues to remain at high risk of flooding.

2.3.6 Synergistic relationship between water supply, wastewater and stormwater management

For city planners to develop a sustainable city, an essential requirement would be the need to look holistically at all the components that shape urban water management – water supply, wastewater (liquid and solid waste) and stormwater. This is because these components demonstrate strong linkages within the urban water cycle and show that one aspect of water management can have repercussions on other aspects (Table 2.2) (Howe, Vairavamoorthy & van der Steen, 2011). The impacts can be positive or negative; for example, a positive effect of wastewater recycling can be the provision of additional water supply for the city. The SUWM approach tends to provide the opportunity to bring out and harness these positive linkages while minimising the negative impact of the linkages within the urban water system. The expectation is that water managers can understand these linkages so that they can develop an integrated and more holistic mechanism that considers the implications of these linkages while delivering multiple goals across the various components of urban water management (Closas, Schuring & Rodriguez, 2012; Marlow, Moglia, Cook & Beale, 201).

Water supply > Stormwater management	**Water supply > Wastewater management**	**Wastewater > Stormwater management**
● When harvested, stormwater can provide a	● The reuse of greywater and treated wastewater is an	● Wastewater collection: the stormwater collection is linked

good source of non-potable water for irrigation of parks and gardens, toilet flushing and industrial use. ● Stormwater serves a significant water source for recharging aquifers, from where it can be re-abstracted for water supply purposes at a later date. ● Stormwater run-off is a pollution threat, as it can convey contaminants such as oils, heavy metals, nutrients and sediment into water sources, increasing the cost of treating the drinking water	alternative water supply source that can supplement a city's water supply, particularly non-potable uses such as parkland irrigation and industrial use. ● Residential, commercial and industrial water use is directly related to the volume of wastewater produced. The high rate of wastewater production put pressure on wastewater treatment plants. ● Poorly treated wastewater discharges can pollute water supply sources such as aquifers and lakes.	to wastewater management through combined sewer networks. Heavy rainfall and associated run-offs can cause overflows from the system releasing untreated sewage into the environment. ● Wastewater treatment: Combining stormwater with wastewater increases the volume and cost of wastewater treatment. Treatment measures also need to cope with additional pollutants contained in stormwater such as heavy metals and oils.

Table 2.2 Linkages between various components of urban water management (Adapted from Howe, Vairavamoorthy & van der Steen, 2011)

At the same time, it is necessary to sustain the linkages between the urban water system and the hinterlands where water sources are found in the river basin. This is because cities' water systems rely on the hinterlands for their raw water sources and the hinterlands could rely on cities to protect the catchment areas through management practices that protect ecosystem degradation and preserve the smooth functioning of the ecosystem and maintain the water sources. In sustaining the water resources supply to Accra metropolis, water managers must consider the critical importance of upstream and downstream activities and the need to incorporate them in the planning process at the river basin and urban scales. Activities such as farming, small-scale mining and deforestation at the upstream can alter the hydrologic regime (that is the quantity and quality of water flow in the river basin) thereby stressing the water supply systems (Jacobsen, Webster & Vairavamoorthy, 2012). Equally, chemical pollution, wastewater and effluent discharge in the city can affect the water availability and the quality of water for downstream users. The interdependence of the urban water system, the city and the hinterland form an integral aspect of the SUWM approach.

2.4 Research philosophical dimensions

Existing research paradigms have been distinguished through four main philosophical viewpoints, namely ontology, epistemology, axiology and methodology (Bryman, 2015; Ritchie, Lewis, Nicholls, Ormston & others, 2013; Saunders, Lewis & Thornhill, 2009). Ontology referred to a particular view of how reality is perceived. Epistemology is related to ways of knowing, understanding the social world, and generating and utilising knowledge deemed to be acceptable and valid (Ritchie, Lewis, Nicholls, Ormston & others, 2013). Axiology is concerned with ethics, thus the roles of values in the research choices and the researcher's judgement on the research subject. Methodology, which can be qualitative or quantitative or both represented the model for carrying out the research process in the context of a specific research paradigm.

From an objectivist perspective, the existence of reality is detached from, and autonomous of, social actors and how they interpret reality (Bernard & Bernard, 2012; Saunders, Lewis & Thornhill, 2009). The subjectivist perspective, on the other hand, visualised reality as a construct of society, reliant on social actors. The reality was thus pluralistic (i.e. could be expressed through symbols and language systems) and flexible (i.e. could be stretched and shaped to fit individuals' purposes) (Martela, 2015; Moon & Blackman, 2014; Van de Ven, 2007).

A blended approach of a subjectivist view with pragmatists orientation is adopted by the study. This position reaffirms the notion that worldviews, discourses, interests, cultures, and traditions are socially constructed versions of reality. It acts as a reminder that one cannot separate the observer from the reality that he or she describes as noted by Schlindwein & Ison (2004). From this position, it became possible to see how the perspectives of society are brought together through social learning and dialogue among the different water sector stakeholders to create meaning in the current status of water management in the Accra metropolis. The role of principal global actors in constructing narratives and realities around water management, which inspired the emergence of concepts and ways of sustainable management of water resources are highlighted.

Hector et al. (2009) referred to two schools of thought when it came to the subjectivist conception of complexity. First, under a systematic, reductionist notion, the world system was composed of different units, which could be divided into simple individual elements. Second, they characterised a holistic view of the world's reality as a unified whole that could not be reduced into individual components. This study agrees with the latter notion of a holistic view given the complex nature of the system, as emphasised throughout the study. Informing this position is the epistemology that fundamentally recognises the world's complexity, uncertainty, and infinite knowledge of several natural occurrences, primarily entities with unexpected behaviours and effects (Hector *et al.*, 2009: 696).

2.5 Research Paradigms

A research paradigm is a set of fundamental assumptions and beliefs about the perception of the world, which provides a thinking framework that guides attitude and orientation of a researcher (Jonker & Pennink,

2010; Wahyuni, 2012). Four major research paradigms inform the philosophical viewpoints of researchers. These include positivism, post-positivism, subjectivism, and pragmatism.

From the positivism paradigm, there is an objective world which is stable and predictable. In characterising and predicting the behaviour of physical and social phenomena, the positivist researcher would typically rely on quantitative data to establish general 'truths', which can be verified and used for projections (Meissner, 2016; Sharp, McDonald, Sim, Knamiller, Sefton & Wong, 2011). In the study of water management issues are perceived by a positivist as 'hard' objects that can be defined, distinguished, and solved by water experts. For example, the concepts of water scarcity and water stress are used as objective measures of water resource availability (Sharp, McDonald, Sim, Knamiller, Sefton & Wong, 2011).

The post-positivism paradigm is "grounded on the centrality of meaning (and often language) to human affairs" (Connelly & Anderson, 2007: 215). The research defined by this perspective highlighted the importance of background, values, and politics for influencing the observations of people. In policy science, the post-positivist sought to explain past events by offering rich narrative accounts of phenomena and assessing policy values through these accounts (Hajer & Wagenaar, 2003). Post-positivist research in water management would explore the interactions between multiple stakeholders and their influence on decision-making toward urban water management.

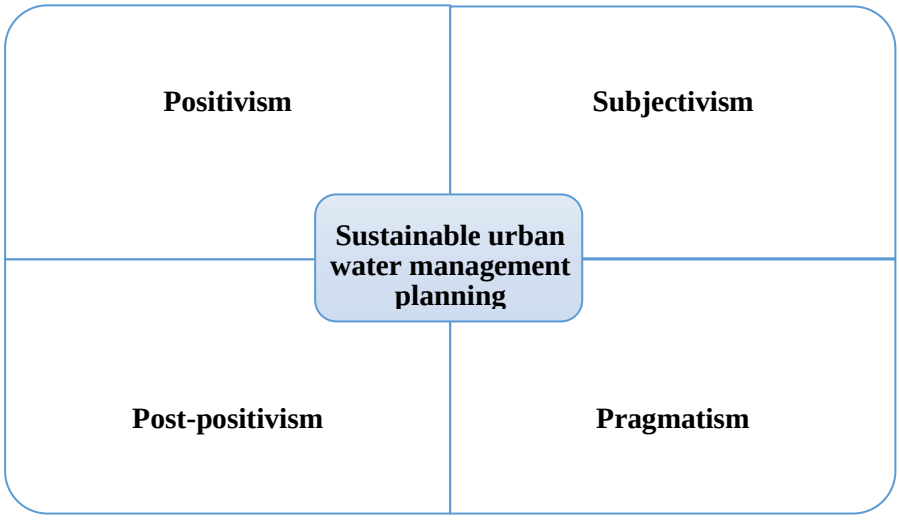

Figure 2.2 The research paradigms informing sustainable urban water management planning (Author's design)

In the subjectivism paradigm, proponents argued that reality is socially constructed and subjective. The contribution of diverse backgrounds, assumptions, and experiences of individuals in the construction of reality through social interaction is recognised (Wahyuni, 2012). The world's reality appeared to be characterised by multiple perspectives due to the subjectivity of human perceptions and experiences (Hennink, Hutter & Bailey, 2011). Subjectivists perceived water issues as 'soft' or intangible due to the

inherent complexities, and these cannot be defined and separated (Essaw, 2008). Instead, an assessment of multiple factors and forces related to water issues is essential. There are various means of constructing realities around water issues, with each subject to its validity when seen through its lens of expectations, assumptions, experiences, and purposes (ibid). This study acknowledges the inherent complexities in wicked problems such as water challenges, which require the assessment of multiple factors including political, social, economic, and environmental factors and processes that shape the problem, thereby highlighting the critical role of stakeholders from different disciplinary background and perspectives in the problem-solving process.

Contrary to positivism and subjectivism paradigms, pragmatism is a deconstructive paradigm that circumvents the "contentious issues of truth and reality" (Feilzer, 2010: 8), and instead emphasises what works best to address research problems under investigation (Teddlie & Tashakkori, 2009). Driven by results, pragmatist researchers must ask the right questions to determine their research framework (Fendt & Sachs, 2008: 473). Pragmatists advocated for the use of both quantitative and qualitative data (mixed methods) in research because this combination facilitated a better understanding of the real world. Research under this paradigm usually entailed prolonged engagement and triangulation, which enabled researchers to capture multiple stances and values (Fendt & Sachs, 2008; Onwuegbuzie, Leach, Collins, Williams & Vogt, 2011).

These ontological and epistemological standpoints influence humanity's way of understanding the world (Essaw, 2008). Such foundations, in turn, impact the kind of theoretical viewpoint suitable for a particular 'way of knowing'. People's fundamental epistemological framings firmly inform their inclination to one viewpoint or another. A theoretical view shapes a specific methodological approach for analysis and for promoting recommendations (ibid). The methodological approaches, in turn, influence the type of tools or method to be employed in the research activities. In Table 2.3, the trend of research paradigms, epistemological and ontological viewpoints, axiology, the methodological approach, and the implications for water management is presented.

Research paradigm	Ontology and epistemology	Axiology	Methodology	Implications for water management
Positivism (Naïve realism)	● There exists a perceptible reality that is external, objective, and independent of social actors. ● Only observable phenomena can produce reliable data and facts. ● Belief in the existence of a universal generalisation that is applicable across contexts.	Value-free: Research is conducted in a value-free way, the researcher is independent of the data and maintains an objective stance	Quantitative	Water issues are perceived as definable and separable and can be solved by experts who produce clear, workable solutions using analytical approaches of their disciplines (Rittel & Webber, 1973; Sharp, McDonald, Sim, Knamiller, Sefton & Wong, 2011).
Post-positivism (Critical Realism)	● Objective reality exists devoid of context and only able to be imperfectly apprehended. ● Objective realities exist irrespective of human beliefs, knowledge, or thoughts of their existence. Social conditioning informs the interpretation of reality. ● Only observable phenomena can produce reliable data and facts.	Value-laden: Research is value-laden; the researcher is influenced by world views, cultural experiences and upbringing	Quantitative or qualitative	● Water resources are perceived as complex, involving multiple stakeholders with conflicting interests and values (Meissner, 2016). ● Interactions between different stakeholders are explored in sustainable water management innovations (Sharp, McDonald, Sim, Knamiller, Sefton & Wong, 2011).
Subjectivism	● Realities and meanings are not discovered but socially constructed. There exists a multitude of perceptible and equally valid facts. ● People construct meaning in different ways, even about the same occurrence.	Value-bond: Research is value bond, the researcher is part of what is being researched, cannot be separated and so will be subjective	Qualitative	● There exist inherent complexities in water issues; factors and forces that cause the problem are more likely to be scrutinised, and stakeholders willing to engage in the problem-solving process are sought out (Kreuter, De Rosa, Howze & Baldwin, 2004).
Pragmatism	● Either or both observable phenomena and subjective meanings can provide agreed-upon knowledge dependent upon the research question. ● Focus on practical and applied research, integrating different perspectives to help interpret data. ● There is a participative reality with a link between subjective and objective reality.	Value-bond: Values play a significant role in interpreting the results, the researcher adopting both objective and subjective points of view	Quantitative and qualitative (mixed or multi-method design)	● There exist inherent uncertainties and complexities inherent in water issues; the multiple factors and forces that lead to various problems are more likely to be examined. ● Stakeholders willing to engage in the participatory problem-solving process are sought out.

Table 2.3 Research paradigms, ontology, epistemology, axiology, and methodology and the implications for water management (Sources: Feilzer, 2010; Jackson, 2015; Wahyuni, 2012)

A blended approach of overall subjectivism viewpoint, with a pragmativism orientation, which informed this study does not conform to one philosophical standpoint and reality. It allowed for individual experience, observation and interpretations of reality and the material conditions and social relations to inform the perspective of the researcher (Wiebe, Durepos & Mills, 2009). This approach gave the researcher the flexibility of choice in the selection of methods, techniques and analytical tools that best suit the requirements and purpose of this research. Through this approach, the researcher was able to apply mixed methods and analytical tools to understand the varied interpretations of the water management concepts and to produce real-world interventions and solutions for sustainable water management rather than testing a theory. The research questions in this study are both qualitative and quantitative and therefore the blended approach made provision for the application of both qualitative and quantitative research methods for collecting data and inquiries into complex phenomenon of social and natural contexts (Creswell, 2009; Creswell & Creswell, 2017).

2.6 Conclusion

This chapter has brought to light the interrelated concepts and approaches that reinforce the idea of pursuing an alternative pathway to the sustainable management of urban water resources. The chapter brings to attention the growing body of knowledge about society's exploitation of water resources for socio-economic development to the disadvantage of the environment, and this has brought a twist to the relationship between water, urban economy and the urban environment. It discussed the sustainability and sustainable development concepts as the underlying concepts that established the premise for the emergence of new water management paradigm, in particular, the rise of the IWRM globally as an alternative way to the sustainable management of water resources. The IWRM approach has become politically dominant discourses in the water community, paving the way for the emerging alternative thinking about how society can sustainably manage water resources in urban areas.

The SUWM approach provided a framework that could be used to complement the effort of conventional management practices to tackle problems that affect water-related services in cities. It is necessary to reiterate that there is not one single pathway under the SUWM approach. Instead, there could be a mix of interventions that are defined considering the prevailing dynamics in a particular city. This implies that different cities may apply different interventions under SUWM to address water and urban issues, depending on the current local situation. For example, for a city that is confronted by water pollution due to the flooding problem, SUWM interventions may include expansion of the drainage system, and conservation and use of wetlands as ecological sinks. On the other hand, for a city with water scarcity issues, interventions under SUWM would consist of the construction of storage facilities for rainwater harvesting, demand management, and wastewater recycling and reuse.

The Accra metropolis is making an effort to implement interventions that reflect the principles of SUWM under public sector ownership. There seem to be several gaps in the way the problems of the city have been framed to identify the interventions defined from the SUWM perspective. Preliminary analysis also reveals the lack of in-depth understanding of the dynamics of the city and these dynamics help define interventions

for water management. In sum, SUWM could be regarded as an approach that can stimulate new ways of thinking about the multiplicity of urban water problems and defining interventions that could be implemented to deal with the identified issues.

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Chapter 3: Research methodology

3.1 Introduction

In this chapter, the study adopts the TDR process to guide the execution of the study. Fundamental to the TDR is the value associated with the social learning process that brings together different stakeholders with diverse disciplinary backgrounds and bodies of knowledge from research and practice to work and produce solutions that can address multi-faceted water problems. By integrating scientific knowledge with societies' understanding, there is a relatively high potential to create solutions that consider the stakeholders' values (Siew, Aenis, Spangenberg, Nauditt, Döll, Frank, Ribbe, Rodriguez-Labajos, Rumbaur, Settele & Wang, 2016). The expectation is that the exchanges and learning from the TDR could result in the production of new knowledge and information that can help water managers define solutions for water management for the Accra metropolis.

As a researcher with several years of experience at the IWMI, I subscribed to the idea of self-immersion as a means to gain a broader perspective of the issues under examination, seeking views from different angles to produce a more holistic understanding of the problem being investigated. Another practice that was instrumental to the researcher was withdrawing from the research process and observing the discussions and interactions among stakeholders, taking note of how their communal or professional orientation influence their reasoning and position on the issues under discussion. These positions enabled me to have a deeper appreciation and broader perspective about the research topic and also to collect diverse information from the various experts to enrich the research.

Borbye et al. (2011: 8) defined immersive learning as "the learning that occurs as a result of immersion in a particular environment. It involved a deep-level involvement and engagement of the researcher with an object of study, whether it was a practice, lifestyle or culture. Immersing myself in the previous study on "small dams and reservoirs in the northern part of Ghana" helped reveal deep-rooted challenges that go beyond the usual limited financial, infrastructure and technical capacities of local beneficiary communities. It helped unravel some political undertones that influenced the design and quality of dam built in certain communities and the sheer defiance by beneficiary communities who felt slighted by a government agency for neglecting their concerns in the project. This study revealed that the politics of allegiance to the political party in power somehow contributed to the quality and kinds of projects implemented in local communities of Ghana. Examples of previous immersive studies I have conducted include:

(i) Participatory evaluation of the performance of small reservoirs for small scale livelihoods in the northern region of Ghana (Acheampong, Ozor & Owusu, 2014),

(ii) Multi-stakeholder engagement in the assessment of the vulnerability of northern Ghana to climate variability (Acheampong, Ozor & Owusu, 2014, and

(iii) Revisiting dominant notions: A review of costs, performance and institutions of small reservoirs in sub-Saharan Africa (Venot, de Fraiture & Nti Acheampong, 2012).

Before delving into the TDR process and the outcome of the process, the theoretical framework that provided a structure and guide to the study is presented. A description of the research design and methods used for data collection and analysis in this study are also presented.

3.2 Theoretical Framework

This study is grounded in political ecology, which serves as the overarching theoretical framework. The term political ecology first appeared in the academic work of Frank Throne in an article published in 1935 (Throne, 1935), but it was the anthropologist Eric R. Wolf who reignited the political ecology notion in his 1972 article entitled "Ownership and Political Ecology." In this article, Wolf shed light on how local rules of ownership and inheritance "mediate between the pressures emanating from the larger society and the exigencies of the local ecosystem" (Wolf, 1972). Since then, political ecology has been extensively applied in several research areas including land degradation (Blaikie & Brookfield, 2015), water conflicts and equity (Rodríguez-Labajos & Martínez-Alier, 2015), urban metabolism (Delgado-Ramos, 2015; Swyngedouw, Kaika & Heynen, 2006), and climate change (Jayaraman, 2014), among others.

Political ecology has since been established as a dominant field of human-environmental inquiry and works to highlight unequal power relations and natural resources distribution, conflict, and the neglect of the importance of human and environment interactions in a political economy of global capitalism (Walker, 2005). It adopted an integrated style and embraced a broad scope of interpretations of the interactions between society and nature drawn from a broad ideological spectrum, ranging from neo-classical theory to neo-Marxist theory (Khan, 2013). As a result, political ecology lacks a coherent theory or 'grand theoretical' underpinning. Scientists continue to deliberate on the scientific status and research approaches regarding the definition of its boundaries and associations with other disciplines, epistemological framing, and practical approaches (Peet, Robbins & Watts, 2010; Robbins, 2012; Rodríguez-Labajos & Martínez-Alier, 2015). Nevertheless, a consensus existed among scholars in the characterisation of political ecology as a typical power-laden construct rather than a politically inert theoretical field of inquiry (Biersack, 2006: 5). The political ecology approach to environmental crisis provided a counter-discourse and situates people, places, and practices in the wider processes of social and economic changes at various scales (Klein, 2002).

In the wake of renewed interest in environmental issues, scientific literature on the political ecology of water resources and water systems continues to grow (Swyngedouw, 2009). Smith (2001) adopted the urban political ecology framework to bridge the dichotomy between environmental concerns and human development issues while focusing on equity and access to water to township inhabitants in the Cape Town Metropolitan Area (CMA). Crifasi (2002) explored water use and development in the first world and how different stakeholders affect water resources to understand better the anthropocentric stresses placed on water systems and the environmental manifestations of such pressures. In assessing the political ecology of water, Derman and Ferguson (2003) established the idea of water scarcity as the motivation for water reform while highlighting the role of stakeholder participation in water management as key to the sustainable management of water resources. Loftus (2009) characterised water flow in Durban as full of tensions and contradictions, which

emanated from a crisis-prone accumulation process. Truelove (2011) employed the feminist political ecology framework to conceptualise water inequalities and micro-politics within communities in Delhi, India. Cole (2012) examined the interaction between social power and ecology and its impact on inequitable and unsustainable water distribution on the island of Bali. Beltrán and Velázquez (2015) conceptualised water as part of an independent and objective reality rather than as a constructed reality backed by pre-existing ideas. Using a political ecology theoretical framework, Whiteford et al. (2016) examined the impact of water flow on human and environmental health while revealing the invisible and hidden agenda that shape water use and practices.

The political ecology theory provided additional insights into the relationships between society and the environment, concerning water resource management and, in particular, the social status, gender, economic, and power dynamics that shape these relationships (Lawhon & Murphy, 2012). Bringing these insights from political ecology to the study of water management practice in the Accra metropolis can help unravel the institutional, economic, socio-political, and environmental realities that influence the implementation of water management interventions and the outcomes. The study aims to demonstrate how political ecology can provide a deeper understanding of the role of power, social mobilisation, and grassroots innovation in facilitating the transition in water management practices in the metropolis.

3.2.1 Epistemological framework for political ecology

A major philosophical ambiguity of political ecology has been its relationship with the epistemologies of its parent disciplines – natural and social sciences (Klein, 2002)**.** Both sciences have emerged and evolved from different academic paths that are relevant to the epistemological framing of political ecology. According to Rosenberg (2018), the natural sciences aligned with the objectivist and reductionist approaches to society and human-nature interactions while social sciences offer idiographic, social constructivist, and a more narrative approach to knowledge production. In this study, the application of the political ecology field of inquiry depicts several elements of the epistemological perspectives. From the positivist perspective, political ecology partially reflected the positivist view of water as a physical entity that can be measured, which helps to characterise and predict behaviours (Sharp, McDonald, Sim, Knamiller, Sefton & Wong, 2011). For example, measuring water scarcity forms a central basis for a post-positivist perspective to elucidate the values, narratives, and the politics surrounding the occurrence of water shortages. Embedded in political ecology is the post-positivist view that seeks to provide a historical account of a social phenomenon and explore the relationship between multiple stakeholders and their influences on sustainable water management.

The political ecology framework also reflected a constructivism viewpoint, which recognised the contribution of diverse backgrounds, assumptions, and experiences of individuals in the construction of reality through social interaction (Wahyuni, 2012). Even more reflective in political ecology has been the pragmatist view, which defined the knowledge of reality through experience (Schoneberger, 2016). The pragmatist perspective provided practical solutions to problems in social constructivism by identifying ways of addressing real issues (Klein, 2002). By connecting the idea of political ecology with the different epistemological elements, new

meanings and interpretations of water management transitions and various observations and constructions of such changes can be explored and expounded in a philosophically non-antithetical manner.

3.3 Research design

A research design is a vital component of any research study as it guides the choice of appropriate data collection methods and approaches. The intention was that data gathered, analysed and interpreted would not deviate from the objectives and questions of the research study (Creswell & Creswell, 2017; Yin, 2013). It provided a research framework or a blueprint for researching with absolute control over elements that may hinder the validity of the research findings (Grove, Burns & Gray, 2012). In the simplest terms, it is "a plan that describes how, when, and where data are to be collected and analysed" (Parahoo, 2014: 142). Several research design options exist including experiments, action research, survey; ethnography, grounded theory, archival research and case study as detailed in Table 3.2. Understanding and distinguishing between these research design options are essential for a researcher to know their purpose and to choose the appropriate option(s) suited for a particular research. This study combines several of the options described below to develop a holistic method for addressing the research questions.

Options	Purpose
Experiment	It is used for the controlled testing of causal processes (Briony, 2006). It can also be applied where time priority is critical in a causal relationship, or when examining consistency in a causal relationship and a high level of correlation between variables and factors.
Survey	It has proven to be a vital data collection method in social or market research. It involves asking questions about respondents or products. A survey may emphasise factual information about respondents or aim to gather the views of the respondents (Briony, 2006).
Case study	This method permits the investigation of a contemporary event or phenomenon within its real-life context using multiple sources including primary and secondary data (Crowe, Cresswell, Robertson, Huby, Avery & Sheikh, 2011; Yin, 2013). It is useful for providing an in-depth and multi-faceted examination of the complicated real-life situation.
Action research	It aims to address an immediate practical problem or is a reflective progressive problem-solving process led by individuals in a collaborative team or as part of a community of practice to improve their approach towards addressing issues and solving problems (Atkins & Wallace, 2012).
Grounded theory	It is an inductive research method that entailed the generation of theory through systematic collection and analysis of data (Corbin, Strauss & Strauss, 2014; Faggiolani, 2011). In other words, it allowed data collection without an initial theoretical framework and testing before concluding (Creswell, 2009). It differed from the traditional model of research where research applies an existing theoretical framework upon which data can be collected to show how the theory is applicable or not applicable to the research focus (Allan, 2003).
Ethnographic research	It is a qualitative method originating from social and cultural anthropology. The researcher immersed himself or herself into the lives of study participants, observe and interact with them in

	a real-life context (Hammersley & Atkinson, 2007). Researchers usually spend quite some time in the field to contextualise their studies socially and culturally (Fetterman, 2010).
Archival research	This research design involved searching and extracting data and information from original records about organisations, individuals, and events. It entailed studying historical documents, created in the relatively distant past, but also investigating non-historical documents and texts produced by and about contemporary issues (Ventresca & Mohr, 2017). It is often used to complement other research methods (such as surveys)

Table 3.1The research options and purposes in research methods (Source: Creswell & Creswell, 2017)

Concerning epistemological perspectives, the experiment and survey research designs subscribed to the positivist and objectivist research paradigm. Research using experiment was often more structured and controlled and therefore not suitable for this study as it undermined the overall goal and objectives of the study (Creswell & Creswell, 2017). The survey research design is dynamic as it can fit in other research designs. For example, survey research is employed to collect data in a case study of the Accra metropolis. The survey research allows the study to affirm the information collected using other research designs.

Research design options, namely action research, grounded theory, case studies, ethnographic research and archival research, seemed to subscribe to the constructivism and interpretivism research paradigms. By its definition, the grounded theory design did not align well as a research method for this study. Ethnographic research design allowed researchers a more extended period to understand the norms and values of society, humanity and organisational characteristics of the social-cultural phenomenon (Saunders, Lewis & Thornhill, 2009). In spite of its real-life context appeal, several features and principles of this research design are inconsistent with the nature of this research study, making it unsuitable for this study. The archival research design addressed research questions that highlighted past events and changing patterns. The challenge is that it may be restricted by the condition and type of the information and data in the archives pertinent to the research due to confidentiality reasons. It may narrow the scope of available data and information analyses and therefore risk losing vital information that would allow for more comprehensive results and conclusion. Based on these characteristics, the archival research design is not entirely appropriate for this research study.

The nature of the research objectives and questions, as well as the underlying epistemological positions for this study, makes the application of a case study method suitable for this study. According to Yin (2012), the case study research allowed the use of multiple sources of data such as documentation, focus groups, consultations; survey, direct observations; stakeholder dialogue; and physical artefacts. Additionally, informed by the interpretive, inductive and deductive research viewpoints, the case study research design explored insights and meanings of experience with typically no hypothesise a priori (Yin, 2009). The principles and characteristics of the case study research design are consistent with this study. Furthermore, the case study method seems suitable for this study as it takes an interpretive stance in the pragmatic research paradigm. In the next section, the study presents further details about the case study research design.

3.3.1 Case study

The case study research design provided a more in-depth insight into an event within a limited scope that reinforces or questions a theoretical perspective which was previously introduced or self-developed (Yin, 2009). Accordingly, the case study method is appropriate when the research seeks to address either a descriptive question (e.g. "What is happening or has happened?") or an explanatory question (e.g. "How or why did something happen?") (Yin, 2012: 5). Yin (2013) noted three categories of the case study, namely exploratory, descriptive, and explanatory. An *exploratory* case study is typically used to gain an understanding of how a phenomenon occurs, particularly when it is not well known or has an unclear outcome. A *descriptive* case study describes in detail real-life events that occur within the data in question, while an *explanatory* case study is employed to understand why an event occurs. This study adopts both exploratory and explanatory case studies as they provide in-depth details and an understanding of the relationship between the independent variables and dependent variables.

Stake (1995) identified three types of case study research design, namely the intrinsic, instrumental, and collective. In an intrinsic case study, a researcher is interested in the case for its sake, while in the instrumental case study, the researcher is interested in another idea or subject and uses the case study to explore a specific pattern of behaviour. In a *collective* case study, a researcher coordinates data from multiple sources. Unlike an intrinsic case study, findings from instrumental and collective case studies could be generalised to a larger population (Zainal, 2007). In conducting a case study research, Yin (2013) cautioned researchers against separating these categories or conceiving them as a hierarchy. This study reflects an instrumental case study of urban water management in the Accra metropolis, from which outcomes can be generalised for developing cities in Africa. The metropolis represents an emerging city with characteristics – rapidly rising population, urban expansion, and intensive economic activities – that are shared with many growing cities in Africa and other developing regions. It means the outcomes of the study could widely be generalised in the context of these emerging cities while water managers in the Accra metropolis could draw lessons of successful urban water management outcomes from other cities.

Despite its flexibility and applicability to many relevant real-world context studies, there seem to be some limitations of the case study. According to Yin (2012), some researchers deemed the case study to be the last option or a prelude to using other social science methods (i.e. to collect data to determine the feasibility of a topic for further investigation), thus rendering it a less rigorous scientific method of inquiry. However, Yin insisted that such a traditional and chronological view of social science methods is entirely obsolete, given that experiments and surveys have their exploratory modes, and case study research provides information well beyond exploratory functions (Yin, 2012: 6).

Several schools of thought exist on the case study research design. According to Stake (1995), a case study approach identified with the social constructivist paradigm, which claims that truth is relative and reliant on one's viewpoint, whereas Yin (2012) approached the case study method from a post-positivist standpoint. The case study method, however, was not intended to prove one 'truth' but instead helps to collect new information

about the research phenomenon or event. An essential feature of the case study research design was that it was grounded in reality with an insider's perspective, pertinent to areas of policy development and examination (Ritchie, Lewis, Nicholls, Ormston & others, 2013). Such a method was suitable for addressing levels of complexity which cannot rely on purely experimental research approach (Ibid).

3.3.2 Description of the Accra metropolis water system

The Accra metropolis is located at 5°30 North, 0°10 West along the coast of Ghana and covers a total land area of 185 square kilometres. According to the United Nation's population estimates, the population of Accra stood at 2.48 million in 2018 (UN DESA, 2018). The city has sprawled beyond its boundaries, forming part of a larger area called the Greater Accra Metropolitan Area (GAMA). It represents an urban primacy, which houses the principal administrative, political, and economic hubs of Ghana. The metropolis serves as the capital of the country, the regional capital of the Greater Accra Region, and the administrative headquarters of the GAMA, with which it is coterminous (Accra Metropolitan Assembly (AMA), 2011) (figure 3.1).

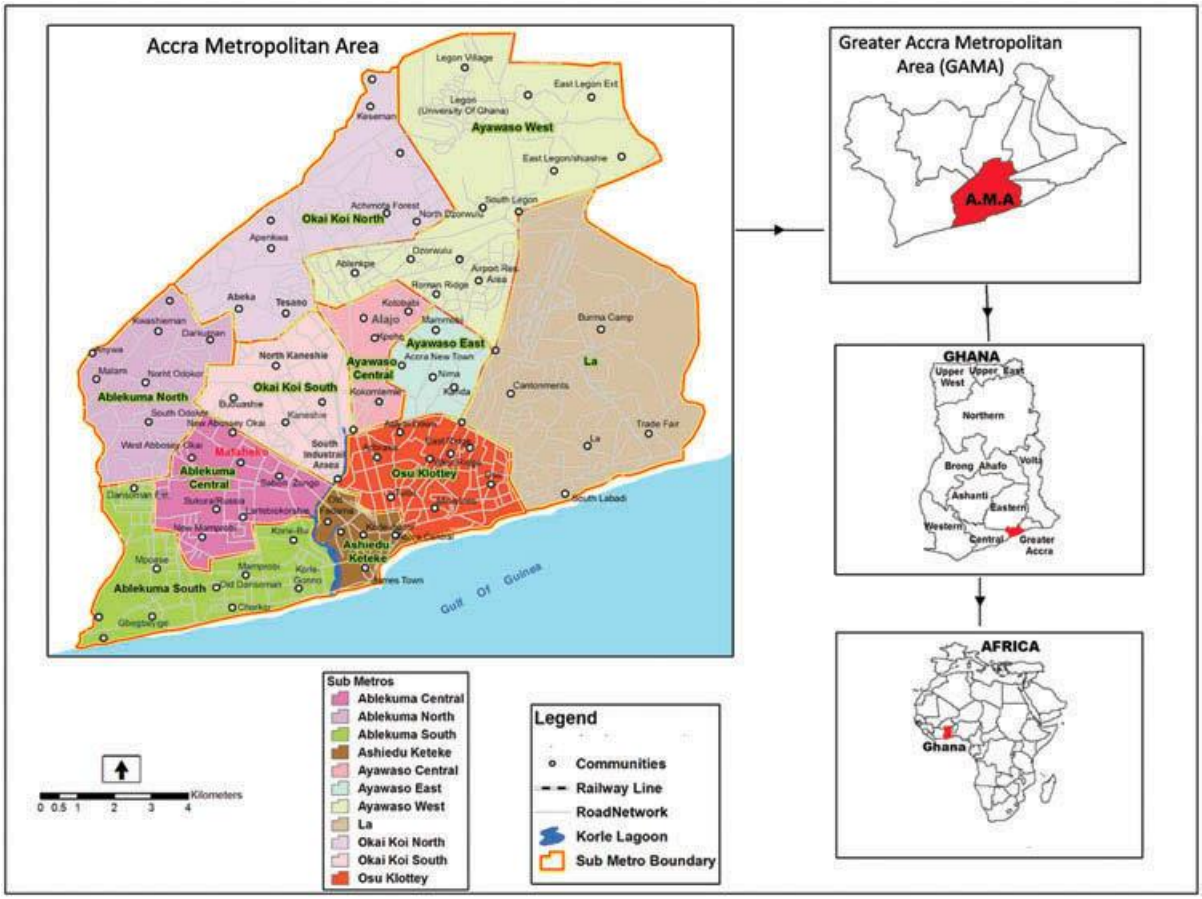

Figure 3.1 Map of Accra (Source: Amoako & Boamah, 2015)

The water system in the Accra Metropolis begins with water extraction from multiple sources, including groundwater, seawater, rainfall and surface water. The reservoirs at the two primary waterworks (Kpong and Weija) collect raw water and then pass it through the processes of filtration and chlorination before delivering the treated water to industrial, commercial and residential establishments through bulk storage systems and network of extensive pipe systems. In several suburbs in the metropolis, which are not connected to the

reticulation system, individual households make use of multiple sources of water, including treated water sold by vendors, rainfall, and groundwater drawn from boreholes. The metropolis receives approximately 95 per cent of its freshwater from the Densu and Volta River Basins through the Kpong, and Weija water treatment works, located 15 km west and 75km northeast of Accra respectively (figure 3.2). These waterworks are managed by the GWCL, which is a state-owned limited liability company. At the Weija waterworks, water from the intake passes through three treatment plants comprising the Adam Clark (new plant), Pintsh-Bamag and Candy Patterson plants (old plants). Water treatment in the Adams Clark plant passes through five different chambers, namely the aeration tank, contact tank, clarifying chambers, slow sand filtration, and disinfection chamber. Treatment in the Pintsh-Bamag and Candy Patterson plants involves the use of raw water tank, sedimentation tanks, clarifying chambers, slow sand filtration and disinfection chamber (Lunani, Van Der Steen & Vairavamoorthy, 2008). The Kpong waterworks is situated 75km northeast of Accra and supplies treated water to the eastern and central parts of Accra. The Kpong waterworks consist of the 'new' Kpong plant and the 'old' Kpong plant. From the intake, raw water moves to the new plants where it goes through the 8 stage treatment processes, namely mixing, clariflocculation, filtration, backwashing, post-chlorination, pH-adjustment, monitoring, and high-lifting stages. Treated water is transported by gravity through a network of pipes with different diameters ranging from 300mm to 900mm to large reservoirs from where the various booster stations pump water through the pipe network or reticulation system to domestic and industrial users in the metropolis (GWCL, 2015).

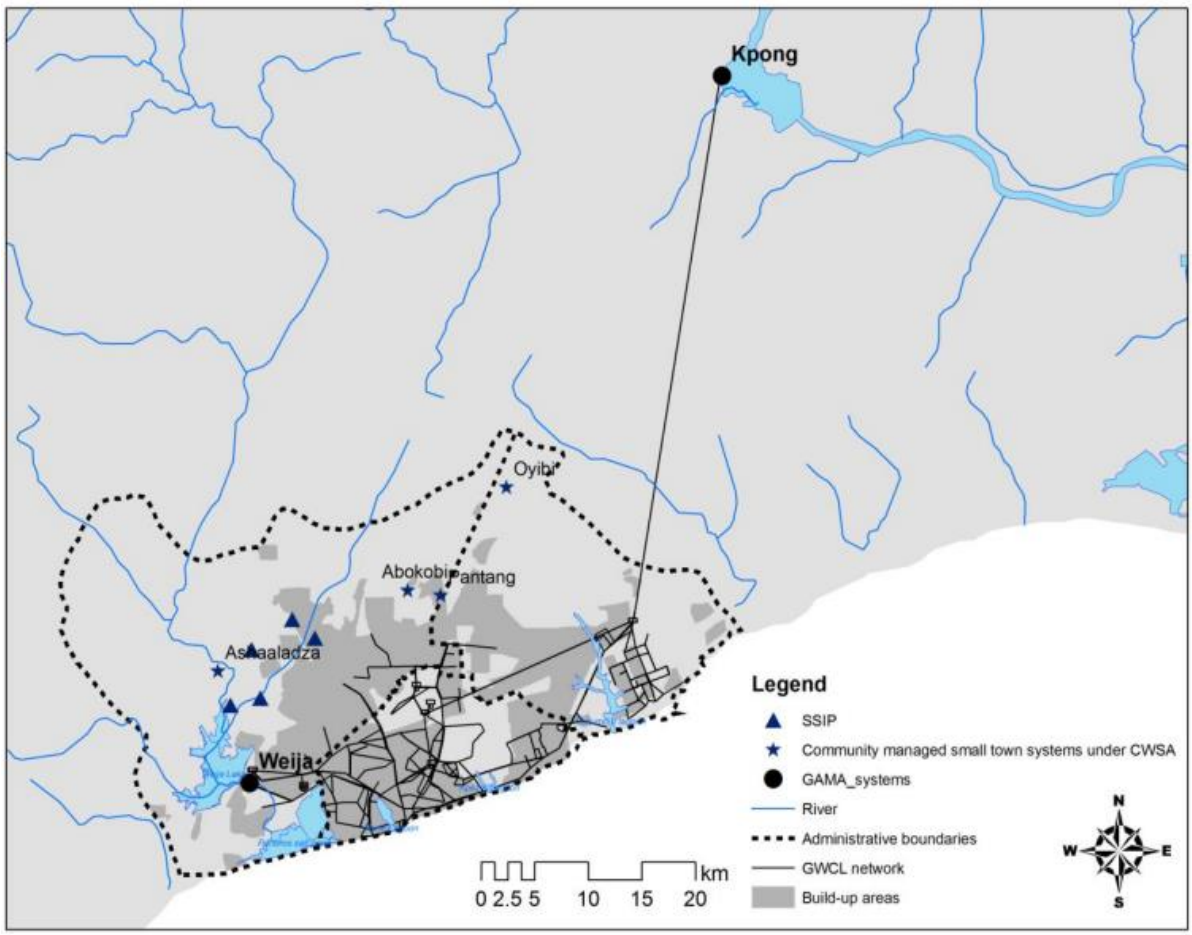

Figure 3.2 Water sources and distribution networks in the city of Accra and surroundings(Source: Owusu & Teye, 2015)

The Accra metropolis has established dynamic resource flow systems based on resource availability, urban population density dynamics (formal and informal settlements), and resource demand mainly due to its status as the largest city in Ghana and as an essential economic hub in West Africa (Silver, 2014: 201). The metropolis has experienced significant growth in three broad areas: infrastructural development, urban population, and commerce. It represents a powerhouse of national economic activities, which manages the flow of goods, services, imports, and exports and serves as the hub for the management of utility services provisions in the entire country. Since 2000, the metropolis has experienced a surge in economic growth. The economic boost was triggered by a policy shift that allowed the implementation of structural adjustment programmes, including the liberalisation of trade and prioritisation of private sector engagement in Ghana. The city entered into a development transition influenced by the globalisation movement that saw the influx of international companies, migrant inflow from abroad and rural areas, and the establishment of new business markets (Grant, 2009; Pescina, 2013). This movement served as a significant boost for socio-economic activities and infrastructural expansion in the metropolis.

3.3.3 Research method

The study adopts a mixed-method approach embedded in a case study research design. The mixed-method approach represents the combination of research methods used for the collection and analysis of qualitative and quantitative data. These methods include (i) focus group (ii) one-on-one consultation, (iii) literature survey, (iv) direct observation method and (v) survey. In Table 3.2, the research methods for this study, their strengths, and limitations are presented. The application of the mixed method allows for simultaneous multiple data collection, pragmatic reasoning, and independent data collection and analysis. Below is a brief description of the research methods used for data collection and analysis in this study.

Research methods	Advantages	Limitations
Focus Groups	• Flexible nature of questioning allows exploration of a wide range of views, attitudes and interpretations from stakeholders. • Stakeholders draw from personal experiences to stimulate and guide discussions • Help focus discussions on issues specific to each group and how research could address them. • It is an efficient use of time and more cost-effective than one-on-one interviews.	• Time exhaustion, challenging to coordinate and execute. • Some participants may be uncomfortable in expressing their views in a group context. • Group dynamics may hamper the prioritisation process. • Small sample size limits the credibility to generalise findings. • With divergent views, a consensus may be difficult to reach

	• It is an effective way for stakeholders' engagement.	
One-on-one consultation	• It is an effective way of capturing individual perspectives and experiences. • It is an excellent way to identify priorities with the decision-maker and practitioner buy-in. • It helps draw expert opinions and perspectives from stakeholders on the ground.	• Characterised by small sample size to support statistical analysis of differences in perspectives; data and results not generalisable. • It is time-consuming when targeting many stakeholders. • It is challenging when targeted stakeholders are geographically dispersed.
Literature Survey	Offers a two-prong methodological approach: 1. A search and analysis of existing literature 2. Expert views and perspectives in the field are obtained.	• It does not account for non-expert views and priorities.
Case study method	• Flexibility and applicability of carrying out the relevant real-world context and addressing important research questions • In-depth understanding makes possible analytical generalisations	• Difficult to generalise findings statistically
Survey	• Provides on-site realities of water service delivery • Helped triangulate data for this research	• Responses could be subjective or underlie by political undertones

Table 3.2 Research methods, strengths and limitations (Adapted from O'Haire, McPheeters, Nakamoto, LaBrant, Most, Lee, Graham, Cottrell & Guise, 2011)

Focus group is a qualitative research method that provides insights into people's perceptions, beliefs, and opinions and provides a deeper understanding of the subject matter under study (Krueger & Casey, 2014). In the focus groups, usually comprising five participants, the researcher was interested in the interactions and engagement among the participants and how they were able to generate qualitative data and information on the subject matter. Here, participants had the unlimited opportunity to deliberate on the issues, to bring out the ideas and views without interruptions. The focus group usually occurred on the learning platform (more details in Section 3.3).

A one-on-one consultation with 25 key informants (senior-level professionals and practitioners from different institutions) in the water sector was a suitable method for exploring the perspective of policymakers and practitioners through interactions and discussions. This group of people could be considered as "authority" in the field of water management in the metropolis. They make decisions and shape the direction of water management in the city. Of late, high-level experts, especially in the government agencies in the metropolis, have been sceptical about the use of the term 'interview', which entails using a structured or semi-structured questions to seek responses due to the one-sided nature of extracting information. According to some

participants, some of their colleagues who granted interviews to both researchers and the media about water issues in the past had either received stern queries due to misreporting. Rather, “consultations” (both formal and informal) were preferred as they were more flexible and allowed stakeholders to be more responsive by raising issues, asking essential questions and making suggestions that potentially shaped the content of this study. It gives experts the avenue to speak freely without being bound to a predetermined set of questions. What was critical in the application of this method was that the researcher needed to have an outline of issues that would shape the interaction and bring out the vital responses that would address the research questions and the objectives of the study.

Literature survey forms an integral part of this study. A systematic literature survey comprising the collection, analyses, and review of scholarly materials and grey literature on specific subjects was carried out during the study. In the first year, a robust literature database, which included vital topics such as sustainability, sustainable development, IWRM, and sustainable urban water management, among others was created. A reference database consisting of published journal articles, books, and other documents was created and constantly updated using the RefWorks and Zotero referencing programmes. A review of public records on water governance in the metropolis was carried out. This included, among others, NWP, IWRM Plan, and the WSSDP.

Direct Observation was a powerful instrument for gathering information in the research process. As a data collection instrument, the purpose was to observe what people do, listening and taking notes of what people said, analysing qualitative data and drawing deductions (Yin, 2009; Saunders, Lewis & Thornhill, 2009). Direct observation is one of the essential data collection techniques in case study research design for issues relating to attitude and behaviours (Saunders, Lewis & Thornhill, 2009). According to Saunders et al. (2009), proper observation of research activities and events can provide valuable data and enrich the research data. However, it requires significant input in terms of planning and organising to avoid unpredictable events that may unfold during the research observation process.

Survey of water users and government officials in the Accra Metropolis – In addition to data gathered using other methods, a survey of the Accra metropolis was conducted from July to September 2016. The survey targeted two key water stakeholders in the metropolis, namely government officials in water-related government institutions, including the GWCL, WRC, EPA, HSD and WRI, and urban residents who form the significant consumer bloc. For government officials, a list of senior officials from the various public water institutions was created. Before sending the forms to the identified officials, the survey guiding questions was tested to gather opinions on the content, its relevance, clarity and the reasonable duration for responding to the questions. Following a successful testing, an electronic version of the survey form was created and dispatched to the target officials. Later after a month and a half of waiting for responses from the officials, a printed version of the survey form was individually handed to officials who had not returned their completed forms. The responses provided by these officials were that of their views and perspectives. In addition to the answers provided on the survey forms, notes were taken by the researcher during the discussions with the officials and also cross-checked some of the information provided with available official documents.

The second survey targeted urban residents. Data and information asked for included among others, the availability and usage of potable water, water quality, water service coverage, cost and delivery, water management practices and the impact on access to water. The survey covered residents from five neighbourhoods in the Accra metropolis, namely, Nima, Airport Residential Area, Old Fadama, Abeka and Adenta. These residential areas were selected based on several characteristics, including their spatial planning and arrangements, water access, pipe network coverage and infrastructure, and their classification according to the AMA.

Nima is one of the most popular neighbourhoods in the Ayawaso East sub-metro area of the Accra Metropolis. It is an unplanned neighbourhood with a high population density and limited access to pipe-borne water in the majority of the households. The majority of residents in this neighbourhood are found to access water through communal standpipes, vendors or kiosks for selling water and water tankers.

Airport Residential Area, situated in the Ayawaso West sub-metro area of the metropolis is a well-planned neighbourhood in the city with well-established pipe network coverage and infrastructure. Water vendors, tankers and kiosks for selling water are absent in this particular neighbourhood due to regular and reliable piped water supply in the area.

Old Fadama is a typical informal settlement or slum which emerged as a result of the rising cost of accommodation in the metropolis. Located in the Ashiedu Keteke sub-metro area, it is characterised by temporary structures with no formal pipe network and connections in the area. The suburb has been in contention with authorities for evacuation and relocation over the past decade due to the poor standards of living, including lack of access to water, poor sanitation, insecure tenure arrangements and inadequate living space. The primary mode of water supply to the area is through water tankers, water kiosks and vendors.

Abeka is considered one of the oldest established but unplanned neighbourhoods in the metropolis. It is located in the Okaikoi sub-metro area. The suburb is adequately connected to the reticulation system but suffers occasional intermittent water supply. Other water services to the area included water tankers and community standpipe.

Adenta, found in the Greater Accra Metropolitan Area, has grown to become an integral part of the metropolis. The suburb is unique as it combined both well-planned and unplanned infrastructure. It has an extensive pipe network coverage, but for a long time, it has been one of the water-stressed areas with very inadequate water supply from GWCL and sometimes no water supply for several months. It is one of the areas where water tankers and vendor businesses have thrived for a very long time.

The use of survey proved to be very useful in collecting vital information at the lower level and incorporating urban resident's outlook on water issues in the research in addition to data obtained from other sources. Microsoft Excel was used to process the data and analysed data were presented in table, graphs and charts. Of the 75 survey forms sent to the government officials by mail, 35 completed survey forms were received. In addition to this, 24 completed forms were received from the one-on-one discussion with officials during the field visit. In total, 59 completed forms were obtained giving a response rate of 78.7%. These officials did not

participate in the discussions held on the learning platforms and so this survey provided vital additional information to the research. The total sample size of urban residents from the five selected areas in the metropolis was 250, with each suburb receiving 50 survey forms. Out of the 250 survey forms sent out, 168 were received giving a response rate of 67.2%.

The mixed-method approach has proven to be very useful in social science research, characterised by complex phenomena where existing data collection methods have certain limitations, and where deeper insights of research content are not always captured using quantitative surveys (Creswell, 2009; Creswell & Creswell, 2017). The combination of different research methods for data collection is useful for data triangulation as well as for gathering comprehensive data about a complex issue (Abowitz & Toole, 2009). In this research, a combination of methods to examine various aspects of urban water management and the water system in the Accra metropolis was employed because this approach provides stronger inferences and the avenue to present a wide range of divergent views. Using mixed methods for data collection brings confidence and impetus to the research results and has complementary strengths that reinforce the different methods applied.

3.4 Research process - Transdisciplinary research (TDR)

The TDR process offers a scientifically sound way of co-producing knowledge with society by combining science and real-life experiences to understand relevant problems (Lang, Wiek & von Wehrden, 2017; Weichselgartner & Truffer, 2015). It goes beyond the mono-disciplinary, interdisciplinary, and multidisciplinary modes of knowledge production to highlight the active participation of society in the processes of co-defining research problems, finding solutions and promoting mutual learning among scientists and stakeholders (Lang, Wiek & von Wehrden, 2017).

Three types of knowledge production are defined under the TDR process, namely system knowledge, target knowledge, and transformation knowledge (Hadorn, Pohl & Bammer, 2010; Pohl, 2011). System knowledge refers to knowledge about the existing systems and associated problems, for example, the urban water system and water deficit crisis. Target knowledge is about knowledge of what should happen or a desired sustainable future state; for instance, the prospect of water regimes exhibiting improved efficiency and adequately closing the supply-demand gap. Transformation knowledge denotes practical knowledge which details the transition from the current unsustainable situation to the desired sustainable state. An example is transitioning from inefficient and state-managed urban water systems to the desired condition characterised by improved water and sanitation service delivery and financial self-sufficiency.

It is not uncommon for researchers and stakeholders to identify what the problems are (system knowledge) and what the solutions ought to be (target knowledge). However, what has proven to be a challenge is the translation of knowledge into practices to effect change, which explains why transformation knowledge is often lacking as part of the outcomes of the TDR process. While this study aims at generating both system knowledge and target knowledge, the expectation is that transformation knowledge could also be produced in

the process of unravelling the water reform processes and co-defining interventions for urban water management practice through various methods.

This study aligns with the "three-stage conceptualised model" for the TDR processes developed by Lang et al. (2012) (figure 3.3). The model seeks to bridge the gap between scientific knowledge and societal practice through (i) The establishment of a collaborative research team and the co-framing of the problem (Phase A); (ii) The co-production of solution-oriented and transferable knowledge through collaborative research (Phase B); and (iii) The (re-)integration and application of knowledge produced in both societal and scientific practice (Phase C).

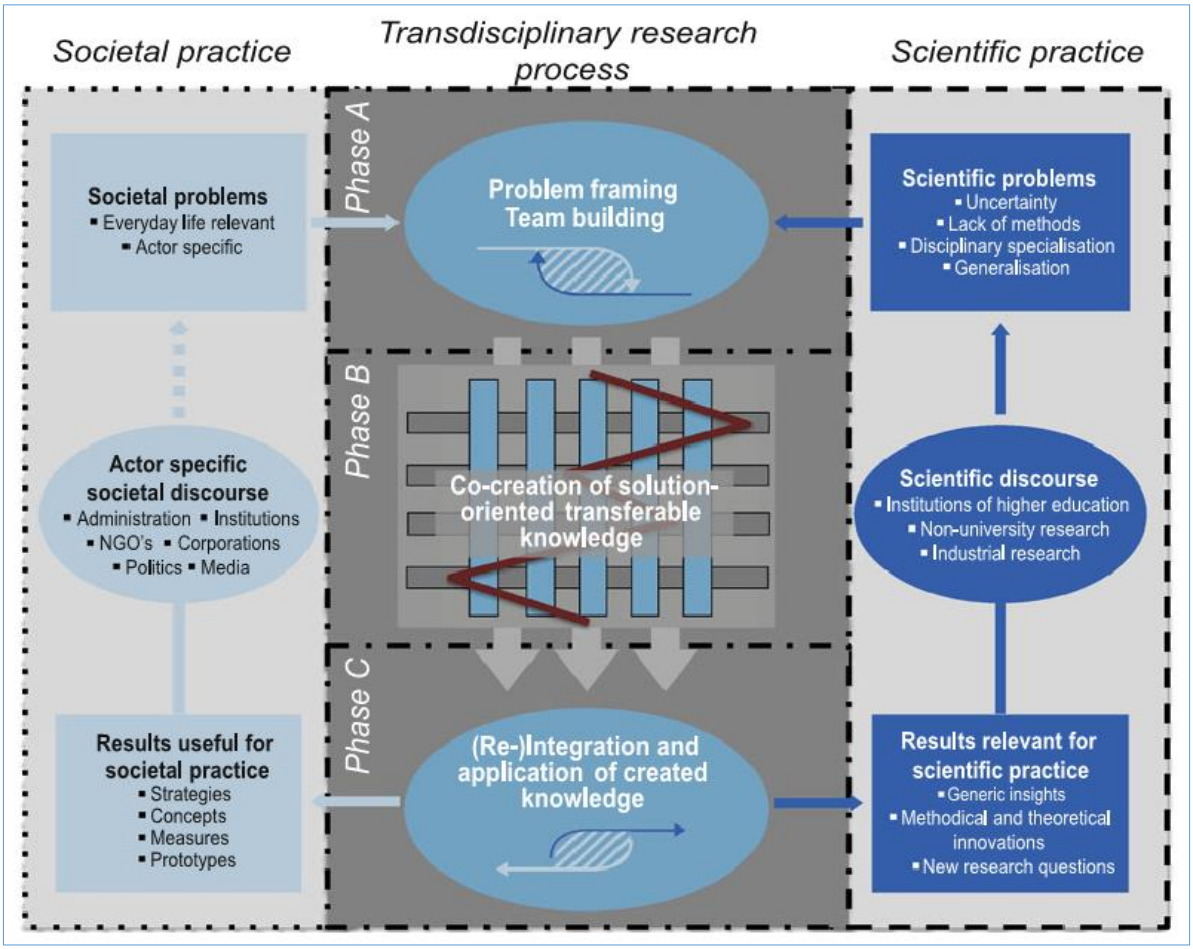

Figure 3.3 Conceptualised model of the idealistic transdisciplinary research process (Source: Lang, Wiek, Bergmann, Stauffacher, Martens, Moll, Swilling & Thomas, 2012)

Phase A entails the establishment of a research team consisting of different stakeholders who help steer the orientation and co-framing of the research process. It allows for the identification and definition of the real-world problem, joint formulation of research objectives and societally pertinent questions, and the shaping of the conceptual and methodological framework for knowledge integration. Unique to this phase is the translation of a real-world challenge into a boundary object that can be researched while we can integrate insights into societal practice and scientific knowledge (Clark, Tomich, Van Noordwijk, Guston, Catacutan, Dickson & McNie, 2011; Lang, Wiek, Bergmann, Stauffacher, Martens, Moll, Swilling & Thomas, 2012). The

intent here is to promote the integration of *a problem solution pathway* and the *scientific innovation pathway* to facilitate the implementation of collaborative research in Phase B.

In Phase B, the research implementation phase, the research team develops and applies a set of integrative (scientific) methods to promote the integration of the different bodies of knowledge assembled in the research process. Collaborative research ensures the dynamic interaction between researchers and stakeholders outside academia to co-create solution-oriented transferable knowledge (Lang, Wiek, Bergmann, Stauffacher, Martens, Moll, Swilling & Thomas, 2012). Essential at this stage of the research process is knowing who does what, the means, and to what end (Krütli, Stauffacher, Flüeler & Scholz, 2010). Therefore, defining the extent of stakeholders participating in the research process is vital (Stauffacher, Flüeler, Krütli & Scholz, 2008; Wiek & Walter, 2009). Phase C details the use, application, and implementation of the research results. This phase merges a mix of different worldviews, perspectives, values, and knowledge types into the research process to produce results that can be integrated into societal and scientific practices (Lang, Wiek, Bergmann, Stauffacher, Martens, Moll, Swilling & Thomas, 2012).

Even though the research process in this model seems rather linear, the individual phases are firmly connected and function in an iterative way through their sequencing, which allows for reflexivity (Fortuin & van Koppen, 2016; Palmer, Riedy, Fam & Mitchell, 2016). Guided by this model, different stakeholders were engaged in co-defining the research issues and objectives as well as the joint formulation of societally relevant questions through the learning platform in the Accra metropolis. This platform assembles different stakeholders from diverse backgrounds, including research, policymaking, academia, civil society, and urban water consumers.

3.4.1 TDR process in the case study of Accra metropolis

The TDR process can stimulate stakeholders to identify practical solutions to sustainable development and sustainability problems while producing knowledge and fostering social learning (Siew, Aenis, Spangenberg, Nauditt, Döll, Frank, Ribbe, Rodriguez-Labajos, Rumbaur, Settele & Wang, 2016). As emphasised earlier, it requires a well-coordinated collaboration among diverse stakeholders to co-frame the research problem, questions, and objectives; to co-produce solution-oriented knowledge and apply this knowledge in both societal and scientific practice. The various stages in the transdisciplinary research process are discussed.

a. Building a collaborative team and co-defining research problem

As an individual research project, building a collaborative research team with all relevant stakeholders during the initial stage of the research was not feasible. Instead, a learning platform was established to mobilise diverse water stakeholders from different water-related institutions, organisations and agencies in the Accra metropolis. Consistent with the goal of the TDR approach of producing knowledge with society, the learning platform is a well-established innovative platform that brings together different stakeholders from government agencies, research institutions, private sectors, civil society, and non-governmental organisations for participatory co-production of knowledge and consensus decision-making (Howe, Vairavamoorthy & van der Steen, 2011; Moreno-Leguizamon, Tovar-Restrepo, Irazábal & Locke, 2015).

The learning platform for the Accra metropolis was designed based on the national-level platform established by the Resource Centre Network (RCN), an institution that promotes knowledge management (KM) services within the water, sanitation, and hygiene (WASH) sector in Ghana. The underlying model of the platform is the learning alliance model. This model is characterised by multi-level institutional and multi-stakeholder processes that facilitate knowledge production through participatory research with society and attempt to translate knowledge outcomes from the research to practice (Verhagen, Darteh, Osei-Tutu & Adank, 2011).

The learning alliance model is grounded in the theory of change and premised on the assumption that different stakeholders from various disciplines on a platform can cooperate, learn, and share experiences in action-based research with society to develop innovative solutions that bring about lasting change. Such solutions could be applied to address multiple, interlinked problems that have proven difficult for a single group of stakeholders to solve and for which alternative options can address the risk and uncertainty (IRC & Triple-S, 2014).

b. Collaborative research for co-production of solution-oriented knowledge

An important consideration that could facilitate successful knowledge co-production in the TDR process is the active involvement and participation of all the various stakeholders. At the learning platforms in the Accra metropolis, a combination of methods, including survey, one-on-one consultations, pairing, and focus group discussions were applied. The process of engagement was carried out in three stages. First, a survey of participants at the platform was done using short unstructured questionnaires to collect individual opinions on the problems emerging from different levels and domains within the urban water sector. The use of the survey proved to a useful way of obtaining vital information from stakeholders who by nature would not express their opinions openly in the open session or small group sessions, perhaps due to among other factors the hierarchical relations (Ruiz, Dobbie & Brown, 2017; Siew, Aenis, Spangenberg, Nauditt, Döll, Frank, Ribbe, Rodriguez-Labajos, Rumbaur, Settele & Wang, 2016).

During the second stage, a focus group discussion was carried out. Four groups, each group made up of five participants from different water-related institutions interacted with each other and extensively discussed the issues related to the research. Next, at the same stage, participants were asked to switch groups and interact with more participants from different groups to increase acquaintance, generate more ideas and promote learning and knowledge sharing among stakeholders. The third stage entailed pairing participants to undertake a brainstorming session followed by an open discussion about the outcomes of the pairing session. This stage was particularly revealing as it brought out differing views in a way that enriched the discussions and also shaped the direction of the discussions on the learning platforms.

c. Knowledge integration and application

By recognising that the urban water system is an integrated system, the need for a transdisciplinary way of thinking about the complex nature of management issues within the water system is brought to light. In the transdisciplinary settings, several methods to facilitate stakeholder involvement and collaborative knowledge integration, including focus group discussions, stakeholder dialogue, visits to relevant institutions, and one-on-one consultations were used. The combination of the methods allowed the integration of a wide array of

perspectives from multiple sources, including groups and individuals. On the other side, I had the opportunity to present the outcomes of the transdisciplinary research process as well as the knowledge synthesised with the various stakeholders.

3.4.2 Outcomes of the TDR process in the Accra metropolis

In this TDR process, four research methods, including focus group discussions, pairing, one-on-one, and questionnaire surveys have been employed to support the integration of stakeholder knowledge in co-identifying research problems and questions around urban water management as well as co-defining strategies for supporting water management practice in the Accra metropolis. The integration of the diverse knowledge types (system, target and transformation) in the transdisciplinary research was supported by the learning platform that facilitated the active engagement and participation by stakeholders. In this section, the outcomes of the TDR process conducted in the metropolis from July 2015 to June 2016 are presented.

At the proposal development stage of this research, a 2-hour preparatory learning platform was organised, which allowed extensive engagement with a wide array of key stakeholders from various water-related institutions. From this platform, an active network made up of participants from the various agencies and organisations was established. The entities included the MSWR, WRC, GWCL, PURC, AMA, UG, NDPC, WRI, IWMI, SNV, ISODEC, WUAs, WaterAid Ghana, Plan Ghana, Water Citizens Network, and Water Tankers Association (WTA). Participants came from different institutions with various professional backgrounds with different expertise and experience in the urban water sector. In Table 3.3, a list of agencies and organisations whose participants took part in the learning platform and the study.

Category of stakeholders	**Institutions**	**Role in the TDR process**
Government Agencies	● Water Directorate (Ministry of Water and Sanitation)	Provided insights into water policy development and implementation
	● Water Resources Commission	Provided insight into water resources regulation and management and implementation of the water resource management strategic plan and granting water rights
	● Ghana Water Company Limited	Provided data and additional input
	● Public Utility Regulatory Commission (PURC)	Provided insight into the review and approval of tariffs as well as monitoring the GWCL
	● Ghana Statistical Service (GSS)	Offered statistical information
	● Ghana Standards Authority (GSA)	Provided insights into the standard of drinking water
	● Water and Sanitation Monitoring Programme (WSMP).	Provided information on the status of water and sanitation projects, policy-making engagement

		and citizen involvement in urban water governance
	● Accra Metropolitan Assembly	Provided insight on the status of the Accra metropolis
	● Environmental Protection Agency (EPA)	Provided insights on environmental issues around urban water management
	● National Development Planning Commission (NDPC)	Provided insights on the development planning in the Accra metropolis
Research Institution	● Water Research Institute (WRI) ● International Water Management Institute (IWMI)	Provided scientific input into the discussion
Academia	● Kwame Nkrumah University of Science and Technology ● University of Ghana ● University of Cape Coast ● University of Development Studies	Provided academic and scientific input to the discussions
Private Sector	● Zoomlion Ghana Limited ● Coca Cola Bottling Company ● Voltic Ghana Ltd	Provided insights into wastewater and sanitation Provide a private sector perspective on bottled and sachet water
Non-Governmental Organisation	● WaterAid Ghana ● Care Ghana ● Plan Ghana ● Catholic Relief Services ● Water Citizens Network ● The Integrated Social Development Center (ISODEC)	Advocate for improved urban water sector as well as citizen involvement in water governance
Civil Society Association	● Coalition of NGOs in Water and Sanitation ● Water Tankers Association ● Sachet Water Producers Association Ghana ● Water Users Association (WUAs)	Provided insight about citizen involvement in key water governance roles in the delivery of goods, services and works in the water sector
International Development Agencies (IDAs)	● The World Bank ● United States Agency for International Development (USAID) ● French Agency for Development (AFD) ● Danish International Development Agency (DANIDA) ● GIZ ● SNV	Contributed to the discussion on the development of the urban water sector and their strong influence at the policy level

Table 3.3 Different stakeholders involved in the TDR process (Source: Author's construct)

In this preparatory learning platform, the current status of the management of water resources in the metropolis was examined. The process provided rich and diverse views from participants that would eventually inform the various topical issues identified in the metropolis. The composition of a team of key stakeholders helped shape the initial ideas of this research by providing information on local water problems and formulating research questions based on the discussions on the current context. By doing this, the research objectives were redefined taking into consideration the needs and research demands of the stakeholders in the metropolis during the initial stage of the research. The involvement of various stakeholders at the preparatory phase of the study created a sense of profound association and entitlement as the outcomes of the intense interactions among stakeholders substantially shaped the direction of the study.

Next, on the preparatory platform, participants were engaged in an open discussion on general water issues in the Accra metropolis. The purpose was to set the platform for an in-depth conversation on specific topics related to this study. The next step involved setting up a focus group discussion with each group consisting of five participants from the different stakeholder categories. The small groups were made up of five participants who interacted with and extensively discussed the issues in this research. This stage provided an opportunity for participants to switch groups and interact with more participants from different groups to generate more ideas and promote learning and knowledge sharing among stakeholders. In each group, the assignment for participants was to identify at least three essential water issues in the metropolis that were relevant to the context of this research. A total of 15 water issues were defined and later trimmed down to 12 interrelated topics that would form the discussion topic at the learning platform over 12 months (July 2015 to June 2016) (Table 3.4).

No.	**Month**	**Identified issues in the Accra Metropolis**	**Number of participants**
1	Jul-15	Urban water system and management challenges	20
2	Aug-15	Political, economic, social, and environmental realities of urban water management	20
3	Sep-15	Drivers of water management interventions and reforms in the Accra Metropolis	19
4	Oct-15	Multi-level dynamics of urban water management transitions	20
5	Nov-15	Stakeholders at the centre of water management reforms	20
6	Dec-15	Evaluating water management practices and options in the Accra metropolis	20
7	Jan-16	Framework for sustainable management of water in the Accra Metropolis	18
8	Feb-16	Defining indicators for urban water management	20
9	Mar-16	Options in urban water management	20
10	Apr-16	Strategic planning for urban water management practice	20
11	May-16	Envisioning the sustainable management of water resources	18
12	Jun-16	Knowledge development and information management for SUWM	19

Table 3.4 List of identified topics for discussion on the learning platform (Source: From discussions on the platform)

After the preparatory platform, twelve learning platforms (one per month) were set up to deliberate on the identified topics where each discussion lasted two hours on average. The number of participants per platform ranged from 18-20 persons with at least one representative from the different stakeholder categories identified in the water sector. Participants included mid-level and senior-level officials and the representation of each stakeholder category varied on each platform depending on the specific water topic for that particular platform. The list of water issues identified for deliberation was circulated widely within the urban water community in the metropolis. Invitation letters were sent to all institutions requesting them to nominate representatives who could participate meaningfully in the discussion on the platforms and share their perspectives on the various issues outlined. Invitation letters were sent to all water institutions regarding the schedule of the learning platform and the period for discussion for each topic defined. The rationale for co-defining issues with stakeholders was not only to get their perspectives but to help them get a clear understanding of the research so that they can give clear responses.

3.4.3 Analysis of stakeholder categories on the learning platform

A total of 234 professionals, policymakers and practitioners participated in the discussion on various water topics that were co-defined on the learning platforms during the 12 months. The number represents approximately 20.8% of the total number of stakeholders in the water sector in the Accra metropolis. It is also a statistically significant representation of stakeholders that can contribute effectively to water management decision-making in the metropolis. These participants consisted of mid-level and senior-level officials from government, research institutions, academia, the private sector, non-governmental, civil society and development agencies representing the seven stakeholder categories. Figure 3.4 shows the proportion of the various groups of stakeholders involved in the discussions on the learning platform from July 2015 to June 2016. The analysis showed that representatives from non-governmental organisations accounted for the highest proportion of participants (17%) on the learning platform over the entire period. Civil society groups and government agencies accounted for 16.24% and 15.81% respectively. The least proportion of participants was representatives from development agencies. Overall, all the various stakeholder categories were well-represented on the learning platform.

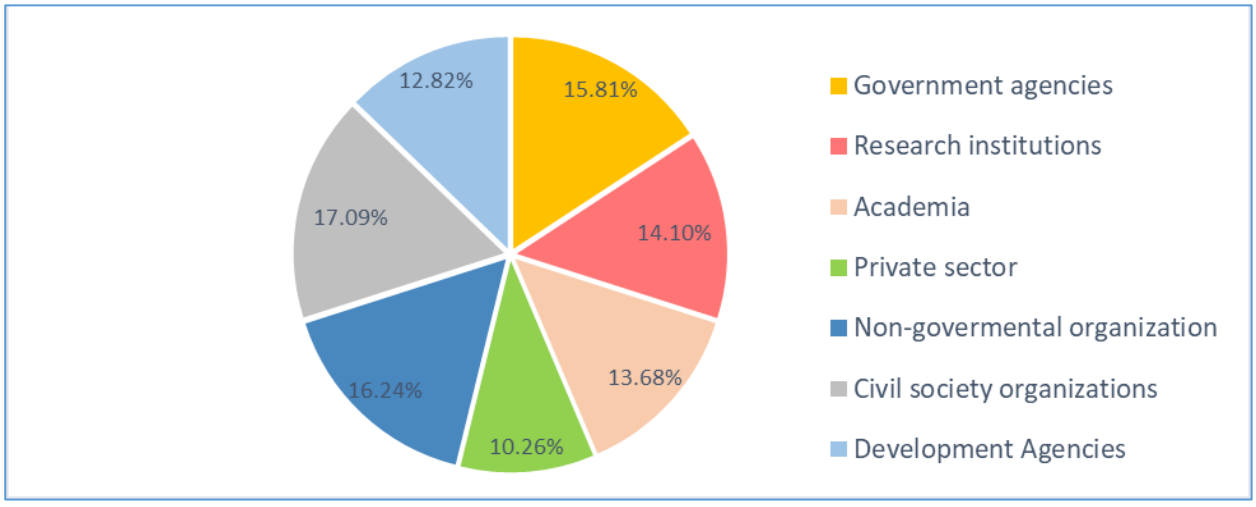

Figure 3.4 Proportion of stakeholder representation on the learning platform in the Accra metropolis (Analysed data)

3.4.4 Disciplinary backgrounds of stakeholders

Figure 3.5 presents the distribution of participants from different disciplinary backgrounds. The highest proportion of participants (18%) on the platform were participants with management disciplinary background, followed by participants with a sociology background at 15% and hydrology background at 12%. Other disciplinary backgrounds of participants included policy (11.5%), water environment (10.2%), engineering (9.8%), and planning (9%). Participants with backgrounds in Chemistry and Economics were least represented on the platform with percentages of 6.5% and 7.8% respectively.

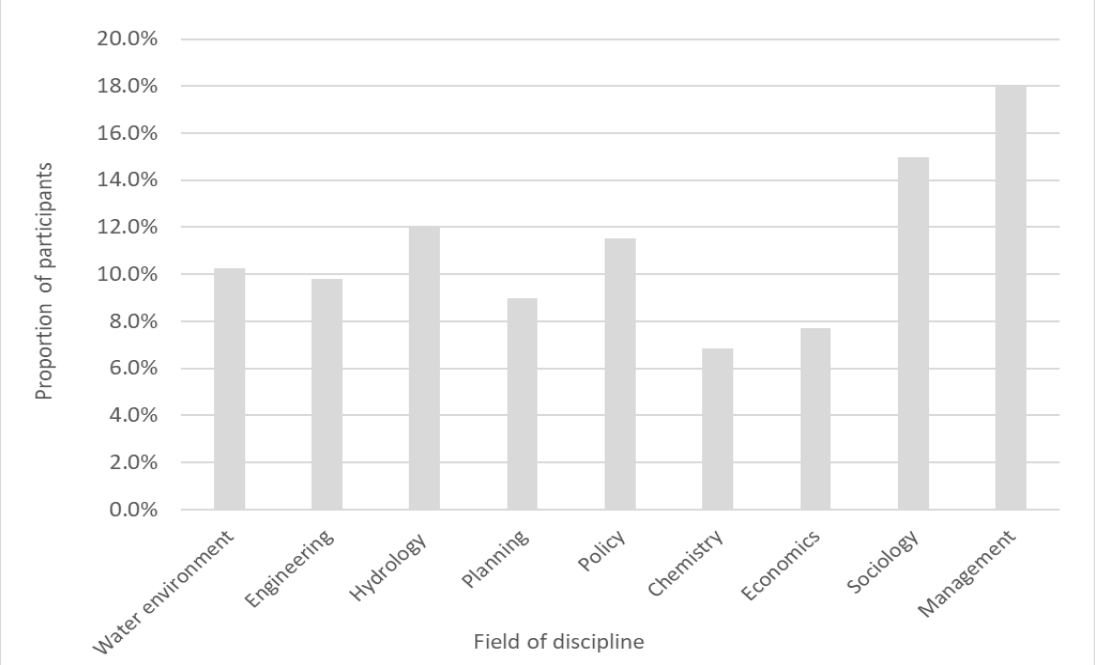

Figure 3.5 Percentage of stakeholders in various disciplines (Analysed data)

3.4.5 Stakeholder representation on water issues on the learning platform

In this section, an analysis of the different stakeholder categories that participated in the discussion on the various research issues on the learning platform over the 12 months is presented. The study showed a changing pattern in the number of participants from each stakeholder category depending on the type of topic under discussion on the platform for a particular month. Within the government agency, the number of representatives per platform ranged from 2 to 4 participants. These officials came from different agencies with diverse disciplinary backgrounds with interest on particular issues. For example, some topics attracted a high number of government representatives to the learning platform – "drivers of water management interventions and reforms in the Accra metropolis" (September, 2015); multi-level dynamics of urban water management transitions (October, 2015); "stakeholders at the centre of water management reforms" (November, 2015); and "strategic planning for urban water management practice" (April, 2016). An important observation on the

learning platforms was the high level of diversity of disciplinary background of professionals from government institutions. For example, on the September 2015 platform where we discussed the "drivers of water management interventions and reforms in the metropolis", government representatives included a planner, environmental scientist, water engineer, and systems analyst from the Ministry of Water and Sanitation, WRC, GWCL and PURC respectively. Coincidentally, this particular set of professionals/ experts were involved in the urban water reforms and management transitions in the metropolis and this put them in an excellent position to provide relevant and diverse perspectives on the issue on the platform. In the November 2015, for the discussion on "stakeholders at the centre of water management reforms", government representatives included policy analyst from the MSWR, integrated water management specialist from WRC, transboundary river basin expert from the WRC and social scientist from the PURC.

Another dominant and active category of stakeholders was the civil society with participants ranging from 2 to 5 people per platform. Participants from non-governmental organisations ranged from 2 to 4 people per platform. In July 2015, the discussion on "urban water system and management challenges" attracted the highest number of participants (5) from civil society. Other topics that attracted high numbers of participants from civil society included political, "economic, social, and environmental realities of urban water management" (4); "stakeholders at the centre of water management reforms" (4); and "strategic planning for urban water management practice" (4).

Surprisingly, the least number of participants (2) from civil society showed up on the December 2015 the topic on "evaluating water management practices and options in the Accra metropolis" was discussed on the learning platform. Generally, civil society stakeholders exhibited a high level of participation in discussions on all the platforms because they wanted to have a say in decision making. For example, on the first issue about the urban water system and management challenges, five participants from that civil society strongly argued that the lack of effective consultations and active participation of low-level stakeholders hindered water managers from having a broader view of water problems. They voiced out their strong opposition against the top-down (hierarchical) approach that was inherent in urban water management reform processes. Details of such grassroots opposition to decisions on the water management reforms in the metropolis are presented in the next chapter.

From the non-governmental organizations (NGOs), the highest number of participants (4) on a platform came during the discussions on "political, economic, social, and environmental realities of urban water management"; "stakeholders at the centre of water management reforms"; and "strategic planning for urban water management practice". The least participation from this stakeholder category was observed during the discussion on "multi-level dynamics of urban water management transitions". Similar to civil society stakeholders, NGOs had a loud voice on governance, access and equitable allocation of urban water and sanitation, especially for deprived urban communities in the Accra metropolis. For a long time, NGOs had stood in the gap between the government policies on urban water and the plight of low-income densely populated communities in the metropolis, advocating for broader coverage and access to affordable potable water. Through empowerment and capacity development activities in low-income communities, NGOs

spearheaded the formation of civil society groups such as urban water user's associations (WUAs), water tankers association, and the coalition against the privatisation of urban water supply. They also aimed at strengthening their participation in urban water governance as well as negotiating with the GWCL for community standpipes, water vendors and kiosks in deprived communities. A typical example of the strong influence of NGOs and one such coalition was the strong opposition against urban water privatisation as part of water reforms in the metropolis and the country at large. The dynamics of the changes and the impact of NGOs and civil society groups on the management transitions in the metropolis is elaborated in Chapter 4.

Two stakeholder categories that were instrumental during the discussions on the learning platform were the academia and research institutions. For academia, the number of participants on the platform ranged from 2 to 4 persons. Generally, we had a fair representation from academia on all the platforms. Participants came from diverse sub-disciplinary backgrounds including environmental engineering, hydrology, integrated water management, water resource engineering, environment and health, wastewater pollution and sanitation, watershed conservation and management, civil engineering, social anthropology and politics, water science and environmental science. The highest representation on the platform occurred during the discussion on "evaluating water management practices and options in the Accra metropolis" (4) and "defining indicators for urban water management" (4). The active participation in discussions on these particular issues, according to participants was due to the growing interest to understand the underlying factors that would contribute to the successful implementation of alternative water management options and the need to define appropriate and context-specific indicators that could be used to evaluate water management options in the metropolis.

On the topic "defining indicators for urban water management" (February 2016), the participants had the following disciplinary backgrounds: watershed conservation and management (4), water science (5) and environmental science (4), integrated water management (3), wastewater pollution and sanitation (4). Inputs from the mix of participants with diverse backgrounds and experiences in the water sector provided useful information for identifying and defining the appropriate indicators for water management in the metropolis. The outcomes of the discussion on this particular topic would influence the identification and selection of indicators for assessing water management in the metropolis (Chapter 6). Participants on the platform that discussed "stakeholders at the centre of water management reforms" had the disciplinary backgrounds in integrated water management (5), water resource engineering (3), water science and hydrology (4) and social anthropology (4), and political geography (4). The interactions among these disciplines provided a blend of perspectives that would inform the development of strategic pathways and options for SUWM practice in the metropolis (Chapter 7).

Representatives from academia had at least three participants on each platform of the four platforms, namely – October 2015 on "multi-level dynamics of urban water management transitions"; January 2016 on "framework for sustainable management of water in the Accra metropolis"; March 2016 on "Framework for sustainable management of water in the Accra metropolis"; and June 2016 on "knowledge development and information management for SUWM". During the discussions, it came out that the high patronage of

representatives from academia might be due to the shift from conventional research to participatory action research that engages multiple people with diverse disciplinary backgrounds on a subject matter.

The last stakeholder category was the IDAs who mainly contributed to the governance, infrastructure and management reforms in the water sector through financial contribution and advocacy. The group consisted of organisations including the World Bank, IMF, USAID, AFD, DANIDA, GIZ, and SNV. Participants on the platforms from this category ranged from 1 to 4 people per platform which was generally a good representation. The highest number of participants (4) on the platform came on August 2015, on the topic "political, economic, social, and environmental realities of urban water management" while the least patronage of 1 person occurred on February 2016 in "defining indicators for urban water management practice". On the remaining platforms, the number of participants ranged from 2 to 3 people per platform. Development agencies have played a key role in urban water development over the years. They have contributed substantial funding for the development of urban water infrastructure and governance. For example, the French Development Agency financed the development of the WSSDP in 2012 while DANIDA provided a significant funding for the water and sanitation sector in the Greater Accra Region in 2003 (Osmanu, Abdul-Rahim, Songsore, Braimah & Mulenga, 2010; Songsore, 2008; Songsore, Alhassan, Avle, Amponsah, Kala & Chama, 2014). However, some stakeholders argued that such contributions from IDAs have sometimes evolved into a strong influence and dominance in steering the decision-making process in the urban water sector. This, among other issues, has informed the rise of civil society groups who are sceptical about the real intentions and have resisted initiatives or reforms driven by development agencies. A discussion on the rise of civil society stakeholders and the resistance to urban water management reforms in the metropolis is presented in Chapter 4.

3.4.6 Challenges of TDR application

Research work underpinned by joint-framing of research questions, objectives and co-production of knowledge is relatively new with no one-size-fits-all model to follow. In the Accra metropolis, the first significant challenge the researcher experienced in pursuing the TDR process was the establishment of a collaborative research platform on which different stakeholders from different institutions, diverse areas of knowledge, interest and different cultures converged to discuss water-related issues in the metropolis. Each institution represented on the learning platforms had a specific mandate and a different understanding of the water issues based on their organisational cultures and mandates. Also, salient are the different perspectives and values held by the various stakeholder categories on how urban water management problems may be framed and addressed.

Another challenge associated with the TDR had to do with how to establish a legitimate collaborative team of stakeholders by preventing underrepresentation, overrepresentation and dominance of certain categories of stakeholders who participated in the TDR process. Dealing with this challenge means being circumspect in the selection of representatives from all the stakeholder categories. The first step the researcher took was to carry out a thorough stakeholder analysis in the urban water sector drawing on the participants' list prepared during

the national water workshops, forums, and conferences as well as visits to water-related institutions in the Accra metropolis. After the analysis, the next step was an attempt to balance the composition of participants on the platforms based on the different categories of organization, including – research institutions, private sector, government agencies, non-governmental, civil society and development agencies as well as a mix of senior-level and mid-level positions to get both perspectives (managerial and operational) based on their roles.

Another challenge was the effort to increase the level of stakeholder participation and interactions at the initial stages of the study. Beyond the balancing and legitimisation of the stakeholders' group, the initial engagement and active participation of stakeholders during the TDR process proved to be challenging. According to multiple studies, this challenge is not uncommon in the TDR research (Hoffmann, 2016; Reed & Abernethy, 2018; Renner, Schneider, Hohenwallner, Kopeinig, Kruse, Lienert, Link & Muhar, 2013). According to Renner et al. (2013), the lack of mutual trust among scientists and society and the lack of interest are two factors that are likely to account for the decline in stakeholder participation. In the case of the Accra metropolis, water and access to it have become a politically sensitive issue based on which politicians can lose or win elections and so experts will only open up to discuss water issues when they are familiar with the researchers. To address this challenge, a disclaimer note to associate individuals with the responses from the platforms became necessary. The researcher also conducted a personal inquiry on the platform to build trust and acquaintance among all the stakeholders to make participation smooth. On each platform, the first 10 minutes used to discuss the trending issue in the news, mostly unrelated to water issues, example football, public goofs on television, and global politics, among others. It was interesting to note that this brief process helped create a pleasant atmosphere for interactions among participants as well as stimulated participants to actively participate in the substantive issues.

3.5 Sources of data

The study collected mainly qualitative data, but also some quantitative data, from both primary and secondary sources. The rationale for choosing multiple data sources is to ensure the study gathers a wide range of data that address all the research questions and objectives of the study. In this regard, the study employed focus groups, literature review, stakeholder dialogue, and survey questionnaires to collect data. A broad range of secondary data sources were consulted, including project reports, policy documents, annual reports, project proposals, contract agreements, memoranda, minutes of meetings, newsletters, press releases, documentaries, and workshop proceedings from public sector institutions, including the MSWR, GWCL, WRC, PURC, GSS, and WSMP. The study collected additional data on different modes of water service delivery, water consumption patterns, and different users from multi-country large-scale water projects such as the SWITCH project. Other Non-Governmental Organisations including ISODEC, CONIWAS, NCAP represented good sources of information on water governance. Furthermore, the study captured data on the politics of reform, privatisation, and decentralisation of the urban water supply from the document repository of the World Bank and the IMF.

Focus groups and stakeholder dialogue have proven to be effective methods of generating and deploying knowledge to better influence water policy, governance, and practice (Howe, Vairavamoorthy & van der Steen, 2011; IRC & Triple-S, 2014; Moreno-Leguizamon, Tovar-Restrepo, Irazábal & Locke, 2015). Information obtained from this platform in the Accra metropolis included the status of urban water supply and demand, stakeholders and their roles and interests in water management, water management reforms, governance, and strategies, water management transitions and implementation outcomes, urban water system performance, strategic future planning, political socio-economic and environmental factors influencing water supply and distribution. One-on-one consultations with experts from several water agencies were conducted to collect additional primary data. The one-on-one consultation complemented data collected from the focus groups, stakeholder dialogue and literature survey.

3.6 Data analysis

A seven-stage process of qualitative and quantitative data analyses within a mixed-method framework provided by Onwuegbuzie and Teddlie (2006) was adopted. These included data reduction, data display, data transformation, data correlation, data consolidation, data comparison, and data integration. In Table 3.5, a detailed description and application of each stage in both qualitative and quantitative data analyses are presented. According to Blaikie (2003), the goal of data processing and analysis was to produce the appropriate responses to research questions or to examine the hypotheses posed by the research. Data processing and analysis entailed bringing all the data collected for processing – arranging, organising, transforming, categorising, coding, interpreting, and validation for presentation and drawing conclusions (Batty & Marshall, 2009). This aspect of the study is critical for creating meanings and drawing conclusions as unprocessed data and information do not automatically translate into outcomes.

Stages in the mixed methods data analysis process	**Description of each stage**	**Application in qualitative data analysis**	**Application in quantitative data analysis**
1. Data Reduction	Reducing the dimensionality of the qualitative and quantitative data	Through exploratory thematic analysis	Through exploratory factor analysis, descriptive statistics and cluster analysis
2. Data Display	A pictorial description of both qualitative and quantitative data	Using matrices, charts, graphs, networks, lists, and Venn diagrams	Using tables and graphs
3. Data Transformation	Transforming either qualitative or quantitative data depending on the kind of interpretation	Qualitative data are converted into numerical codes to be represented statistically	Quantitative data are converted into narrative data to be analysed qualitatively

4. Data Correlation	Establishing the linkage between qualitative and quantitative data	Qualitative data is correlated with quantitative data	Quantitative data is correlated with qualitative data
5. Data Consolidation	Both qualitative and quantitative data are combined to create new or consolidated variables		
6. Data Comparison	Involves comparing data from both the qualitative and quantitative data sources		
7. Data Integration	At this final stage, we integrate both qualitative and quantitative data into either a coherent whole or two separate sets of coherent wholes		

Table 3.5 Seven steps in the data analysis process (Source: Onwuegbuzie & Teddlie, 2003)

Data reduction entailed the reduction of the dimensionality of the qualitative data through, for example, exploratory thematic analysis and quantitative data through descriptive statistics and cluster analysis. The rationale was to transform the data into meaningful information from which the study could conclude. Data display provides a pictorial description of the qualitative data through, for example, charts, and graphs and quantitative data using tables and graphs. At the data transformation stage, some qualitative data were converted into quantitative results using a five-point Likert scale. At the data correlation stage, quantitative data correlated with qualitative data and vice versa to validate the result of the study. The data consolidation stage entails the combination of both quantitative and qualitative data to create new or consolidated data sets. At the data integration, both quantitative and qualitative data were integrated to form a coherent whole in the interpretation of the results and discussion.

3.7 Research limitations

The research process, particularly during the data collection stage, faced some challenges typical of a literature survey, focus group discussion and one-on-one consultation. The urban water sector, following the introduction of institutional and management reforms, remains a contentious sector due to multiple interests, and disagreements among different stakeholders. Therefore, as a researcher, several hindrances, (during the search for data) including data scarcity, restricted data, vague responses on data, and bureaucracies in accessing data in the public sector were encountered. There was some level of restriction in an effort to obtain a more recent urban water data from the GWCL due to unproven suspicion and apprehensiveness among staff. It became evident that there was a long-standing suspicion between researchers seeking for data and public officials due to lack of trust and some assertions of misreporting of data that had landed some staff in trouble. This situation was the case of the Accra metropolis where sweeping institutional reforms and structural changes have occurred against the backdrop of investigations, data collection and performance assessments conducted in the water sector. Most public or government officials were extremely wary of formal interviews, mainly

when such interviews could expose their positions and roles. As a researcher, it was necessary to devise an innovative way of engaging key stakeholders, in particular, public officials to obtain data and information. A strong network with representatives from the various institutions was established through invitations to some officials as guest speakers to workshops, seminars, and conferences. Also, the application of a mixed-method approach helped widen data capture net as well as triangulate the data collection methods.

3.8 Conclusion

In this chapter, the research methodology that underpins this study was expounded. The political ecology theory was defined as the theoretical framework that guided this study. It allowed the study to explore the interactions between the urban water system and the environment in which political and economic interests, power relations, and social actions shape the urban water management realities in the metropolis.

The TDR process was employed as a collaborative and integrative research process that supports the co-production of system knowledge, target knowledge, and transformation knowledge among researchers and stakeholders. Fundamental to the operationalisation of the TDR process was the establishment of the learning platform that brought together diverse stakeholders for dialogue and deliberations on water issues in the Accra metropolis. On the platform, the knowledge, expertise and perspectives of the various stakeholders were taped to identify water issues and formulate solutions for dealing with the water management problems in the metropolis. This approach has proven to be a successful model for facilitating an urban water paradigm shift, with examples in several cities, including Alexandria, Cali, Bogota, Tel Aviv, Lima, and Zaragoza (Howe, Vairavamoorthy & van der Steen, 2011). The platform provided a unique opportunity for various participants to share valuable input and also to gain a new perspective about other institutions represented on the platform.

Lang et al. (2012) pointed out the importance of incorporating different perspectives of knowledge from various related disciplines and diverse stakeholders in the research process to provide a more rounded analysis and solutions to complex sustainability problems. They argued that solving problems through collaborative work among various stakeholders offers increased legitimacy, ownership, and responsibility for the problem and solution choices. The study took into account multiple dimensions, perspectives on water management in the metropolis, and how these perspectives translated into reality. The application of a combination of research design, approach and methods with different linguistic and conceptual attributes provided a suitable way to understand and analyse the issues at stake which the study seeks to address.

Chapter 4: Urban water management transitions in Accra metropolis

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4.1 Introduction

Over the past two decades, the water system in the Accra metropolis has been under pressure to provide sufficient water to meet the rising water demand from both the domestic and commercial sectors. This situation has upset the balance between supply and demand in the metropolis. As the metropolis continues to urbanise and expand beyond its boundaries, we see dynamic changes in the economic development, demography, environmental conditions, and the emergence of various forms of social and institutional interactions at multiple levels, which could deepen the complications surrounding the supply and demand for water in the metropolis. Such complications according to Piña & Martínez (2014) may also trigger asymmetric water use patterns that could increase the risk of water resource depletion, negative ecological impact and threaten efforts towards the sustainable management of water resources.

In an effort to address the growing water management challenges, the GoG in the early 2000s began the process of reforming the water sector. As an essential part of the reform, the government started the preparation to privatise the urban water sector. The privatisation of urban water was mooted in the early 1990s as a response to challenges confronting the public water entity to provide good quality water service and efficiently manage the water system (Amenga-Etego & Grusky, 2005; Yeboah, 2006). Proponents of the water privatisation idea argued that it could lead to a financially stable water entity capable of improving the efficiency of the water system as well as the quality of water service delivery in the country (Agyeman, 2007; Ainuson, 2010). In the Accra metropolis, the goal of water privatisation was to establish a financially self-sufficient water system that was able to ensure sustainable water service delivery.

By 2006, the government had entered into negotiation with a competitively selected private water entity called the Aqua Vitens Rand Limited (AVRL) for a five-year management contract (2006-2011) to extend water infrastructure, increase revenue collection, reduce NRW loss and improve water service delivery among other outcomes. Despite the good intentions, water managers have not been able to realise the intended goal of establishing a self-sufficient water system capable of addressing the socio-economic challenges - such as the growing domestic and industrial water demands, wastewater management and recurrent flooding in the metropolis. The low successful outcomes have prompted the call for water managers and policymakers to rethink how the reform processes were structured and the settings within which the city implemented interventions. It has also provided the opportunity for water stakeholders to take a step back and dig deeper to

understand the dynamics of the urban water system, the driving forces, underlying factors, and interactions at different levels that hindered the process of implementation.

Knowledge of the dynamics, factors and realities in the metropolis could perhaps provide better insights into how to frame and implement future water management interventions in the metropolis. It could also reveal the conditions or context within which interventions can potentially achieve more favourable outcomes. The central questions of this chapter are as follow: What are the economic, technical, social and environmental realities and institutional dynamics in the water system? How did these realities prompt water reforms and transitions in water management in the metropolis? Specifically: (1) what are the critical water management challenges confronting the metropolis? (2) what are the political, economic, social, and environmental realities in the metropolis? (3) What are the multi-level drivers and dynamics of the water management transition in the reform process? and (4) what are the limitations of the reform process in the metropolis?

In this chapter, a multi-level perspective (MLP) analytical framework is employed to analyse the water management transition dynamics in the Accra metropolis at three levels of interactions between social, economic, political and environmental realities, namely – the “regime”, “niche" and “landscape” levels (Geels, 2010) (more details on these conceptualised levels of analyses are provided in section 4.2). This mode of analysis helps describe the struggle of the city to deliver adequate water and sanitation services, and why interventions implemented could not help achieve a self-sufficient water system. It also helps to provide a better understanding of the systemic pressures and struggles faced by the government and related agencies (regime actors) as they adopted policies prescribed by multilateral organisations such as the International Monetary Fund (IMF) and the World Bank (Landscape actors).

In developed economies, the application of the MLP framework has mainly focused on socio-technological configurations, where transitions from the status quo occur as a result of innovations, new ideas, alternative technologies and social practices (Van der Brugge, 2009; Van Ewijk, 2013; Whitmarsh, 2012). Here, there is less emphasis on the politics inherent in interactions and processes within existing systems (Lehtonen & Kern, 2009; Meadowcroft, 2011). In this chapter, the MLP is adapted to the urban context in a developing economy with less technological or engineering emphasis by looking into the socio-political processes that influence the water management transitions in the metropolis. The study aims to bring a novel perspective on managing transitions in the developing country context where politics play such a fundamental role in the implementation of water management reforms. The power relations inherent in water management that produce an unjust and uneven urban water environment in the metropolis is also discussed. In the next section, details about the description of the application and critical review of the MLP are provided.

4.2 Multi-Level Perspective (MLP)

The Multi-Level Perspective (MLP) was first developed by Rip and Kemp (1998)) and conceptually expounded by Geels (Geels, 2011, 2012). It provides a basis for understanding the dynamic patterns of how policies, powers, actors, technology, politics, economics, and culture are interlinked and interconnected within

a socio-technical system, and affected by broader external processes. It distinguishes three levels of analysis, namely, the regime, landscapes, and niche levels (Geels, 2010, 2011).

At the regime level, events and their outcomes may be determined by rules, social norms, belief systems, market preference and dominant practices that underlie strategies of companies, organizations and institutions and policies of political institutions that are often meant to preserve the status quo, constraining flexibility and opportunities for radical change (Smith, Voß & Grin, 2010). Here, events are stabilised by lock-in mechanisms such as sunk investments in infrastructure, machines, favourable subsidies and regulations, institutional commitment, power relations, and political lobbying (Geels, 2012; Whitmarsh, 2012). From the multi-level perspective, the existing regime is challenged, from the top, by external landscape factors and, from the bottom, by social networking arising through the niche. In the case of the Accra metropolis, the regime incorporates the state-managed externally funded water sector and related policies, institutions, and structures at the national level, which together define the nature of water management and the provision of water services in the Accra Metropolis.

At the micro-level, the niche represents a protected space for innovations. These innovations are created by a small social group of actors who believe in the potential of their novelties to influence or even replace existing regimes (Geels, 2011; Van der Brugge, 2009). Breakthroughs in innovation at the niche level are facilitated by the landscape through pressures mounted on the existing regime, thus offering avenues for innovations (Geels, 2011). In the water system of Accra, the niche refers to networks of activists, social groups, or coalitions that emerged to vigorously contest water reforms and attempt to influence policies, discourses, and practices within the existing urban water regime. It is the social practices triggered by events at the landscape and regime levels to deliver innovations or outputs that can potentially disrupt the status quo. An example might be the introduction of sachet water as a response to the low-quality water delivered by the utility company.

The macro-level landscape constitutes a broader external environment that influences the dynamics at the regime and niche levels. The interactions between elements at the landscape level are determined by changes in population dynamics, political cultures, macroeconomic patterns, natural environment, societal values, beliefs, and worldviews that are beyond the direct control of the regime and niche (Geels, 2012; Grin, Rotmans & Schot, 2010). These conditions exert pressures on the current regime and open prospects for critical responses and innovation from the niche and the regime (Geels & Schot, 2007). In this study, the landscape represents economic conditions and external institutional actors that shape socio-economic, technical, and political configurations in the water regime by pushing for the implementation of policies and strategies that intended to improve water management practices in the metropolis.

Given the multi-dimensional settings and dynamics in the existing water system of the metropolis, the MLP provides a useful and adaptive analytical framework that helps to navigate changes and interactions among the policies, actors, structures, institutions, and multiple realities that shape urban water management transitions. Its novelty lies in providing a better understanding of the system approach to transitions through practical analysis of the change processes and detail how external driving pressures and innovations at the landscape

and niche levels shape incumbent regime (Geels, 2011). The MLP analytical framework has successfully been applied in historical and contemporary transition-related studies in several areas such as climate change (Pahl-Wostl, 2007), water management and governance (Nastar, 2014; Nastar & Ramasar, 2012; Van der Brugge & Van Raak, 2007), cities transition (Hodson & Marvin, 2010), and the energy sector (Baker, Newell & Phillips, 2014; Smits, 2011), among others. It also ties in with the political ecology theoretical framework, which reveals the unevenness and power relations that are produced by the interactions between stakeholders and processes that inspire changes at the different levels within the urban water system.

4.3 A critical view of MLP

Despite its growing popularity, the MLP seemed to have provoked a barrage of criticisms. Berkhout et al. (2004) and Genus and Coles (2008) criticised the lack of clarity in the practical application of various levels within the MLP and emphasised the problems of drawing boundaries for the regime and defining the object of analysis. In response, Geels (2011) argued that the MLP is flexible with no prescription for a narrow or broad regime, rather than to constitute a regime, it is essential to determine how to define the scope, subject matter, and the object of analysis, before you can operationalise the analytical levels. For Markard and Truffer (2008), there was confusion on the use of "system" and "regime" interchangeably arguing that the distinction between the two is not adequately defined. In his response, Geels (2011: 31) described systems as tangible and measurable elements, whereas a regime refers to intangible and underlying deep structures. In other words, the regime forms an "interpretive, analytical concept that lies beneath the activities of actors who reproduce system elements" (Geels, 2011: 31).

At the level of the niche, critiques focused on the restrictive nature of the niche for innovation. As a "protected space" with emphasis on internal processes, some scholars have questioned the capability of the niche to spearhead new technologies and transitions in a socio-technical system (Raven, Schot & Berkhout, 2012; Seyfang & Haxeltine, 2012; Smith, Stirling & Berkhout, 2005). As a remedy to this limitation, Seyfang and Longhurst (2013) drew on the concept of community action and grassroots innovation in the context of civil society to extend the niche innovation analysis, thereby highlighting the outstanding contribution of an innovative network of activities and organisations spearheading bottom-up solutions to address local situations, interests, and values of the societies involved. At the macro level, opponents criticised the landscape level conception for lacking dynamism and being a "garbage can" or "black box" that accommodates various contextual needs and aspects that do not fit in the regime or niche. In response to creating a more dynamic landscape, Van Driel and Schot (2005) suggested three types of landscape dynamics: (1) invariable or slow-changing factors such as physical climate; (2) rapid external shocks, such as floods, hurricanes, or oil price fluctuations; and (3) long-term changes in a specific direction (trend-like patterns), such as macroeconomic and demographic changes.

Regardless of the several criticisms, according to Geels (2011), the MLP is continually evolving with the integration of constructive suggestions and critiques to form a robust but flexible framework for sustainability transition analysis. Proponents maintain that the MLP cannot be restricted to a mechanical or methodological

procedure for analysis of complex and multi-faceted transitions, and therefore it would always embrace creativity and subjective interpretation (Geels, 2018; Geels, Sovacool, Schwanen & Sorrell, 2017). All of these insights provided a point of departure for the study on the transition dynamics within and outside the water system in Accra and Ghana at large.

4.4 Multi-level dynamics of urban water management

4.4.1 The Regime

The regime of the Accra metropolis represents a mix of technical, political, institutional, and socio-economic realities that interact at multiple levels (local, sub-metro, metro, and national) to create a dynamic system for water supply, delivery and wastewater management (figure 4.1). Examples of key institutions at the regime level include:

- The Ministry of Finance and Economic Planning, which is mandated to raise funds and approve loans for water sector infrastructural development.
- The Ministry of Water Resources and Sanitation responsible for the formulation and implementation of the national water and sanitation policies and oversee the GWCL, the PURC, the CWSA, and the WRC.
- The Accra Metropolitan Assembly (AMA) that manages sanitation and drainage systems and implement bylaws on sanitation, construction, and city planning.
- The Ministry of Local Government and Rural Development coordinates with the AMA and other ministries.

It also features a top-down management structure that places power in the President of Ghana to make ministerial and top managerial appointments for the development and management of urban water resources.

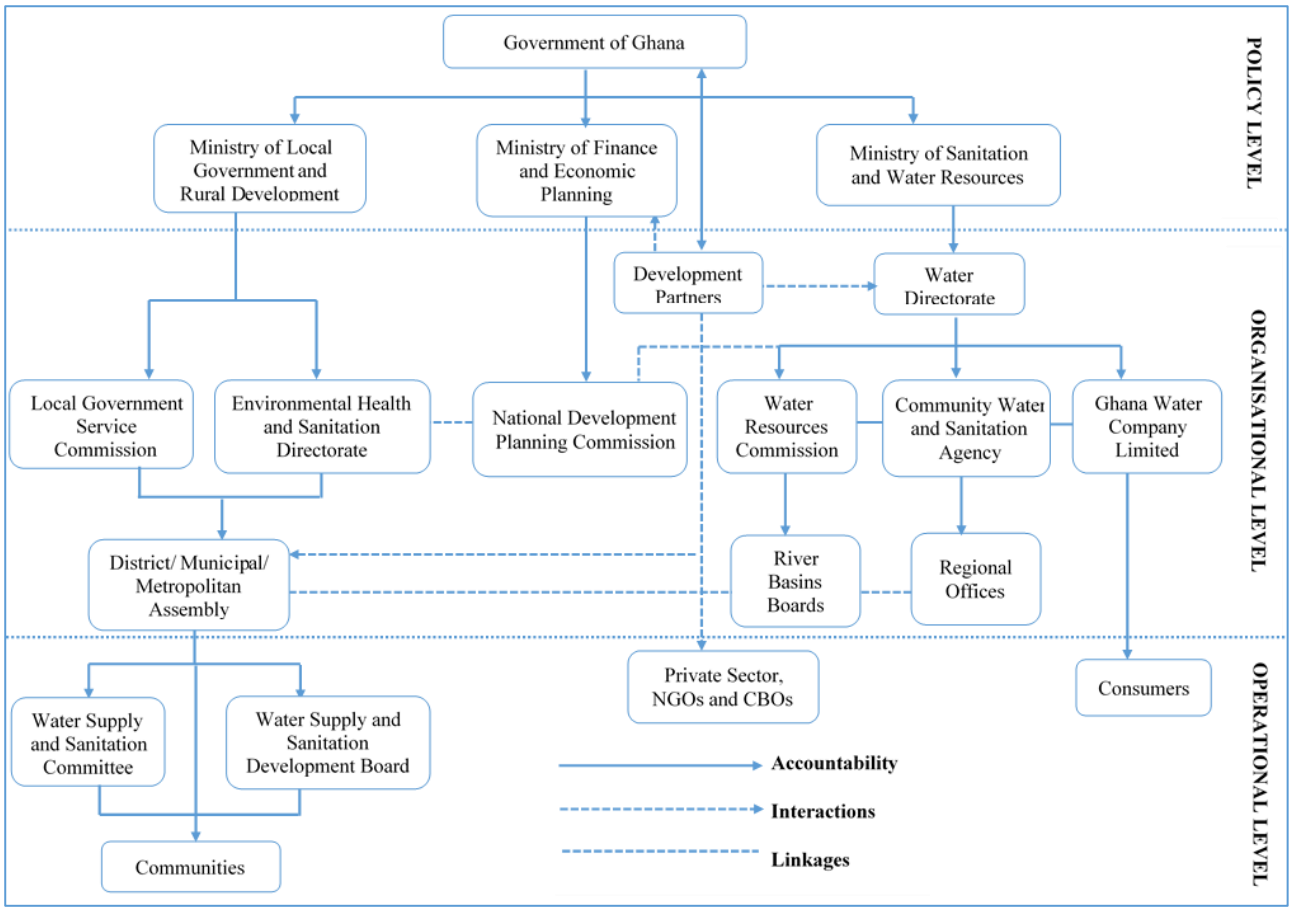

Figure 4.1 Organisational arrangements in the water sector (Author's design)

From the legislative and policy angles under the regime, there are three landmark legal instruments: Act of Parliament (Act 310), which established the Ghana Water and Sewage Cooperation (GWSC) (now GWCL); Act 552, which established the WRC; and Act 538, which established the PURC. These instruments define the operations of the GWCL, WRC, and PURC, and provide regulatory frameworks for policy formulation, water service provision, quality standards and monitoring, tariff settings, and conflict management to facilitate the sustainable water service delivery. The State Enterprises Commission (SEC) is responsible for establishing performance standards for the GWCL and WRC while PURC monitors the standards in urban water service delivery and approves water tariffs. A chart of the key actors and institutions in the urban water sector can be found in Appendix II.

The current institutional arrangements seemed to create overlapping areas of responsibilities, which account for politics, power contestation and sometimes institutional conflicts regarding the control and management of water resources. For example, there are clear signals that suggest a conflict between the authorities of the SEC and the WRC on the regulation and management of water resources use and coordination of all policies related to its functions (GoG, 2014). Another institutional ambiguity is the lack of clear jurisdiction between the CWSA and the GWCL, particularly in the peri-urban areas, which create uncertainties in water service provision and put the fate of residents receiving water in limbo. The Accra metropolis has expanded beyond its original boundaries into areas now referred to as peri-urban areas. These areas were initially rural areas,

which were under the jurisdiction of the CWSA. These are now considered as grey areas because, by urban definition, these areas no longer qualify to be served by the CSWA but are still considered as part of the rural localities. Within the regime, there is a need to establish clear mandates and responsibilities in the management of the different components of the water sector, in particular, the grey areas.

4.4.1.1 Current water management challenges in the regime

The results of the survey of public service officials indicated that of the 59 responses received approximately 85 per cent of the respondents believed that the lack of deeper understanding and implementation of a holistic approach to urban water management remained a significant water management issue in the Accra metropolis. The same percentage was of the view that poor knowledge of the holistic approach originated from the absence of an integrated strategy for the implementation of sustainable solutions. Around 80 per cent of the respondents suggested that the water management challenges were tackled principally from governance and economic perspectives with less attention to environmental and social aspects, such as equity and accessibility. About 80 per cent of the respondents also thought that one significant challenge was the attempt to introduce new water management practices in a system that is locked-into a traditional water management paradigm. Around 70 per cent of the respondents suggested that the continued investment in economically biased interventions, such as water tariff adjustment and private sector engagement tend to alienate deprived urban communities from having access regular and affordable water supply.

In figure 4.2, the responses of urban residents on current water management issues in the metropolis are presented. Of the 168 people who responded to the survey, about 95 per cent of them raised concerns about the continuous increase in water tariffs. According to respondents, the hikes in water tariffs were nothing less than using the collecting revenue to offset the NRW resulting from high commercial and physical losses in the water supply chain. Approximately 92 per cent of the urban residents believed that the high rate of water theft posed a significant challenge to the sustainable management of the water system in the metropolis. Water theft by residents is considered to significantly account for a high proportion of commercial water loss on the metropolis. Around 88 per cent of the respondents were of the view that water-related institutions are not collaborating effectively to deliver water services. Approximately 87 per cent of the respondents indicated that the process of connecting to the water network is complicated. This challenge compelled people to steal water from the water system. Around 78 per cent and 98 per cent of the respondents identified inadequate communication and poor monitoring by the water company as two drawbacks that contributed to the eroded trust and apathy among consumers regarding fault reporting in the communities. Other issues that received a relatively high percentage of attention in the responses included the ageing and poorly managed pipe network system (86%) and low technical and managerial capacity (60%).

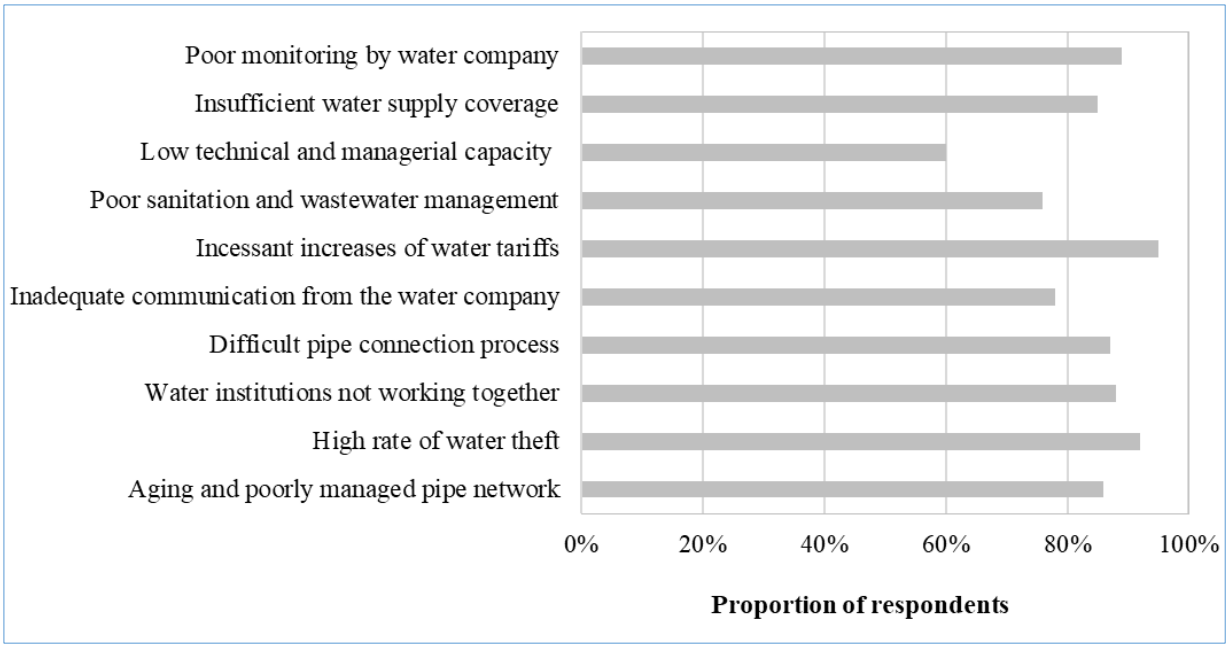

Figure 4.2 Responses of urban residents on current water management issues in the Accra metropolis (Source: Author's analysis)

4.4.2 Landscape pressure on the regime: political and economic realities

In consultations with 25 key water informants, informants were asked about their views (the extent to which they agree or disagree) on factors that might have influenced the development and management of water resources in the regime. These factors were supposed to be landscape factors able to cause a change in the direction of water management in the Accra metropolis or able to influence the choice of management interventions. Figure 4.2 shows the results on the extent to which key informants agree or disagree on the influence of landscape factors on urban water resource development and management in the metropolis over the past decades. Out of 7 factors identified, 4 of them were ranked 5 on a scale of 1 (disagree) to 5 (strongly agree) by key informants. This meant that informants strongly agreed that the following factors were relevant: "change in government and strong political influence"; "growing dominance of donor influence"; "rapid development of unplanned housing"; and "rapid urban population growth due to migration". These were considered to be highly influential to the development and management of water resources in the metropolis. The next highest-ranked factors that informants agreed had an influence on water management in the metropolis included – "continued reliance on external financial assistance and donor support" (4) and the "high fiscal deficit in water resources development and management" (4). The least ranked factor, at 3 (though slightly above average) that was considered by informants as influential to water resource development and management in the metropolis was a "national economic crisis".

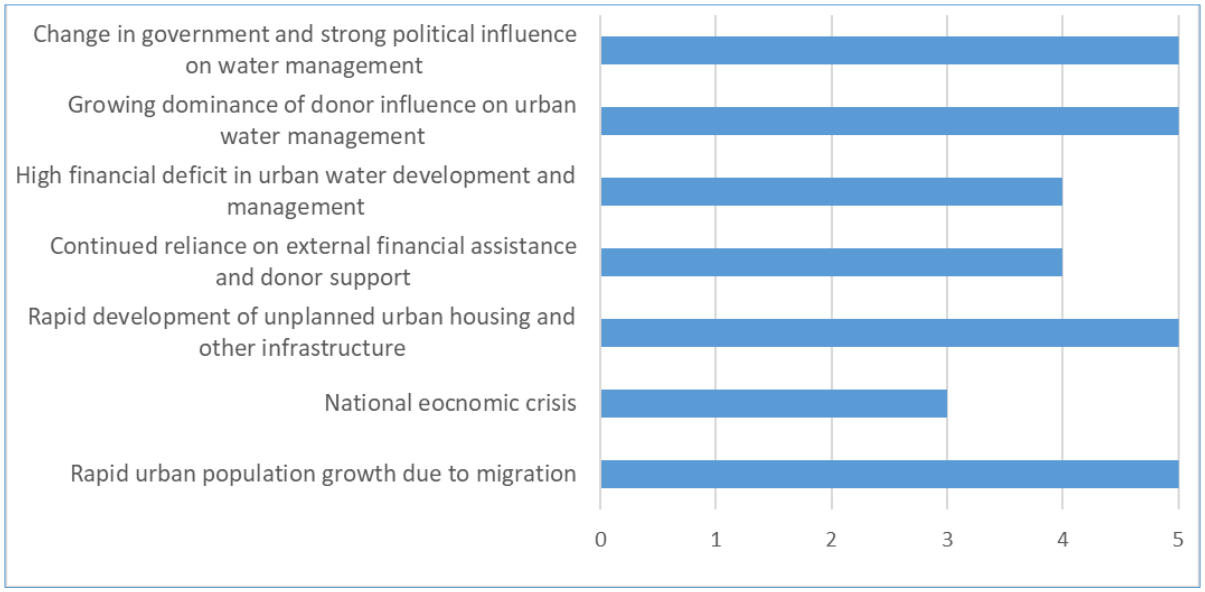

Figure 4.3 Ranking of factor influencing water management in the Accra metropolis. On a scale of 1 (Disagree) to 5 (Strongly Agree) (Author's analysis)

In the history of the water regime in the Accra metropolis, strong political interferences have characterised top managerial appointments at the GWCL, WRC, and PURC. Three realities of political interference have shaped the management with the urban water regime:

- A strong political allegiance of top management appointees to the government in power;
- A change in government usually came with new ministerial and managerial appointments, with some positions linked to political connections rather than merit or competence; and
- long-term retention of top positions rested on the ability to forge a "harmonious relationship" with the incumbent government.

These according to Hirvi and Whitfield (2015) tended to create an avenue for job insecurity, corruption, political manipulation, restricted independent decision-making, and uncertainty in water institutions. For instance, between 1987 and 2007, up to eight changes occurred in the Managing Director position at the GWCL. The often brief tenure of water managers tended to restrict long term planning and strategic development of the water utility company since different managers came with different agenda. This trend is in line with the assertion made by Mollinga, (2008) that current management and decision-making in water system were dominated by asymmetrical power relationships and politics, deeply intertwined in the broader socio-political and economic context, which made water management inherently political.

Within the urban water regime, there was a significant influence from landscape actors such as multilateral lending institutions (World Bank and IMF) and other donor agencies who provided funding for developing and managing water resources in the metropolis. For example, in 1968 according to World Bank report, the GoG was compelled to seek for financial assistance from the International Development Association (IDA) of the World Bank group due to weak government financial standing, harsh economic conditions facing Ghana, and the failing urban water infrastructure. A loan of US$3.5 million was approved for the expansion of urban

water infrastructure and sewage systems in the metropolis and surrounding areas and to improve the operations and organisational capacity of the GWSC (World Bank, 1969). This loan facility began an era of continued financial dependence on external landscape actors such as the World Bank and the IMF. It also offered a conducive environment for lending and donor institutions to influence the regime by steering the policy directions in urban water management and other sectors of the economy. The pressure continued to mount on the regime as external landscape actors pushed for structural adjustments in the 1980s.

In a vulnerable and unstable state, the water regime underwent a complete overhaul through the implementation of interventions promoted by the World Bank. These interventions – decentralisation, privatisation of the water company, and the removal of subsidies on water service provisions - according to the World Bank were essential for addressing the growing water management problems facing the regime. By succumbing to pressure from the World Bank and other actors, some changes unfolded in the regime, including a shift in control of urban water infrastructure, creation of new institutions, changes in institutional practices, norms, and belief systems that underpin the water system.

For the government and water managers, it seemed convenient at the time for the regime to be shaped by the policies and interventions spearheaded by the external landscape actors such as the IMF and World Bank, especially in the absence of national water policies as noted by Amenga-Etego (2003). This act would later prove to be costly as water stakeholders questioned the competence and managerial capacities of existing water institutions. The GWSC, which is the state-owned water utility manager, was unable to break even in its operations due to weak revenue mobilisation, high NRW, and a backlog of capital work (World Bank, 1989). The devaluation of the country's currency as part of the structural adjustment program contributed to the failure of the GWSC to break even. That move resulted in exchange rate losses and dealt a severe blow to the GWSC's capacity to salvage its deteriorating infrastructure. The consequence was that a decade down the line, almost 30% of the urban water infrastructure had become dysfunctional (Halcrow, 1995).

Based on the strong recommendations of the IMF and World Bank, the GoG began the process of reforming the urban water sector in the early 1990s. The implementation of management reforms, which saw the removal of water subsidies, adjustments of water tariffs, and massive capital injection into the water sector by the World Bank, was meant to stabilise the regime by improving efficiency in water service delivery, expansion of water systems and supply coverage, and financial self-sufficiency. However, the reforms and investments rarely reflected the desired water management goals, thus leaving the regime with operational losses and poor water management outcomes.

Despite the poor outcomes that created more instability in the regime, the landscape actors, mainly the IMF and World Bank, maintained the momentum for urban water reforms using the "carrot (financial aid) and stick (making water privatisation a condition)" approach (Hirvi & Whitfield, 2015). By the mid-1990s, an additional investment of US$140 million was provided by the World Bank to initiate a comprehensive reform in the urban water sector. In this reform, the regime witnessed changes in socio-political, institutional, and organisation structural arrangements, with emphasis on the transition from a public management to private sector engagement in the urban water management. Landscape actors considered water privatisation as the most

viable alternative to the management of the water system. There was a strong belief by the Bank that the introduction of private enterprise in the control of the water system in the metropolis could improve water supply efficiency, attract the needed capital investment, improve water quality standards, and encourage stakeholder participation in water service delivery and management. According to the Bank, getting the private sector involved in water management could also help untangle the political intrusion as well increase the chances of improved transparency and accountability based on fair and efficient market principles (World Bank, 2005).

The water privatisation idea, rooted in neo-classical economic theory, regards free markets as the most suitable option for yielding the best possible financial outcomes such as closing the equity gap, and reducing rural and urban disparity (Bauer, 2012; Stilwell, 2014). Others have argued that the proponents of water privatisation did not consider the underlying political and socio-cultural concerns that shape public utilities in delivering social services such as water supply (Hirvi & Whitfield, 2015). For example, water was used as a "bargaining chip" by politicians as they made campaign promises to provide water to deprived residential areas when elected into office. Flipping the situation around, urban residents used campaign promises as their trump card to negotiate for access to a free or affordable water supply. On the other hand, politicians were obligated to fulfil their campaign promises at the expense of State to provide free or subsidised services to their electorates. Such dynamics create a stark gap between free markets and free access, and therefore interventions such as privatisation of water services are likely to suffer. Other people believe water is a fundamental right and that it is an abomination to sell water. To privatise water services, according to the populates, meant to manipulate nature's gift as a profit tool.

Amenga-Etego and Grusky (2005) argued that the idea of water privatisation served as a political manipulation by the World Bank and IMF and donors in the developed North who seek the financial interest of their corporate citizens in the developing south. It appeared that multinational companies from the North were handed hefty contracts to implement projects in the developed south under the urban management reforms. For example, Halcrow and Louis Berger, two foreign companies were contracted to work out modalities for the transition process towards water privatisation in Ghana.

At the beginning of the transition process, Halcrow produced a report recommending a Lease Arrangement for water management in the Accra metropolis while Louis Berger developed a business framework for the implementation of the lease arrangement. The two outputs formed the strategy for the implementation of water privatisation, which became later known as PSM. Despite this recommendation, Halcrow raised some contradictions that appeared to cast doubt on the real intent of the PSM, as noted by Adu-Ampong (2013). For example, the report, while advocating for PSM, identified urban water sector challenges as an internally structured problem particular to the GWSC. This issue, the report reckoned, could have been resolved by establishing effective monitoring mechanisms for expenditure, revenue mobilisation, and improving quality standards. The report by Halcrow in some ways might have exposed the interests and influence of the World Bank and the IMF on the selection of water management interventions in the metropolis. According to Amenga-Etego (2003), such discrepancy in the diagnosis and recommendations raised suspicions about the

real intent of the PSM, given that the World Bank sponsored the report and was pushing for the implementation of the PSM strategy.

Overall, the analysis of the historical management of water resource seemed to suggest that the water sector has experienced a substantial influence exerted by external factors and actors including the political interference, financial crisis, the World Bank and IMF dominance in water issues which might have altered the direction of water management practices in the Accra metropolis. This result is in line with the outcome of key informants' consultations which revealed among other factors the growing influence of multilateral organisations, rising urban populations, and the change in government that were considered to have played a critical role in shaping the water management practice in the regime.

4.4.3 Developing a national water policy for regime change

One of the landmark outcomes of the water management reforms was the development of a NWP in 2007. This policy was intended to guide the direction of urban water management in the entire country, including the Accra metropolis. It proposed some interventions that could help address the growing water demand; the degradation of water quality that contributed to high treatment cost; and need to increase and improve existing water sources, explore new sources to curb water resource depletion and degradation. Deeply rooted in water policy are equity and pro-poor principles - ensuring safe and adequate water supply to all people, particularly poor and vulnerable households. Two fundamental principles of the national policy included (i) recognising water as an economic and social good and (ii) promoting participatory decision making in urban water management. To put these principles into action, five key policy interventions namely decentralisation, removal of water subsidies, structural tariff regime, actors' participation in water governance, and PSM were implemented.

The decentralisation process aimed to segregate and assign clear responsibilities and powers of implementation to various institutions within the urban water system. For instance, the implementation of the decentralised policy led to the transfer of sewage and wastewater management from GWCL to the AMA. The responsibility of sewage and wastewater management in the Accra metropolis was previously the mandate of the GWCL. From the stakeholder dialogue, participants revealed that the decentralisation process was mainly institutional and did not include the actual decentralisation of the sewage system, which entails separating different kinds of (household) wastewater (including urine, faeces, and greywater) to be treated as recommended by Mahgoub et al. (2010). They were of the view that such decentralisation effort at the institutional level has not encouraged the coordination of water and wastewater management activities. One participant questioned the current decentralisation policy, saying:

> "How can we promote an integrated system of water, sewage and wastewater management when institutions feel set apart and independent in their roles under the decentralised system. I understand that the government's intentions of relieving pressure off the GWCL are good; the truth is that there is a huge capacity gap at the AMA to manage sewage and wastewater efficiently in the metropolis.

> This arrangement, I believe, has rather deepened the struggle to understand the essence of coordinating efforts to manage water, sewage and wastewater holistically."

For a long time, the government heavily subsidised water service delivery in the metropolis. The intent was to fulfil the fundamental rights of the population to safe and good quality water. However, the growing recognition of water as an economic good in the water policy compelled the government to remove water subsidies as a means to reduce water production cost and ensure financial self-sufficiency. Nonetheless, subsidy removal did very little to reduce the cost burden of the urban water system.

According to one official of the GWCL, even though it was a good attempt towards increasing revenue mobilisation, the company had not taken advantage to invest in revenue collection facilities, such as water meters and revenue pay points due to lack of capital and high debt. A representative from the water user association argued that the removal of subsidy on potable water served as a boundary between the well-to-do and low-income households in the metropolis. He further explained that this move was a complete betrayal of the fundamental right of water access to all, primarily low-income families. He indicated that the high rate of illegal connections and NRW were perhaps a result of the subsidy removal and the associated rise in water tariffs.

Following the removal of subsidies, the PURC introduced a lifeline tariff that was supposed to serve as a relief for low-income urban households against rising water tariffs. Under this arrangement, low-income families were supposed to enjoy a lifeline of up to 20,000 litres per month under a considerably low tariff plan. However, the outcome of the intervention seemed to suggest that it was less effective in helping low-income households to have access to affordable potable water. A representative of the PURC blamed the unfortunate outcome of the lifeline tariff on operational challenges such as lack of pipe network and distribution system to low income areas, the housing type and the metering system.

Two dynamics in the urban setting seemed to be at play in this situation. First, according to the Ghana Statistical Service (GSS), the majority (80%) of low-income households in the Accra metropolis was not connected to the reticulation system, was without household meters and therefore not able to benefit from this intervention. These households relied on secondary water service for domestic water supply at rather exorbitant costs. Second, data from GSS also indicated a significant proportion of the housing types in low-income neighbourhoods was the type commonly referred to as "Compound House". A compound house usually consists of several single rooms and double room units found on the same compound with shared toilet and bathroom facilities. A compound house typically has one water meter that served the entire house comprising 5 to 10 or more households.

Using the GSS average water consumption of 30 litres per day per person, it meant a compound house on average might consume around 45,000 litres of potable water per month, which exceeded the 20,000 litres per month lifeline threshold for a household using a single meter. The current water consumption rate of a compound house excluded them from the lifeline tariff bracket, putting most compound houses in the industrial

or commercial block tariff regime, thus increasing the charging rate of water consumption per household. Officials of the PURC on the learning platform conceded that the tariff plan had not worked out well as a pro-poor intervention for low-income residential areas. Instead, it has benefited well off households with connection to the reticulation system whose consumption level fell within the lifeline water tariff bracket.

The water policy advocated for increased participation of other actors in water governance. The engagement and involvement of consumers, advocates, and vendors, among other stakeholders, served as a valid platform for deliberation and negotiation of water management. However, the reality was that such a platform was also prone to conflicts, with high contestation, and served as a device for elite capture and to wield power (Mollinga, 2008). In this light, decisions taken during participatory processes on water management may not be entirely representative of the position of the majority of actors. A representative of civil society group argued that even though the call for participation in water governance was an excellent idea, in reality, the involvement of other stakeholders appeared to be used to legitimise or validate decisions already taken by the government or a proportion of elite decision-makers. She believed this practice might have contributed to the several contestations by water stakeholders who felt disenfranchised.

Perhaps the most highlighted aspect of the policy was the PSM in the metropolis. The PSM served as a re-emphasis of the earlier strategy implemented as part of the strategy funded by the World Bank and the IMF. The next sub-section throws more light on the water management transition from public to PSM.

4.4.4 The regime transformation: from the public to PSM

The introduction of the PSM in 2006 signalled a major shift in the water regime in the Accra metropolis from public sector ownership. This intervention targeted the achievement of multiple goals, including increased transparency, accountability, improved water supply coverage, and financial self-sufficiency. Opponents of the PSM strategy saw this new arrangement as a ploy to target profit increases in the economically viable urban water sector, thus leaving behind the poor and undeveloped rural water sector. Making the water problem focus on the urban areas provided the incentive for private sector engagement in a commercially viable industry, according to Adu-Ampong (2013).

The management transition in the Accra metropolis hit a snag when civil society actors raised corruption allegations, lack of transparency, and inadequate accountability against the government in awarding the lease arrangement under the PSM. These accusations brought about a standoff between the government and the World Bank, which resulted in a threat of funding removal (Ainuson, 2010). Continued pressure from the World Bank compelled the government to revisit the lease arrangement and contract, even though it became evident that the World Bank's initial investment offer under the lease agreement would no longer materialise. With modifications, a five-year Management Contract was proposed by the government as the most viable PSM strategy for efficient and effective water service delivery. This move brought about changes in the management arrangements and agency structure in the regime and reinforced the dominance of landscape actors and pressures in altering the pathway of water management in the metropolis. Nonetheless, time was

going to tell whether the regime changes would endure enough to sustain the new arrangements and interactions between public and private sector actors.

Following a transparent bidding process in 2005, the five-year management contract (2006-2011) was awarded to a private foreign company, AVRL, to manage water service delivery in the metropolis and other cities in the country. Again, there was an indication of a strong influence of landscape actors such as the World Bank and Nordic Development Fund, who contributed a considerable portion of the initial investment for the implementation of the new reforms. Under this arrangement, the AVRL (the operator) was responsible for managing existing and future assets of GWCL (the grantor) in designated areas daily to deliver potable water. The GWCL assumed a supervisory role in monitoring AVRL's operations and performance as well as raising capital for water infrastructure development. This arrangement seemed dubious, critics argued, given that the GWCL was once labelled incompetent to manage, thus raising questions about how it could effectively monitor such a sophisticated contract (Agyeman, 2007).

External actors succeeded in pushing the PSM strategy onto the regime by combining persuasion and pressure through financial aid and loans that compelled the borrowing country, Ghana, to meet certain conditions and obligations. From a political ecology perspective, the current realities in the urban system of the Accra metropolis contribute to the production of uneven space and unequal power relationships among urban water stakeholders regarding the control of water and water infrastructure. The implementation of the PSM revealed the inherently contested and political nature of urban water but also showed how changes in the control of water defined water access and how water service delivery was organised and managed in the metropolis.

A participant at the learning platform argued that the government showed its true colours of insensitivity, apathy and lack of interest in addressing the water access needs of low-income households in Accra when it embraced the participation of private sector in water management. In response, an official of the GWCL argued that it was instead the increasing economic and physical water losses, lack of investment in infrastructure, and poor outcomes in the regime that justified the demand for PSM. Critics of the PSM argued that the economically biased position assumed by this strategy to recover costs and make a profit through water tariff adjustments contradicted the principle of water as a social good. They further argued that the PSM would rather exclude already disadvantaged communities that are characterised by low-income dwellers, informal settlements, and poor infrastructure from the urban water system (Ainuson, 2010).

4.4.5 The niche: opposing landscape pressure to shape the regime

Pressure from the landscape level produced changes in institutional arrangement, policy direction and empowered the private sector engagement in the water regime. It also triggered niche level experiments including packaging water in sachets and social mobilization that opposed water management interventions that were believed to be biased and harmful to the masses, particularly low-income households. At the niche level, the rise of social groups against private sector engagement in urban water services and management

became widespread following a sustained increase in water tariffs, which began as part of the PSM implementation.

Leading up to the execution of the management contract, several local social interest groups and grassroots civil society actors joined forces to form the National Coalition Against Privatization of Water (NCAP), a nation-wide social group that set out to oppose the implementation of interventions under the PSM. According to the World Development Movement (2005), the NCAP mounted one of the fiercest opposition campaigns in the history of water sector privatisation in Ghana. In articulating their position, the coalition rejected the dominant role of foreign firms and private capital investment in urban water management, while arguing that the obsession with making the urban water sector profitable through external private capital injection would alienate the majority of the urban poor, who were incapable of paying the corresponding high tariffs.

By devising a mix of strategies, including joining a global platform against privatisation, the NCAP became a potent force as they mobilised water consumers and actors within the country and beyond to dispute the alleged positive impact of water privatisation. They provided evidence of water privatisation implementation from Cote d'Ivoire, Gabon, Guinea, and Senegal, which suggested minimal positive outcomes of water privatisation or PSM in improving water service delivery and poverty reduction (Hall, Lobina & Motte, 2005). The NCAP sensitised and created awareness using the media to build critical masses to pressurise the regime and landscape actors to rescind the implementation of the PSM management contract. The NCAP proposed a public-community-partnership model that emphasised a decentralised system of water provision in localities, which would give more power to communities to manage water service delivery from the public utility.

From the transition perspective, an effort towards a shift in urban water management practices was highly socio-political and economically induced in nature but also emphasised the impact of the powerful actors at the landscape level on water management decisions at the regime level. At the same time, it highlighted the price cities and countries at large have to pay in relinquishing water management control to external actors when a significant share of investment in urban water resources development and management came from external sources. The adoption of the PSM model for urban water management provoked a strong reaction to the changes in the regime and also stimulated grassroots innovation at the niche level (to be discussed in the next section).

Despite the continued opposition from actors at the niche level, the government proceeded with the implementation of the PSM strategy. Nonetheless, the NCAP played an essential role in the suspension of the PSM at the early stages and influenced further modifications in the contract arrangement before implementation (Fuest & Haffner, 2007). This effort by actors at the niche level signifies the contribution of active grassroots networking and social mobilisation practices as an equally fundamental driving force for systemic change and management transitions as the landscape actors.

4.4.6 The regime change: an opportunity for niche experiment

In spite of the changes in management structure and institutional arrangements resulting from the implementation of the PSM strategy in the urban water regime, the outcomes remained unchanged as the Accra metropolis continued to experience challenges that confronted the water system. One major problem was the rising water tariffs in spite of the recurring water shortages in the metropolis. The PSM implementation created an opportunity for the emergence of local private enterprises in water service delivery, who employed innovative ways of packaging water in plastics and sachet. The production and supply of water in 0.5-litre sachet emerged as a grassroots innovation that gained legitimacy and achieved market presence, becoming a significant drinking water source for almost 9% of Accra's urban population (Stoler, Weeks & Otoo, 2013).

Currently, records from the Food and Drugs Authority suggest that there are approximately 54 registered sachet water producers and six bottled manufacturers in the metropolis. Sachet water production has become a strong niche innovation in response to the urban water regime crisis, reaching areas that were unconnected to the pipe network. However, discussion among the actors on the learning platform revealed several implications regarding the growing reliance on sachet water production. First, sachet water producers continue to hijack direct access to piped water, depriving consumers of affordable potable water instead of accessing other sources of water such as spring and groundwater. Second, the growing perception of the high quality of sachet water is dimming consumers' confidence in the quality of water supplied by GWCL. Third, the booming sachet water market seemed unregulated; the result is an influx of low-quality products, thus complicating the monitoring of quality standards. Sachet water production as a grassroots innovation has proven beneficial by providing a reliable supply and access to potable water even if it comes at a slightly higher cost to the consumer.

4.4.7 From the private sector back to public sector management

The AVRL, the private firm mandated to manage urban water supply came under rigorous public scrutiny when it became apparent that the government had decided not to renew the five-year management contract with them in 2011. Drawing on some quantitative data from the GWCL backed by multi-level discussion at the learning platform, an analysis of AVRL's performance during the contract period, which prompted the contract non-renewal is presented. Table 4.1 shows the financial and economic indicators during the contract period (2006–2011) for the Accra metropolis.

An analysis of financial and economic data for the metropolis during the contract period suggests that the total water produced was up by 10 per cent, while the amount of treated water billed and sold to consumers increased by almost 19 per cent. The revenue from water service delivery showed an increase of about 60 per cent during the contract period. However, the positive outcome correlated with 50 per cent water tariffs adjustment rather than as a positive result of sustainable management measures. The increased water revenue was matched by the operational costs of water production, which increased by almost 60 per cent during the period, thus affecting the profit margin. A critical target that remained unachieved was the high NRW which remained above 50 per cent during the duration of the contract. In sum, the effort of the AVRL to improve operational

efficiency and financial self-sufficiency was progressive but unimpressive considering the investments made and the political tumult surrounding the PSM.

Production	Unit	2006	2007	2008	2009	2010	Percentage Variation
Raw water abstract	M m^3	232.60	231.20	229.80	246.00	258.70	10.09
Treated water produced	M m^3	211.80	214.20	215.80	231.70	244.60	13.41
Water sold and billed	M m^3	100.10	103.90	107.70	112.30	122.80	18.49
Average daily production	1000 m^3	580.30	586.70	589.50	634.79	668.30	13.17
Average water tariff	GH₵/m^3	0.56	0.67	0.94	0.93	1.17	51.98
Production loss	%	8.9	7.4	6.1	5.8	5.4	64.81
Daily capacity utilisation	%	74	75	75	79	82	9.31
Revenue							
Total income	M GH₵	57.00	69.40	102.30	106.60	146.00	60.96
Water revenue	M GH₵	55.90	68.70	100.70	104.30	143.20	60.96
Total collection	M GH₵	53.40	61.40	93.80	101.10	130.20	58.99
Collection ratio	%	0.95	0.89	0.93	0.97	0.91	4.49
Non-revenue water	%	53	52	50	52	52	2.13
Production Cost							
Operating cost	M GH₵	48.00	57.80	89.60	87.80	109.60	56.20
Electricity cost	M GH₵	14.60	17.10	32.80	22.60	29.80	51.01
Chemical cost	M GH₵	5.40	5.50	5.90	9.70	10.00	46.00

Table 4.1 AVRL performance indicators for urban water service delivery under private sector reform (Source: GWCL data, 2016) Note: Mm^3 – million cubic meter; GH₵/m^3 - Ghana Cedi per cubic meter; M GH₵ - Million Ghana Cedi

From a broader perspective, the poor performance of the entire urban water system of Ghana diminished the average performance of the AVRL in the metropolis. An audited account of AVRL's operation showed a record of losses in total revenue collected, net operating income, the rate of revenue collection, and NRW. In technical and operational terms, the records showed a dismal performance of AVRL to establish a financially self-sustaining urban water system capable of achieving improved water service delivery. On these accounts, the government ranked AVRL's performance as unsatisfactory and decided against renewing the management contract after expiration.

By mid-2011, the government discontinued the management contract arrangement. Critics of PSM saw the decision to revoke the management contract as a victory. However, there was still a strong push from actors like the World Bank who did not favour the discontinuation of management contracts. These actors were interested in pursuing the PSM policy as a strategy for improving water service delivery and wastewater management. Eventually, the government transferred control of the urban water system back to the GWCL. It would seem that one of the key reasons for the turnaround from the private to public administration was

probably the lack of appreciation by the private entity, AVRL about the social arrangements, the politics, and population dynamics and how they interact to influence adoption and implementation of interventions in the metropolis. For example, the economic conditions of the population of Accra and access to water varied significantly and therefore the implementation of any intervention across the board was likely to fail.

4.5 Water management transition dynamics in the Accra metropolis

In this study, the regime actors responded to pressure from landscape actors through the adoption and implementation of a collection of technical interventions (e.g. rehabilitation and expansion of water infrastructure) and institutional and economic interventions (e.g. institutional reforms, market-oriented strategies such as subsidy removal, tariff adjustments, and PSM. The determinant factors of the transition process included the strong influence of landscape pressures, the extent of regime stability, and it's capacity to respond to landscape pressures and the sophistication of niche innovations (Avelino, 2011; Farrelly & Brown, 2011).

The chaotic atmosphere surrounding the adoption and implementation of water management interventions, the resistance, rejection, struggles and the limited impact of these interventions point to particular inclinations held by both regime and landscape actors as well as some fundamental issues that received very little attention or were ignored from the onset. For example, landscape actors believed that the implementation of a set of interventions, including rehabilitation of water infrastructure, institutional arrangements, subsidy removal, water infrastructural expansion and tariff adjustments, would undoubtedly help achieve multiple desirable goals. These goals included improvement in the efficiency of water supply, improvement in cost recovery and water revenue, and increased transparency in urban water management. Regime actors felt somehow powerless and reliant on the benevolence of certain landscape actors but also experienced a sense of betrayal during the implementation of the private sector engagement strategy. Both landscape and regime actors underestimated the impact of the actions of actors at the niche level, and this might have been the reason for ignoring their full engagement from the beginning of implementation.

From the discussion on the learning platform, some participants strongly suggested that water managers need to have a much broader perspective by implementing interventions that go beyond technology, economically and institutionally biased interventions to include solutions that address the biophysical and metabolic processes and interactions between the water system and the hinterland. Around 90% of water supplied to the metropolis originates from the hinterlands where water flows are largely dependent on climate variability and anthropogenic activities in the river catchment areas. For example, in the focus group discussion, it came to light that in addition to water leakages and losses, prolonged dry spells in the hinterland contributed to the recurring water shortage in the metropolis. This dry spell contributed to the reduction in the volume of raw water supplied to the waterworks.

At the niche level, the creation of innovations and networks was viewed as a potential driver for change in the metropolis. A deviation from the status quo occurred due to the pressures from the landscape actors and destabilisation of the regime. Grassroots innovations emerging from the niche level could spread if linked to

processes and structures at the regime level. The rationale was that transformation occurs through co-evolution and mutual adaptation with and between the different levels (Bos & Brown, 2013). Though innovations at the niche level might not necessarily replace the regime, they had the potential to affect changes in behaviour, practices, and routines of the regime, which could contribute to the innovation uptake in the system (Bos & Brown, 2013; Schot & Geels, 2008).

In the Accra metropolis, the rise of grassroots organisations at the niche level shaped urban water management in the regime by promoting actor participation in the decision-making processes. Niche innovations such as sachet water production took the regime by storm and partially altered the mode of water distribution through the manufacturing and supply of affordable plastic and sachet water to the unreached areas of the metropolis. However, this type of innovation can be counter-productive in future given the growing environmental problems associated with plastic waste disposal and pollution in the metropolis. Currently, the significant contribution of niche innovation and networks to the transition towards sustainable water management practices may seem marginal, but they play a very vital role in the existing regime.

4.6 Findings

In the Accra metropolis, the transition in water management practices through the adoption and implementation of politically motivated economic strategies hardly yielded the intended outcomes. One of the reasons for the limited success of the interventions implemented could be how water managers introduced these interventions. On the September 2015 learning platform that examined the "drivers of water management interventions and reforms in the metropolis", participants highlighted the fundamental issues that were left unaddressed before the implementation of water management interventions in the Accra metropolis. These issues included:

- Water managers implemented water management interventions in a piecemeal manner without a holistic framework that guided the sequencing of the various strategies to be implemented. For example, there was no assessment to determine which was the best approach whether to commence water infrastructural development first or change the management of the GWCL or remove subsidy before tariff adjustment. The absence of a guiding framework might have created some form of chaos and exposed the implementation process to serious criticisms and opposition.
- There was a lack of an in-depth analysis of the dynamic linkages and relationships between the set of interventions and the targets to be achieved, and the economic, socio-cultural and environmental realities that shape water management practices in the metropolis. A typical example was the implementation of an economically-biased water tariff adjustment strategy in a predominantly low-income community without a proper assessment of the situation in these communities. Even the implementation of a lifeline tariff mechanism for low-income communities could not succeed due to the lack of understanding of the dynamics in low-income areas of the Metropolis. In other words, there was a lack of appreciation on the part of implementers about the reality of balancing social needs of access to affordable clean water with the economic goal of building a profit-making utility and a financial self-sustaining management system.

- There were inadequate consultations and engagement with the various water stakeholders before the introduction of the interventions. With a maturing democracy and empowerment of people in the metropolis, it is no longer possible to take the participation of groups, communities and individuals in water management decisions for granted. Urban water stakeholders, especially civil society groups, associations, and NGOs, are strongly empowered and have devised several powerful mechanisms to resist or frustrate the implementation of new water management interventions. These stakeholders had used tools such as protest, mass demonstration, and grassroots lobbying to resist government interventions when authorities disregarded their contributions in the decision-making process.
- From the focus group discussion, it was gathered that water management interventions mainly targeted the removal of the political and institutional bottlenecks to optimise the performance of the urban water system and the GWCL. This is evident in institutional rearrangements and a strong emphasis on privatisation or private sector engagement.
- The discussion also revealed that water management practice in the metropolis aligned with the linear metabolic pathway. This meant water consumption and wastewater disposal were carried out with no recourse for recycling and reuse. An important observation was the lack of attention to how the metropolis interacted with the hinterlands regarding raw water flows from different sources in the hinterlands. Due to the high metabolism in the Accra Metropolis, factors such as urban expansion in catchment areas, mining, agricultural activities, chemical and wastewater pollution tend to alter the ecological process and thus affect the water quality and quantity from rivers and lakes in the hinterlands that supply the metropolis. The lack of attention to the metabolic processes of water flows and flux dynamics in the urban system and the hinterland suggested that water managers and actors missed the opportunity to identify and implement water management strategies in a holistic way.

4.7 Conclusion

In the Accra metropolis, efforts to transform the water sector through the implementation of interventions under the PSM triggered reactions and responses from various stakeholders at different levels of interactions, namely the regime, niche, and landscape levels. The discussion among participants on the learning platform seemed to suggest that the measure of the extent of successful outcomes of these interventions varied, depending on who was assessing the outcomes. For example, government officials were likely to say that the performance of AVRL in the management of water service delivery was deemed unsatisfactory.

A common critique among participants on the platform was the absence of standard measures or a set of criteria for evaluating the results of urban water management interventions in the metropolis. One of the critical limitations seemed to be the lack of reliable data based on which we could assess water management outcomes. For example, it was challenging to draw on data from the statistical office in Accra or government database to analyse critical factors, such as domestic water consumption per capita, industrial water use, water use efficiency, and annual water demand. Chances were that due to the lack of reliable data and information, some outcomes might not have been recorded as successful outcomes.

A more sustainable pathway to managing water resources in the metropolis may perhaps require a holistic assessment of the dynamic settings in which water managers implement these interventions. The outcome of such an evaluation is likely to inform the design of specific interventions that are well interrogated and accepted by all stakeholders and suited to the context of the metropolis. In Chapter 5, an evaluation of water management practices under PSM in the Accra metropolis is presented.

Chapter 5: Evaluation of water management practice in the Accra metropolis

5.1 Introduction

Between 2006 and 2011, the Accra metropolis experienced a transition from public water management to PSM that resulted in the implementation of reforms in the urban water sector. The control of the urban water system was transferred to a private entity called Aqua Viten Rand Company Limited (AVRL). Under the change, five main interventions including institutional arrangements, decentralisation, removal of subsidy, water infrastructural expansion, and tariff adjustment were implemented to help establish a technically and financially efficient system that could achieve at least five outcomes, namely:

- Improved water governance by building a functional institutional set up that was accountable, transparent and free from political influence as well as establishing a public-private partnership for urban water management;
- Increased water supply efficiency and availability of water by replacing some infrastructure to reduce water leakage and theft in the water system as well as conservation of water resources;
- Increased water supply coverage and access to the metropolis, particularly deprived neighbourhoods not connected to the main pipe network;
- Increased water savings through the reduction of NRW, water tariffs adjustments, and removal of subsidies; and
- Reduced water-related health risk by improving water quality and implementing ecological restoration projects to reduce pollution of water sources in both the hinterland and the metropolis.

The state of the water system since the private sector water reforms from 2006 to 2011 has resulted in a myriad of responses regarding the outcomes. The type of responses depended on the category of stakeholders. At the December 2015 learning platform, proponents of the water reforms such as the World Bank and other multilateral institutions argued positively about the effects of interventions on improved infrastructures and water supply coverage, enhanced institutional arrangement, and improved quantity of treated water produced per day. On the same platform, civil society actors and scholars insisted on unsuccessful outcomes of the water reforms. They argued that the interventions could not sufficiently address several issues, including leakage detection and reduction, reducing NRW, improved water supply coverage, particularly in low-income areas of the metropolis.

The private sector water reforms in the metropolis occurred at a very high cost amidst a strong push by external actors such as the World Bank and the IMF, but also faced strong contestation from civil society actors (as shown in Chapter 4) about the way interventions were implemented. However, it would seem the “push and pull” factors among stakeholders coupled with the outcomes of the reforms made the PSM solution untenable in the Accra metropolis. The consequence was the shift in the management of the water system from private

to public control. This meant that the government was back in control of the water system. In this chapter, the water system of the Accra metropolis is evaluated by examining the extent to which the interventions under the PSM were able to achieve the five outcomes stated above. The process to develop and implement a new framework by the government for guiding the new era of public water management from private control is also discussed. A mix-method of focus group discussions and survey of participants at the learning platform and consultations with selected top officials of government water agencies were employed. At the learning platform, the use of the focus groups was intended to exposed members of each group to an array of views from each participant and to help gain a broader understanding of the issues being discussed from various perspectives. The individual questionnaire survey gave participants on the platform the opportunity to make independent evaluation of water management interventions while the consultations with other top officials and experts outside the platform sought to consolidate the results on the deliberations on learning platforms.

5.2 Evaluation criteria for water management practice in the Accra metropolis

Between December 2015 and January 2016, participants on the learning platform had in-depth discussions on what may constitute a reliable assessment of outcomes following the implementation of water interventions under PSM in the Accra metropolis from 2006 to 2011. The need for such an evaluation was triggered not only by the lack of comprehensive information on the impact of the interventions on the water system but also on the lack of consensus among water stakeholders due to disparaging views on the outcomes of the water reforms in the metropolis. For some stakeholders, the water management interventions under the private water reforms were successful in achieving the expected outcomes, while opponents argued about the lack of desired results. Part of this "confusion" could be linked to the absence of a holistic framework that defines outcome-specific instruments for assessing water management outcomes. The intent here is not to prove the outright failure or success of the reform process based on the judgement of proponents and opponents but to examine the extent to which these interventions were able to improve on the existing situation. It is also to understand how current realities and conditions in the metropolis had facilitated or hindered the achievement of the expected outcomes of these interventions.

The study employed three research methods to define the components of the framework of analysis of the outcomes of interventions under the PSM. These methods included focus group discussion, individual surveys and informant consultations. At the 31st December 2015 learning platform, a focus group discussion was organised for 20 participants. Participants were divided into groups of five using randomised selection where participants were grouped according to the number each of them selected (from 1 to 4). In total, four groups were formed. Each group was asked to interrogate the implementation of the various interventions and identify critical determinants that could be analysed to determine the extent to which interventions implemented under the reforms helped to improve water management outcomes or not.

Based on the targeted outcomes of the water management interventions stated earlier in this chapter, participants on the platform identified 25 determinants of the water management outcomes for the Accra

metropolis. In Table 5.1, a summary of the water management interventions, outcomes, determinants and the evaluation criteria is presented.

Water management interventions	**Water management outcomes**	**Determinants of water management outcomes**	**Evaluation criteria**
• Decentralisation, • Institutional Arrangement, • Tariff Adjustments, • Infrastructural Expansion, • Subsidy Removal,	Improve water governance	• Institutional coordination and collaboration • Stakeholder participation • Integrated planning • Decentralisation • Lifeline water tariffs • Public-private partnerships • Management capacity and competence • Knowledge production and information management capacity	Level of extent (ratings by experts on the learning platform)
	Improve water resources availability	• Total available water extracted • Total volume of treated water produced per day, • Alternative water sources	Quantitative data from GWCL and WRC
	Increase water access	• Water supply coverage, • Reliable supply of water • Water allocation to poor and deprived households • Water cost per m^3	Quantitative data from GWCL
	Reduce water-related health risk	• Sewage/ wastewater system coverage • Extent of polluted water • Flooding events, • Waterborne disease	Quantitative data from the GSS and GWCL
	Increase water savings	• Cost of water treatment • NRW • Wastewater recycled and reuse • Alternative water sources • Smart metering system • Awareness and education	Quantitative data from GWCL

Table 5.1 Water management interventions, expected outcomes and their key determinants (based on discussions on the learning platform)

5.2.1 Expected outcomes and determinants

Water Governance: This was one of the most desired results of the water management reforms – to improve governance in the management of the water system in the Accra metropolis. By definition, improving water governance in the context of the metropolis entailed strengthening institutions and organisational capacities, policies and practices, and cooperative structures between government and non-state stakeholders to manage water resources and water services delivery. In examining water governance following the management reforms, the effectiveness of interventions, including decentralisation, subsidy removal, and public-private partnerships for water management were evaluated. Other critical determinants of water governance included

the level of managerial competence of institutions, integrated planning for water management, institutional coordination and collaboration for water management, and stakeholder participation in decision making.

Water resource availability: The threat of water scarcity and shortages in the metropolis brought to the discussion platform concerns about conserving and protecting the resources base that supplies the water system. These factors brought to light the importance of knowing how much water is available per year to meet the water demand. As the population grows and water demand soars, water managers are compelled to think about increasing the quantity of treated water supply to meet the growing demand. This thinking raised a number of essential questions, including how much water resources are available and how much could be drawn on a sustainable basis, what are the risks of increasing the volume of water extracted to increase the supply of treated water, and what are there alternative sources of water that could significantly augment current supply? For water resource availability, total available water supply, the total volume of potable water produced per day, alternative sources, preservation and conservation efforts and the proportion of raw water samples at intake point with applicable quality standard were examined.

Water Access: Increasing water coverage and access, particularly in residential households with no reticulation system, were considered crucial to the management reforms. The government introduced measures including infrastructural expansion, water tariff adjustments, and cost recovery mechanisms to increase potable water production and supply, regulate water use and to invest in other sources of water. The extent to which these measures introduced by the government helped to improve water supply coverage, ensure the reliable supply of water and improve water allocation to poor and deprived households in the metropolis was examined.

Water health risk: The lack of attention to wastewater and stormwater management posed significant health risks such as pollution and flooding to the Accra metropolis. Discussions on the learning platform indicated that measures such as infrastructural expansion and decentralisation were supposed to reduce the water-related health risk in the metropolis. The sewage/ wastewater system coverage, the extent of contaminated water, the capacity of the water system to reduce flooding events, and the extent of economic losses associated with flood damages were examined.

Water savings: Perhaps the most sensitive sticking point for the Accra metropolis was the continuous struggle to improve water supply efficiency through water savings. Following the implementation of management interventions such as subsidy removal, tariff adjustments and PSM, the following critical determinants of water-savings were examined, namely, energy costs for water treatment, the proportion of wastewater recycled and reused, alternative water sources, and smart metering system installation coverage.

5.2.2 Process of analysis

During deliberations at the 31st December 2015 platform, notes on the proceedings on the platform were taken by the researcher, assisted by a research assistant from the RCN who has been in charge of taking notes at the national learning platform for the past 5 years. As the researcher, I also doubled as the facilitator of the platform. Submissions from the different groups were given to the researcher and all of them were posted on

the wall. At this stage, all participants came together to have an open discussion on the four submissions and identify similarities and areas of synergies to form a consolidated list. The open discussion was quite revealing as participants offered varying views and justifications for the inclusion of certain determinants deemed essential for assessing the outcomes of water management interventions in the metropolis. Based on the expected outcomes of the interventions - improved water governance, increased water resource security, improved water access, enhanced water health risks, and water savings - a total of 25 determinants were identified and agreed upon by participants on the platform.

Following the deliberations at the platform, individual participants were asked to fill out a questionnaire to provide their views on the extent to which implemented interventions were able to improve water governance in the metropolis. The questionnaire can be found in Appendix III. Data gathered from the questionnaire were mainly qualitative data. The Likert rating scale (with 1-very low; 2-low; 3-average; 4-high; and 5-very high) was employed to quantify the results based on which participants will assess the extent to which the determinants contributed to the improvement in water governance in the metropolis. The five water governance determinants identified in the metropolis included decentralisation, subsidy removal and lifeline tariffs, public-private partnerships for water management, the level of managerial competence, institutional coordination and stakeholder participation in water management. The analysis of water governance was mainly derived from the individual survey.

In the next step, which was on a separate occasion in January 2016, a field survey was conducted involving 15 key experts and professionals in water institutions, among others the GWCL, WRC, WRI and Water Directorate of the MSWR. These informants were not part of the discussion on the platforms. This aspect of the process was intended to gain a broader view of the outcomes of interventions from people outside the platform and to confirm the validity of water data gathered from various sources including their institutions. Information from this survey, in addition to the qualitative data gathered from different institutions were used to assess the determinants of these outcomes - water resources availability, water access, water health risk and water savings.

For the questionnaire on water governance, each determinant was rated using the Likert rating scale (1-very low; 2-low; 3-average; 4-high; and 5-very high) based on the frequency of responses from the participants on the learning platform, which was calculated using Excel. A descriptive statistical graph to assess the various water governance responses by participants is presented as Figure 5.1. The qualitative data obtained from unstructured informant consultations were presented as quotes or blocks to emphasise certain responses and also support interpretations put forward in this study. The researcher decided not to apply individual names of participants to guarantee the anonymity of respondents. For this purpose, the study referred to participants as officials of certain institutions, or by their profession such as engineers, water chemists, and researchers.

At the next platform on the 29 January 2016, the analysis of the results from the different stages were presented on the platform. The results seemed to have generated varying opinions that were more or less skewed towards the general viewpoint held at the institutions where these participants were working (details presented in 5.5)

5.3 Data sources

To undertake the evaluations of the determinants defined under each expected outcome, it was possible to obtain both primary and secondary data from a survey of various water-related institutions in the Accra metropolis. Most of the quantitative data on water supply, access and savings were collected from the GWCL, Water Research Institute (WRI) and Water Resources Commission (WRC). The study drew additional data on water health risk from the Environmental Protection Agency (EPA) and the Ghana Statistical Service (GSS). In the analysis, the pattern of improvement or decline of current and past available data associated with the determinants of these outcomes were examined. For example, to know whether the water manager achieved growth in water supply coverage, it was necessary to calculate the current volume of water supplied based on data before and after water management interventions. In the absence of comprehensive data for past years, available data were compared to the baseline data provided by renowned institutions such as the World Bank, Agencies of the United Nation (UN), and World Health Organisation.

The initial challenge for the researcher during data collection had to do with collecting data on governance issues because it was difficult to identify a standardised system of data collection and data series to measure water governance in the context of Accra metropolis. Part of the reason was that governance issues tend to be politically sensitive issues and therefore, stakeholders, especially those working within government agencies, were extremely cautious about the subject. Water governance data were obtained from the focus group discussion on one of the learning platforms. The platform was made up of a total of 20 experts from various institutions who played vital roles in water management decision making in the Accra metropolis. These experts came from a number of organisations, including the MSWR, AMA, GWCL, PURC, WRC, WRI, EPA, IWMI, CONIWAS, the University of Ghana, and the Water Citizens Network.

The experts came from different academic backgrounds, including water engineering, sociology, water resource management, urban planning, economics, environmental science, water resource science, and hydrology. These people had many years of rich experience and expertise in the field of water resource development and management in the metropolis, and therefore their views on water management issues in this study could be considered as valid data source that is representative of the current situation. For instance, some representatives from the MSWR, WRC, EPA, GWCL, PURC, and the University of Ghana played various roles in the development of the NWP, the IWRM plan and WSSDP.

5.4 Assessing water management practices based on expected outcomes

5.4.1 Water governance

In Figure 5.1, the results of the assessment of water governance following the water reforms in the Accra metropolis are presented. Of the 8 determinants defined for water governance, majority fall within the low (2) and medium (3) ratings according to the responses of the majority of participants on the learning platform. The results suggested that the implementation of the water management interventions might not have significantly improved water governance in the metropolis.

On "subsidy removal and tariff adjustment", of the 18 participants on the platform, 12 scored a low rating (2), 4 participants gave a very low rating (1), while 2 participants scored an average rating (3). The very low to low ratings by the majority of the participants suggested that the implementation of subsidy removal and tariff adjustment did not work as effectively as expected and therefore contributed minimally towards improving water governance in the metropolis. According to representatives of the water users' association on the learning platform, this intervention was rather seen as a measure to alienate the majority of low-income households from participating in decision making in water management. A study by Obeng (2015) confirmed the results on the impact of water tariffs on water service delivery in low-income households in the metropolis.

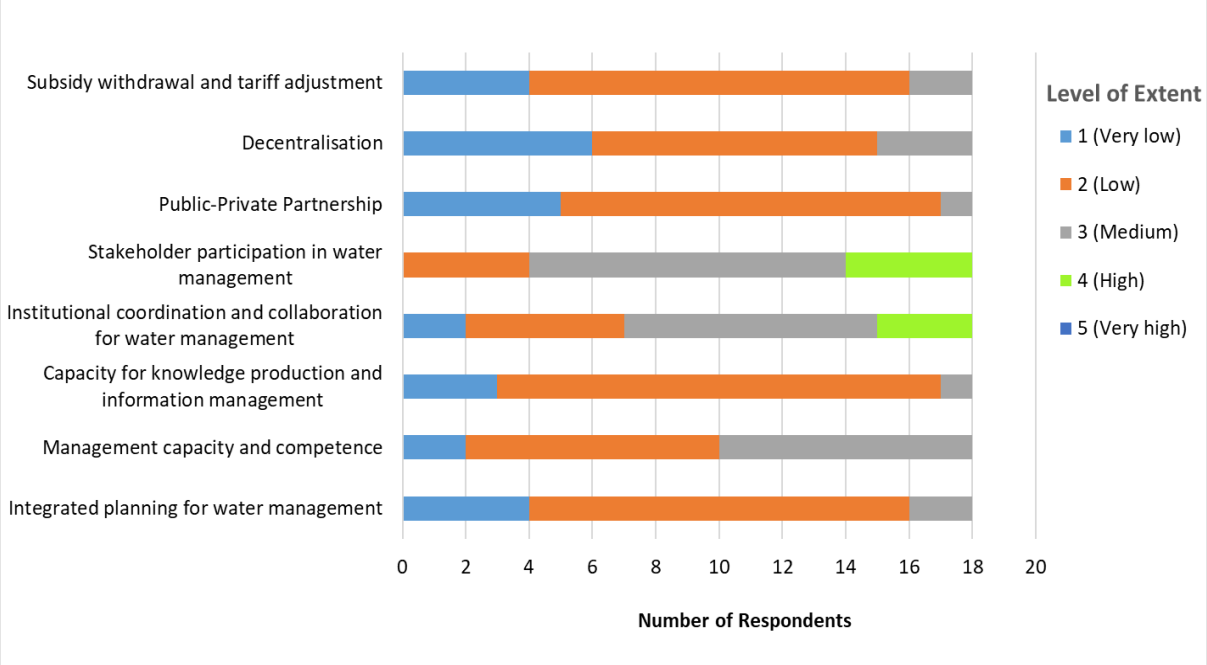

Figure 5.1 Results of the rating of the determinants of water governance

Of the 18 participants on the platform, 9 participants rated the "contribution of decentralisation" to urban water governance in the Accra Metropolis as low (2). Five participants rated the contribution of decentralisation to improved water governance a very low (1), while 4 participants gave an average rating (3). Many stakeholders initially lauded the decentralisation process as an effort to improve local and municipal water governance. It was supposed to reduce the bureaucracies within the centralised administrative system of water governance, clarify roles and responsibilities and equip institutions with the requisite capacities (financial, human and technical) to participate in the efficient management of water and wastewater. However, in the implementation of a devolved system, the capacities of institutions at the local, district, municipal and sub-metro levels with devolved responsibility were not adequately developed thereby leaving a skeletal set up of a decentralised system that could not function effectively.

Twelve participants rated "public-private partnership (PPP)" a low score of 2, while 5 participants gave a very low (1) rating. The unfavourable ratings by the majority of the participants could be due to the poor perception of stakeholders about the real intent and opportunities of the PPP model. As a response to the institutional

crisis, the government introduced the PPP model in urban water management as part of the reforms. The PPP model, presented as a strategy to inject financial capital into a debt-ridden water utility service received mixed reactions from different stakeholders. Proponents of the model, mainly the government argued that the model had the potential to improve the efficiency of water service delivery by removing institutional roadblocks, promoting autonomy, increase transparency, and providing efficient systems for revenue generation, among other solutions.

On the other hand, opponents of the model, including non-governmental stakeholders argued that the PPP focused more on the economic value of water, a situation which somehow impacted negatively on water access to low income and deprived communities in the metropolis. This assertion was shared by several scholars who argued that privatisation or PPP tended to ostracise the sustainable water principle of providing water as a fundamental human right, particularly for the marginalised urban poor (Dagdeviren & Robertson, 2013; Kayaga, 2009). The implementation of the PPP model in the metropolis, referred to as PSM under the private sector reforms was riddled with contestations by several categories of water stakeholders, including some government agencies that felt side-lined by the introduction of a private entity, which later took absolute control of water management instead of a shared management arrangement.

Among all the determinants, "stakeholder participation in water management" recorded a high rating (4) by 4 participants followed by an average rating (3) by ten respondents. These ratings were the most positive ratings so far. One of the visible activities under the reform was the involvement of different stakeholders during the early stages of implementation of some water management interventions such as decentralisation, which paved the way for the establishment of national platforms and forums where different water stakeholders could deliberate and participate in decision making on water issues.

Prominent among these platforms was the setup of the GWF, an annual conference for water stakeholders. This provided a national learning platform, an essential platform from which this study drew key lessons to establish the learning platform. In addition, the Mole Conference Series took place, which was a multi-stakeholder annual platform for water, sanitation and hygiene practitioners. Generally, the majority of participants believed that government policy of encouraging multi-stakeholder participation in water management decisions contributed to improved governance. However, some participants disagreed with this assertion. They instead argued that efforts towards multi-stakeholder involvement in urban water management seemed to be an 'act of showmanship' to "tick the box" or just a façade. They further argued that most decisions were owned by government irrespective of the views of other stakeholders. In the researcher's opinion, there seemed to be some level of truth in both cases – the participation of stakeholders in water management issues was visible and provided a strong sense of ownership among stakeholders, but the critical question remains at to what extent did the involvement of stakeholders contribute to decision making on water management in the metropolis? In a case such as the introduction of the private sector in urban water management, the voice of stakeholders seemed to have been neglected, which later culminated in the rise of the grassroots coalition that mounted fierce resistance to private sector engagement in water service delivery.

The responses on "institutional coordination and collaboration for water management" were somewhat mixed. Of the 18 participants on the platform, 3 rated this determinant high (4), 8 participants rated it an average (3) while 5 participants gave it a low rating (2). In general, the majority of the participants deemed the ratings for this determinant favourable, implying that collaboration and coordination among the different water institutions on water management practices had contributed towards improved governance in the Accra metropolis. For example, according to the WRC, the effective coordination and collaboration between WRC, EPA, and GWCL in the implementation of the river basin plans at the Volta and Weija river basins has yielded positive results in reducing freshwater pollution in the Densu and Volta rivers. These efforts at one point might have contributed to significant improvement in the quality of water and subsequently, reduced water production costs and significantly reduced the excessive use of chemicals by GWCL for water treatment. Participants who rated this determinant very low argued that most of the so-called institutional coordination and collaborations between government and other stakeholders were superficial. They argued that underneath the façade was a show of institutional ego, politics of dominance and unwillingness among key water institutions to collaborate that often hindered joint programming. One such example was the botched collaboration between the GWCL and PURC in the establishment of a social network fund together to improve water supply and access in poor communities in the metropolis (Amankwaa, 2017; Nti, 2016). With such institutional egos and politics of dominance, dealing with the intertwined nature of current water management challenges would require the development of institutional capacities to understand cooperation and the interconnected roles of the various water-related institutions.

With regards to "knowledge production and information on water management", majority of the participants (14) rated it low (2). This is very significant as the issue of knowledge production and information on water management for decision making has been extensively discussed in recent years. A researcher from the University of Ghana on the learning platform stated that the lack of attention and investment in data collection and research on water issues at the institutional level could have been potentially detrimental to the evidence-based water management decisions and policy direction in the metropolis. He further revealed that data and information on water resource development and management in the metropolis remained patchy and in some cases not validated. A scientist from the WRI emphasised the absence of comprehensive water data. In a rhetorical mode, he queried,

> "How can water management decisions and policies be made based on limited data and factual information?"

In a rebuttal, an official from the GWCL argued that, in their case, the company has a robust research division that was responsible for data collection, rejecting the notion that decisions were made based on limited data and information. Other participants argued that there was a general lack of data and information on water issues in the metropolis or data is merely inaccessible for public consumption.

In my reflection, I couldn't agree more with this low rating on knowledge production and information as I experienced challenges in accessing the data available at the various water agencies and institutions, including

the GWCL and WRC. An explanation by a representative from the GWCL was that the institution had become very cautious about releasing data to the public due to past experiences of manipulation and misinterpretation by specific individuals and some media outlets.

The development of a web portal for the water sector by the government seemed to be an excellent opportunity to address the challenges of access to data and information on water. However, the portal has remained dormant due to the absence of data and information to populate it. There seemed to be limited attention and investment on water data and information, which in so many ways might have contributed to the apathy exhibited by public water agencies on research and its role in improving water management in the metropolis. As one participant put it:

> "The reality is that improving governance for sustainable management of water resources in the metropolis is about building trust among water stakeholders, and building trust is about improving transparency by providing sound and reliable data and information about water. Without this, we cannot move forward."

From the results, 8 out of 18 participants gave an average (3) rating on the "management capacity and competence of water institutions" in the metropolis. The same number of participants provided a low rating (2) for this determinant. Although a split response, this was regarded by experts at the learning platform as an improvement following the implementation of management reforms that resulted in the establishment of new water-related institutions. According to participants who gave an average rating, the twists and turns of the shift in water management – from the public to private management and back to public administration signalled a certain level of improvement in the management capacity and competence of water managers in the metropolis. This transition allowed water managers to have a broader perspective on the contribution of other stakeholders in water management, making them more flexible while embracing multi-stakeholder participation in water management decision-making in the metropolis.

Participants who gave a low rating argued that nothing significant has changed in terms of the management capacity and competence of water institutions due to the often subtle political intrusion in water management. They further argued that the water sector in the Accra Metropolis was inherently hydro-political with asymmetrical power relationships deeply meshed in the broader socio-political context of development. For instance, the position of the heads of most public water institutions had become political appointments, with different government appointees assuming leadership positions after every election cycle. Hirvi & Whitfield (2015) found a strong correlation between power relationships and management incompetence in the water sector in the Accra Metropolis. The politics of urban water managerial appointment, contract awards, and procurement processes created institutional tensions and weakened the capacity of the institutions to efficiently and effectively implement appropriate strategies for sustainable management of the urban water system (Hirvi & Whitfield, 2015; Morinville & Harris, 2014). In sum, political interference in water management continued to pose a threat to both institutional and managerial competence in the water sector in the Accra metropolis.

With regards to "integrated planning for water management", 12 out of 18 participants gave a low (2) rating, followed by 4 participants who scored a very low (1) rating while 2 participants scored an average rating (3). Marginal improvements in stakeholder participation and institutional coordination and collaboration for water management have not translated into integrated planning in the metropolis. Unfortunately, Accra does not have a plan that incorporates the management of water, wastewater and stormwater with urban development and planning. From the planning perspective, a planner from the AMA on the platform argued that the current locked-in infrastructure and sparse spatial arrangement in the Accra Metropolis did not encourage integrated planning. According to him, households in several neighbourhoods in the metropolis did not have basic utility provisions such as water and wastewater systems. Such houses lacked spaces for toilets and bathrooms. He laid part of the cause of this challenge on the lack of enforcement of regulations and bye-laws that mandated owners of houses to incorporate water and sanitation utilities in the home.

Another official at the AMA revealed that the lack of investments and the guarded nature of some institutions in the past might have contributed to the poor ratings on integrated planning among stakeholders. He argued that integrated planning at the institutional level was a very cumbersome process that required a lot of time, money and paperwork, and many institutions were not willing to invest in any of these conditions. He further explained this was likely to change with time, particularly in an era where politicians and government were creating an enabling environment for private sector investment in public goods such as water and sanitation infrastructure. For example, the metropolis is now witnessing growing interest and investment in wastewater and sewage recycling under the public-private partnership model. A discussion with a top official of the AMA revealed that the metropolis in partnership with key stakeholders was developing an integrated master plan called the Integrated Urban Environmental Sanitation Master Plan that would harmonise current strategies for sanitation, drainage and waste management to holistically address sanitation and waste management problems in the city.

5.4.2 Water resource availability

According to an official of the GWCL, the volume of water drawn from the Densu river to the Accra metropolis was likely to witness a significant decline due to the havoc caused by mining activities at the upstream of the river. Illegal small-scale illegal gold mining activities, popularly referred to as "Galamsey" (a locally coined word from the phrase 'gather them and sell') has significantly contributed to high levels of chemical pollution of many water bodies according to the government. Chemicals such as cyanide and mercury used in mining activities worsened the degraded quality of freshwater (Affum, Dede, Nyarko, Acquaah, Kwaansa-Ansah, Darko, Dickson, Affum & Fianko, 2016; Kusimi & Kusimi, 2012).

A manager at the GWCL lamented how this mining menace led to the shutdown of some water treatment plants as well as the rising cost of treating poor quality water originating from a mining zone. While the extent of forest and land degradation and damage to water bodies was yet to be estimated, validated footage of the gravity of the polluted water from the National Television and other media outlets in the metropolis showed the almost irreparable damage of water bodies. Any restoration process at the Densu and Volta rivers that flow

into the Weija lake and Volta lake respectively was likely to take many years according to an official from the WRC.

Determinants	Indicators	Description	Unit	Data	Source
Resource	Treated water capacity	The total volume of water produced per day	m^3/ day	463,017	GWCL
	Alternative water supply	The proportion of alternative sources (excluding the largest source) by volume to total available water resources	Per cent (%)	10	WRC
	Freshwater quality	The proportion of 30 raw water samples at intake point with applicable quality standard	Per cent (%)	40	WRI

Table 5.2 Data on water resources in the Accra metropolis (Source: AVRL, 2010)

Accra metropolis receives around 90 per cent of potable water from the two main waterworks – Kpong and Weija. The total volume of treated water produced daily by the GWCL for the Accra Metropolis and its environs is estimated to be 463,017 m^3/day. The amount of treated water produced by the Weija waterworks to Accra for consumption is around 169,987 m3/day of the plant capacity of 203,680 m3/day while that of Kpong is approximately 293,030 m^3/day (AVRL, 2010). The Kpong waterworks have witnessed an increase in the volume of treated water produced by about 40 per cent since 1995 due to the expansion of the water treatment plant at the Kpong waterworks (GWCL, 2015). Analysis of the water supply and demand revealed a deficit of 8 per cent of the daily water supply to the metropolis. A possible reason for this deficit could be the rising population of the city, low contribution of other sources of water supply, and the high level of water loss occurring through leakages. Data from the World Bank suggests that the urban population in the metropolis will very likely surpass 5 million by 2020 and 14 million by 2050, should the urban population continue to grow at the current rate of 3.1 per cent per year (World Bank, 2017).

The contribution of alternative sources of water such as groundwater and rainwater to urban water supply remained very low. Data from the GWCL indicated that groundwater and rainwater contributed approximately 10 per cent of total water supply to households in the metropolis. An official of the GWCL predicted that the use of groundwater for domestic purposes will increase over the next decade based on the emerging pattern of how households were now looking for innovative ways of developing back-up water sources, especially in areas where piped water supply is unreliable.

In neighbourhoods that were not likely to connect to the reticulation system, most households had developed their mechanised boreholes that served as the primary source of water supply. The GWCL anticipated that the increased patronage of groundwater and rainwater usage could help to reduce demand on water supplied by the GWCL to the Metropolis. Nonetheless, an official of the WRC raised concerns about potential overexploitation since groundwater development was currently unregulated. This concern was in light of the

growing exploitation and use of groundwater by plastic and bottled water companies in the metropolis. Even a more significant concern may be the lack of awareness among households and small water businesses about the risk of over-abstraction and misconception about the continuity of groundwater resources. A recent study by Grönwall and Oduro-Kwarteng (2018) reported a general sense of unawareness among residents of the metropolis regarding fluctuations in the groundwater table and risks associated with groundwater over-abstraction. The WRC has the mandate to manage and regulate freshwater resources, including groundwater under the Legislative Instruments (L.I.) (1692) Water Use Regulations, 2001, and the Drilling Licence and Groundwater Development Regulations, L.I. (1827), 2006. However, the WRC official lamented about the limited human and technical capacity of the Commission to measure aquifer recharge and monitor groundwater abstraction in the metropolis.

To further increase the volume of water supplied in the Accra metropolis, the government through a public-private partnership arrangement with Messrs Befesa Limited completed the construction of a desalination plant in 2015. This plant was expected to treat seawater and produce approximately 60,000 m^3 of potable water to supply the metropolis and surrounding areas. However, the desalination treatment plants halted operations after a few months of operating due to a misunderstanding regarding the water purchasing agreement between the Befesa and the GWCL, according to an official of the GWCL. In sum, the production cost per litre of seawater was far more expensive than the selling price. Four years down the line, the desalination plant is yet to make any meaningful contribution to the current volume of water supplied to the metropolis.

5.4.3 Water access

The Accra Metropolis has experienced a mixed pattern of water supply coverage in the past two decades. In spite of the recent increase in water supply coverage, the Metropolis still faces a supply deficit. Approximately 25 per cent of the residents in the Metropolis had no piped water coverage. Such residents relied on secondary water service providers to meet their daily water demand. This limitation in water supply coverage to the metropolis allowed small and medium private water service providers to fill the gap. According to the GWCL, there were around 1200 small and medium scale enterprises that were providing secondary water service delivery to residents in the Metropolis. In a survey of these private water service providers, the study identified three categories of secondary service providers based on their sources of water. The first group of service providers were those that operated mechanised boreholes, drew groundwater and sold it to consumers in areas not connected to the reticulation system. There was no treatment of water from boreholes or groundwater sources. The second group tapped water from the GWCL distribution points and redistributed to unconnected areas and areas that did not receive regular water supply at a higher cost. The third group of water service providers were the more sophisticated group that tapped water from both sources (mechanised boreholes and pipe water from GWCL), conducted another layer of water treatment and put the treated water in bottles and sachets for supply.

Outcome	Determinants	Description	Unit	Data	Source

Access	Water supply capacity	Daily water supply per capita	m^3/cap/day	0.50-1	GWCL
	Water supply coverage	The proportion of residents with access to piped water supply	Per cent (%)	69	GWCL
	Water tariffs	Cost of water /m^3/average	U$/$m^3$	0.9	GWCL
	Reliability	Proportion of residents with regular water supply	Per cent (%)	75	GWCL

Table 5.3 Data on water supply and access in the Accra Metropolis (GWCL, 2011)

In the survey, it came to light that many water service providers were switching from piped water sources toward borehole water sources. According to the representative of the water users' association, two possible reasons were likely to drive this shift. One, the cost of treated water supplied by GWCL to water service providers was very high, which made the profit margin almost insignificant. Compared to the cost of treated water from GWCL, water from the mechanised borehole was significantly cheaper with a high-profit margin. Households would instead use water from a borehole for domestic chores such as washing, bathing and cooking and buy sachet or bottled water for drinking.

The results showed that the activities of these water service providers were not regulated by law despite the GWCL, WRC, and PURC knowing about their existence and operations. According to the Water Resources Act, 2006, all water exploitation activities, including boreholes, and irrigation dams, among others require permits issued by the WRC. An official of the WRC conceded that monitoring the activities of water service providers had proven to be very difficult due to the scattered and hidden nature of the business. He explained that many of these enterprises hid in walled houses in neighbourhoods that made it difficult to detect and regulate them.

Analysis of data from the PURC suggested that the average water tariff per month was relatively high for the average household in the Accra metropolis. The average cost per cubic meter of water was said to be US$0.9, which may be expensive based on the standard of a developing city where the majority of the population lived on less than US$30 a month. Even though the water tariff was on the rise, the reliability and access to water in the Accra metropolis had improved during the period of private sector water reforms. Approximately 69 per cent of residents have access to potable water for at least 6 hours daily throughout the week. There were variations in terms of the duration of access. Data from the Ghana Statistical Service suggested that approximately 25 per cent of the city's residents received uninterrupted water supply daily throughout the week, while 40 per cent received an average of 12 hours of water supply every day for the week. About 25 per cent of the residents received piped water less than 6 hours a day, while the remaining 10 per cent did not get water running through their pipes. The stakeholders on the learning platform validated these figures.

Figure 5.2 shows the spatial classification according to the frequency of water supply to the metropolis, including areas that receive regular water supply. The significant parts of the metropolis identified with the

three categories of "no or poor water supply", "intermediate water supply" and "rationed water supply" (Tutu & Stoler, 2016). The frequency and access to water supply often correlated with the existence of well-established pipe network, area of prominence (planned neighbourhood), as well as areas in dire water needs such as areas with large hospitals and industries. For instance, in the map of the metropolis below, areas with "good water supply" are characterised by well-established pipe network to households and in some cases, residential areas where eminent people lived. Areas with "rationed water supply" were mostly low income, spatially unplanned areas with often high water losses and little water revenue.

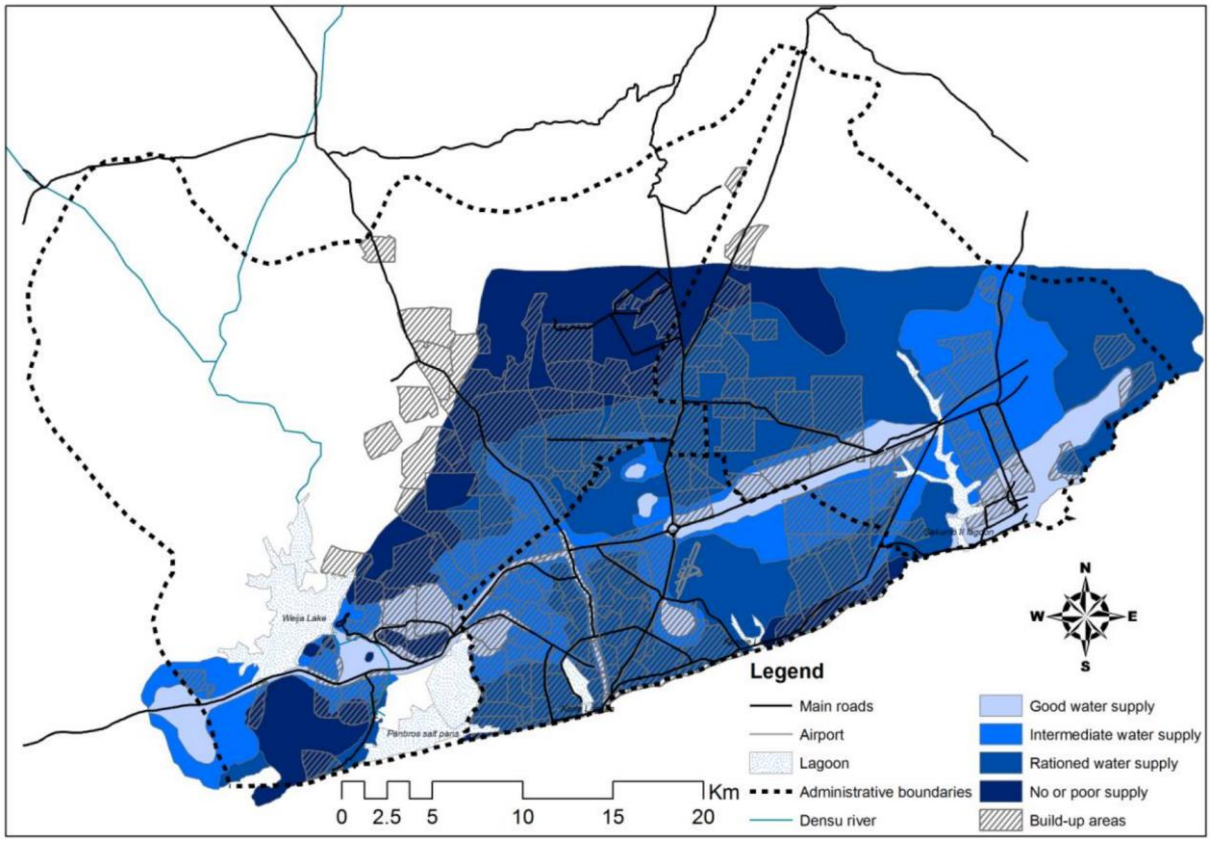

Figure 5.2 Rate of water supply within the Accra metropolis (Source: Dzodzomenyo, Dotse-Gborgbortsi, Lapworth, Wardrop & Wright, 2017)

Access to potable water supply varied according to the level of income of consumers, the frequency of water flow and area of residence. Within the domestic (household) sector, the study categorised water users into three main groups based on the socio-economic status and water flow conditions, ranging from the continuous flow, intermittent good, and intermittent poor flow (Table 5.4). These user groups consisted of low-income water users, who lived in densely populated areas of the city, the middle-income, and the high-income water users. Based on the analysis of customers' consumption data from the GWCL, the results showed that in the low-income water user group, the daily water supply per capita ranged from 43 litres per capita per day (l/c/d) for intermittent water flow to 66 l/c/d for continuous water flow. Daily water consumption for the middle-income group ranged from 54 to 90 l/c/d, which was above the minimum water requirement of the WHO, indicating reasonable access to water. In the high-income category, water consumption per capita ranged from 75 to 138 l/c/d. These results had not changed significantly compared to the findings of Lamptey (2010), who

analysed customers' water consumption data from 2004 to 2008. The World Health Organisation (WHO) estimated the basic water requirements (drinking, cooking, bathing, flushing toilet, and personal hygiene) to be between 50 and 150 l/c/d (United Nation-Water, 2013). In the metropolis, the daily water supply per capita for intermittent water flow (43 l/c/d) was below WHO's minimum requirement of 50 l/c/d and the UN-Water optimal water demand of 150 l/c/d, indicating a deficit or limited access to water.

Socio-economic Category	**Water Flow Conditions**		
	Continuous (l/c/d)	**Intermittent good (l/c/d)**	**Intermittent poor (l/c/d)**
Low Income	66.0	56.0	43.0
Middle Income	90.0	83.0	54.0
High Income	138.0	110.0	75.0

Table 5.4 Water consumption per capita according to socio-economic category (Based on data from GWCL, 2010)

5.4.4 Water health risks

Responses from consultation with water officials suggested that potable water supplied through the pipe network system was generally free from contaminated elements, with the quality of treated water from both waterworks conforming to the WHO guidelines for drinking water. A study by Gyamfi et al. (2012) to determine potable water quality in Accra revealed a pH range (6.64-7.80), temperature range (25.2^{o} C - 26.2^{o} C), conductivity range (187-725 µS/cm), total dissolved solids (90-352 mg/L), total suspended solids (0-4 mg/L), bicarbonate (68.27- 121.91 mg/L), chloride (11.996-343.89 mg/L), Phosphate, (BDL-0.128 mg/L) and sulphate (0.08-0.40 mg/L).

According to data from the metropolis, the proportion of residents with access to domestic sewage system was at an all-time low with only a quarter of the population connected to the sewage system. The metropolis has experienced a decline of 25 per cent in sewage coverage over the last decade due to the rapid urban expansion and the declining capacity of the sewage system to cope with the excessive sewage (WHO & UNICEF, 2008). From the data analysed, the metropolis produced 120,000 m^3 wastewater and sewage per day. Only 26,000 m^3 of the total volume of wastewater passed through the centralised sewage system (Takouleu, 2019). A significant proportion of wastewater produced was neither treated nor passed through the public sewage system. Instead, users discharge wastewater directly into the lagoon, rivers, stormwater drainage systems, and on the bare ground. The inadequate sewage system coverage and the lack of proper channels of treatment and discharge contributed to the high inefficiencies in the wastewater flow as well as the high level of pollution of surface water. Most of the streams, rivers, and lagoons in the metropolis were characterised by high turbidity and high concentrations of heavy metals as a result of the inappropriate discharge of untreated wastewater from the households, hospitals, industries, and commercial centres. These actions contributed to high water pollution and the outbreak of water-borne diseases, such as cholera and diarrhoea in the metropolis.

Under the Accra Sewage Improvement Project (ASIP), the GoG planned to construct two new major Sewage Treatment Plants (STPs) at Densu Delta and Legon to reduce the sanitation challenges confronting the Accra metropolis (AfDB, 2005). The project included:

(i) Construction of two treatment plants at Densu Delta (5,934 m^3/day) and Legon (6,424 m^3/day);
(ii) Eight (8) Pumping Stations (PSs) provided at interception points of the existing gravity mains;
(iii) Pumping/gravity mains of length 32.8 km supplied and laid to transfer the wastewater flows from the TPSs to the respective STPs;
(iv) An Outfall Pumping Station (OPS) and a 1.25 km marine outfall provided at Densu Delta STP with all associated environmental protection and improvement works;
(v) Rehabilitation and extension of the sewage network of a total length of 63.1 km to non-sewered areas;
(vi) Rehabilitate house connections and construct new ones totalling 4,184, in parallel with the construction of the sewage network to ensure adequate flows to run the system;
(vii) Construction of 147 public toilet blocks and 37 septage /night soil reception holding tanks around the city;
(viii) Procurement of sewer maintenance equipment and cesspit emptier to cope with the expected increased demand and operational requirements of the sewage system;
(ix) Provide institutional training and consultancy services to execute organisational, operating policies and procedures, tariff studies and comprehensive local functional training to the sewage staff.

The appraisal report of ASIP noted that there was approximately 15 per cent conventional sewage network coverage in the metropolis in 2005. Even though it is not clear how authorities arrived at this figure, it seemed a bit higher considering that data from the GWCL put the total production capacity at about 10,000 m^3/day, which appeared to cover less than 10 per cent of the metropolis. The total number of entities connected to the sewage system was estimated to be 1,133, including 537 households, 529 Commercial sewers, 59 Government sewers, one industrial sewer, and one institutional sewer. Even with the completion of this project, the total capacity of the wastewater treatment plant would not adequately cover the entire metropolis.

The Accra metropolis experiences frequent events of severe flooding annually. Between 2006 and 2011, the metropolis witnessed an average of two critical flooding incidents yearly (Asumadu-Sarkodie, Owusu & Rufangura, 2015). These flooding incidents had severe social and economic implications. The high frequency of flooding could be associated with the weak drainage system and the absence of integrated risk prevention and disaster management strategy to deal with the annual crises. With the rapid rise of urban expansion and informal settlements in the metropolis, both natural and artificial drainage systems appeared to have diminished drastically. One of the significant limitations of the management reforms was the lack of laid-out plan to integrate flooding and stormwater management as a critical component of urban water management. As a result, flooding and the associated impacts have been managed in an ad hoc manner by the NADMO without effective coordination with other institutions such as the GWCL, AMA, and the MSWR.

5.4.5 Water savings

One of the expected outcomes of the water management reforms was to improve water savings by reducing the high level of NRW. Data from the GWCL revealed that the Accra metropolis continued to struggle with a rate of above 50 per cent NRW. The percentage of NRW far exceeded both the international best practice standard benchmark range of 20 – 33 per cent for low-income countries (van den Berg, 2014). Data from the GWCL suggested that the daily cost of NRW was estimated to be over US$300,000. An official of the GWCL, describing the NRW dilemma as the "Achilles Heel" of the GWCL, indicated that the difficulty in achieving set NRW targets emanated from years of accumulated failure to address the underlying causes. These causes included (i) physical leakages, (ii) illegal connections, (iii) inaccurate manual metering readings, (iv) estimation and use of flat-rate water rates, and (v) weak revenue collection procedures.

The process of obtaining a meter has been described by customers as very tedious and complicated, making it difficult for residents to pursue a legitimate pathway of connecting their houses to the reticulation system. For example, to connect a house to the reticulation system via a metering system, one has to submit a proof of ownership of the structure, facility or house, site plan, land titles, and other documentation. Documentation such as proof of ownership, land titles, and site plans were difficult to obtain due to the long complicated and money-involving process. This challenge serves as a deterrent for house owners and tenants who want to apply for a metering system. For people who rented houses and other properties, they were by default unable to obtain a meter to connect to the reticulation system.

An important measure to save water in the Accra metropolis was to promote wastewater recycling and use. As a desirable outcome, there was a thinking that the implementation of water management interventions under the reforms would also promote the emergence of wastewater recycling enterprise and encourage the application of treated wastewater in non-consumptive uses, including landscape watering, urban irrigated agriculture, and toilet flushing. However, wastewater recycling remained very low following the implementation of the water management reforms. Data from the GWCL suggested discharge of close to 95 per cent of wastewater into rivers, lagoons and the sea without any form of treatment. A possible reason given by an official of the GWCL for the low level of wastewater recycling and reuse activities was that the idea was still new, expensive and complex to undertake in the context of a developing city. In his view, the absence of infrastructure, technologies, lack of investment, and policy incentives are key factors that did not encourage wastewater recycling and reuse. In a counter view, a representative of the Metropolitan Assembly asserted that wastewater recycling and reuse were instead not considered as priorities nor regarded as a potential resource that can substitute for treated water in specific water uses.

Wastewater use for irrigated agriculture remained a very silent but a common practice in the metropolis (Antwi-Agyei, Biran, Peasey, Bruce & Ensink, 2016; Keraita, Abaidoo, Beernaerts, Koo-Oshima, Amoah, Drechsel & Konradsen, 2016). A significant proportion of the vegetables produced in the metropolis come from the use of wastewater from rivers, streams and gutters. The probable reason for the silence was that the metropolis had not experienced any major disease outbreak as a result of consuming vegetables produced using untreated wastewater. Despite the silence on wastewater use for irrigated agriculture, promoting recycled

wastewater use at a broader scale may face public scrutiny and social acceptance hurdles. This situation partly explained the less reporting on recycled wastewater reuse for irrigated agriculture in the metropolis.

5.5 Stakeholders views versus reality

On the subsidy removal and tariff adjustment, the majority of participants argued that the removal of water subsidy and the subsequent tariff adjustment reaffirmed that notion water consumers had about the new era of thinking, about water for business (as an economic good) rather than water for society (as social good). Participants argued that the implementation of such an intervention clearly drew the line between the "haves" (medium- to high-income residents) and the "have less" and the "have nots" (low-income residents) by somehow establishing access, based on the ability to pay for water service. For the stakeholders, it might have also strengthened the voice of "the haves" in decision-making regarding water service delivery while alienating the majority of the populace who fall in the category of the "have less" and have nots".

Records of complaints at the GWCL indicated that water supplied by the communities via standpipes was not sufficient to meet the water needs of these communities. As a result, communities supplemented their water needs with services from secondary service providers. Water consumers in these areas – normally low-income with a high number of unconnected households – complained that their "voices" have not been heard regarding their demands and requests for more investment in pipe networks in their areas. They argued that tariff adjustments in water service delivery tended to hit them harder due to the complicated arrangements associated with the multiple water delivery channels. Water service delivery to these areas was mainly through the community standpipes, and secondary and tertiary water service providers such as water vendors, water tankers and sachet water producers who charge exorbitant fees for water service delivery. According to residents in unconnected low-income areas, it is not attractive to participate in decision-making on water services delivery because for a long time their contributions have not yielded the desired outcomes.

Deeply rooted in the NWP are the equity and pro-poor principles of ensuring safe and adequate water supply to all people, particularly the poor and vulnerable urban households. Yet, the implementation of the pro-poor model, based on the principle of the fundamental right of access to water conflict with the policy strategies of full cost recovery and water sector privatisation (Ghana Integrity Initiative (GII), 2011). Water service delivery to low-income areas remains a major challenge given that these areas constitute about 60 per cent of the urban population without a pipe network to their households (Ainuson, 2010; Obeng-Odoom, 2012a).

According to data from the GWCL, the implementation of the "subsidy removal and tariff adjustment" intervention increased water coverage to around 75 per cent by 2011. This coverage consisted of pipe connections to both households and community standpipes in areas with unconnected households. The GWCL maintained that standpipes in unconnected communities served as contingency measures to address water needs and that there was a long-term plan to build pipe networks in all communities. The GWCL argued that the adjustment of water tariffs from time to time was necessary to mobilise adequate funds to invest in pipe networks and extend water coverage to unconnected areas. It also counter-argued that adjusting tariffs was not

about creating boundaries between "haves" and "have nots" but mainly about ensuring full cost recovery as well as regular and reliable water supply, particularly to deprived communities. The GWCL asserted that its effort to improve local water governance was manifested in the establishment of the community-based Local Water Boards (LWBs) in densely populated low-income areas of Accra to facilitate water service delivery to under-served and unconnected urban areas in Accra (Morinville & Harris, 2014). These Boards, which comprises 10 to 15 elected representatives from social groups such as women, youth, and cooperatives serve as intermediaries between the GWCL (producer) and communities (consumer), as well as a communication channel for the communities to present key issues related to the water supply to the GWCL.

By operating water tanker and vendor services, the LWBs purchase bulk water from the GWCL and distribute to their communities at a negotiated fixed price. The LWB model demonstrated certain aspects of a polycentric system of governance, representing a formal institution fashioned to regularise informal water service provision through participation and involvement of communities in urban water decision-making (Ostrom, 2012). As a good initiative, the LWB attracted financial assistance and collaborative partnerships with donor agencies such as United States Agency for International Development (USAID), Bill and Melinda Gates Foundation (BMGF) and Global Communities to strengthen the organisational capacity of the Boards as well as execute activities such as borehole construction to extend alternative sources of water supply to underserved communities (Morinville & Harris, 2014). However, the LWB model has come under intense scrutiny due to the fact that the actions of the Boards have not significantly contributed to affordable water supply, rather water charges remain more expensive for the majority of low-income households (Ibid).

In the researcher's view, the removal of subsidies was a "necessary evil" to avoid the collapse of the utility company, GWCL and the financial burden on the government. Water tariff adjustments from time to time are inevitable and essential to match the soaring cost of water production. However, the complementary policies such as the lifeline policy designed by the PURC and GWCL and meant to cushion low-income groups might bring a sense of self-importance and benefits to low-income and deprived groups if effectively implemented.

On the contribution of decentralisation to improve water governance in the Accra metropolis, majority of participants on the platform concluded that the decentralisation contributed to the establishment of institutions for water management and service delivery but failed to make a desirable impact in the Accra metropolis. Evidence from multiple sources seemed to corroborate this conclusion about the failure of decentralisation to significantly improve urban water governance or to strengthen the financial viability of the GWCL (Abdul-Gafaru, 2017; Owusu, 2015). According to Owusu (2015), the spread of autonomous local and municipal government assemblies within the context of urban expansion in the metropolis tended to restrict metropolitan-wide planning. This was probably due to the lack of adequate resources including, human capacity, financial, and technologies to implement interventions at the local and municipal levels.

Under the decentralised system, the GWCL became solely responsible for the treatment, processing and management of water supply and distribution to the metropolis. For wastewater management, the AMA was responsible for the collection, treatment and discharge of wastewater and sewage, and managing stormwater

drainage systems in the city of Accra. The decentralisation process was purely institutional, with limited technical capacity and resources to back institutions involved. Following devolution, the AMA established a new Sewage Unit to operate and maintain the city's sewer infrastructure. In spite of the split, the GWCL continue to charge sewage fee on the water bill, which was expected to be transferred to the Sewage Unit periodically. Evidence of the low sewage coverage (15 per cent) in the Accra metropolis seemed to suggest that this arrangement did not work out well (GWCL, 2011).

The majority of the stakeholders were of the view that public-private partnership (PPP) intervention in the form of PSM of the water system failed to live up to its hype. Analyses of economic and financial data from the GWCL (2011) on the outcome of the private sector control of the water system in the metropolis revealed an increase in water production by just 15 per cent from 212 to 245 Mm^3 between 2006 and 2011. The volume of water billed and sold to water users also increased by almost 23% from 100 to 123 Mm^3 during the same period. Water revenue increased from GH₵ 55 million to GH₵ 143 million, with total income increase from GH₵ 57 million to GH₵ 146 million during the period. These increases were linked to 50 per cent increase water tariffs instead of the impact of outcomes of interventions under the reforms. Again, NRW remained above 50 per cent during the period. One of the reasons given by the government for the non-renewal of the PSM contract was the limited effort put in place to drastically reduce the NRW (Hirvi, 2012; Morinville & Harris, 2014).

Stakeholder participation, institutional coordination and collaboration, and management capacity and competence rated relatively favourable in improving the outcomes of water management interventions in the metropolis. It is modest to say that the implementation of water management reforms improved some aspects of water governance in the metropolis based on the viewpoints and justifications provided by participants on the learning platform. For instance, the enhanced stakeholders' participation and engagement of civil society actors and water users' association in water governance strongly influenced the outcome of the reforms (Adam, 2011). Evidence of increased participation of stakeholders and coordination among water institutions could be seen in the several functional platforms, including the National Level Learning Alliance Platform (NLLAP), GWF, and Joint Monitoring Program (JMP) on water and sanitation, among others (Verhagen, Darteh, Osei-Tutu & Adank, 2011). According to a public official on the platform, the engagement of various stakeholders in the decision-making process enhanced the legitimacy of negotiations and helped to validate decisions taken.

Even though stakeholder's engagement and participation in water management decision-making process had gained popularity, the reality of such a platform might often be prone to conflicts with high contestation, serving as a tool for elite capture and power-wielding. On such a platform, decisions made during the participatory process on water management might not entirely be representative of the position of the majority of actors but the few with power.

According to the GWCL, the metropolis has multiple sources of freshwater supply. For stakeholders, chances were that freshwater supply to the metropolis might not run out anytime soon. However, there seemed to be potential threats to the availability of freshwater supply to the metropolis. There has been a decline in water

resources flow from the primary water sources due to several factors including sedimentation, mining, land degradation, deforestation, and agricultural activities (Anornu, Kabo-bah & Anim-Gyampo, 2012; Owusu, Asumadu-Sarkodie & Ameyo, 2016). An important observation regarding the implementation of water management interventions was the lack of attention to the interaction between the water system and the hinterland, which holds the two primary surface water sources. It seemed the GWCL did not realise that fact that the collapse of upstream water sources due to mining, sedimentation, erosion, and other factors could significantly limit flow into the dams that supply the two waterworks. For such a situation, strengthening institutional coordination between GWCL and WRC could be instrumental in dealing with the water catchment challenges.

Perhaps one of the outcomes of the water management interventions with its "twists and turns" was the improvement in access to potable water in the metropolis. The coverage and access to treated water in the metropolis increased from 62 per cent to 75 per cent following the private sector water reforms from 2006 to 2011 (GWCL, 2011). However, the majority of stakeholders questioned the percentage of water coverage and access defined by the GWCL as misleading because this percentage consisted of standpipe installations in low-income neighbourhoods. For example, a whole neighbourhood of about 10, 000 households with 5 or 10 standpipes was included in the percentage coverage. The reality was that these neighbourhoods with standpipes and not household pipe connections had complained about the limited water supply provided by standpipes.

Stakeholders at the learning platform argued that water savings remained a deep-rooted challenge in spite of the PSM in the metropolis. Data from the GWCL indicated that water loss through NRW was consistently at 50 per cent or above from 2006 to 2011 despite the implementation of several interventions that were aimed at reducing water loss and increasing water savings (GWCL, 2011). From the survey of neighbourhoods in the metropolis, there seemed to be a weak culture of water savings among domestic consumers. Perhaps, this culture was likely to stem from decades of enjoying water as a free commodity because of subsidised water. However, the massive acute water shortages that hit the metropolis in the mid-2000s ushered in a new era of progressive change in attitude about the value of water and the need to save water (Amankwaa, Owusu, Owusu & Eshun, 2014; Harris, Rodina, Luker, Darkwah & Goldin, 2016). As part of the nation-wide water-saving effort, the AMA instituted a ban on the use of potable water for non-drinking purposes such as commercial car washing, industrial cooling, and urban irrigated agriculture (Accra Metropolitan Assembly (AMA), 2011). At the household level, people began saving water in large storage cans and became more purposeful in the use of water. Despite this effort, the critical recurring question remained why NRW was still high.

The NRW menace was a complex challenge that traversed multiple levels within and outside the water system. At the physical level, NRW was prevalent due to leakages in the reticulation system. At the societal level, several households and vendors were illegally connected to the reticulation system without a metering system. And at the administrative level, several public sector institutions such as public hospitals, that were legitimately connected did not pay or delayed in the payment for water service delivery. To implement interventions to

deal with NRW, water managers must understand the dynamics of NRW and prepare a mix of infrastructural, economic, regulatory and technological solutions that could target the specific areas where NRW occurs.

In a nutshell, it might not be about the management regime per se, whether private management or public sector ownership, but the types of interventions implemented and the outcomes generated. It would also be about the process of implementing these interventions whether the various prevailing dynamics in the city described in Chapter 4 are factored into the process of implementation. For example, having adequate stakeholder consultations and creating public awareness prior to the implementation of a particular intervention can strongly determine the success of the implementation. Several interventions were applicable in both the PSM or public sector ownership. However, critical was the effectiveness of these interventions to drive the necessary changes and contribute to the desired outcomes in the urban water system.

5.6 Towards a framework for a sustainable pathway towards water management in the Accra metropolis

Some positive outcomes did emerge from the water reforms in the Accra metropolis that were introduced during the 2006-2011 period. However, from the assessment, there were limitations as well as areas of opportunity that can be looked at to improve water management outcomes. A key problem was the lack of an appropriate guiding framework that could support water managers to have a holistic view and a pathway for implementing water management strategies. In 2011, the WSSDP was proposed by the government as a framework that could provide essential guidelines to support water managers in the implementation of interventions for sustainable management of the water system.

Several activities were carried out in preparation of the WSSDP. The stages of the iterative process that led to the development of the plan are outlined below. These stages were considered critical to the preparation of the framework and also a necessary response to stakeholder participation issues raised during the period of water privatisation reforms. The process which included eight iterative stages: setting up the multi-stakeholder platform, diagnosing the water management problem, ideal visioning outcomes, strategising and risk analysis, developing water management strategic plan, implementing the plan, developing indicators, and monitoring and evaluating:

Stage 1: Platform Setting – By mid-2011 when PSM had been transferred back to public management, the government set up a multi-stakeholder platform that brought together all water stakeholders across the country to deliberate on the development of the WSSDP. The rationale was also to build a sense of co-ownership of the process as well as encourage active participation in thinking about a more sustainable pathway to address the issues identified during the era of private sector water management. The platform lasted for 3 months with consultations and deliberations among stakeholders occurring in all the cities across the country. According to the government, the establishment of the platform was also meant to legitimise consultations and engagement of all stakeholders on deliberations on water management issues right from the beginning. Stakeholder

participation seemed to have gained roots in the current water management practice in the metropolis following years of strong advocacy for stakeholder participation (Oteng-Ababio, 2014). According to representatives of NGOs and civil society actors on the learning platform, the multi-stakeholder platform set up by the government was not about "showing up and being counted" but to ensure that the views and positions of the various stakeholders are captured and translated into strategies, outcomes, activities, and indicators to support the sustainable management of the water system in the metropolis. Experience from the researcher's earlier work on small dam's management in the northern part of Ghana affirms the critical importance of multi-stakeholder participation and engagement in research and decision-making processes (Acheampong, Ozor & Sekyi-Annan, 2014).

Stage 2: Diagnosis – On the multi-stakeholder platform, all stakeholders, including the government, participated in the deliberations on the current status of water management in the Accra metropolis - the transition from PSM back to public control. Through dialogue and focus group discussions, stakeholders made several submissions that seemed to capture the multifaceted problems and threats facing urban water sector from a broader perspective. At the end of the meeting, it appeared that the government got from multiple stakeholders an array of submissions that could help give a more accurate diagnosis of the nature of problems as well as provide essential clues for proposing targeted solutions to address the issues.

Stage 3: Visioning – This stage allowed stakeholders to assess the magnitude and interconnected nature of water management problems, the associated causes, and impacts. For example, one issue that came up strongly was how to re-establish the connection between water and wastewater management challenges and environmental challenges (such as pollution, degradations and over-extraction) as well as the quality of water sources in the hinterlands. It may be recalled that during the period of PSM, the water supply to the metropolis was separated from wastewater management. Stakeholders eventually settled on the vision to "sustainable water and basic sanitation for all by 2025". This meant ensuring total access to adequate, affordable and reliable water services, and safe sanitation by all residents while managing water resources sustainably.

Stage 4: Strategising and risk analysis – Based on the diagnosis and vision, stakeholders initiated the development of suitable strategies for the sustainable management of urban water and sanitation. This stage proved to be quite challenging in terms of capturing the views and assumptions of various stakeholders. Here, the different stakeholders argued and justified the inclusion of their suggestions for improving water management in the Accra metropolis. It was also the stage where the multiplicity of ideas from several stakeholders with diverse backgrounds created stagnation in the process of strategising. In the end, the following goals and strategies were defined for the WSSDP:

Goal 1: To achieve universal coverage for water and sanitation services by 2025:

- increase urban water coverage from 59 per cent in 2009 to 85 per cent in 2015 and 100 per cent in 2025;

- contribute to improving the national sanitation coverage from 13 per cent in 2008 to 53 per cent in 2015 and 100 per cent by 2025;

Goal 2: To ensure sustainable financing for investments, operation and maintenance of water services:

- increase sector investment to US$350 million annually for water and sanitation services
- ensure full recovery of rehabilitation, operation and maintenance costs of urban water service by 2015;
- secure at least 5 per cent of the water and sanitation sector investment financing from other sources including private sector financing and internally generated funds for investments by 2020;

Goal 3: To ensure that water sector institutions have the required expertise, information, equipment, logistics and financing to perform their functions efficiently and effectively in a transparent and well-coordinated manner by 2025

Goal 4: To ensure sustainable harnessing, utilisation and management of water resources by 2025:

- Develop a framework for managing and protecting water resources for improved water security and enhanced resilience to climate change;
- Strengthen water resource planning, decision-making and operational capacity through improved access to knowledge and expertise in integrated water resource management;
- Ensure that effective institutional coordination and collaborative mechanisms for water resource management are in place; and
- Strengthen and improve trans-boundary and international cooperation in the management of shared water resources.

Stage 5: Development of the WSSDP– The multi-stakeholder platform ended with a clear plan of action to prepare a draft WSSDP over three months based on the goals and strategies identified. The plan contextualised the current urban water problems and identified tailored-made medium and long-term water and sanitation management. A 15-member committee led by the representative of the MSWR and composed of representatives of the different government water and related institutions, NGOs, metropolitan and municipal assemblies, civil society group, and the private sector was tasked to submit a draft plan with the help of a consultant by 2012. A more detailed description of the various components and implementation of the WSSDP in the Accra metropolis will be presented in Chapter 6.

5.7 Conclusion

Divergent views have been expressed about the outcomes of the water reforms that occurred due to the transition from public to PSM in the Accra metropolis. Under the reforms, interventions, namely decentralisation, institutional arrangement, tariff adjustments, infrastructural expansion, and subsidy removal were implemented. The implementation of these interventions was intended to build a technically and financially self-sufficient water system that could achieve the following sustainable outcomes of water management. These outcomes included – improved water governance, increased water supply efficiency and water availability, increased water coverage and access, increased water savings, reduction in water-related health risks.

Based on the evaluation of these outcomes, it is safe to say that the implementation of interventions under the water management reforms brought about some positive changes in the water management in the metropolis but fell short of fully achieving the expected goals as stated from the outset. The below-par performance led to the return of water management to public control again, after five years of PSM (2006-2011). The GoG developed the WSSDP intended to provide the framework for achieving the vision of providing sustainable access to clean water and basic sanitation for all citizens by 2025. The underlying idea behind the framework is to stimulate holistic thinking around water management solutions, taking into account linkages among the multiple water challenges and various interests. According to the government, lessons drawn from previous water management phases including the PSM (2006 -2011) were instrumental in the development of the WSSDP. In the next chapter, the attempt by water institutions to operationalise the WSSDP through the implementation of interventions deemed capable of addressing the management challenges in the Accra metropolis is presented.

Chapter 6: Implementation of Water Sector Strategic Development Plan (WSSDP) in the Accra Metropolis

6.1 Introduction

The implementation of interventions under the PSM reforms represented a transition milestone in the history of the Accra metropolis. The interventions that were implemented to transform the water system in the Accra metropolis produced somewhat mixed outcomes. These results prompted the return to public water management at the end of 2011. At this point, it appeared pressure was mounting on the government to assure the country of its capacity to manage the water system. The government began the preparation of a framework that would support urban water management practice in 2011. The output was the nationwide WSSDP in 2012. This plan articulated the government's vision under public water management to implement interventions that were aimed at facilitating the sustainable management of water resources and ensuring universal access to sufficient, and affordable water and reliable sanitation services by 2025 (Government of Ghana, 2014).

Since 2012, interventions under the WSSDP have been implemented. Within this period, several milestones have been achieved. In this chapter, the implementation of the WSSDP is presented, focusing on how the plan addressed some limitations of the PSM solution discussed in Chapter 5. This is followed by the development of a set of indicators to measure the extent to which the outcomes of the interventions implemented under this WSSDP were achieved.

6.2 Water Sector Strategic Development Plan (WSSDP)

The WSSDP was prepared by a Committee led by the MSWR on behalf of the GoG. The plan provided a framework for the implementation of interventions set out by government agencies for water and sanitation service delivery. It was also meant to guide the non-state institutions as they plan water resources development programs and execute sustainable water and water-related sanitation activities in the country. In line with the government's vision to ensure "sustainable water supply and basic sanitation services for all by 2025", the goal of WSSDP was to improve the living standard of the people of Ghana by increasing access to and use of safe water, sanitation and the sustainable management of water resources. The plan articulated the medium to long-term priorities of GoG stated in the NWP.

The GoG intended to achieve the goal of the plan by 2025 through the implementation of two components that contained a set of interventions and activities to be implemented from 2012 to 2025. The interventions targeted the strengthening of the policy, regulatory, financial, and institutional frameworks to support the efficient operation, maintenance and delivery of water and sanitation services (Government of Ghana, 2014). The MSWR was mandated to facilitate the implementation of the plan and coordinate activities in the water and sanitation sector among implementing institutions. The MSWR established an Inter-Ministerial Steering Committee (IMSC) to oversee the execution of activities of all water sector stakeholders including the GWCL, WRC, PURC, NGOs, Metropolitan Assemblies, Departments and the private sector.

In the urban water sector, the WSSDP was structured to deliver on two clustered packages, which include – (1) Service delivery and (2) Cross-cutting issues. Under service delivery, the government targeted an improvement in water service delivery through investments in rehabilitation and new water infrastructure. The GoG recognised the need to address NRW as an important element for improved service delivery (GoG, 2007, 2014). While targeting investment in hardware infrastructure to improve service delivery, the government outlined four cross-cutting soft issues, including – (1) Institutional Capacity Development and Governance, (2) Finance, (3) Knowledge Management, Gender, Monitoring and Evaluation; and (4) Water Resource Management. Even though this was a national document, the interventions outlined in the plan were expected to occur at the metropolitan and municipal levels with the same outputs, outcomes and indicators defined in the document.

6.3 Interventions of urban water service delivery

In the urban water sub-sector, water infrastructure had relatively improved through new installations and rehabilitation works during the era of PSM (GWCL, 2015). However, this upgrade was not adequate in achieving total water supply coverage in the Accra metropolis. There was a universal recognition among water stakeholders (in particular the government) about the urgency to increase water supply coverage and significantly reduce NRW, which was estimated to be above 50 per cent under PSM (Government of Ghana, 2014; GWCL, 2015) In the WSSDP, the following interventions were outlined to reduce NRW to 45 per cent in 2015 and 33 per cent by 2025:

1. The development and installation of a robust metering system to monitor water production, supply and use. This was intended to make available the necessary data on the amount of water produced and lost in the supply and distribution networks. A zonal metering system will be introduced and scaled up as an additional measure to track leakages and theft within the distribution system. The GWCL will be responsible for the implementation of this intervention.
2. Conduct an assessment of institutional capacity to help design and implement a capacity building plan and institutional reforms for GWCL. This action was intended to help improve work ethics, customer relations and staff productivity in service delivery. The capacity building program also included training on innovations and water technologies for technical staff. These activities were regarded as follow-up actions to the return to public management considering the exit of expatriate staff after the end of the private sector water reforms.
3. As indicated earlier in Chapter 5, the decentralised process under the water reforms did very little to improve governance or strengthen effort at the local level to reduce illegal connections. The government aimed to support the GWCL under the public water management to further decentralise its operations and strengthen collaboration with metropolitan and municipal structures. New GWCL offices were expected to be opened at the district and municipal levels. The officials of GWCL were tasked to participate in General Assembly and Executive Committee meetings of metropolitan and municipal assemblies to strengthen interactions with other stakeholders. The expectation was that such engagement and

collaboration with these structures will improve monitoring and help curb water theft in the distribution system.

4. The government decided to bear the cost of rehabilitation, upgrading and expansion of the urban water systems being managed by GWCL. It would seem that the regime was aiming to take absolute control of decision making regarding urban water management, devoid of external influence from landscape actors such as the World Bank, IMF, and Development Partners as happened in the private water reforms.
5. Under the PSM, urban water tariff was set up to include NRW charges. A decision was taken by the government to work with the PURC to prepare a progressive mechanism to gradually reduce the NRW charges on water tariffs to 40 per cent by 2020 and a further 33 per cent by 2025. This goal was to remove the burden of GWCL's inefficiencies from consumers as has been practised through the upward adjustment of tariffs under the PSM.

6.3.1 Emergency water service delivery

In the case of emergencies or water shortage, the WSSDP made provision for the MSWR to work with the GWCL to install water tanks at vantage points to supply water to users in the metropolis. The GWCL was tasked to work with secondary water service providers, mainly water tankers, to deliver emergency water services. This model of water service delivery, according to the GWCL, was expensive and unsustainable but critical during emergency situations.

6.3.2 Water quality monitoring

One of the critical issues that created distrust among water consumers was the declining quality of water supplied to the metropolis. It was also the same issue that contributed to the rise of the sachet and bottled water production. For a long time, many urban residents did not consider treated water supplied as potable enough to drink. Many residents preferred to drink sachet or bottled water and use water from the taps for cooking, washing and bathing (Dzodzomenyo, Fink, Dotse-Gborgbortsi, Wardrop, Aryeetey, Coleman, Hill & Wright, 2018; Stoler, Weeks & Otoo, 2013).

The WSSDP recognised the concern about the quality of water supplied to the metropolis. To improve the quality of water supplied, a water quality safety framework was developed and implemented by 2016. The framework, developed through a joint consultative process among the GWCL, PURC, WRC, GSA and CWSA was intended to establish the value chain for water service delivery i.e. from production to consumption and to clarify safety standards for water supply in urban areas. The framework was also expected to guide the delineation of areas of collaboration and coordination and responsible institutions in water quality monitoring.

6.3.3 Water-related sanitation services

Under the WSSDP framework, the government aimed to develop a Household Water Treatment and Safe Storage Strategy (HWTSSS) that would help promote household water treatment technologies and approaches as a means of improving sanitation and hygiene. It was also intended to contribute to a measurable reduction in waterborne diseases through the adoption and long-term use of effective measures under the HWTSSS,

particularly by low-income urban residents who did not have access to safe drinking water and adequate sanitation services.

6.4 Cross-cutting issues

6.4.1 Institutional capacity development and governance

Policy framework

Three important national policy documents, the NWP-2007, National Environmental Sanitation Policy (NESP, 2010) and the Ghana Shared Growth and Development Agenda (GSGDA-2010-2013) provided a guiding framework of implementation for the WSSDP. The development of the WSSDP according to the government was informed by the objectives and strategies of these policy documents to define strategies capable of helping to achieve sustainable water and basic sanitation for all by 2025. It also responded to Ghana's commitment to national, regional and global resolutions on water and sanitation, including the Sanitation and Water for All (SWA) Ghana Compact (2010), the eThekweni Declaration on Water and Sanitation (2008), and stakeholders' Code of Conduct for initiating the Sector Wide Approach (SWAp) in the water and sanitation sector in Ghana.

Apart from the policy frameworks, several sub-sector-specific plans were deemed fundamental to the development of the WSSDP. These included: GWCL Strategic Investment Plan (SIP-2008) for urban water, the CWSA Strategic Investment Plan (SIP-2008) for water and sanitation in rural areas and small towns, the Sanitation Strategy and Action Plan (SSAP-2010), the Strategic Environmental Investment Plan (SESIP) and the Integrated Water Resource Management (IWRM - 2012) Plan. One of the gaps identified under the private sector reform was the lack of cohesion among water-related institutions as well as lack of integration of activities that supported efforts towards urban water management. The aim of the WSSDP was to harmonise various water-related policies and strategies on the management of water resources. The actual process of developing this framework was also intended to strengthen coordination and collaboration among water institutions in the country.

Improving Governance

To ensure smooth implementation of the WSSDP, the government set up an Inter-Ministerial Steering Committee to monitor activities in the water and sanitation sector. The committee, chaired by the Minister of Sanitation and Water Resources had a broad representation from the six ministries: (1) Sanitation and Water Resources, (2) Environment, Science, Technology and Innovation, (3) Women and Children's Affairs, (4) Energy, (5) Finance and Economic Planning, and (6) Local Government and Rural Development. The committee was expected to meet bi-annually to evaluate the progress as well as areas of collaboration in the implementation of the WSSDP.

Apart from the work of the committee, a Sector Working Group was set up to monitor and give a progress report and recommendation every month on the implementation of the various activities of the WSSDP. The members of the group came from the GWCL, CWSA and WRC. Each ministry involved in a specific activity reported on the progress of their work. Also, the audited statement of account of the WRC, GWCL and CWSA

was expected to be published annually in the general newspapers from 2012 as a way of increasing transparency and accountability as well as building public interest in urban water management.

Sustainable Financing

According to the government, the total estimated cost of implementation of the WSSDP was around GH¢13,692.85 million (US$5,416.48 million equivalence). This involved a capital investment cost of US$4,822.84 million (89.04%) and recurrent cost of US$593.64 million (10.96 per cent). The government reiterated its commitment to fund 41.49 per cent of the total cost through annual budgetary allocations. Around 48.98 per cent of the cost was to be secured through grants, aids and loans from development partners. Water user fees and contributions towards operation and maintenance (O&M) investments constituted 3.49 per cent of the total cost and balance of 6.04 per cent to be borne by the AMA.

In the WSSDP, the government positioned itself as the "crucial funder" for the implementation of the plan. The government was committed to supporting measures that would increase the financial viability of the urban water sector such as providing funding to help PURC's automatic adjustment formula to cover the full cost of O&M in urban water delivery service. According to the plan, one per cent of the cost of new investments in water services was supposed to go to the WRC for water resources and catchment management. This was intended to help the WRC develop and implement programs that targeted the protection of water sources and preservation of available water resources.

Improving Knowledge Management

The government planned to provide funding and logistical support for research on cost-saving measures, innovations and best practices in water and sanitation service delivery. Under the plan, the government tasked the research institutions, agencies and departments, civil society as well as the private sector to conduct research in priority areas and produce outputs that could support the delivery of water and sanitation services in the country. According to the government, funding provisions were made to support for institutions to conduct research and disseminate research outputs on national learning platforms, including the Ghana Water Forum (GWF), the National Environmental Sanitation Conference (NESCON), the NLLAP and, Mole Conference, among others. The learning platforms were to be strengthened and extended to other regions of the country by 2014. As part of capacity building objective in the plan, members of the Water and Sanitation (WATSAN) Committees at the local levels were to receive training on the gender complementary roles of both female and male in water and sanitation service delivery regularly. The MSWR in consultation with stakeholders planned to develop a framework that defines modalities for engagement of the Ministry of Gender, Children and Social Protection (MoGCSP) in water and sanitation delivery by 2015. These measures were intended to address some of the challenges associated with collecting and accessing data/ information during the era of the private sector water reforms.

Strengthening Monitoring and Evaluation

The MSWR planned to develop a Sector Information System that would facilitate monitoring and evaluation for the water and sanitation sector by 2012. Under the WSSDP, M&E system was developed by 2012 based

on the indicators for the activities in the plan. Data from the various sub-sectors of the water and sanitation sector were to be fed into the system to help monitor the progress of implementation. The government intended to provide human and financial resources to strengthen the Water Directorate of the MSWR in the monitoring and evaluating the WSSDP implementation. To further strengthen the institutions, M&E Units were to be established at the GWCL, WRC and CSWA by 2014. The establishment of these M&E Units was intended to improve regular data flow among these institutions as well as timely reporting by the Water Directorate to the NDPC and the Ministry of Finance as part of the annual and quarterly reporting under the GSGDA. Compared to the era of PSM, there seemed to be a growing desire by the government and stakeholders to intensify monitoring and evaluation and to provide relevant data on agreed sector indicators

Sustainable Water Resource Management

The government recognised the alarming rate of water resource degradation in the catchment areas of the country. This challenge was identified during the implementation of the private water reforms, where there was minimal attention to the welfare of the catchment areas and the hinterlands. This challenge resulted in occasional water shortages that severely impacted on the water supply to the urban areas. The WSSDP advocated for the sustainable management of water resources. The goal was to make sure that water extraction and consumption is within sustainable threshold by 2025. To achieve this goal, strategies in the Medium Term Strategic Plan for IWRM (2011- 2015) were harmonised with strategies in other sub-sectors and implemented within the WSSDP framework. The implementation of the WSSDP is currently in the 8th year since it was developed in 2012. Four key strategies are currently being pursued:

- Develop water resource protection and management frameworks to support water security effort and enhanced resilience to climate change;
- Strengthen institutional and professional capacities for water resource planning, decision-making and operations by improving access to knowledge and expertise in SUWM;
- Develop effective coordination and collaborative mechanisms for institutions managing water resources; and
- Strengthen transboundary and international cooperation for shared water resources management.

As stated earlier, the implementation of this plan was more than halfway through the period (2012-2025) set to complete the tasks in the plan. The meant several activities were expected to have been completed or significant progress made on the implementation of specific activities. Based on the activities implemented under the WSSDP, a set of indicators that could be used to measure the outcomes of water management practices was developed. A review of the process of selecting indicators to assess the outcomes of water management interventions implemented over the past seven years (2012 – 2019) in the Accra metropolis is presented below.

6.5 Process of selecting indicator sets for Accra metropolis

To develop an indicator set to assess the WSSDP in the Accra metropolis, the Process Analysis Method (PAM) developed by Tahir and Darton (2010) was adopted. The PAM offered a systematic approach to organise an

evaluation and provided guidelines for selecting indicators tailored to the context of the Accra metropolis. To use this method, it was appropriate to identify the system's impacts together with their causes, termed as Impact Generators (IGs). The IGs were categorised into Internal Impact Generators (IIGs) and External Impact Generators (EIGs). The IIGs described activities or practices within the urban system such as water governance, public-private partnership, decentralisation, water supply efficiency measures, etc., while the EIGs referred to events outside the scope of the system, such as climate change, rapid population growth, urbanisation, and climate variability (Jensen & Wu, 2018). The IGs had a significant influence on the capitals and their realities and vice-versa. Impacts generated had consequences on key actors referred to as Impact Receivers (IRs). For example, the improvement in water coverage through the expansion of water infrastructure to unconnected areas impacted positively on low-income households, and that was likely to contribute to increased was revenue as more people access and pay for water service. In figure 6.1, five main steps that guided the process of selecting a set of indicators for assessing the implementation of interventions under the WSSDP in the Accra metropolis are presented.

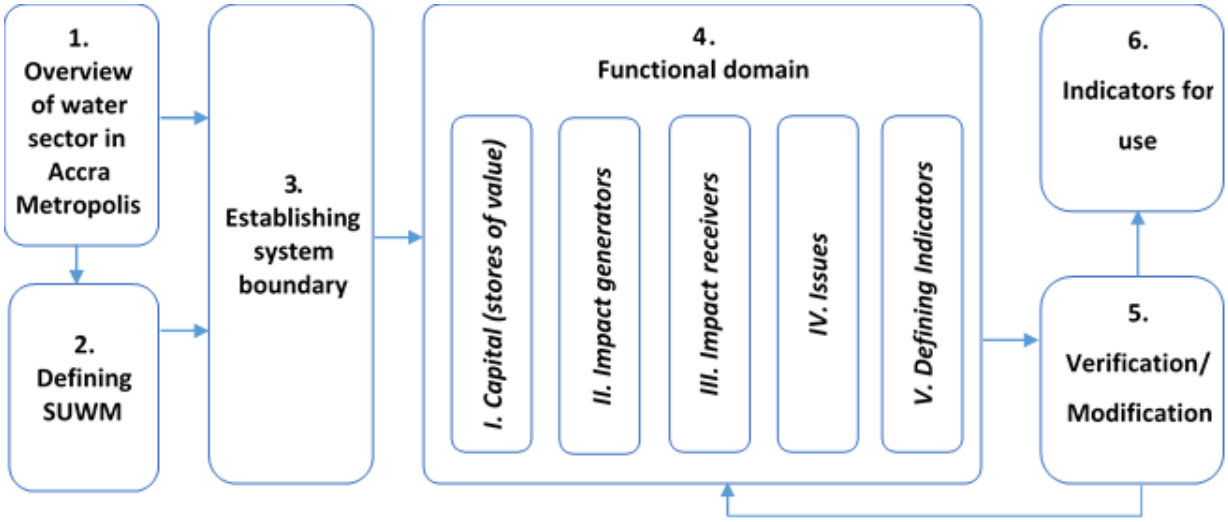

Figure 6.1 The Process Analysis Method (Adapted from Tahir and Darton, 2010)

Step 1. Overview of the water sector in the Accra metropolis

Chapters 4, 5 and part of this chapter provided an overview of the management of the water system over the before, during and after the PSM regime. An account of the status of the implementation of interventions in the transition era (PSM) as well as the public management regime, including the limitations and areas of improvement was presented. Different from the PSM regime was the understanding that the development of the WSSDP was defined by the principles of the SUWM approach. Fundamental to the WSSDP is the ambition to push the government's agenda of sustainable management of urban water resources and to facilitate universal access to water and sanitation services by the year 2025 through interventions inspired by the SUWM principles (Government of Ghana, 2014). It is, therefore, necessary for participants at the platform have a fair understanding of what constitutes SUWM as it would inform the process of selecting the appropriate set of indicators for the metropolis.

Step 2. Working definition for SUWM

A description of the SUWM perspective for guiding the assessment of outcomes of WSSDP in the Accra metropolis was ideal for the study. On 16 February 2016, participants at the platform defined the SUWM as an approach that could help secure a well-governed and self-sufficient water system capable of ensuring sustainable access to potable water for economic development, to meet societal water needs and wellbeing against water-related health risks while ensuring the protection of the ecosystem. This definition applied to the set of interventions developed under the WSSDP. The WSSDP aimed to facilitate the effective management of water resources through a holistic approach that ensured sustainable access to water while preserving the water resource base (Government of Ghana, 2012). In line with this definition, six essential outcomes expected from the implementation of WSSDP interventions in the metropolis were derived. These included (1) self-sufficient water system; (2) improved governance (3) enhanced water security; (4) improved sanitation and health; (5) improved water quality; and (6) enhanced knowledge development, learning and data management. Defining these outcomes allowed the study to determine if there were certain interventions that were deemed essential but were not implemented. In Chapter 7, a framework for managers and policymakers to consider is proposed. This framework could serve as the basis for SUWM planning in the Accra metropolis.

Step 3. Establishing the system boundary

At the next level, the system boundary was defined based on two factors: the spatial and temporal scales (Bell & Morse, 2012). The spatial scale involved the size of the geographical area of the Accra metropolis, in which the urban water infrastructure, urban residents and structures, water resources and the users were contained. Using this boundary definition for the Accra metropolis, the study excluded the hinterland which served as freshwater sources. Nonetheless, the role of hinterlands was assessed with respect to the interactions and processes between the metropolis and the hinterlands that supplied freshwater to the water system.

The temporal scale detailed the impact of urban water management practices over time in this case over a seven-year period (2012-2019). Nonetheless, the consequences of past interventions were likely to have an influence on current outcomes, which meant that it was advisable to structure temporal scale widely enough to capture inter-generational effects. According to Voskamp & Stremke (2014), the use of indicators with long-term time-series data (against standard, goal, or reference value) provided deeper insights into the temporal dynamics essential for sustainable planning, design and management of changes over time regarding the state of existing systems or the impact of management interventions. Acquiring long-term data in the Accra metropolis was a challenging task since data was not in existence or inaccessible to the public. In the absence of data that described long-term patterns, this study was limited to the use of descriptive indicators that defined the outcome at a particular time or patches of data from some past years to show a specific trend or extent of change.

Step 4: Selected indicator set for measuring outcomes of WSSDP interventions

A list of determinants was derived from the participatory process at the platform in Chapter 5 for assessing the outcomes of interventions under the private water reforms. This list was updated by the researcher in line with the new objectives, activities, and outcomes of the interventions implemented under the WSSDP. At the February 2016 platform, focus group discussions were conducted for four groups of five participants each to

discuss the list of identified indicators. Each group at the platform deliberated on the indicators, taking into consideration the existing water management practices and realities in the Accra metropolis. Based on the discussions, a set of indicators considered appropriate for assessing the outcomes of interventions under the WSSDP was selected by each group. This time around, the discussions and arguments that preceded the selection of the indicators by each group were not so intensive because lessons drawn from the experiences gained in developing the determinants at the platform in Chapter 5 were put into good use. After the group work, representatives of all groups presented the group's list of indicators to the entire platform. All the indicators from all the groups were harmonised and a set of indicators was prepared.

In selecting the indicator set, the contextual patterns and realities that influenced water management practices in the Accra metropolis were taken into account. The following essential criteria guided the selection and application of the indicator set by participants on the platform:

- According to the WSSDP, six expected outcomes of the interventions, namely self-sufficient water system, improved water security, improved water quality, improved sanitation and health, enhanced water governance and robust water data system should define a sustainable water system in the Accra metropolis.
- Both qualitative and quantitative data with different measurement units were normalised and standardised. For instance, water quantity was measured in litres; water quality was assessed to be extremely polluted or high quality; and NRW in percentage, etc. Both qualitative and quantitative indicators were normalised through a standardisation process that ensured uniformity and comparability in reference. A rating system on a scale of 0 (a very poor outcome/ low performance) to 10 (excellent outcome/ high performance) was used. Indicators were scored based on their contribution towards improving or derailing the performance or outcomes of the water management interventions under the WSSDP. The indicators that contributed most towards improving water management outcomes were assigned a high score and indicators that contributed less towards improving water management outcomes recorded low values. For example, a high percentage of water system leakage recorded a low rating because of the low contribution it made to improving water management outcomes in the Accra metropolis. The indicator rating was also guided by pre-determined standard/ benchmark values set by scientific research and renowned institutions such as the WHO, UNDP and UNEP or determined subjectively using expert views. For instance, according to the WHO, the average human water needs per day ranged from 50 – 100 litres, which is enough to prepare meals, shower, and flush toilets to maintain proper hygiene (UN-Water, 2012). A water consumption indicator with a value less than this average was likely going to receive a low-performance rating.
- The selection of indicators was guided by the reliability of data, time-series data, and up-to-date data on the indicators. The latter turned out to be challenging as some data were collected several years back without regular updates. This limitation was addressed with inputs from key experts who provided additional estimated data based on trends and experience about the behaviour of specific indicators and their performance over time.

Guided by the criteria mentioned above, 26 indicators were selected by participants on the platform to evaluate the outcomes of water management interventions under the WSSDP. The complete set of indicators are categorised and presented in Table 6.1.

Outcomes	**Indicators**	**Description**
Self-sufficient water system	Water system leakage (%)	Physical water losses in the distribution system
	Non-revenue water (%)	Percentage of water lost without revenue
	Reliability of water supply (hr/day)	Average hours of water supply per day
	Operational cost and revenue ratio (%)	Cost of water production against revenue generated
	Operational efficiency of waterworks (%)	The capacity of water production against actual capacity
Water Security	Water sources diversity ratio (%)	The proportion of other water sources being used against surface water from GWCL
	Water supply coverage (%)	Percentage of the population with potable water service
	Drinking water access per person (l/person/ day)	The volume of potable water used per person per day
	Water-saving ratio	Percentage of water saved by the city
Water Quality	Water quality standards	Chlorine residual
	Water pH	The measure of acidity or alkalinity
	Total Coliform	Measure the degree of bacteria
	Turbidity	The measure of water transparency loses
Sanitation	Wastewater collection and treatment coverage (%)	Percentage of the population served by wastewater collection and treatment service
	Wastewater treated (%)	Percentage of wastewater treated
	Wastewater pollution (%)	Percentage of wastewater contribution to water pollution in the Accra Metropolis
	Stormwater drainage system	Percentage rate of the functioning of the system
	Incidence of waterborne disease outbreak	Number of waterborne disease outbreaks per year
Water data system	Well-functioning water database	Up-to-date data on the various aspects of water resources and water production
	Annual published water data	The availability and accessibility to public water data
	Knowledge and learning platform	The forum for verification and validation of water data system and available data
Governance	Participatory and integrated planning	The measure of the coordination and collaboration of integrated planning for the development of a water management plan
	Public participation	The measure of the commitment and willingness of stakeholders and organizations to voluntarily engage in water management without being paid

	Institutional capacity	The measure of managerial competence and skills of water institutions
	Comprehensive strategic plan for Accra	Existence and implementation of a strategic plan for water management in Accra Metropolis
	Public-private partnership	The measure of the participation of private sector in water management
Data source	GWCL, WRC, GSS, Scientific Literature, Questionnaire, Experts views, Learning platform	
Rating	0 (low performance) to 10 (high performance)	

Table 6.1 Indicators for evaluating outcomes of water management interventions in the Accra metropolis (Defined by participants on the platform)

Step 5: Verification and modification

In consultation with key informants and participants on the learning platforms, the indicator set and data were subjected to a verification process to ensure that the indicators defined were reliable, standard and applicable to assessing the implementation of WSSDP interventions in the Accra metropolis. Right after the selection of the indicators at the learning platform in February, a survey was conducted in various water institutions in the metropolis and a total 30 participants were invited via an online survey to comment on the relevance and suitability of the selected indicators. These institutions included the Water Directorate, GWCL, WRC, PURC, the University of Ghana, IWMI-Ghana, WRI, and WaterAid. In the process, participants were asked a series of general questions about the comprehensiveness of the indicator set, whether there were omissions or some additions may be required. Out of the 30 survey forms used, responses were provided by 29 informants with one official declining to participate in the survey. Appropriate responses from the participants were incorporated to modify the indicator set where necessary. At the next platform on the 31 March 2016, the verification process was carried out with participants and some minor modifications were carried out to arrive at a set of indicators considered to be well-suited for evaluating the outcomes of water management interventions in the metropolis.

6.6 Results

6.7 Assessing the implementation of the WSSDP in the Accra metropolis

In Figure 6.2, the summary of the performance ratings of the indicators for measuring the outcomes of interventions under the WSSDP in the Accra metropolis on a scale of 1 to 10 (with 1 = low performance and 10 = high performance) is presented. Data were analysed along with benchmarks or standard values provided by international organisations to gauge the extent to which the results of these indicators suggested the achievement of the outcomes of interventions in the metropolis. These indicators were scrutinised by a group of 20 experts at the February 2016 platform. These people were professionals from IWMI, WRI, WRC, GWCL, SNV, WaterAid, CONIWAS, NDPC, WSMP, PURC and WUAs. The group of professionals represented a critical mass of knowledge that contributed significantly to decision-making on water management in the Accra metropolis. Based on the analysis, ratings were carried out, and majority ratings are presented here.

Outcomes	Indicators	Description	Ratings
Self-sufficient water system	Water system leakage (%)	Physical water losses in the distribution system	6
	Non-revenue water (%)	Percentage of water lost without revenue	5
	Reliability of water supply (hr/day)	Average hours of water supply per day	6
	Operational cost and revenue ratio (%)	Cost of water production against revenue generated	3.5
	Operational efficiency of waterworks (%)	The capacity of water production against actual capacity	6
Water Security	Water sources diversity ratio (%)	The proportion of other water sources being used against surface water from GWCL	4
	Water supply coverage (%)	Percentage of the population with potable water service	7.5
	Drinking water access per person (l/person/ day)	The volume of potable water used per person per day	6.5
	Water-saving ratio	Percentage of water saved by the city	3
Water Quality	Water quality standards	Chlorine residual	7
	Water pH	The measure of acidity or alkalinity	6.5
	Total Coliform	Measure the degree of bacteria	6
	Turbidity	The measure of water transparency loses	7
Sanitation	Wastewater collection and treatment coverage (%)	Percentage of the population served by wastewater collection and treatment service	6
	Wastewater treated (%)	Percentage of wastewater treated	2
	Wastewater pollution (%)	Percentage of wastewater contribution to water pollution in the Accra Metropolis	3
	Stormwater drainage system	The percentage rate of functioning of system	6
	Incidence of waterborne disease outbreak	Number of waterborne disease outbreaks per year	4
Water data system	Well-functioning water database	Up-to-date data on the various aspects of water resources and water production	4
	Annual published water data	The availability and accessibility to public water data	5
	Knowledge and learning platform	The forum for verification and validation of water data system and available data	8
Governance	Participatory and integrated planning	The measure of the coordination and collaboration of integrated planning for the development of water management plan	5
	Public participation	The measure of the commitment and willingness of stakeholders and organizations to voluntarily engage in water management without being paid	7
	Institutional capacity	The measure of managerial competence and skills of water institutions	5
	Comprehensive strategic plan for Accra	Existence and implementation of a strategic plan for water management in Accra Metropolis	2
	Public-private partnership	The measure of the participation of the private sector in water management	6
Data source	GWCL, WRC, GSS, Scientific Literature, Questionnaire, Experts views, Learning platform		
Rating	0 (low performance) to 10 (high performance)		

Table 6.2 Ratings of indicators for assessing water management outcomes in the Accra metropolis (Source: Analysis of stakeholder views and GWCL data)

6.7.1 Self-sufficient urban water system

The results showed that the five indicators defined by the study to assess the self-sufficiency of the water system showed mixed performance. The results showed a performance rating of 6 for "water system leakage". Participants on the platform gave a performance rating of 5 out of 10 for "NRW". The indicator for "reliability of water supply" recorded a performance rating of 6 out of 10 based on a daily average of 10 hours of water supply to several parts of the metropolis. The performance rating for the "operational efficiency of the waterworks" indicator was 6, which was a little above average. For the indicator on "Operational cost and revenue ratio" participants gave a rating of 3.5 out of 10. Overall, the participants on the platform were not impressed with the effort to establish a self-sufficient water system after seven years of implementing interventions under the WSSDP.

According to the WSSDP, to curb physical system leakages, one of the key interventions implemented targeted restoration and functioning of water facilities at 95 per cent in the metropolis by 2015. Although it was difficult for the study to measure the per cent rate at which water facilities function in the metropolis, it was safe to say that despite some improvements in water infrastructure over the last six years, water facilities were not be performing at optimal levels. This was attributed to the high percentage of water lost through leakage, about 35 per cent according to data from the GWCL.

In the WSSDP, several interventions were outlined for implementation to help reduce NRW to 45 per cent in 2015 and 33 per cent by 2025. However, by 2019, the 2015 target was not achieved with the current estimated NRW said to be 49.8 per cent of treated water produced (Government of Ghana, 2014; GWCL, 2015). The 2019 figure for NRW seemed to suggest that interventions under implementation so far have had minimal effects on reducing NRW. From the current outcome, experts on the learning platform postulated that given that the GWCL was unable to achieve even 5 per cent decrease in NRW in 2015, chances were minimal for the metropolis to achieve a reduction target of 33 per cent by 2025 as given. This outcome raised a serious concern for water managers to review the existing practices under the public water management. The encouraging news is that the GWCL is implementing a new metering system connected to the central control room, which is expected to ensure accurate meter readings, quick leakage detection and detect meter tampering. With the successful installation of 40,000 smart metering systems in 2017 in the Accra metropolis, the GWCL was expected to install approximately 500,000 smart meters to replace manual metering systems over the next five years (GWCL, 2018). Stakeholders argued that there was a high probability to reduce NRW if the GWCL continued to replace old manual meters throughout the metropolis.

Ensuring a reliable supply of water to the metropolis was a difficult challenge facing the GWCL. The two waterworks supplying the metropolis had consistently encountered technical difficulties that interrupted water production and hindered regular water supply to the city. Even though there were some improvements in their operations through investment in water infrastructure, the two water facilities were a long way from operating at full capacity to ensure regular water supply for the metropolis. From the strategic investment plan, the GWCL anticipated a 24-hour uninterrupted water flow and access throughout the week by 2025. Current data from the GWCL puts the average continuous water flow per day at a range of 8-10 hours. Compared to an

average of 6 hours per day in 2008, the increase was somewhat significant. Nonetheless, some experts on the learning platform believed this level should have been much higher since there was a substantial increase in water infrastructure investment over the past seven years.

With regards to the low operating efficiency, the results indicated that the two waterworks were operating at a little over half their production capacities. Under the WSSDP framework, several restoration projects were undertaken to replaced aged infrastructure and other dysfunctional facilities. An example was the recent rehabilitation project initiated by Siemens NV/SA at the Kpong waterworks at the cost of 16.568 million euros with funding from FINEXPO and KBC Bank of Belgium (GWCL, 2018). This involved replacing existing intake pumps, laying of intake pipelines and replacing high lift pumps at the old waterworks. In addition to the rehabilitation project, a treatment plant supplying 15,000 m^3 per day was installed to boost water supply to certain parts of Accra metropolis and its environs.

Another project completed recently was the expansion of water supply at Kpong waterworks at an estimated cost of US$273 million with funding from the GoG and China Exim Bank (ibid). The project entailed the construction of a new 353,000 m^3 per day intake, expansion of treatment plant to 250,000 m^3 per day and development of new transmission mains to Accra Booster Station. As stipulated in the WSSDP, it appeared the government had increased its direct investment in the urban water sector as evident in the growing investments in water infrastructure. With the rising investment in water infrastructure at the Kpong waterworks, experts on the learning platform were optimistic of seeing a more improved water system that was capable of producing more water to supply the entire metropolis by 2025. However, they were quick to add that achieving complete water coverage was subject to a significant reduction in NRW and other limitations.

Another major concern was the aspect of financing water management and the revenue mobilised from water service delivery. The low-performance rating given by experts on the platform might be related to the high cost of operation and maintenance of the water system against the low revenue mobilised from water service delivery. In the last five years, the cost of water production soared significantly. A probable reason, according to the GWCL was the rising costs of treatment chemicals, fuel, electricity, and the high percentage of water losses in the supply and distribution chain. In table 5.6, the cost of operation of water production, transmission and distribution incurred by the GWCL for the entire country in 2014 and 2015 are presented. On the production cost, water treatment chemical cost increased by around 33% from GH₵ 18.7 million (US$ 5.8 million) in 2014 to GH₵ 27.8 million (US$ 7.3 million) in 2015. Even though segregated data for the metropolis were not available, there was a similar pattern of increase in the chemical cost at both waterworks. The Accra metropolis received the largest proportion of treated water produced by the GWCL compared to other urban areas in the country. Data from the GWCL also revealed an astounding over 100 per cent increase in electricity cost for only water production from GH₵ 64.7 million (US$ 20.1 million) in 2014 to GH₵143.3 million (US$37.5 million) in 2015.

Cost of operations		
a. Production cost	**2015 (GH₵)**	**2014 (GH₵)**
Personnel cost	27,356,512	20,796,548
Water treatment chemical cost	27,762,830	18,713,662
Electricity	143,279,623	64,732,408
Fuel and Lubricant	1,254,433	1,264,038
Material cost	123,701	229,437
Laboratory analytical chemical reagents	66,385	217,599
Hiring of equipment	61,193	97,111
Overheads	2,458,932	2,517,129
Repairs and maintenance	14,908,234	6,050,669
Depreciation	23,378,609	3,095,373
	240,650,452	**117,713,974**
b. Transmission/ Booster station cost		
Personnel cost	3,279,927	2,469,420
Water treatment chemical cost	185,460	99,042
Electricity	9,111,622	8,088,005
Fuel and Lubricant	81,441	78,112
Material cost	74,488	96,802
Laboratory analytical chemical reagents	12,497	56,926
Hiring of equipment	16,993	9,966
Overheads	544,747	207,995
Repairs and maintenance	360,749	633,372
Depreciation	1,586,553	150,769
	15,254,477	**11,890,409**
c. Distribution cost		
Personnel cost	25,510,729	2,469,420
Water treatment chemical cost	1,644	99,042
Electricity	913,251	8,088,005
Fuel and Lubricant	2,517,697	78,112
Material cost	15,584,030	96,802
Hiring of equipment	7,390,459	6,383,431
Overheads	7,033,770	831,380
Repairs and maintenance	326,587	56,926
Depreciation	2,921,936	9,966
	62,200,103	**18,113,084**

Table 6.3 Operational cost for water production, transmission and distribution in urban areas of Ghana (GWCL, 2015)

The GWCL estimated approximately US$717 million worth of investment in water infrastructure to have universal water coverage in the metropolis and other urban areas by 2025 (GWCL, 2015). In the WSSDP, the government targeted the achievement of 80 per cent direct investment in the urban water sector by 2020 and 100 per cent by 2025. Several stakeholders on the platform were of the view that such an investment over that period was difficult to mobilise since funding for most large-scale urban water projects came from external donors and development agencies. External funding amounted to approximately US$ 30 million annually,

while the State's annual budget allocation was around US$ 2 million, plus internally generated funds of US$ 1 million annually (GWCL, 2015). The reliance on external funding (loans, grants and donor assistance) remained a contentious issue because of the uncertainties and unfavourable conditions attached to such funding in the past. According to a representative of NGOs on the platform, the high level of external funding for water projects amounted to foreign interference and was likely to complicate the management of the urban water system and the vision to achieve universal water supply coverage.

6.7.2 Improved water resources security

The results portrayed mixed ratings for indicators of water security. Participants gave"water supply coverage" and "daily drinking water access per person" performance ratings of 7.5 and 6.5 out of 10 respectively. However, two indicators, "water sources diversity ratio" and "water-savings ratio" recorded very low-performance ratings of 4 and 3 out of 10 respectively. Participants gave a low scare of 3 to "diversity of water sources" indicator. Overall, it seemed there was more attention to the supply side to achieve total urban water coverage by 2025, as stated in the WSSDP.

The metropolis had witnessed increased water coverage as the proportion of residents with access to potable water rose from 69 per cent in 2010 to 75 per cent in 2016 based on data from the GWCL and GSS. However, the water coverage target of 85 per cent according to the WSSDP was achieved by 2015 since the percentage of water coverage as at 2019 stood at 78 per cent.

As at 2018, the Accra metropolis received around 90 per cent of potable water from the two main waterworks – Kpong and Weija. Groundwater and rainwater constituted the remaining 10 per cent. The total volume of daily treated water produced by the GWCL for the metropolis and its environs was estimated to be 553,846 m^3/day. The amount of treated water produced by the Weija waterworks to Accra for consumption is around 162,700 m^3 per day while that of Kpong is approximately 391,146 m^3/day. The Kpong waterworks increased in the volume of treated water produced by about 40% since 1995 due to the expansion of the water treatment plant (GWCL, 2015). The total daily capacity of the two waterworks increased by 20 per cent from 2006 to 2016, with a corresponding two per cent increase in the total volume of water supplied to the metropolis.

Access to drinking water supply improved significantly with an average of 120 litres per capita per day (l/c/d) according to data from the GWCL. This figure exceeded the minimum water requirement of 50 l/c/d set by WHO and close to the United Nations optimal water demand of 150 l/c/d. Access to drinking water in the metropolis was likely to increase, considering the expansion of the water treatment capacity at the two waterworks.

While the GWCL continued to make efforts to increase water coverage in the metropolis, the question lingered about the need to increase the diversity of water sources. Surface water remained the primary sources for water supply to the city. The limited exploitation of other sources of water raised concerns about the future of surface water use. In spite of the commitment of the government to attain total water coverage and access by 2025, many households were already exploiting groundwater through mechanised boreholes. These individual efforts

also seemed to be a direct response to the low level of reliability of water supply to the city. Another primary concern was the issue of saving water at the institutional and domestic levels. Data from the GWCL revealed that the Accra metropolis continued to struggle with a high rate of economic water losses. In Table 6.3, a summary of the total amount of potable water supply, volume and percentage of NRW for 2014 and 2015 is presented. Of the total volume of water billed per month in the metropolis in 2014, the GWCL lost approximately 2.4 Mm^3 as NRW, representing about 49 per cent of the total volume of water billed. The percentage of the actual amount of water sold was just a little above 50 per cent. In 2015, the rate of NRW rose to almost 55 per cent, a significant 8 per cent increase over NRW in 2014. The analysis also showed that NRW exceeded the actual water sold in 2015 in the metropolis. The NRW consisted of physical losses (35 per cent) arising from extensive leakages in the pipe network and aged distribution channels, and economic losses (20 per cent), which occurred due to water theft and unmetered pipe connections. This was further worsened by the lack of efficient leakage detection system and the absence of bulk metering in the water system. By 2018, there was a significant monthly increase in the volume of potable water (16.6 Mm^3) produced and supplied to the metropolis. However, the NRW continued to exceed 50 per cent of the total amount of water billed to consumers.

Year	Parameters	Annual	Monthly
2015	Volume of water billed (m^3)	70,970,000	5,914,167
	Volume of water actually sold (m^3)	32,148,000	2,679,000
	NRW (m^3)	38,822,000	3,235,167
	NRW (%)		54.70%
2014	Volume of water billed (m3)	58,280,000	4,856,667
	Volume of water actually sold (m3)	29,704,000	2,475,333
	NRW (m3)	28,576,000	2,381,333
	NRW (%)		49.03%

Table 6.4 Volume of water billed, water sold and NRW in the Accra metropolis (Source: GWCL, 2015)

It was somewhat surprising to observe that a city with less reliable water supply hardly attached any premium to water conservation. Instances of temporary water shortages in the metropolis exposed the vulnerability of residents in especially low-income neighbourhoods regarding access to water - yet these experiences have not compelled water users or the GWCL to adopt serious water-saving measures. From the learning platform, participants believed that with the high rate of NRW and the lack of innovative solutions to address it, the only means of compensating for the losses would be an increase in water tariffs.

Under the PSM, urban water tariffs were set up to include NRW levy. Under the WSSDP, the government intended to work with the PURC to prepare a progressive mechanism that would help to gradually reduce this levy on water tariffs to 40 per cent by 2020 and 33 per cent by 2025. This goal is to remove the burden of GWCL's inefficiencies from consumers as has been practised through the upward adjustment of tariffs under

the PSM. From the persistent rate of a high NRW rate, it seems this intended plan may not come to fruition by 2025.

As with water tariffs, the metropolis has experienced a continuous surge due to several factors including the high cost of energy, and chemical for treatment and declining exchange rate of the local currency. In December 2015, GWCL requested a tariff increase of 400 per cent to cater for the operational and maintenance costs, but the regulator, PURC approved only 67.2 per cent increase citing concerns about affordability (Global Water Intelligence, 2015). Tariffs increased from GH₵ 1.78/m^3 ($0.45/$m^3$) to GH₵ 3.01/$m^3$ (US$0.76/$m^3$). This meant the average monthly bill for a household of five members was estimated to be GHS10.00 (US$2.50). An official of the GWCL indicated that with this increase, the GWCL was still very far from achieving full cost recovery for water service delivery.

The increase in water tariffs has not slowed down treated water demand and consumption in the metropolis. A portion of residents, in particular, middle to high-income earners stated that they would pay a little more as tariffs so far as water is flowing regularly through the taps. However, tariff increase in low-income neighbourhoods compelled residents to find alternative sources of water fit for non-drinking water purposes.

6.7.3 Sanitation and Health

Overall, indicators for sanitation and health in the Accra metropolis recorded some of the lowest performance ratings (on a scale of 1 – low to 10 – high). Participants on the learning platform gave a "percentage of wastewater treated" a performance rating of 2 out of 10 while "level of wastewater pollution' recorded a performance rating of 3. The indicators, "wastewater and sewage coverage" rated 6, "stormwater drainage system coverage" rated 6 and the "incidence of waterborne disease outbreak" rated 4 out of 10.

These ratings seemed to suggest that interventions under the WSSDP had a low level of impact on addressing wastewater, stormwater, sanitation and health issues in the metropolis Data from the GSS indicated that only 15 per cent of the total sewage water was collected and treated. This meant a large proportion of sewage was discharged without treatment. Untreated wastewater in the metropolis ended up mainly in rivers, streams and lagoons in the capital city. Under the WSSDP, the government was exploring public-private partnership opportunities for wastewater and sewage management. For example, the government under the Accra Compost and Recycling Program partnered with the Sewerage Systems Ghana Limited (SSGL), a private enterprise to commence wastewater and sewage treatment service delivery in the Accra metropolis. According to an official of the company, the company has three treatment plants with a total capacity of 21,000 m^3/ day but at that moment was able to treat 17.5 per cent of the daily wastewater and sewage generated in the metropolis because only one treatment plant was in operation.

Regarding access to sanitation, the WSSDP targeted 54 per cent in 2015 and 100 per cent by 2025. Data from the GSS indicated that sewage and wastewater coverage for the metropolis was estimated to be around 40 per cent, leaving the majority of households with no connection to the centralised sewage system. The implementation of the Accra Sewage Improvement Project (ASIP) increased sanitation coverage per capita in Accra from 40 per cent to 52.5 per cent in 2016 (AfDB, 2018). The increase in coverage was almost close to

the target set by the WSSDP in 2015 and also below the initial goal of 65 per cent set by the project. Activities under the ASIP project entailed the construction of 37 septage reception tanks, a sewage treatment plant with a capacity of 6,424 m^3/ day, and the connection to 7000 households to the sewage network (ibid).

The Accra metropolis remained highly prone to severe flooding and yet it is one of the cities where stormwater management has received little attention. In June 2015, a major flood in the metropolis led to one of the deadliest gas explosions, which killed 150 people and affected 52,622 residents (Amoako & Boamah, 2015). A World Bank assessment estimated the economic cost of the damage caused by the flood to be US$55 million and rebuilding cost of US$105 million for the water, housing and transport sector along (World Bank, 2017). For a long time, the metropolis lacked a comprehensive stormwater drainage system as a significant proportion of stormwater flow occurs through natural drains. The WSSDP was silent on the development of stormwater drainage networks. A probable reason for this neglect was the complicated and weak institutional arrangements governing the development and management of the stormwater drainage system. Even though the NWP actively promoted an integrated approach to water resources management, it failed to define a clear pathway for stormwater management. The policy made a brief mention of stormwater management under Focal Area 10 where natural hazards such as flooding were mentioned. The responsibility of drainage development seemed to fall on different ministries, including the MSWR, MRH, and MLG. Primary drains were supposed to be constructed and maintained by the HSD of the MSWR. The Department of Urban Roads under the MRH was responsible for secondary and tertiary drains as part of road construction. After the decentralisation process, secondary and tertiary drains development became the responsibility of Urban Roads Development under the AMA. The process also facilitated the creation of a Drainage Maintenance Unit (DMU) under the Waste Management Department (WMD) of the AMA. With the arrangement and capacity development under the Urban Environmental Sanitation Project, the management of stormwater drainage was transferred to the DMU.

The Accra metropolis has seven primary drains which included Lafa, Chemu, Odaw, Kpezie, Mokwe, Songo, and Sakumo drains. These drains were upgraded through the construction of complete concrete linings under multiple drainage improvement projects a decade ago (Government of Ghana, 2014). In spite of the upgrade, several portions of these upgraded drains were washed away after heavy downpours. In the absence of efficient wastewater and sewage systems in low-income neighbourhoods, existing drainage systems served as dumping ground for liquid waste, semi-liquid waste, and plastic waste thereby blocking the channels and discharge capacity (World Bank, 2017).

6.7.4 Knowledge and water system data

Of the three indicators defined for measuring the data collection and the contribution of data to knowledge development and learning around the water management, “knowledge and learning platform” was rated favourably (8) by participants on the learning platform. The other indicators “well-functioning water database” and “annually published data” were rated close to an average of 4 and an average of 5 out of 10 respectively.

Perhaps, an essential but often neglected aspect of water management in the Accra metropolis was a robust database and knowledge management system. This absence of such database and information system affected was likely to affect national water reporting, as available data and information were on a number of occasions not up-to-date. Under the WSSDP, the government committed to improving access to knowledge, data and information on water resources. This was intended to help inform planning and decision-making on water resources in the country. To achieve this, the plan mandated the WRC to establish a water resource database in 2015. A web portal for information exchange and framework protocols for water resources data sharing were supposed to be created by 2015. The government also planned to build the capacities of Policy, Planning, Monitoring & Evaluation Division (PPMED) of the MSWR and M&E Unit at the GWCL and WRC for adequate data mobilisation by 2014.

Following a check at the MSWR and the WRC regarding the implementation of these interventions, it became clear that the proposed interventions had not been implemented. There was no active web portal or framework for data sharing. The database provided by the WRC either lacked up-to-date information on water resources or data remained patchy. One area that received a lot of attention was the strengthening of the learning platform at the national level. However, the government's commitment to extend the learning platforms to the municipality and metropolitan levels by 2014 had not yet materialised. It also came out that very little had been done to produce annual reports on data collection and progress of activities in the urban water sector. WHO's Joint Monitoring Programme for Water and Sanitation provided an example of annual reporting for the country, but this effort seemed to have fizzled out due to lack of funding.

6.7.5 Improved governance

The analysis of indicators for assessing water governance improvements showed that 4 out of 5 indicators received average to favourable performance rating from 5 to 7 out of 10. Participants on the learning platform rated "integrated planning" 5. The indicator, "public participation" was rated 7, while "institutional capacity" was rated 5. Participants rated "public-private partnership" 6. One indicator that was rated low (2) was the "Comprehensive strategic plan" specifically for the metropolis.

A significant highlight of the WSSDP was the attempt to improve governance in the processes of water resources planning and implementation of interventions by forging a stronger interconnection among water institutions. The established Inter-Ministerial Steering Committee made up of representatives from six ministries (mentioned earlier) served as a pivotal platform on which allied water ministries were rallied to provide updates on the interventions implemented under the WSSDP as well as planned future projects. Participants on the platform reiterated the vital role of the Committee in harmonising activities within the urban sector but also lamented the lack of frequent meetings by the Committee. Another essential group established to improve governance and institutional coordination were the Sector Working Group. Members of this group came from implementing institutions namely the GWCL, AMA, PURC and WRC. Through the proper functioning of the working group, annual audit reports of these institutions were made public, which hitherto

was not the case under the PSM. According to participants on the platform, the publication of accounts contributed to improved transparency and accountability in the water sector in the metropolis.

Under the WSSDP, the government facilitated the participation of water stakeholders in the water resource planning and decision-making processes. This appeared to be lessons well-learnt from the implementation of interventions under the PSM between 2006 and 2011. Despite the improvement, some participants from civil society organisations were still sceptical about the value-addition of public participation in water management decision-making. They attributed their doubt to the fact that in their experiences, some policymakers and government agencies saw these engagements as "institutional requirement that needed to be adhered to" without placing a premium on the contribution from these stakeholders. From the researcher's perspective, public participation in the national or metropolitan decision-making process was not just a fluke but has become a very systemic instrument used in steering the direction of planning and policy direction. Policymakers could no longer take public participation for granted because of the severe implications it may have on their political career.

In spite of the return of the water system to public management, the arrangements made under the PSM era created an enabling condition for public sector management in water service delivery in the metropolis. Sachet and bottled water production was a grounded market niche that transformed the drinking water style of the residents of Accra (Tutu & Stoler, 2016).

6.7.6 Water quality

The results of a study by Karikari and Ampofo (2013) on the quality of treated water supplied in the Accra metropolis showed that:

- The mean turbidity ranged from 1.6 to 2.4 Nephelometric Turbidity Unit (NTU),
- pH ranged from 6.8 to 7.4,
- Conductivity ranged from 71.1 to 293 µS/cm,
- Chlorine residue ranged from 0.13 to 1.35 mg/l,
- Total coliform ranged from 0 to 248 colony-forming units (CFU)/100 ml, and
- Faecal coliform values ranged from 0 to 128 CFU/100 ml.

The results indicated that the water quality conformed to the drinking water quality standards of WHO. Even though these results were considered as an improvement in the water quality during the PSM era, there were still incidences of bacteria and opportunistic pathogens present in the water supply chain (Ibid). Such contamination resulted from broken pipes, leakages in the pipe networks, installations, and repair works.

A study by Acheampong et al. (2014) on the physicochemical properties (pH, turbidity, dissolved oxygen, chemical oxygen demand, electrical conductivity, total suspended solids, and true colour) and concentrations of some heavy metals (cadmium, copper, manganese, and lead) in water bodies in the metropolis revealed high levels of pollution including a high concentration of heavy metals. Several studies also concluded that the high pollution level of water bodies severely impaired aquatic life and contributed to the high toxicity levels in

groundwater. These results rendered water unsafe for consumption in several parts of the metropolis (Acheampong, Ocloo, *et al.*, 2014; Akoto, Bismark Eshun, Darko & Adei, 2014). The high level of pollution and the poor state of water bodies in the metropolis accounted for substantial socio-economic and environmental cost implications. For example, analysis of a failed $89.52 million restoration project of the Korle Lagoon (a highly polluted lagoon in the metropolis), which started in the year 2000, showed a negative net value of approximately $187.64 million as at 2017(Amoako, 2018; Amuzu, 2018). This implied that the project was not viable or not worth undertaking.

The recently developed water quality safety framework under the WSSDP was a good milestone for water quality assurance. The implementation of the framework would ensure that water producers and water service providers adhered to high water quality standards in the metropolis. The next six years of implementing this framework under the WSSDP will be very crucial, particularly, regarding the negative perception water consumers have about the quality of drinking water supplied by the GWCL.

6.8 Conclusion

In this chapter, the implementation of interventions proposed under the WSSDP was examined. The WSSDP served as a framework for guiding the management practices following the return of the urban water system to public control after five years of PSM (2006 -2011). After seven years of implementing the WSSDP, an assessment of the outcomes was necessary in order to know the extent to which the WSSDP has contributed to achieving the vision of safe drinking water and sanitation for all urban residents. To do this, a process analysis method was employed to develop an indicator set for assessing the implementation of interventions under the WSSDP in the Accra metropolis. The development of appropriate indicators was motivated by the experience from water management reforms that saw water managers struggle to provide measurable outcomes from the implementation of the interventions.

Overall, the progress of implementation of the WSSDP was encouraging. The study showed that the facilities at the Kpong waterworks had been substantially improved following the rehabilitation and expansion of the water treatment plants. The Accra metropolis also recorded some expansion of the water network, which resulted in an increased volume of potable water produced and supplied. Sewage and wastewater management was receiving some attention as the government pursued public-private-partnerships to inject capital in the subsector. Water governance continues to improve at the national level, and the expectation was that this would influence on practices at the metropolitan level. From the assessment, the study identified several areas that required further strengthening. These included fixing water systems leakages, reducing the volume of NRW, improving wastewater recycling, access to water data, and water health, among other issues. In the next chapter, the study will attempt to provide a framework based on the gaps identified in the implementation of the WSSDP to complement existing water management interventions in the Accra metropolis.

Chapter 7: Framework for supporting water management planning in the Accra metropolis

7.1 Introduction

The development and implementation of the WSSDP in the Accra metropolis was a prompt response to the need for a new framework for urban water management following the transition from PSM (2006 -2011) to public control in 2012. This plan articulated the government's vision to implement strategies that would lead to universal access to sufficient, reliable and affordable water and sanitation services by 2025 (Government of Ghana, 2014). The WSSDP was lauded by stakeholders for the bold and ambitious targets – to achieve a complete urban water and sanitation coverage by 2025 – considering the financial investment among other elements required to do this.

The year 2020 marked the ninth year of implementation of interventions under the WSSDP and the progress made was described as encouraging according to the assessment of the outcomes of the interventions. In Chapter 6, several gaps were identified in the implementation of interventions under the WSSDP including the high rate of NRW, which continued to prove very difficult to address. The proportion of NRW according to figures released by the GWCL remained extremely high – more than twice the 20 per cent level based on international best practice (World Bank, 2011). The cost of water production outweighs the revenue mobilised and thus derailed efforts towards full cost recovery and financially self-sufficient water system. The average bill collection ratio during the implementation of the plan had improved but not at the desired rate, and therefore remained lower than the rate of 96 per cent and 99.2 per cent for low and middle-income groups respectively (Banerjee & Morella, 2009; Foster & Pushak, 2011; Ying, Skilling, Banerjee, Wodon & Foster, 2010).

Another gap identified in the plan was the absence of demand management interventions such as public education, economic incentives and subsidies for the adoption of water-saving technologies, water use restrictions (quota system), bans on water use during emergencies, and penalties for water wastage (quota system), among others that would limit the water demand, create consciousness about water saving and wise water use. There were also certain aspects of the water system management – wastewater and stormwater management and ecological integrity – that were critical for water service delivery but received limited emphasis in the WSSDP.

One challenge that came up during a discussion with stakeholders on the learning platform was that water managers often found it challenging to adapt national-level policies and strategies to the metropolitan and municipal levels. Two issues emerged from the discussion – the first was that national-level priorities were sometimes at variance with priorities at the metropolitan or municipal level. This was because some national priorities were derived from the manifesto of the political party in power, and sometimes, these might deviate from the national plan as well as the preferences of the metropolis. It was also the case that water service delivery projects were funded by the State, and therefore, the decision to use the funding and the priorities

were defined at the national level for the metropolis. Accra was obliged by the decentralisation law to define its priorities in water resource planning, taking into account essential guidelines from the national water sector plan. Second, national averages were often lower than figures for the Accra metropolis due to the gap between cities. For example, the cost of living in Accra was higher than the rest of the country, and therefore, national figures based on the averages were sometimes misleading when used as a benchmark for planning or decision-making. The point argued by stakeholders was that as the government intended to strengthen a decentralised system, it would have been more beneficial for the Accra metropolis to have its own strategic plan that detailed the specific interventions and outcomes. This, of course, should be guided by the national plan.

From the assessment of what has been achieved so far in the WSSDP, stakeholders on the learning platform were of the view that achieving the target of 100 per cent urban water and sanitation coverage by 2025 in the Accra metropolis might seem far-fetched. There was a consensus among stakeholders that interventions in the national plan should be contextualised and adapted more to the priorities at the metropolitan level. For the Accra Metropolis, there were evidence of meetings, consultations and forums that suggested the desire of water stakeholders to develop a strategic water plan, but for a long time, these activities had not been translated into a concrete plan (Gaisie, Kim & Han, 2019; Oduro-Appiah, Afful, Kotey & de Vries, 2019; Twum & Abubakari, 2019).

One of the outcomes of the TDR process was the need for a framework for sustainable management planning of water in the Accra metropolis. Between April and May 2016, two learning platforms focused on deliberations around the envisioning of sustainable management and strategic planning for urban water management practice in the Accra metropolis. On these learning platforms, a participatory-scenario building (PSB) process was employed to construct multiple narrative case scenarios of the state of water management in the metropolis based on factors, including possible future trends in water resource availability, population growth, economic crisis, climate change and change in power.

Based on the limitations identified in the implementation of interventions under the WSSDP, a framework that define an overall goal, specific objectives and water management interventions SUWM Accra metropolis was developed by this study. The cost-effectiveness of implementation of identified interventions was also highlighted. The idea is to provide water managers with further insights into consideration for developing water management for the metropolis. In the next section, a description of PSB as a method to help define interventions and sustainable pathways .to urban water management is presented.

7.2 Participatory-scenario building (PSB) on the learning platform

The application of a PSB approach was to help understand the implications of different realities in the context of a possible future of sustainable management of the water system in Accra. The scenarios were used to offer a context within which stakeholders could define appropriate interventions for urban water management over time. In the process of scenario building, different views and responses were drawn from stakeholders based on observations, experience and knowledge. The rationale was to gather diverse, wide-ranging and context-specific knowledge and carefully draw out the divergent values and interests. The process facilitated the

framing and reframing of stakeholders' views and perceptions of the challenges, and the outcome was greater social learning among stakeholders. The following steps were employed to define the various scenarios, highlighting the specific interventions that were applicable under these scenarios of the Accra metropolis:

1. In April 2016, a total of 20 stakeholders were invited to participate in a discussion on the platform in the Accra metropolis where the overall goal and detailed insight into the PSB process were introduced. This was followed by an open discussion about the factors driving the current development in the metropolis, including economic growth, population, power supply, urban expansion, mining, politics, public attitude and consciousness, water resources use, and climate change impact, in particular, flooding events that were considered highly prevalent. These factors had a direct impact on water demand, supply and quality. Political commitment to promoting good water policies also had a direct impact on water service delivery while public attitude and awareness directly impacted on water resource use and savings.
2. With this knowledge, participants were divided into 4 groups of 5 members and asked to discuss and prepare a detailed vision for Accra metropolis drawing on their expertise and experiences in the water sector. In each group, participants were to think about the development trends of the past 15 years, the present trend and develop a likely future pattern. One group was asked to create a future of highly prosperous growth in the metropolis. Two groups were asked to create a mixed vision of both challenges and some level of growth. One other group was tasked to develop a crisis vision of the metropolis where all factors are beyond acceptable limits, and the metropolis is facing severe challenges.
3. Following the development of the visions or scenarios, the next step was for the groups to define pathways that were considered critical for each scenario by stakeholders. These pathways were informed by the gaps and limitations identified during the implementation of the WSSDP, also by the components that defined the scenarios.
4. In the process, inputs from all the groups were compiled to create a set of interventions that could be considered. Participants went on to identify the priorities for short-, medium- and long terms. These priorities were linked to the ongoing water management interventions in Accra metropolis. At this point, we attempted to determine the ability of the responses to measuring up to "what if" questions about the various scenarios and then subjected these interventions to feasibility tests under different situations. For example, in a crisis-ridden metropolis, can a water equity intervention be successful?
5. At this stage, all the groups reconvened to report on the outcomes of their work. Participants presented their interventions at different timescales. Following the presentations, we deliberated on the interventions of each group to identify similar actions while exploring synergies for the different timescales. The goal was to enable us to have a comprehensive outlook of the prioritised interventions to create a pathway for the sustainable management of the water system in the Accra metropolis. There was a consensus among participants that a vision of providing safe, reliable, high-quality water and sanitation for all residents of the Accra metropolis would take up to 15 years (2019 – 2034) of implementing the various water management interventions.

7.2.1 Economic and population growth – current and future demand for water

To understand the current and future water demand as well as the need for water conservation in the era of rapid population and economic growth in the Accra metropolis, a historical development perspective about Ghana's economy (a reflection of Accra's economy) would be essential. Ghana's economy over the past 5 decades could be described as a roller coaster. With prospects of becoming an economic giant after independence in 1957, the direction the economy turned, strongly influenced by the world market and political unrests, came as a surprise to many economists.

Ghana's economy immediately took a dip in mid-1960 after the first elected President, Dr Kwame Nkrumah was overthrown in a coup d'état. Per capita gross domestic product (GDP) showed negative growth throughout the 1960s, dropping by 3.2 per cent per year from 1970 to 1981 (World Bank, 2005b). This drop was attributed to the decline in cocoa production, which fell by 50 per cent between the mid-1960s and the late 1970s, drastically reducing Ghana's world cocoa market share from about 33 per cent in the early 1970s to 12.5 per cent in 1983 (Fosu & Aryeetey, 2008; World Bank, 2005b). Concurrently, gold production declined by 47 per cent, manganese by 43 per cent, bauxite by 46 per cent and diamonds by 67 per cent. The annual inflation averaged more than 50 per cent between 1976 and 1981, skyrocketing to 116.5 per cent in 1981. Real minimum wages dropped from an index of 75 in 1975 to 15.4 in 1981. Tax revenue mobilisation fell from 17 per cent of GDP in 1973 to only 5 per cent in 1983, while the low productivity, low standard of living, and dwindled government's resources characterized the economy. In short, the economy fell into an advanced state of collapse.

The worsened economic conditions resulted in limited investments in the water sector, which strongly affected the operation of the water system and threaten the collapse of the utility at that time. To deepen the crisis, there was a mass exit of skilled professional from the public water sector due to the deteriorating conditions such as the lack of funding for operations and salaries, operational deficiencies and ageing water infrastructure (Addo, 2010; Fuest & Haffner, 2007). The economy began to turn around following the implementation of the Economic Recovery Program (ERP), which was supported by the IMF and the World Bank. Since 1983, an average of 5% GDP per annum was recorded, with minerals, cocoa and timber recording substantial price increases. Inflation fell from as high as 123% in 1983 to 10 % in 1992 amidst several fluctuations (Adu, Marbuah & Mensah, 2013; Aryeetey & Fenny, 2017). The country also witnessed a rise in overall gross domestic investment from less than 5 per cent of GDP to over 20 per cent since 1993, with private domestic investment also recovering strongly (Fosu & Aryeetey, 2008).

Fast forward to 2019, Ghana's economy continued to expand at an average growth rate of approximately 6.7 per cent (African Development Bank, 2019). Relying heavily on the service sector, Accra's economy is worth about $3 billion, which is 10 per cent of Ghana's overall GDP (ibid). Accra's recent history has been characterised by rapid population and economic growth because it is the economic hub of the country. The current population stands at 2.5 million at an annual growth rate of 4.3 per cent. This accelerated rate of growth has effectively outstripped water supply, urban planning, presenting the city with a range of complex urban challenges.

The recent attention to water infrastructure development in the metropolis is being driven by rapid economic growth, increased population, rapid urbanization, and a growing gap between water demand and supply (Cobbinah, Okyere & Gaisie, 2020; Oteng-Ababio, Smout & Yankson, 2017b). According to the GSS, the current average per capita water consumption of Accra was estimated to be 120 l/c/d. This was likely to increase as many households entered the middle-income bracket, investing in water-intensive appliances such as coolers, swimming pools and irrigated systems for watering green lawns (Cobbinah, Okyere & Gaisie, 2020). There was a high correlation of high incomes with high water consumption as people move to bigger houses with larger spaces with gardens, lawns and pools that consume large volume of water.

As water demand rises and the economy and population grow, it would be critical to think about water savings and reduction in the current water demand. The current and future growth patterns in population, economy and infrastructure raise serious uncertainties in water supply, demand and management in the metropolis. In the next 20 years, it is anticipated that the daily water demand would increase to between 1,000,000 m^3 and 2,400,000 m^3 (Adank, Darteh, Moriarty, Osei-Tutu, Assan & van Rooijen, 2011). The current water supply to the metropolis is estimated to be 553,846 m^3/day (Ghana Water Company Limited (GWCL), 2017).
The need to conserve water by reducing demand and consumption is also being reverberated by the rising effect of climate change and variability on the metropolis (World Bank, 2017a). In the past, long dry accounted for the reduction of the volume of raw water inflow to the two waterworks, thus reducing the amount of treated water supplied to the metropolis. Additionally, recurrent flooding also contributed to severe destruction of transmission and distribution networks, creating water shortages. The flooding event in 2015 served as a reminder of the vulnerability of the city to flooding, water shortages and sanitation, and housing challenges (Amoako, 2018). With a quarter of the population living along the coast, rising sea level would have a serious impact on infrastructure, water supply and hydropower.

7.2.2 Scenarios for urban water management in Accra

From the PSB process, three scenarios of the potential future status of water management are presented, considering multiple unpredictable factors that could have an impact on the outcome of the implementation of water management interventions. These included - worst-case scenario, medium-case scenario and best-case scenario.

Worst-case scenario

In this scenario, the Accra Metropolis in 2034 is crisis-ridden and in a depressing and chaotic state. The population has quadrupled from the 2016 census figure of 2.3 million, and infrastructure development has exceeded the boundaries of the metropolis. Water demand from the society and industries is four times higher than the actual capacity of the water supply system in 2016. The absence of effective leadership, together with a weak economic outlook and a high poverty rate meant a limited ability to address the challenges of underinvestment and poor management of water supply and wastewater systems. Raw water scarcity has worsened the crisis, causing river flow reduction and increasing competition for available water.

Medium-case scenario

The population of Accra Metropolis has tripled since 2016, driven by a robust economic performance from the manufacturing, tourism, agriculture and oil sector. Urban infrastructure expanded twofold compared to 2016 levels. These increases resulted in a sharp rise in water demand, four times the value of 2016. Despite the rapid growth in the metropolis, it had not been chaotic. However, climate change, coupled with pollution and land degradation, contributed to the reduction in available water resources for the Accra Metropolis. The rise in water demand, coupled with these factors represented a hindrance to the sustainable management of water resources in the Accra Metropolis. This was further complicated by the limited financial capacity of the government to develop new water infrastructure. Nonetheless, water management interventions contributed to improved capabilities of water managers at the GCWL and AMA while the introduction of new innovative technologies and engagement of residents inspired public optimism about finding sustainable solutions.

Best-case scenario

In this scenario, the Accra metropolis, in 2034, is represented as a well-managed city with a population growth that was twice that of 2016. Water demand was at 200 l/c/day. Contrary to the multiplicity of problems that confronted the city in the early 2010s and scepticism about the inability to recover from its crisis, the city was performing well economically, environmentally, and socially. The recurrent power outage of the early 2010s was no more. The city had witnessed a marked improvement in the political process that contributed to advances in planning, law and regulatory enforcement. A strategic plan for sustainable management of the water system was put in place. This, together with strong socio-economic growth (driven by manufacturing, tourism, agriculture and oil wealth), empowered residents and increased their ability and willingness to pay for water and wastewater services. The city witnessed a rise in water demand due to the steady increase in population and economic growth. However, this demand was manageable.

Based on the scenarios defined above, participants proposed four strategic pathways and a framework for urban water management planning in the Accra metropolis. The feasibility of the interventions was examined in light of the three scenarios formulated. In the following section, a proposed vision of water management in the Accra metropolis by stakeholders is presented.

7.2.3 Water management vision for Accra in the next 15 years

In April and May 2016, stakeholders on the learning platforms reached a consensus regarding a vision for sustainable management of water resources for the metropolis in 15 years. Participants envisioned a highly efficient and financially self-sufficient water system that would be able to meet demand by 2034. Taking cues from the underachievement of the Millennium Development Goal 7 target on water and sanitation by 2015, participants argued that the city was inadequately prepared and was unlikely to fully achieve the desired outcomes by 2025 or the Sustainable Development Goal (SDG) 6 on clean water and sanitation for all residents by 2030. Participants, therefore, agreed that a long-term framework could assist water managers to think about

interventions that could help build on the gains made by WSSDP. Based on the current realities and future trends, the stakeholders proposed the following expected outcomes.

- *A 100 per cent coverage and access to a regular potable water supply to the metropolis* – By 2034, all households in the Accra metropolis, irrespective of the social and economic standing, would have access to an affordable and reliable water supply via a pipe network connection to the house or within a reasonable distance from the household.
- *Between 30 to 40 per cent usage of alternative water sources such as groundwater and rainwater* – By 2034, households using groundwater and rainwater for non-drinking purposes would increase significantly to reduce pressure on using potable water for non-drinking purposes.
- *High water quality that meets the standard requirements of WHO and the Ghana Standards Authority* – By 2034, the quality of potable water will reach the highest quality standard-free from bacteria and other contaminants. It is expected that achieving the highest quality standards would bring back consumers' confidence and change the misconception of residents about the quality of drinking water from the tap. It is expected that this achievement would help reduce the sachet water patronage, whose waste (plastic) has become a sanitation and environmental hazard in the metropolis.
- *A significant reduction in NRW in the water system from 50 per cent to 15 per cent* – By 2034, the volume of NRW caused by physical leakages, water theft, and unmetered households would be reduced to 15 per cent, which is below the standard water reduction losses. The GWCL could generate more from recovered water as we target a financially self-sufficient water system.
- *Approximately 80 per cent of households in the metropolis practice good water savings* – By 2034, the majority of water users in the city would save water through an improved storage system and reduction in excessive water use.
- *Approximately 80 per cent reduction in waterborne diseases* – By 2034, there would be a significant reduction in the proportion of residents in the metropolis who suffer from water-related diseases.
- *Approximately 100 per cent of sanitation coverage* – By 2034, all households in the metropolis with access to a decent level of sanitation and wastewater system coverage through an integrated sewage system (collection, transport, treatment and final disposal) that would be able to collect 80 per cent of the waste produced.
- *Approximately 80 per cent well-connected drainage system coverage in the metropolis by 2034* – that could significantly improve stormwater management, thereby considerably reducing the recurrence of flooding in the metropolis.
- *About 30 - 40 per cent wastewater recycling and reuse in the metropolis* – By 2034, the proportion of wastewater recycled and used for non-drinking purposes would reach up to 40 per cent as we expect to have well-established wastewater treatment and recycling systems in the Accra Metropolis.

7.3 Strategic pathways for water management in the Accra Metropolis

On the learning platform, stakeholders defined a vision for the sustainable management of water resources in the Accra metropolis. This vision stipulated that by 2034, Accra would have a highly efficient and financially

self-sufficient water system that: (1) provides 100 per cent water supply and sanitation coverage, (2) provides access to affordable and reliable water supply, (3) guarantees economic water returns, (4) increases the usage of alternative water sources, (5) produces high-quality standard water, and reduce water-borne diseases, (6) significantly reduces the volume of NRW, encourages water savings, and (7) improves wastewater, sanitation and stormwater management.

According to stakeholders, a context-specific water management framework that defined vital elements was necessary to facilitate transformation in the water system towards achieving the vision stated above in the Accra metropolis. These strategic pathways, presented below constituted the elementary unit of the framework defined by stakeholders on the learning platforms. Water managers could think about these suggestions as they attempt to develop a strategic plan for the Accra metropolis.

7.3.1 Reduction of water input, losses, demand and non-essential water use

7.3.1.1 Reducing the demand for water

Reducing the demand for water among the various users could help minimise the need to expand the capacity of the water supply system. This could have a favourable impact on the demand/ supply ratio, reliability of water supply, and availability of water supplied to the city. Below, some practical interventions that could help to reduce water demand by households, industries, government institutions and service institutions such as hotels are presented (Table 7.1). Interventions to reduce water demand include awareness creation and educational campaigns, incentives for water savings technologies, revised regulations and by-laws for water-saving technologies in new infrastructure, and water tariff adjustment.

- A common but useful intervention that could encourage water savings and reduce demand for water from the GWCL managed system is awareness creation and education campaigns. The city could implement this option with specific and targeted messages on water-saving mechanisms for various categories of water users, including restaurant workers, manufacturers, school children, hotel workers, etc. These campaigns have succeeded in influencing social and behaviour changes in water consumption and savings (Dhakal & Chevalier, 2017; Fan, Gai, Tong & Li, 2017; Neto, 2016). The impact of this intervention may not be visible shortly after implementation since the social transformation, and behavioural change can be a long-term process.
- The government, working with the AMA can introduce incentives to facilitate water savings at the metropolitan level. Incentives such as subsidies, tax exemptions on water-saving devices, and financing mechanisms for water-saving technologies can facilitate their availability and encourage water users to choose and adapt water-saving innovations and technologies at organisational and household levels. For example, tax exemption on some water-saving devices such as highly efficient water closets, quick showers and mini-water treatment plants for treating water alternative sources, among others, could go a long way to support the reduction of water consumption while freeing water for other essential uses (Gomez & Teixeira, 2017; Lee, Tansel & Balbin, 2011). Incentives can thrive in medium to best-case

scenarios due to enabling conditions such as economic growth. This would require effective administrative systems and adequate financial resources for operationalising these incentive mechanisms.

- The review of current regulations and enactment of by-laws, making it mandatory for new commercial, public properties and residential buildings to integrate water-saving technologies can have a significant impact on water savings. The implementation of this intervention requires strict enforcement backed by a strong political will. This intervention seems feasible in the medium and best-case scenarios.

- Tariff adjustment could reduce water demand and increase water savings, especially in middle-income households that are conscious of their spending and looking at ways of reducing their expenditure on basic utilities. Nonetheless, increase in water tariff may not have an impact on high water-consuming households with high income who can afford water services from secondary service providers such as water tankers at far higher rates than the rates charged by the GWCL. For low-income households, tariff increases remain a highly unpopular option and could be counter-productive in improving water savings since deprived citizens may tend to resort to illegal connections and water theft. This intervention is feasible under medium and best-case scenarios but not viable under the worst-case scenario due to a weakened economy.

Option	**Impact (m^3/day saved)**	**Costs**	**Time frame**	**Challenges**	**Feasible under scenario**		
					Worst case	**Medium case**	**Best case**
Awareness creation and educational campaigns	Unknown (estimate: low to medium)	Unknown (estimate: medium)	Medium to long term	Limited human and financial resources	Yes	Yes	Yes
Incentives for water-saving technologies	Unknown (estimate: low to medium)	Unknown (estimate: Medium-high)	Short to medium	Human, financial resources and administrative systems	No	Yes	Yes
Revised regulations and by-laws for water-saving technologies in new infrastructure	Unknown (estimate: low to medium)	Unknown (estimate: low)	Medium to long term	Limited financial and human resources	No	Yes	Yes
Water tariff adjustment	Unknown (estimate: low)	Unknown (estimate: low)	Medium to long term	Lack of strong political will	No	Yes	Yes

Table 7.1 Actions for the reduction of water input, losses, demand and non-essential water use in the Accra metropolis (From discussion on the learning platform)

7.3.1.2 Improving GWCL water supply services

The GWCL anticipated that the renovation and expansion of the water treatment and production systems at the Kpong and Weija waterworks would put the total production capacity at around 917,990 m^3/day by 2025 (TAHAL Group, 2008). As at 2019, both waterworks were operating at 60 per cent capacity relative to the

2025 target. The expansion of the treatment plant capacity of both waterworks by 2025[1] would provide adequate water to meet the demand of an estimated population of 6,857,285. A demand analysis suggested that both waterworks functioning at full capacity would meet only 94 per cent of the expected water demand in the least water demand situation by 2025. This would not be adequate in the medium and high water demand scenarios by 2025. In a high water demand situation, the treatment capacity would be around 39 per cent of the projected demand in 2034. The implication is that water managers may need to explore other sources of water supply in the metropolis to meet the future total water demand. The proposed interventions below could provide useful ideas for water managers and policymakers in the metropolis.

Apart from surface water use, other alternative water sources could be explored to increase water supply from the GWCL. Groundwater represented an important alternative water source that could contribute significantly to the GWCL water supply to the Accra metropolis. The GWCL has started prospective drilling of boreholes in various neighbourhoods in the metropolis which would contribute about 5000 m^3 of water per day. The use of groundwater by the GWCL seems to be technically and financially viable options in all three scenarios. Further feasibility analysis on resources availability and environmental impact could help confirm available stock.

Besides groundwater use, another alternative option could be the desalination of saline water. A 60,000m^3/day Seawater Reverse Osmosis (SRO) plant was installed and commissioned in 2016 to provide water services to an estimated population of 500,000 residents of surrounding neighbourhoods of the Accra metropolis (including Teshie, Nungua, Burma Camp, GREDA Estates, Spintex, Baatsona, Sakumono, parts of La-Dadekotopon Lashibi). The drawback of this option was the high cost of production. For example, the cost of producing and distributing water to consumers was estimated to be US$1.57/$m^3$ (GWCL, 2018). This option seems less likely to be sustainable and feasible in the medium and worst-case scenarios, considering the high water tariff charges to consumers in neighbourhoods, where the majority of residents are found in the low-income category.

Areas in the Accra metropolis with a shallow groundwater table could benefit from harvesting and storage of rainwater. It seems interests in rainwater harvesting are growing among urban residents and government agencies in the metropolis. According to Adank et al. (2011). the capture and storage of even one per cent of the rainwater in the metropolis through roof-top rainwater harvesting could give a harvestable amount of 9,360,000 m^3/year. From this amount, the city could have a total amount of 25,635 m^3/day of rainwater. The National Building Code (2018) highlighted the need for rainwater harvesting in new housing. The optimisation of rainwater harvesting through the use of cost-effective technologies and innovation could provide a substantial volume of water and perhaps help to lower the demand pressure on the GWCL system. This intervention is not expensive, and it is feasible under all the scenarios. In Table 7.2, a summary of the management interventions to increase water supply to the Accra metropolis is presented.

[1] Projected population of the Accra metropolis by 2025 according to the Ghana Statistical Service

Option	Impact (m^3/day)	Investment Costs (US$/cap)	Recurrent cost	Time frame	Challenges	Feasible under scenario		
						Worst case	Medium case	Best case
Treatment plant capacity expansion	High (917,990)	High (US$123 million)	Unknown (estimated: low based on production costs of 0.1- 0.22 GHC/m^3)	Long term	Availability of financial resources	No	Yes	Yes
Increasing current capacity through desalination	Medium (60,000)	Unknown (estimate: high)	Unknown (estimate: high)	Short to medium	Management requires high standard requirements	No	No	Yes
Increasing current capacity using groundwater	Low (5,000)	Unknown (estimated: medium)	Unknown (estimated: low)	Short to medium term	Limited financial and human resources	Yes	Yes	Yes
Rainwater harvesting and storage	Low to medium	Unknown (estimate: high)	Unknown (estimated: low)	Short to medium term	Access to land or space and financial resources for infrastructure at household level	Yes	Yes	Yes

Table 7.2 Actions for increasing water supply capacity of GWCL in the Accra metropolis (From discussion on the learning platform)

7.3.1.3 Reducing physical losses in the water system in the Accra metropolis

The restoration and upgrade of old distribution systems could significantly reduce water losses from leakages as well as enhance the reliability of the water system. Additionally, the following interventions for leakage detection could contribute significantly to reduce physical losses in the water system: (1) creating sub-metro meter areas (SMMAs) to improve monitoring of leakages; and (2) developing an innovative leakage detection system monitored from by a master control room; and (3) investing in innovative leakage detection technologies, equipment and staff capacity development. All these interventions can be feasible only in the medium and best-case scenarios. To effectively reduce leakages and physical water losses, the GWCL might need a shift from a reactive approach to leakage management to an active approach of early detection and management of leakage in the water system. A summary of actions for reducing physical water losses in the Accra metropolis is presented below in Table 7.3.

Actions	Impact (%)	Investment Costs (US$/cap)	Time frame	Challenges	Feasible under scenario		
					Worst case	Medium case	Best case
Restoration and upgrade of the distribution system	High Physical losses	High (US$123 million)	Long term	Availability of financial resources and	No	Yes	Yes

	reduced from 27% to 10%)			technical difficulties			
Creating sub-metro meter areas (SMMAs) to improve monitoring of leakages		Unknown (estimate: medium)	Medium -term	Lack of interest from GWCL	No	Yes	Yes
Developing an innovative leakage detection system managed by a master control room		Unknown (estimated: high)	Medium to long term	High technical and management requirements	No	Yes	Yes
Investing in innovative leakage detection technologies, equipment and staff capacity development		Unknown (estimated: high)	Short to medium term	Availability of financial and human resources	No	Yes	Yes

Table 7.3 Actions for reducing physical water losses in the Accra metropolis (From discussion on the learning platform)

7.3.1.4 Improving the financial resources

Improvement in the financial situation of the GWCL could help address several issues including, expanding production systems, improving maintenance schedule, replacing worn-out equipment, and subsequently reducing physical water losses. Some actions that can be taken to help improve the financial situation of the GWCL are presented below (Table 7.4). The easiest way to increase revenue is to adjust water tariffs. However, evidence from past experiences proved that this action was ineffective in raising revenue (Amankwaa, Owusu, Owusu & Eshun, 2014; Oteng-Ababio, Smout & Yankson, 2017). Reducing commercial or economic losses that occur due to water theft, inaccurate meter reading and faulty meters could be an essential step towards financial self-sufficiency. The following actions could be taken in the metropolis to address commercial losses – (1) investment in smart metering system, thus eliminating human meter readings; (2) improved billing management system; (3) periodic monitoring to assess the performance of installed meters; and (4) Awareness creation and education on the consequences of water theft and manipulation of metering system.

Extensive installation of smart leakage sensors into the pipe network for leakage detection could be useful in reducing water theft or manual meter reading. In another effort, the GWCL in partnership with a private firm has introduced a smart metering system to reduce NRW, operational cost and fraud related to manual meter reading. This new system, connected to the central control room, was expected to ensure accurate meter readings, quick leakage detection and detect meter tampering. With the successful installation of a 40,000 smart metering system in 2017 in the Accra metropolis, the GWCL was expected to install approximately 500,000 smart meters to replace manual metering systems over the next five years (GWCL, 2018).

Actions	**Impact (%)**	**Costs**	**Time frame**	**Challenges**	**Feasible under scenario**		
					Worst case	**Medium case**	**Best case**

Tariff adjustments	Unknown (estimate: low to medium)	Not applicable	Short to medium term	Social unacceptance; Lack of political will	No	Yes	Yes
Investment in smart metering systems, thus eliminating human meter errors	High (economic losses reduced to 0-5% from 33%)	Unknown (estimated : medium to high)	Medium to long term	limited financial resources	No	No	Yes
Improved billing management system			Medium to long term	Limited technical capacities	No	Yes	Yes
Periodic monitoring to assess the performance of installed meters			Long term	Lack of technical capacity and political will	No	Yes	Yes
Awareness creation and education on the consequences of water theft and manipulation of the metering system			Short term	Lack of interest and political will	Yes	Yes	Yes

Table 7.4 Actions for increasing financial resources of the GWCL (From discussion on the learning platform)

7.3.2 Efficient production of affordable water and equitable access and use across all sectors

7.3.2.1 Improving access to the water system

Interventions to enhance access to affordable water could help reduce the cost burden on water users, particularly, low-income households who struggle to access water. Some actions that could improve access to water from the GWCL system are presented (Table 7.5).

Water managers can address water connection issues in densely populated areas by installing standpipes at vantage points within those neighbourhoods. The GWCL installed 6,000 standpipes across the metropolis in 2016. The installation of standpipes by GWCL with fixed tariffs can help to improve access to water for residents without household pipe connections. The cost involved is rather low; it is politically expedient but economically unappealing to the GWCL. The construction and operation of standpipes in densely populated communities should be regarded as a short term venture to address emergency water needs. This is because many communal standpipes did not last long due to poor maintenance and management neglect by the beneficiary communities.

The procedure for house connection to the water supply network could be redefined to make it flexible for new households to be connected to the water system. As at 2019, individual households mostly employ uncertified plumbers to connect their houses to the main water distribution network. This practice has contributed to damages to the pipe network, illegal connections and water theft according to an official of the GWCL.

The establishment of bulk water storage and supply by the GWCL in areas not connected to the GWCL reticulation system could provide relief for households in densely populated areas and informal settlements. Here, the GWCL could partner with communities to establish Water Boards to manage the distribution and

sale of water to consumers. The Water Board would be expected to liaise with the GWCL to set appropriate water tariffs for the community. This arrangement has been successfully piloted in Nima, one of the densely populated suburbs of the metropolis (Harris & Morinville, 2013).

Actions	Impact	Costs (US$/cap)	Time frame	Challenges	Feasible under scenario		
					Worst case	Medium case	Best case
Expanding the water distribution system	Unknown (estimate: high for spatially planned high and medium-income area, but low for densely populated low-income areas	High (US$123 million)	Medium to long term	Technical and legal difficulties in extending the distribution system to high populated and informal settlements	No	Yes	Yes
Redefining the water connection process to promote households connection	Unknown (estimate: medium to high)	Unknown (estimate: low)	Short to medium term	limited political will and administrative system	No	Yes	Yes
Installing standpipes	Unknown (estimate: medium to high)	Unknown (estimate: low)	Short to medium term	Resistance from GWCL and policymakers, as household connections are the preferred option	Yes	Yes	Yes
Bulk water storage and supply by GWCL to unconnected areas	Unknown (estimate: medium to high)	Unknown (estimate: low)	Short to medium term	Resistance from secondary service providers and policymakers, as household connections are the preferred option.	Yes	Yes	Yes

Table 7.5 Actions for improving access to water services (From discussion on the learning platform)

7.3.2.2 Reducing water tariffs for low-income households

In the Accra metropolis, houses that are not connected to the reticulation system continue to pay higher prices for water services provided by secondary water service providers. Water tariffs for compound houses fall within the high tariff block category. Some alternatives that might help reduce the water charges set by the private water service providers, as well as tariffs paid by low-income households, are presented in Table 7.6.

To bring down the exorbitant prices charged by secondary water service providers, authorities including the PURC, WRC, GWCL and AMA must regulate the activities and pricing of these service providers. Already, the PURC has developed a “Water Tankering Guideline” to help monitor and control the activities of water tanker operators to ensure safety, efficiency and reliability of water service delivery to consumers. Although

this is a good start, as a regulatory body responsible for urban water pricing, the role of the PURC must be clear in the water pricing process used by the secondary water providers. The PURC, GWCL and WRC must be actively involved in the registration and regulation of the activities of secondary water service providers, particularly in the setting of water charges. Once the PURC has regularised the activities of secondary service providers, guidelines for regulating water pricing set by the service providers should be developed. An effort to achieve this would require the right amount of investment in setting up physical systems, procedures of permits, regulations and enforcement, and also creating opportunities for negotiation between WTA, PURC, GWCL and WRC.

The GWCL must revisit its water tankers services model that was instituted in 2008 as an emergency response to the acute water shortage in parts of the metropolis. In this model, the GWCL established water selling points in unconnected suburbs, worked with private tankers to charge a fixed monthly rate to transport water from the GWCL system to the selling points where a hired vendor would sell the water to consumers. Except that this time around, the GWCL must on a more permanent basis invest massively in many water points in unconnected suburbs, which are likely not to be connected to the reticulation system any time soon. Extending connections to unplanned neighbourhoods (informal settlements) have proven to be very difficult, according to officials at the GWCL. Attempts to do this meant demolishing some houses to make way for the construction of pipes. In some localities, attempt to undertake this kind of project did not go well with residents (Tutu & Stoler, 2016).

Another intervention that could help reduce water tariffs for the benefit of low-income households is the removal of compound houses in low-income areas from the high tariff block and setting up a special water tariff that could bring down the cost of water in compound houses. Reducing tariffs for compound houses should work out in medium and best-case scenarios where proper management and sound administrative systems are put in place.

Action	**Impact**	**Costs (US$/cap)**	**Time frame**	**Conditions**	**Feasible under scenario**		
					Worst case	**Medium case**	**Best case**
Regulating the activities of secondary water service providers	Unknown (estimate: high)	Unknown (estimate: low)	Short to medium term	Requires political will and sound administrative system of secondary service providers	No	Yes	Yes
Subsidising water tariffs for secondary water providers	Unknown (estimate: low)	Unknown (estimate: low)	Short to medium term	Requires political will and sound administrative system for implementation	Yes	Yes	Yes
Removing compound houses from high tariff block and set up a special water tariff	Unknown (estimate: high)	Unknown (estimate: low to medium)	Short to medium term	Requires political will and sound administrative system for implementation	No	Yes	Yes

Table 7.6 Actions for reducing water tariffs for low-income households in the Accra metropolis (From discussion on the learning platform)

7.4 Strategic pathways for sanitation and wastewater management in the Accra metropolis

On the learning platform, stakeholders defined a vision of 100 per cent wastewater and sanitation coverage in the Accra metropolis by 2034. Records from the sewage improvement project by the African Development Bank (AfDB) put the coverage at 52.5 per cent as at 2018. This meant that the metropolis could achieve total sanitation coverage in the medium and best-case scenarios. However, for a long time, sewage and wastewater management compared to other utility service provisions in the Accra metropolis have received the least attention in terms of public financial investment and institutional support (Murray & Drechsel, 2011). The capacity of existing wastewater treatment plants (WWTPs) is very limited compared to the volume of wastewater produced daily. Currently, three wastewater treatment plants (WWTPs) with a total capacity of 21,000 m^3 serve the metropolis, which produces an average of 120,000 m^3 per day. Several studies have identified a total of 36 small institutional WWTPs (unknown capacity), majority of which were not in good working condition (Adu-Ahyiah & Anku, 2010; Antwi-Agyei & Ensink, 2016; Murray & Drechsel, 2011). The three working WWTPs included Mudor WWTP, Lavenda WWTP and Kotoku WWTP. The current operational arrangement for these WWTPs is a 20-year management contract under a public-private partnership (PPP) between the Government of Ghana and a private entity called Sewerage Systems Ghana Limited (SSGL). Mudor and Lavenda WWTPs were existing plants that were rehabilitated recently and have been in use over the past three to four years. Under a PPP arrangement, the three functional WWTPs are now serving the entire metropolis.

Mudor Wastewater Treatment Plant

The Mudor WWTP, formerly known as the Accra Central Sewerage System was built in 1972 with a 16,000 m^3 capacity to accommodate 1,500 houses, offices and public institution connections in the central part of the metropolis. The system worked for almost three decades before shutting down due to poor management (Agodzo, Huibers, Chenini, Van Lier & Duran, 2003; Obuobie, Keraita, Danso, Amoah, Cofie, Raschid-Sally & Drechsel, 2006). It was later rehabilitated in 2000 by Taylor Woodrow and operated for 2 years before shutting down again, due to defective pumps, lack of funds and poor management. Following the rehabilitation by SSGL, the total capacity was of the plant was increased from 16,000m^3/day to 18,000 m^3/day connecting over170,000 new households. The treatment process comprised (1) Primary treatment - screening and grit removal; (2) Secondary treatment - Upflow anaerobic digestion (UASB) and sludge thickening and (3) tertiary treatment - digested sludge drying. The biological process start-up time is between 90 to 150 days.

Lavender Hill Wastewater Treatment Plant

The newly rehabilitated Lavender Hill WWTP has a design capacity of 2000 m^3/day and 5,500m3/day storage tank. The plant has four UASB tanks, each with a capacity of 1,700m^3/day. On average, the plant receives 208 trucks (approx. 1200m^3) daily to discharge septage. The treatment process begins from the discharge of the

septage into discharge troughs for screening to remove debris and sand. The septage is then dewatered using a coagulant and then screw pressed into bio-solids that are collected and dried for further composting to produce organic manure. The effluent moves into the UASB tanks for further treatment (UASB) as well as the generation of methane gas. From here, the effluent moves into the Anoxic and Oxic Tanks for nitrification and denitrification respectively. The last stage of the process is the flow of the effluent into the sedimentation tanks. One end product of the process is clear water that is now used for irrigation, car wash, and aquaculture. According to SSGL, about 7000 m^3 biogas, comprising methane, carbon dioxide and hydrogen sulphide would be produced from the UASB process to power two 500 KVA Gas-powered turbines to generate 0.5 Megawatts of electricity, valued at US$800,000[2] for internal consumption.

Kotoku Wastewater Treatment Plant

At a cost of US$10 million, the new Kotoku Plant has a design capacity of 600 m^3/day with a maximum capacity of 1000 m^3/day. The Plant is a smaller version of the Lavender Hill Plant, with the similar treatment process and a lifespan of 20 years.

7.4.1 Good progress but still not enough

In spite of the improvement, the current capacity of 21,000m^3 for wastewater treatment was far below the estimated 120,000m^3 of wastewater produced daily in the metropolis. This means only 17.5 per cent of wastewater produced was collected and treated leaving a large proportion of wastewater discharged into storm drains, soak-away, nearby rivers, and onto the dusty streets (Ahmed, Ofori-Amanfo, Awuah & Cobbold, 2018). A portion of this wastewater will infiltrate the soil and join the groundwater resources while the remaining portion will flow through the storm drainage system and rivers to be used for irrigated agriculture and discharge into the lagoon and sea (Boon, 2019).

An increase in water supplied to the metropolis will contribute to the rise in wastewater production, prompting the need for safe collection, treatment and discharge. The estimated projection for the next 10 years puts the volume of wastewater production at approximately 530,000 m^3/day from an estimated population of 3.2 million (Boon, 2019). This means either more medium to largescale WWTPs should be to constructed or the metropolis must find new innovative cost-effective ways of wastewater treatment, recycle and reuse.

As indicated earlier, the majority of the existing WWTPs are not working or in bad working condition. The could be attributed to the high cost of installation, high operation and maintenance costs, particularly electricity costs, and the low level of service enough to break even (Antwi-Agyei & Ensink, 2016; Murray & Drechsel, 2011). Other studies attributed the failure to poor management and lack of human capacity to operate and maintain these plants (Iacob, 2013). The rehabilitation and operation of three WWTPs under a PPP arrangement over the past 4 years appear to provide an optimal solution to dealing with the problems that confronted the operation of WWTPs in the metropolis.

[2] Based on current rates from the Electricity Company of Ghana

7.4.2 Public-Private Partnership in Wastewater Management

Public-Private Partnership is gradually returning to the Accra metropolis as an alternative intervention for improving wastewater management (Ahmed, Ofori-Amanfo, Awuah & Cobbold, 2018; Ameyaw & Chan, 2015; Walker, Ameyaw & Chan, 2015). It comes at a time when the annual investment in wastewater and sanitation management is US$0.7 per capita in the entire country and the share of wastewater collected and treated is about 17.5% in Accra based on data from the World Bank (UN DESA, 2018). The PPP model is touted by proponents as a more effective and efficient way of delivering wastewater services – through improved coverage, improved customer responsiveness, increased capital investment, technological advancement and development of innovative products (Shrestha, Chan, Aibinu & Chen, 2017; Vedachalam, Geddes & Riha, 2016). Through PPPs, an enabling environment is provided by the public sector for the private sector to invest in infrastructure, technology, innovations, finance, and entrepreneurial wisdom to transform debt-ridden ventures into profit-making ventures (Amoah, Muspratt, Drechsel & Otoo, 2018).

In the Accra metropolis, the initial attempt to implement PPP arrangement in the water and wastewater management sector could not leave up to its expectations. Several factors among other the lack of transparency, absence of well-structured and clear policy guidelines, poor assessment of value for money, risks of proposals, and limited public consultation and stakeholder engagement have been mentioned as the causes of PPPs' failure in the past (Owiredu, 2018). Implementing a successful PPP model requires that certain enabling key success factors that can facilitate the PPP process in wastewater management in the metropolis. Based on the discussion on the learning platform, some key success factors are discussed below:

7.4.2.1 Well-structured and clear policy guidelines

One of the most important factors is the existence and execution of well-structured and clear policy guidelines for the implementation of PPP. Stakeholders were of the view that the absence of a regulatory framework and policy guide for PPP contributed to the past failure of PPP implementation in the metropolis. Several scholars and experts have highlighted the need to have a clear regulatory framework and policy guideline that shapes PPP implementation (Cheung & Chan, 2011; Osei-Kyei, Chan, Dansoh, Ofori-Kuragu & Oppong, 2018; Rahman, 2018). This view is reinforced by Public-Private Infrastructure Advisory Facility (PPIAF) of the World Bank, which stated that without a clear policy guide and framework for PPP proposals in place, many PPP projects would face many impediments and eventually fail (PPIAF, 2014). The provision of a well-structured regulatory framework and policy guidelines allows private investors to submit reasonable and innovative proposals while allowing public departments to receive proposals that align with national interest (Osei-Kyei *et al.*, 2018; PPIAF, 2014).

7.4.2.2 Transparency and openness in the tendering process

Another critical factor considered by many experts and stakeholders as necessary for fostering a successful PPP was the need for transparency and openness in the tendering process. PPPs have been at the receiving end of multiple criticisms their lack of transparency (Hood, Fraser & McGarvey, 2006; Papadopoulos, 2007; Willems, 2014; Willems & Van Dooren, 2016). Hood, Fraser and McGarvey (2006) argued that in 50 - 50 partnerships, supervision may be lacking and that performance measurement may provide only scanty

information that may not be easily understood by policymakers and civil servants. In practice, PPPs are not easy to achieve because of the diversity of stakeholders involved in the process, lack of data and difference in opinions, etc. However, efforts toward transparency could start with operationalizing these elements - a regulatory framework and policy guide, an open-access database that facilitates information flow between stakeholders, more communication, public participation and stakeholder engagements (PPIAF, 2014; Shrestha, Chan, Aibinu & Chen, 2017). In the metropolis, we are witnessing some level of improvement in PPP arrangement in the wastewater sector (as highlighted above) because some of these elements were under implementation.

7.4.2.3 Competitive tendering

To avoid the controversies associated with sole sourcing in the Accra metropolis, competition in tendering processes may be essential for successful PPPs project. Competitive bidding allows the public sector to select the most viable, cost-effective bid and agree on terms that are of interest to the general public (PPIAF 2014). Several studies have highlighted the crucial role competitive bidding plays in the successful management of PPP projects (Cheung, Chan & Kajewski, 2012; Osei-Kyei, Chan, Dansoh, Ofori-Kuragu & Oppong, 2018; Osei-Kyei, Chan, Javed & Ameyaw, 2017). Many countries, including Chile, Rwanda, Malaysia, Philippines, Argentina and South Korea have introduced competitive and transparency mechanisms into their tendering process procedures which have significantly improve the quality of proposal submitted, the effectiveness of selection process and implementation of PPP project (Yun, Jung, Han & Park, 2015; Zawawi, Kulatunga & Thayaparan, 2016). Nonetheless, it should be noted that the extent of competition would largely depend on the government's policies on procurement, fairness and accountability, which should be clearly stated in the regulatory framework and policy guide.

7.4.2.4 Public consultation and stakeholder engagement

It has been well-established that public consultation and stakeholder engagement cannot be underestimated when implementing PPP water projects in the Accra metropolis. This is backed by several studies that found this strategy to be very crucial for implementing successful PPP wastewater projects (Cheung & Chan, 2011; Osei-Kyei, Chan, Dansoh, Ofori-Kuragu & Oppong, 2018; Osei-Kyei, Chan, Javed & Ameyaw, 2017). A wide range of stakeholders has a stake in public projects, as they are affected directly or indirectly. Therefore, any attempt to implement PPP that is not of interest to them may be resisted. It has been reported that several public tensions and political unrests over PPP projects, particularly the unsolicited ones, often stemmed from the lack of wider public consultation and stakeholder engagement (Calabrese, 2008; Osei-Kyei, Chan, Dansoh, Ofori-Kuragu & Oppong, 2018; Walker, Ameyaw & Chan, 2015). This was the case in the Accra metropolis in the mid-2005 when the government attempted to implement a PPP model in urban water management. Suspicions may arise about fraudulent acts when public consultation and stakeholder engagement are not carried out in the early stages of the PPP arrangement. To avoid future resistance, early consultations and engagements during the early stage of the PPP process could help identify and incorporate interested stakeholders and their views (PPIAF, 2014).

7.4.2.5 Employment of highly skilled and competent staff

Getting the right people with the right skills for proposal evaluation could be very critical to the selection and implementation of a successful PPP project. In the Accra metropolis, for a long time, the wastewater and sanitation subsector has been understaffed and unskilled, thus limiting the capacity of the Sewage Unit at the AMA to undertake PPP ventures. Even at the national level, the lack of financial and technical capacity of local government agencies often made it challenging for them undertake due diligence and ascertain the viability of project proposals submitted by investors (World Bank, 2017b). Recruiting highly experienced and technically skilled professionals who understand the complexity and technicality of PPP proposals is considered important to set up a robust evaluation team for PPP projects.

7.5 Summarised framework for sustainable urban water management planning

Following the discussion of the different strategic pathways and interventions for water management, a consolidated framework that define the overall goal, key objectives and prioritises 5 key interventions that could support the effort towards SUWM planning in the Accra metropolis is presented (Figure 7.1).

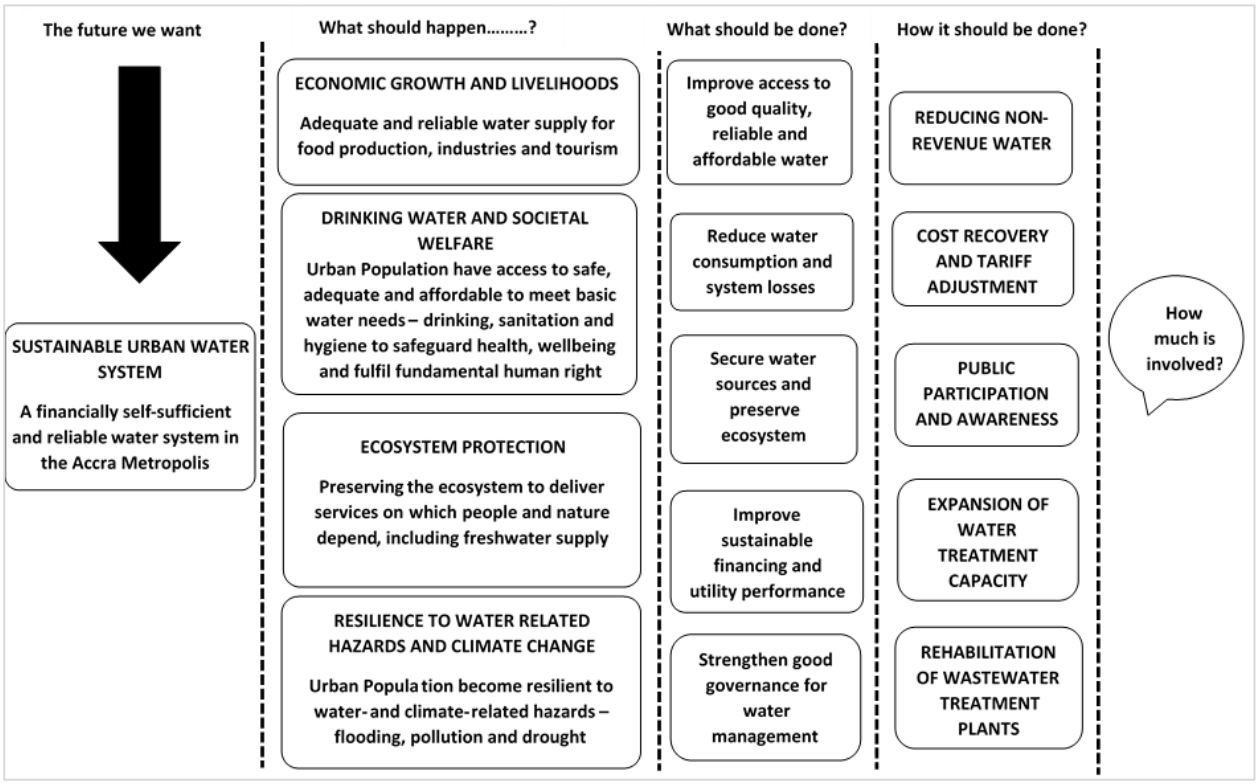

Figure 7.1 Framework for supporting SUWM planning in the Accra metropolis (Source: Author analysis)

The overall goal is to establish a financial self-sufficient water system with the capacity to provide secured and equitable access to good quality and adequate water and sanitation services at affordable cost, to facilitate economic growth, societal wellbeing and ecosystem preservation.

To achieve the overall goal, five specific objectives are outlined below:

- To improve access to good quality, reliable and affordable water
- To reduce water consumption and system losses
- To secure water sources and preserve the ecosystem
- To improve sustainable financing and utility performance
- To strengthen good governance for water management

It appears that the water system in the metropolis is predominantly characterised by a supply-oriented practice despite the effort to adopt of demand-driven water management model. This means that a major proportion of the current investment is going into expanding the capacity of water treatment plants in order to produce and supply more water (GWCL, 2015). Efforts towards building a sustainable urban water system may require a

transition from supply-side solutions towards water demand management and conservation-based interventions. In this light, multiple interventions defined by the study were crystallised into five priority interventions, which include:

1) Reducing unaccounted for water (UFW)
2) Cost recovery and tariff adjustment
3) Public participation and awareness campaign
4) Expansion of water treatment capacity
5) Rehabilitation of wastewater treatment plants

Below, analyses of these interventions, their contribution to improving the water system and their financial implications are presented. Later on in this chapter, a cost and benefit analysis will be performed to determine the viability of each intervention.

7.5.1 Reducing unaccounted for water

In developing countries, the unaccounted for water (UFW) account for 45 million m^3 per year, which is sufficient to serve about 200 million people (Bhagat, Welde, Tesfaye, Tung, Al-Ansari, Salih & Yaseen, 2019). Some experts estimated that reducing this figure by just 50 per cent could generate about US$3 billion annually without further investment into the production system (Smith-Asante, 2015). However, the high cost rehabilitating the water network coupled with technical difficulties have served as a deterrent to the execution of this intervention. The GWCL estimated a cost not less than US$200 million dollars to restore the entire water transmission and distribution network in the metropolis. However, the annual average investment contribution by the Government of Ghana to urban water supply in the entire country according to the GWCL is US$160.5 million, with a matching fund of US$189.5 million from developing partners (GWCL, 2015, 2018). This means funding the cost of intervention like this will have to come from external sources such as a loan, a grant or a PPP venture. Despite the high cost of investment, evidence suggested that there was a long-term beneficiary outcome from the rehabilitation, replacement and repairs of the transmission and distribution network (Güngör, Yarar & Firat, 2017).

The current arrangement to compensate for UFW through a special levy has failed to make any positive impact. Rather, it has become a “bone of contention” between the GWCL, PURC and water consumers, threatening to undermine the credibility and the integrity of the GWCL as well as raising questions about the legitimacy and accuracy of water bills. The reduction of UFW is thus an important strategy that is believed to drive the water system towards the desired goal (Fuest & Haffner, 2007; Morinville, 2017). Some areas of intervention as discussed below:

- Active leakage control: Several water experts consider this as a cost-effective action that would require fewer logistics and minimal effort to quickly detect, identify and repair of leakages in order to reduce the volume of water loss and possibly third party damages (Berardi, Laucelli, Simone, Mazzolani & Giustolisi, 2016). Fortunately, several innovative computer software packages and programming are now

available to aid the fast detection of system leakages and the management of NRW/UFW (Christodoulou, Agathokleous, Kounoudes & Milis, 2010; Li, Ling, Liu, Zhao, Liu, Chen, Qiang & Qu, 2011; Poon, 2016; Seyoum, Alfonso, Van Andel, Koole, Groenewegen & Van De Giesen, 2017). However, the effective detection and repair of physical leakages and subsequent losses will require behavioural and attitudinal changes from institutions from water managers at the GWCL by transitioning from reactive leakage management to active leakage management.

- Pressure management: Another important action for reducing NRW would be the reduction of operating pressure of the distributing system. While this can be considered as cost-effective, its drawbacks include slow and poor water service that would be delivered to consumers at the end of the pipelines. The installation of pressure-reducing valves (PRV) is considered to be cost-effective as it covered a large and could make a significant impact on average pressure. However, care must be taken regarding the number of PRVs to be installed at a particular location as the benefits derived would be less than the cost incurred if more PRVs are installed (Monsef, Naghashzadegan, Farmani & Jamali, 2018). Several approaches have been developed by experts for pressure management in the distribution system. Bakker et al. (2013) applied an active pressure control model in managing the outlet pressure of a pump station in the Midwest of Poland according to off-line pressure loss prediction in transmission pipelines. The model combined a predictive and a feedback controller and the results indicated a decrease of 20% water losses. Tricarico et al. (2014) employed the use of turbines instead of the conventional PRVs to reduce the network's pressure, whilst generating electricity simultaneously and minimizing operational operation cost. Monsef *et al.*, (2018) used a momentary demand multiplier estimator code to control the PRVs and VSPs which resulted in the 41.72% reduction of background leakage.
- Pipe Replacement: This action guarantees high returns in terms of the initial reduction in and NRW and UFW despite the high investment cost. A smart way to undertake the replacement of pipes is to conduct target monitoring to determine points or locations in the system prone to frequent leakages and burst. According to Farley and Trow (2003), this approach could be cost-effective if this exercise is well-conducted to identify targeted interventions. The reduction in water losses by fixing leakages in pipe supply networks, and installing efficient and advanced leakage detection monitors. By addressing these problems, water supply to various users can be significantly increased by as much as 30-50%, particularly for developing countries where water losses through leakages account for up 50% of water supplied in the pipe system (Dighade, Kadu & Pande, 2014). However, this requires a long-term commitment to the execution of this intervention.

It remains to be seen whether the implementation of this intervention will be cost-effective and beneficial in the context of the Accra metropolis.

7.5.2 Public participation and awareness campaign

Financial improvement and technological advancement in water management may be of less value to stakeholders, including water users if they fail to take into account their perceptions and demands. Some scholars agree that SUWM could be deemed as people-focused rather than technologically oriented (Sharp,

2017; Taylor, 2009). Therefore, public participation in the decision-making process is integral to the water management in the Accra metropolis, in ensuring that strategies, interventions and measures for SUWM are shaped by users' perceptions and demand. Even though they are excluded from the participatory process, the voice of the urban poor is not be discounted because they form a dominant voting bloc in the political election (Dapaah & Harris, 2017; Nathan, 2019).

The GWCL and PURC now acknowledge that decisions related to issues such as cost recovery, tariffs adjustment and access for the low-income urban residents should be informed by consumer's views and not only by external assumptions. Past implications of such neglect have been discussed in chapter 5. Notwithstanding its positive influence, effective participation remains a difficult task in practices. It is still an area that receives little investment and where even well-thought-out mechanism can be easily altered by the stakeholders involved. For example, elite stakeholders have often dominated in discussion and decision making, leaving the underprivileged stakeholders inferior in the process (Egan & Agyemang, 2019; Jollymore, McFarlane & Harris, 2018).

From the learning platform, experts argued that decisions on interventions such as tariffs adjustment, cost recovery and water service delivery options needed to be informed by consumer's willingness to pay. Willingness to pay surveys were very rare in the Accra metropolis. This was probably because of the monopoly being enjoyed by the GWCL as the sole water producer and the stature of the PURC as a mandated authority, whose decisions hold whether favourable or unfavourable. A survey prior to tariff adjustment to determine consumers' willingness to pay for water and related service may be instrumental in improving cost recovery, ensuring good governance and contributing to the financial sustainability of the GWCL.

Awareness campaign was one of the often marginalized strategies that provided the opportunity for target beneficiaries to gain a clear understanding of the importance of interventions and how they could contribute towards their successful implementation. In the Accra metropolis, the adoption of rainwater harvesting techniques to conserve water was stalled by the lack of understanding and information on the techniques (Damman, Helness, Amisigo, Banu, Asante, Williams, Amu-Mensah & Essegbey, 2017; Dapaah & Harris, 2017). In a recent study in California, Quesnel & Ajami (2017) showed that a regular media campaign on drought and the necessity for water conservation was linked with 11–18 per cent reduction in water consumption. Inman and Jeffrey (2006) found that a reduction of water demand by 2–5% in a residential was associated with media broadcasts, however, the effectiveness of awareness campaigns in the range of 0 to 8% was unclear.

It appears water consumers in the metropolis held some misconceptions, which the GWCL and the PURC must overcome as they pursue a demand-driven pathway to water management. These included:

- the perception that water service was not reliable with average quality and not worth paying for,
- the notion that water was a free commodity and should not be paid as reinforced by traditional beliefs and previous practice,
- Consumers were unaware of the urgency associated with efficient water use and savings, and

- The wild assertion about the environmental issues was not relevant to water service delivery.

In order to not to repeat the past mistakes, some suggestions for GWCL and PURC in planning awareness campaign are presented below:

- A well-crafted overall purpose of the campaign. For example, to draw public support for curbing illegal connections and water theft and encouraging domestic water savings.
- Specifically, the campaign could target these actions:
    - Ensuring that all water users understand the need for cost recovery
    - Ensuring that consumers understand how illegal connections can collapse the water system and end up disrupting water supply.
- Monitoring the impact of awareness campaign towards on targets such as revenue mobilisation, protection of the watershed, and water theft.

7.5.3 Tariff adjustment and cost recovery

The adjustment of water prices was a critical aspect of urban water demand management. Strong evidence existed to suggest that increasing water charges contribute significantly to the reduction in water consumption (Mylopoulos, Fafoutis, Sfyris & Alamanos, 2017; Park & Lee, 2019; Zhang, Fang & Baerenklau, 2017). Therefore, setting water tariffs at full cost could incentivise the reduction in water demand and promote efficient water use. However, in developing cities like the Accra metropolis where the dominant population is low-income urban residents, this may be complicated. As a contentious issue in water service delivery, increase in water prices has often not been received well by a portion of water users. Some users argued that the quality of water service did not commensurate with the charges being paid while others argued that the urban poor were not able to afford water service at the current price.

The GWCL argued that the current water prices do not reflect the true cost of water production and supply, maintaining that increasing water tariffs to reflect actual prices could be a disincentive for excessive water use and help reduce water consumption. For example, domestic consumers pay US$0.53 /$m^3$ of drinking water produced at a cost of US$1.21/$m^3$ (GWCL, 2018). Other argued that increasing water tariffs could deprive a portion of the population the ability to pay for water services (Amankwaa, Owusu, Owusu & Eshun, 2014; Nti, 2016). However, several studies have shown that in reality, low-income urban residents pay high water charges than high-income residents as the former buy water from secondary service providers - water vendors and kiosk - who charged 10 to 20 times the rates charged by the GWCL (Jaglin, 2002; Nti, 2016; Oteng-Ababio, Smout & Yankson, 2017). In this regard, they were likely to pay for a reliable and much affordable service from the GWCL.

One of the major reason for reforms in the water sector in Ghana was the transition from financial dependency to financial self-sufficiency through full cost recovery. It has become inevitable for the GWCL to move towards full cost recovery, however, this was not likely to materialise if the actual cost of water service was not paid by water users. The GWCL also faced stiff opposition from the PURC who set the water tariffs. Therefore, implementing a pro-poor objective within the context of the full cost recovery for water service

delivery required careful planning. An assessment of consumers' willingness to pay new tariffs for drinking water would be essential to determine who could or could not pay for water service.

The remaining two interventions - expansion of water treatment capacity and rehabilitation of wastewater treatment plants have previously been discussed. More emphases on them will be made below when the results of the benefit-cost analyses are presented.

7.6 Benefit-cost analysis of interventions

It is highly likely that water managers may not be in a position to implement all the interventions identified. There is need to prioritise the interventions based on factors such as the financial resources available, costs and the beneficial outcomes over a time frame. To determine the viability of selected interventions, the benefit-cost analysis of selected interventions over a 15-year period was carried out. This analysis took into account the direct and indirect costs drawing on the cost of past and recent water management projects as well as the benefits by quantifying the volume of water produced or saved in monetary terms. Some indirect cost considered included among others, compensation costs associated with land acquisition, environmental impact assessment, and insurance. Below, the analysis of each intervention is presented.

The results of the cost-benefit analysis showed that out of the five water management options presented, four showed positive net benefits over a fifteen-year period, i.e. the value of gains measured in monetary terms exceeded the costs of implementing these interventions, also expressed in monetary terms. Total costs and benefits are presented in per year terms from year 1 to year 15. All future costs and benefits were discounted at a rate of 5 per cent per annum to convert future values into present-day values.

7.6.1 Reducing unaccounted for water (UFW) – Rehabilitation of water transmission and distribution networks

In the metropolis, due to aged and weak infrastructure, any intervention aimed at reducing UFW must go beyond detecting and fixing leakages in the water transmission and distribution networks. Rather, it may require more extensive rehabilitation, replacement and repairs of the entire network of pipes and storage tanks. In Table 7.7, the outcome of benefit-cost analysis for the rehabilitation of water transmission and distribution network in the Accra metropolis is presented. Based on the GWCL estimates, an initial capital of US$200 million would be required to complete the rehabilitation of the transmission and distribution pipe network in the Accra metropolis in 3 years. The cost elements of the project included tools and equipment, supplies, parts, energy, fuel, compensations, both skilled and unskilled labour, and supervision. It also required an annual amount of about US$13 million to cover operation and maintenance cost. The present cost value at a discount rate of 5% was estimated to be US$301 million over a 15-year period.

The project when completed was expected to contribute to saving about 35 per cent of the water lost through leakages thus increasing water supply to the metropolis. This translate into around 197,000 m^3 of water saved

per day, which amounted to US$238,700[3]. The present value of benefit at a discounted rate of 5 per cent was estimated to be approximately US$690 million over a 15-year period. The analysis produced a net present value of US$ 389 million and a B-C ratio of 2.29, which indicated the viability of the project. In addition to this benefit, the successful implementation of this intervention is expected to improve access to an additional volume of water while preventing the cost of further water production. Compared to the business-as-usual scenario (no intervention), the benefit of not undertaking this project would be saving this amount of money or investing it in another venture. However, there was a huge cost of not undertaking this intervention other than minor maintenance, thus approximately US$389 million worth of water would be lost through leakages over a 15-year period, with serious implications for achieving a financial self-sufficient water system in the Accra metropolis.

OPTION A: REDUCING UNACCOUNTED FOR WATER (UFW)								**Discount rate**	**5%**
	COST					**BENEFIT**			
Year	**Cost ($'000)**	**Total Cost ($'000)**	**Discount Factor (5%)**	**Present Value ($'000)**	**Year**	**Benefit ($'000)**	**Total Benefit ($'000)**	**Discount Factor (5%)**	**Present Value ($'000)**
0	150,000	150,000		150,000	0	0	0		0
1	30,000	30,000	0.952	28,571	1	0	0		0
2	20,000	20,000	0.907	18,141	2	0	0		0
3	13,000	13,000	0.864	11,230	3	85,938	85,938	0.864	74,236
4	13,000	13,000	0.823	10,695	4	85,938	85,938	0.823	70,701
5	13,000	13,000	0.784	10,186	5	85,938	85,938	0.784	67,335
6	13,000	13,000	0.746	9,701	6	85,938	85,938	0.746	64,128
7	13,000	13,000	0.711	9,239	7	85,938	85,938	0.711	61,075
8	13,000	13,000	0.677	8,799	8	85,938	85,938	0.677	58,166
9	13,000	13,000	0.645	8,380	9	85,938	85,938	0.645	55,396
10	13,000	13,000	0.614	7,981	10	85,938	85,938	0.614	52,758
11	13,000	13,000	0.585	7,601	11	85,938	85,938	0.585	50,246
12	13,000	13,000	0.557	7,239	12	85,938	85,938	0.557	47,853
13	13,000	13,000	0.530	6,894	13	85,938	85,938	0.530	45,575
14	13,000	13,000	0.505	6,566	14	85,938	85,938	0.505	43,405
15	13,000	13,000	0.481	6,253	15	85,938	85,938	0.481	41,338
	Total PV of Cost			**301,222**		**Total PV of benefit**			**690,875**
Net Present Value (NPV)			**389,653**						
B-C Ratio			**2.294**						

Table 7.7 Benefit-cost analysis for reducing UFW in the Accra metropolis

7.6.2 Cost recovery and tariff adjustments

In Table 7.8, an analysis of the cost and associated benefit for an intervention to achieve cost recovery and tariff adjustments in the Accra metropolis is presented. Based on estimated from the GWCL, an amount of US$300 million was required to replace old, error-ridden water meters with new smart prepayment water meters and build an innovative remote system for managing water billing. Approximately 500,000 smart

[3] US$1.21/m^3 of water produced

meters were expected to be installed in households in the Accra metropolis over a 5-year period. The cost elements for this project included among other things, smart meters, labour, supervision, cables, surveys, leakage detectors, and transportation. In addition, this option included a series of upward adjustments of water tariffs and meter repayments. From the benefit-cost analysis, the present value for the cost of investment was estimated to be around US$277 million over a 15-year period. The present value of the benefits was approximately US$1 billion over a 15-year period. The net present value of the intervention was estimated to be around US$750 million with B-C ratio of 3.72 indicating that this intervention is a viable one worth investing in.

Compare to a scenario where no investment was made to improve cost recovery, the opportunity cost was using the money for other profitable venture. This decision not to invest may come at a heavy loss to the GWCL who will lose around US$750 million profit over a 15-year period. Other consequences were likely to be the total collapse of the water billing and metering system and reduced revenue due to errors in meter readings.

OPTION B: COST RECOVERY AND TARIFF ADJUSTMENT							**Discount rate**		**5%**
COST					**BENEFIT**				
Year	**Cost ($'000)**	**Total Cost ($'000)**	**Discount Factor (5%)**	**Present Value ($'000)**	**Year**	**Benefit ($'000)**	**Total Benefit ($'000)**	**Discount Factor (5%)**	**Present Value ($'000)**
0	100,000	100,000		100,000	0	0	0		0
1	50,000	50,000	0.952	47,619	1	4,596	4,596	0.952	4,377
2	50,000	50,000	0.907	45,351	2	73,534	73,534	0.907	66,698
3	50,000	50,000	0.864	43,192	3	80,887	80,887	0.864	69,874
4	50,000	50,000	0.823	41,135	4	81,623	81,623	0.823	67,151
5	0	0	0.784	0	5	81,696	81,696	0.784	64,011
6	0	0	0.746	0	6	81,704	81,704	0.746	60,969
7	0	0	0.711	0	7	89,874	89,874	0.711	63,872
8	0	0	0.677	0	8	98,861	98,861	0.677	66,913
9	0	0	0.645	0	9	108,747	108,747	0.645	70,099
10	0	0	0.614	0	10	119,622	119,622	0.614	73,437
11	0	0	0.585	0	11	131,584	131,584	0.585	76,935
12	0	0	0.557	0	12	144,742	144,742	0.557	80,598
13	0	0	0.530	0	13	159,216	159,216	0.530	84,436
14	0	0	0.505	0	14	175,138	175,138	0.505	88,456
15	0	0	0.481	0	15	192,652	192,652	0.481	92,669
Total PV of cost				**277,298**					**1,030,495**
Net Present Value (NPV)		**753,197**							
B-C Ratio		**3.72**							

Table 7.8 Benefit-cost analysis for cost recovery and tariff adjustment

7.6.3 Public participation and awareness campaign

Based on the cost of recent public participation and awareness campaigns in the Accra metropolis, an initial amount of US$30 million could be invested in this option over a 5-year period. This amount was expected to

drop to US$1 million per year in the 7th year. The cost elements included radio ads, television ads, staff, documentaries, learning and multi-stakeholder forums, conference, roundtables, and ground surveys, etc. Following the analysis, the present value of the total cost was estimated to be approximately US$37 million while the present value of the benefit was estimated to be US$238 million at a discounted rate of 5% over a 15-year period. The expectation was that this option would contribute to at least 1-2 per cent of annual water savings. The net present value was estimated to be US$201 million at a B-C ratio of 6.8 indicating the viability of the option (Table 7.9).

In the alternative scenario, by not investing in public participation and awareness campaign, the initial investment cost could be put in other investment opportunities. However, the real outcome would be the loss of over US$200 million worth of benefit that could have contributed to the GWCL's effort to become financially self-sufficient.

OPTION C: PUBLIC PARTICIPATION AND AWARENESS CAMPAIGN						**Discount rate**			**5%**
COST					**BENEFIT**				
Year	**Cost ($'000)**	**Total Cost ($'000)**	**Discount Factor (5%)**	**Present Value ($'000)**	**Year**	**Benefit ($'000)**	**Total Benefit ($'000)**	**Discount Factor (5%)**	**Present Value ($'000)**
0	10,000	10,000		10,000	0	0	0	0	0
1	5,000	5,000	0.952	4,762	1	22,979	22,979	0.952	21,885
2	5,000	5,000	0.907	4,535	2	22,979	22,979	0.907	20,843
3	5,000	5,000	0.864	4,319	3	22,979	22,979	0.864	19,850
4	5,000	5,000	0.823	4,114	4	22,979	22,979	0.823	18,905
5	3,000	3,000	0.784	2,351	5	22,979	22,979	0.784	18,005
6	2,000	2,000	0.746	1,492	6	22,979	22,979	0.746	17,147
7	1,000	1,000	0.711	711	7	22,979	22,979	0.711	16,331
8	1,000	1,000	0.677	677	8	22,979	22,979	0.677	15,553
9	1,000	1,000	0.645	645	9	22,979	22,979	0.645	14,812
10	1,000	1,000	0.614	614	10	22,979	22,979	0.614	14,107
11	1,000	1,000	0.585	585	11	22,979	22,979	0.585	13,435
12	1,000	1,000	0.557	557	12	22,979	22,979	0.557	12,796
13	1,000	1,000	0.530	530	13	22,979	22,979	0.530	12,186
14	1,000	1,000	0.505	505	14	22,979	22,979	0.505	11,606
15	1,000	1,000	0.481	481	15	22,979	22,979	0.481	11,053
Total PV of COST				**36,877**					**238,514**
Net Present Value (NPV)			**201,637**						
B-C Ratio			**6.47**						

Table 7.9 Benefit-cost analysis for public participation and awareness campaign

7.6.4 Expansion of water treatment capacity

In table 7.10, benefit-cost analysis of a proposed project on an expansion of water treatment plant capacity is presented. Based on recent projects by the GWCL, an initial amount of US$273 million was needed to construct a 350,000 m^3 capacity water treatment plant. The cost elements included planning, equipment, tools, supervision, labour, design, and construction. The total present value of the cost was estimated to be around

US$308 million over a 15-year period at a discount rate of 5%. In return, the total present value of the benefit over a 15-year period was around US$582 million. The results showed a positive net present value of US$273 million and B-C ratio of 1.88 indicating that this option is viable for investment.

OPTION D: EXPANSION OF WATER TREATMENT CAPACITY								**Discount rate**	**5%**
	COST					**BENEFITS**			
Year	**Cost ($'000)**	**Total Cost ($'000)**	**Discount Factor (5%)**	**Present Value ($'000)**	**Year**	**Benefit ($'000)**	**Total Benefit ($'000)**	**Discount Factor (5%)**	**Present Value ($'000)**
0	150,000	150,000		150,000	0	0	0		0
1	73,000	73,000	0.952	69,524	1	0	0		0
2	50,000	50,000	0.907	45,351	2	0	0		0
3	5,200	5,200	0.864	4,492	3	68,400	68,400	0.864	59,086
4	5,200	5,200	0.823	4,278	4	68,400	68,400	0.823	56,273
5	5,200	5,200	0.784	4,074	5	68,400	68,400	0.784	53,593
6	5,200	5,200	0.746	3,880	6	68,400	68,400	0.746	51,041
7	5,200	5,200	0.711	3,696	7	68,400	68,400	0.711	48,611
8	5,200	5,200	0.677	3,520	8	68,400	68,400	0.677	46,296
9	5,200	5,200	0.645	3,352	9	68,400	68,400	0.645	44,091
10	5,200	5,200	0.614	3,192	10	68,400	68,400	0.614	41,992
11	5,200	5,200	0.585	3,040	11	68,400	68,400	0.585	39,992
12	5,200	5,200	0.557	2,896	12	68,400	68,400	0.557	38,088
13	5,200	5,200	0.530	2,758	13	68,400	68,400	0.530	36,274
14	5,200	5,200	0.505	2,626	14	68,400	68,400	0.505	34,547
15	5,200	5,200	0.481	2,501	15	68,400	68,400	0.481	32,902
Total PV of Cost				**309,181**	**Total PV of Benefit**				**582,785**
Net Present Value (NPV)			**273,604**						
B-C Ratio			**1.89**						

Table 7.10 Benefit-cost analysis for the expansion of water treatment plant capacity

7.6.5 Rehabilitation of wastewater treatment plants

In table 7.11, a benefit-cost analysis for the rehabilitation of one wastewater treatment plant is presented. In this option, an initial cost of US$42 million was invested into the rehabilitation of a 2500m^3 capacity wastewater treatment plant in the Accra metropolis over a 2-year period. An additional amount of US$5 million was invested annually from the 3rd to the 15th year of the project. From the analysis, the present value of the cost was estimated to be US$84 million over a 15-year period while the present value of the benefit was estimated to be US$67 million at a discounted rate of 5% over a 15-year period. The benefits also included returns from the processing of liquid waste, production of compost, charcoal from faecal matter, and aquaculture using treated water. The net present value showed a negative value of US$26 million and a B-C ratio of 0.8 indicating this venture was likely to be at loss over a period of 15 years.

OPTION E: REHABILITATION OF WASTEWATER TREATMENT PLANTS	**Discount rate**	**5%**

COST					BENEFIT				
Year	Cost ($'000)	Total Cost ($'000)	Discount Factor (5%)	Present Value ($'000)	Year	Benefit ($'000)	Total Benefit ($'000)	Discount Factor (5%)	Present Value ($'000)
0	40,000	40,000		42,000	0	0	0		0
1	1,000	1,000	0.952	952	1	0	0		0
2	1,000	1,000	0.907	907	2	0	0		0
3	5,000	5,000	0.864	4,319	3	5,000	5,000	0.864	4,319
4	5,000	5,000	0.823	4,114	4	7,000	7,000	0.823	5,759
5	5,000	5,000	0.784	3,918	5	8,000	8,000	0.784	6,268
6	5,000	5,000	0.746	3,731	6	8,000	8,000	0.746	5,970
7	5,000	5,000	0.711	3,553	7	8,100	8,100	0.711	5,757
8	5,000	5,000	0.677	3,384	8	8,200	8,200	0.677	5,550
9	5,000	5,000	0.645	3,223	9	10,000	10,000	0.645	6,446
10	5,000	5,000	0.614	3,070	10	10,000	10,000	0.614	6,139
11	5,000	5,000	0.585	2,923	11	10,000	10,000	0.585	5,847
12	5,000	5,000	0.557	2,784	12	10,000	10,000	0.557	5,568
13	5,000	5,000	0.530	2,652	13	10,000	10,000	0.530	5,303
14	5,000	5,000	0.505	2,525	14	10,000	10,000	0.505	5,051
15	5,000	5,000	0.481	2,405	15	10,000	10,000	0.481	4,810
		Total PV of Cost		**84,056**			**Total PV of benefits**		**67,977**
NPV		**-16,079**							
B-C Ratio		**0.81**							

Table 7.11 Benefit-cost analysis for the rehabilitation of wastewater treatment plant

7.7 Risk Analysis

Urban water development represents not only a difficult and complicated sector to finance but also a risky sector for public and private sector investments (Nguyen, Ngo, Guo, Wang, Ren, Li, Ding & Liang, 2019; Pryke & Allen, 2019). Typically, the development of the water sector is characterised by multiple features among others, large sunk costs, long-term rate of returns, high capital investment, multiple policy goals, fragmented sector, multiple institutional arrangements, and several performance indicators (Ameyaw, 2014; Ameyaw & Chan, 2015). All these features create a complex dynamism that exposes any intervention to an avalanche of risk factors.

At the learning platform, a brainstorming session among participants in May 2016 highlighted the need to identify the risks when planning urban water management interventions in the Accra metropolis. Two critical elements are relevant to the analysis of risks associated with urban water management. These include the probability of occurrence of the risk in relation to the implementation of water management projects and the level of impact or severity of the risk.

To determine the risks factors, the probability of occurrence of the risks and the impact of the risks, four stages of assessment are followed in this study.

1. **Identification of risk factors:** Two methods were employed to identify the risk factors in the Accra metropolis. First, an extensive review of water management project documents and investigation into completed and ongoing water development projects in the Accra metropolis were carried out. Second, a brainstorming session with experts from various water institutions in the metropolis was carried out to identify the risk factors associated with the implementation of interventions identified. These experts had experiential knowledge in implementing or managing water projects in the metropolis. Their background and insight provided a guarantee over the reliability of their responses for this study.
2. **Evaluation of risk factors on a scale:** This stage was determined by a range of criteria that allowed the risk factors to be rated based on the probability of occurrence and their severity on a seven-point rating system (1= extremely low and 7 = extremely high). This system of rating allowed for detailed statistical analyses while curbing the problems of leniency and central tendency associated with ordinal scales (Ameyaw & Chan, 2015).
3. **Data analysis**: Ratings by the participants on the learning platform were analysed using the average score ranking in Microsoft Excel. The average score is commonly used because it represents the central tendency measure to define the significance of the variables (Anderson, Sweeney, Williams, Camm & Cochran, 2020; Suardika, Suryawan, Sutapa, Sudiarta & Kader, 2018). By using this method of analysis, it became possible to determine the relative significance of each risk factor using the equation below:

$$AvS = \frac{7n_7 + 6n_6 + 5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{N}$$

Where AvS is the average score of each risk factor: n_1, n_2, n_3, n_4, n_5, n_6, and n_7 represent the number of participants who ranked their responses as 1, 2, 3, 4, 5, 6 and 7, respectively, and N is the total number of participants that rated the risk factor (18 in this case).

Two kinds of data were collected from participants on the learning platform – (1) data on the probability of occurrence and the severity of each risk factor. The risk was therefore defined as a joint function of the probability of occurrence and severity, measured by (Nicholas & Steyn, 2017):

$$\text{Risk} = f\ (\text{probability, severity})$$

Quantifying risk using this approach is deep-rooted in decision theory and has been applied in several scholarly studies (Abdel-Basset, Gunasekaran, Mohamed & Chilamkurti, 2019; Gul & Ak, 2018; Linkov, Trump & Fox-Lent, 2016). The ranking of each risk is directly linked to the product of its probability and severity. This risk measurement approach was employed to establish significant risk factors associated with the implementation of interventions. The highest-ranked risk factor would be considered as the one that deserves the most urgent attention and resources. According to Nicholas and Steyn (2017), an intervention may be weighed as "risky" whenever the probability of occurrence or level of impact is high. In reality, a risk factor with a high probability of occurrence but with minimal impact is likely to be ignored to save money.

Critical risk factors: the study goes beyond the identification of risk factors to determine the critical factors that could have a significant impact on water management interventions. To determine the critical risk factors, the overall impact of each risk factor was computed using the formula: $[impact = \sqrt{probabilityx\ severity}, (mean\ value \in (1,7)]$ (Ke, Wang & Chan, 2010; Suardika, Suryawan, Sutapa, Sudiarta & Kader, 2018). Based on the seven-point Likert scale and applying the "half-adjusting" principle (Walker, Ameyaw & Chan, 2015b), a risk factor with an impact value ≥ 4.50 is classified as critical. A similar approach employed for previous studies by Walker et al (2015) and Ke et al (2010) was followed.

7.7.1 Identification, evaluation and analysis of risk factors

In this section, a list of risk factors which have been identified and evaluated by participants on the learning platform is presented. Based on this, the average scores of each risk factor and its severity were calculated. The risk significant index was also calculated from the products of the risk probability and risk severity. Based on the risk significant index, a ranking of the risk factors was carried out. The results of the assessment of the identified risk factors based on the expertise and knowledge of participants on the leaning platform are presented in table 7.12.

Risk factors	Probability	Severity	Significant Index	Ranking	Risk Impact
Water theft and leakages	5.85	6.60	38.61	1	**6.21**
Non–payment of water bills	5.86	6.46	37.86	2	**6.15**
Corruption	5.89	6.36	37.46	3	**6.12**
Foreign exchange rate	5.78	6.05	34.97	4	**5.91**
High operational costs	5.52	5.85	32.29	5	**5.68**
Climate risk	5.25	5.65	29.66	6	**5.45**
Political interference	5.02	5.52	27.71	7	**5.26**
Volatility in inflation rate	4.92	5.35	26.32	8	**5.13**
Change in government regimes	4.94	5.32	26.28	9	**5.13**
Interest rate	4.63	4.98	23.06	10	**4.80**
Financial risk	4.62	4.95	22.87	11	**4.78**
Delay in contract payments	4.54	4.42	20.07	12	4.48
Regulation risk	4.34	4.45	19.31	13	4.39
Early contract termination	4.35	4.38	19.05	14	4.36
Water tariff adjustment uncertainty	4.22	4.63	19.54	15	4.42
Technology risk	3.88	4.97	19.28	16	4.39
Poor contract design and budgeting	3.96	4.60	18.22	17	4.27
Project deadline defaults and cost overrun	3.87	4.40	17.03	18	4.13
Public resistance to interventions	4.12	4.11	16.93	19	4.11

Table 7.12 Analysis of risk factors, probability of occurrence, severity and impact

7.7.2 Critical Risk factors

From the analysis, "water theft" recorded the third-highest probability (5.85), but the highest severity (6.60), the highest risk significance index (38.61) and the highest impact value (6.21). The results indicated the critical

effect of the prevalence of water theft and leakages on water service delivery in Accra. It accounted for more than 60% of the NRW, which is around 50% of the water produced and contributing to a huge financial loss to the GWCL and the economy at large (Egan & Agyemang, 2019; Stoler, Tutu, Ahmed, Frimpong & Bello, 2014). The enforcement of regulatory frameworks by security agencies could help mitigate this risk.

"Non-payment of water bills" recorded the second-highest probability (5.86), the second-highest severity (6.46), the second-highest risk significant index (37.86) and the impact value (6.15). This was another social issue that had a high-risk impact on interventions. It was considered a major threat to the survival of GWCL and the sustainability of the water system in the Accra metropolis. For a very long time, institutions, particularly government agencies and some domestic consumers refused to pay or were unable to pay their water bills due to poor habits of non-payment, "institutional entitlements", harsh economic conditions and poor revenue collection practice. Autonomy for PURC and GWCL these entities could help reduce the risk of

The third critical risk factor was "Corruption risk", which recorded probability (5.86), risk severity (6.36), risk significance index (37.46), and impact value of 6.12. Several studies showed the vulnerability of the water sector in Accra to corrupt practices, including fraudulent claims, internal theft, over-budgeting, bid-rigging, and over-pricing (Hirvi, 2012; Hirvi & Whitfield, 2015; Suleiman & Khakee, 2017a). It is a critical risk factor that was highly likely to hamper the completion of water projects. Several corrupt allegations have been reported in the past. For example, in 2013, it was reported that two staff of the GWCL stole an amount of GH₵5 billion (US$1.2 billion) from the account of the company. On a separate account, thousands of pipes procured for a project were diverted to a staff's residence to be sold on the local market (The Herald, 2013). The implementation of good transparency and accountability mechanisms could help mitigate this risk.

Foreign exchange (FX) ranked fourth critical risk factor with probability (5.78), severity (6.05), significance index (34.97) and impact value of 5.91. Most of the cost of input material and equipment for water production are imported with foreign exchange, yet, water revenues are generated in the local currency. Ghana's currency, the Cedi is Ghana's cedi is considered as one of the worse currencies in the world, depreciating against the dollar and other major trading currencies over the past 25 years (Alagidede & Ibrahim, 2017; Aryeetey & Fenny, 2017). This followed a transition from a fixed exchange rate regime to a floating exchange rate regime in the early 1980s (Abor, 2005). Recent data from the Bank of Ghana put the average annual cumulative depreciation rate for the Cedi at 8.5 per cent. The high depreciation served as a major risk private investment and to eroding investors' confidence. Implementing a strong fiscal and regulatory policy could help mitigate this risk.

The fifth critical risk factor was "High operational cost" with probability (5.52), severity (5.85) significance index (32.29) and impact value of 5.68. This risk threatens the financial sustainability of the GWCL. In some cases, the risk was driven by external factors such as the rising cost of imported supplies, foreign exchange rate, inflation rate, high energy cost and low freshwater quality. For example, water production and supply were highly dependent on energy and prone to the unreliability and volatility of energy prices in Ghana. From the analysis of the operational cost of the GWCL in chapter 6, energy cost accounted for over 50 per cent of only the production cost in 2014 and 2015. Energy cost was exceptionally high for those years due to the

energy crisis, that compelled the GWCL to rely on diesel generators. However, an assessment of the total cost of water supply by Tenkorang et al (2014) puts annual energy cost at 29 per cent, that is US$0.13 of the US$0.44 spent on producing one cubic meter of drinking water.

The "climate risk" ranked sixth with probability (5.25), severity (5.65), significance index (29.66) and impact value of 5.45. The impact of climate change poses a significant risk to the sustainability of the water system in the Accra metropolis. Over the past decade, the metropolis has witnessed increased in variation rainfall and the frequency and intensity of floods that have exposed vulnerabilities in the water system. For example, the flooding event in the Accra metropolis in 2015 created serious leakages in pipes network causing severe damages to the water system, houses, transport systems (World Bank, 2017a). The integration of robust adaptation measures into the implementation of water interventions could help reduce this risk.

Political interference ranked seventh with probability (5.02), severity (5.52), significance index (27.71) and impact value of 5.26. This risk factor permeates different aspect of urban water management, from appointments to tariff adjustments. Unsolicited interference from the government was identified as a critical risk factor in the failure of urban water privatisation in the Accra metropolis in the past (Adu-Ampong, 2013; Hirvi, 2012; Hirvi & Whitfield, 2015). Political interference has been known to influence water tariffs setting as government interference often delay tariff increases for political gains, particularly in an election year (Adam, 2011; Adams, Sambu & Smiley, 2019). Complete autonomy for PURC and GWCL devoid of government appointments for positions in these entities could help reduce the risk of political interference in water projects.

The risk factor "volatility in inflation rate" ranked eight with probability (4.92), severity (5.32), significance index (26.32) and impact value of 5.13. The fluctuations in inflation rate raised serious concerns for private sector investors and lending bodies due to the risk of losing profits and running losses (Ameyaw, Chan, Owusu-Manu, Edwards & Dartey, 2017). Water managers argued in the past that the fluctuation and high rate of inflation contributed to the high optional cost of water production (GWCL, 2011). From 2000 to 2010, Ghana's inflation rate was in the double-digit, rising to as high as 32.93 per cent until it dropped to 6.7 per cent in 2010 (African Development Bank, 2019). Currently, the inflation rate stands at 9.8 per cent and this is expected to go down to 6.25 per cent by 2024 according to predictions of the Bank of Ghana. Despite the decreasing trend of inflation, critics argued that it still remained a critical risk to the implementation of water projects in the metropolis. Implementing a strong fiscal policy could help mitigate this risk.

The risk factor "Change in government regime" ranked ninth with probability (4.94), severity (5.32), significance index (26.28) and impact value of 5.13. Change in government regime has become a major source of unsolicited changes in top management changes in government institutions as well as the delays in government-approved projects (Chileshe & Yirenkyi-Fianko, 2012; Lundin, Tryggestad, Amoatey, Ameyaw, Adaku & Famiyeh, 2015). Water projects facilitated by the government often suffer long delays due to changes in political administration to allow for new audit and renegotiation of contracts (Ameyaw & Chan, 2015; Obeng-Odoom, 2012b). Change in government regime was likely to lead to a change in some professional staff which might delay or even halt the implementation of water management interventions. The introduction

of PPP and private sector funding in the implementation of interventions could create the needed impetus to reduce government influence and thus help mitigate the risk of losing competent personal when there was a regime change.

The risk factor "Interest rate" ranked tenth with probability (4.63), severity (4.98), significance index (23.06) and impact value of 4.80. Despite all the so-called favourable macroeconomic indicators in Ghana, the interest rate remained very high posing as a major risk for investments in water projects. This could be attributed to the weak financial system and the rising prime lending rate of commercial banks (Ameyaw & Chan, 2015; Walker, Ameyaw & Chan, 2015). At the Bank of Ghana, the rate stood at 16 per cent while commercial banks charged up to 22 per cent interest on loans. This served as a major deterrent for borrowing locally for water projects. A strong hedging strategy that establishes forward rate agreement for loans could mitigate this risk.

Financial risk ranked eleventh with probability (4.62), severity (4.95) significance index (22.87) and impact value of 4.78. The core issue remains how to bridge the financial gap in the water sector between supply and demand. Data from the GWCL suggested that an amount of US$800 million was needed to ensure 100 per cent coverage in the Accra metropolis by 2025 (GWCL, 2015). Perhaps, the limited private investment in the water sector could be attributed to the reluctance and the high-risk perception held by multinational corporations following some negative experiences in the past (Ameyaw, 2014). To mitigate this risk, a financial framework and guidelines that incentivise market opportunities in the urban water sector could be developed and implemented. Such a framework could promote local invests by developing local credit markets and establish social investment funds for water project.

Although some of the risk factors determined as critical factors have been elaborated in the study, this was not to say that the remaining identified risks were not relevant. These risks were subject to a time frame with a specified context and so the significance of a risk factor was subject may change over time. Current critical factors may decline in importance over time when conditions change while other non-critical risk factors may become critical and relevance at a point in time. For example, risk factor such as "delay in contract payments" might become a critical factor during a change in government regime, and this was likely to create uncertainty and stall water projects for a long time. In another instance, what was considered a critical risk factor in Accra might not be significant in another country. For example, Cheung and Chan (2011) revealed that corruption was not a critical risk for water projects in China even though it ranked third in the Accra metropolis.

7.8 Sustainable financing

Funding for water and wastewater infrastructure and service delivery in the Accra metropolis comes from six sources. The first funding source has been the national government who provided subsidies, subventions and guaranteed loans. International development partners, such as German Cooperation, Danish Cooperation, and Norwegian Agency for Development also provided loans on concessional term or grant for water projects. The third funding source was the multilateral financial institutions such as the World Bank, IMF and the AfDB, which provided the largest volume (over 60 per cent) of financing through loans and grants (Ndirangu, Luwesi, Beyeneand & Akudugu, 2018). The GWCL served as an important source of financing as the fund recurrent

expenditure on water production and undertake new project through revenues collected from water users. The next funding source is the formal (sachet and bottling water producers) and informal secondary water service providers who tended to fill the gap by selling bulk water in tankers or large storage facilities. The last but a critical source of finance is the water users – domestic and industrial users – who pay water tariffs.

The current financing arrangement with the largest proportion of funding from foreign firms may not be sustainable as it put a heavy toll on the water system in the long term. With water revenues collected in entire local currency, it would be prudent to finance infrastructure and service delivery in the local currency – the Cedi – to reduce to high foreign currency exchange rates. This calls for a rethinking of financing sources from foreign sources towards developing the domestic funding sources and local capital markets. The study is of the view that financial sustainability of the GWCL will only come from generating domestic sufficient revenue to cater for operation and maintenance, thus positioning the utility to become attractive for investment.

Evidence exist to support the fact that water users including low income residents are willing to pay a bit more for quality and reliable services (Amankwaa, 2017). With an average consumption per capita per day 0.12m^3, a domestic water consumer paid approximately US$3.2 per month at a rate of US$ 1.21 per m3. Several reports put the average income per person per day in the metropolis between US$3.50 and US$7.50 for low income earners (Adams & Vásquez, 2019; Addo, 2016). With a monthly income of between US$108.5 and US$232.5 per person, low-income households could conveniently afford to pay at least 5 per cent of their incomes on water services.

For low-income household, the initial cost of connecting to the GWCL water system may be usually high. Here, a smart subsidy could be applied to relief low income households of their initial investment cost. In reality, a proportion of the very low-income residents may not be able to pay for affordable water service and therefore subsidy provisions for pipe water service may be necessary, at least in the interim. In cases where subsidies are applied, they should be transparent, targeted and time bound to ease cost-recovery tariffs (Goksu, Bakalian, Kingdom, Saltiel, Mumssen, Soppe, Kolker & Delmon, 2019).

Base on the current dynamics in the metropolis, a sustainable cost recovery model characterised by incremental water tariff mechanisms could generate sufficient revenue to improve water service delivery, undertake water infrastructure expansion, reduce water consumption and attract foreign and private investments, while freeing up government subventions for activities that genuinely require public funding support. To improve domestic investment prospects for urban water development, the GWCL should optimise its operating efficiency to significantly reduce physical and financial losses and report on its performance achieving these targets. Public-private partnerships should be given adequate securities and insurance provision by the government to build trust to sustain long-term management contracts.

7.9 Maintenance and Monitoring

Effective maintenance and monitoring of urban water system can improve the quality of water service delivery and prolong the lifespan of the water system facilities, which are likely to improve the financial performance

of the system. Past lessons from the management of water systems in developing cities, including the Accra metropolis revealed the high cost of poorly run water and sanitation systems incurred by the State (Oteng-Ababio, Owusu-Sekyere & Amoah, 2017). In the review of the performance of the supported projects, the World Bank noticed that the short span of water and wastewater treatment plants was linked to the lack of maintenance and the lack of funding to recruit competent staff and buy spare parts (World Bank, 2013). Currently, urban water projects were focused on the water treatment plant capacity expansion to increase water supply while paying lip-service to the maintenance of existing facilities. Major maintenance of water facilities is mainly reactive, particularly, when it has become completely necessary. The study is of the view that the transition from reactive to active routine maintenance. Better still, the GWCL could pursue the business partnership model that develop operation and maintenance of the water system as a business for a competent private enterprise to execute. This means the aspect of operation and maintenance is ceded to an enterprise with the skills and capacity to monitor and service the transmission and distribution system. Implementing such a partnership model could help address the lack of competent staff issue as well provide the opportunity to source for capital investment.

7.10 Conclusion

In this chapter, the interventions under the WSSDP have been examined. Some water management actions based on an analysis of the gaps and limitations in the implementation of interventions have been analysed and suggested. The result is a framework that could help water managers and other water stakeholders in the Accra metropolis to gain an understanding of what to consider in the development of a plan for water management in the metropolis. A participatory-scenario building (PSB) process to construct three scenarios was used. This resulted in the selection of normative scenarios as the basis for analysis in pathways that could lead to the achievement of the best-case normative scenario. With this framework, stakeholders in the metropolis would have a more holistic understanding of how to deal with water problems and finding pragmatic solutions that could support the vision to achieve 100 per cent sanitation and water coverage by 2034 in the Accra metropolis. The multiple risks associated with the development and implementation of interventions for sustainable management of water resources were acknowledged. It is useful to identify these risks so that actions can be taken to mitigate them before the implementation of activities under the plan. Lessons from the benefit-cost analysis suggested that the interventions proposed for the Accra metropolis could be economically viable and cost-effective when compared to business-as-usual scenario.

The need to prioritise comes down to the lack of financial resources to implement all the identified water management solutions. In the Accra metropolis, one of the major barriers to developing a sustainable urban water system has been limited funding to undertake water projects. This necessitates the prioritisation of interventions based on the costs of investments as measured in the cost per unit volume of water produced and the benefits, as measured in the value of the volume of water saved over a period. In the concluding chapter, a decision on the best cost-effective intervention will be presented.

Chapter 8: Summary and Conclusions

8.1 Overview

This chapter summarises and concludes the findings of the study. It comprises eight sections. Following a brief introduction, which recaps the research aims and questions of the study, the next section summarises the findings reported in the previous chapters. Next, the study situates the research outcomes within the political ecology theoretical perspective, followed by a discussion on the contribution of the research to knowledge and practice. A reflection of the transdisciplinary research process, its contribution to knowledge production, and how it could potentially impact on water management practice in the Accra metropolis is also presented. An analysis of the trade-offs of managing urban water resources sustainably is provided, followed by a conclusion to the study and recommendations for future research.

By mid-2000, water managers, and policymakers in the Accra metropolis had decided to implement water management reforms that resulted in the transition from public to PSM from 2006 to 2011. Through the changes, several management interventions were implemented to help establish an efficient and financially self-sufficient water system capable of delivering these sustainable outcomes – improved water governance, increased water availability and supply coverage, improved water savings, and reduced water-related health risks. Under the PSM, a private entity, AVRL was introduced as the new manager of the water system.

The AVRL assumed that it could address the water management challenges in a more sustainable way through the implementation of five key interventions, namely institutional arrangements, decentralisation, removal of subsidy, infrastructural expansion, and tariff adjustment. However, the implementation efforts did not translate into the desired goals and outcomes. As a result, the GoG did not renew the contract with the private entity, AVRL in 2011, effectively ending the era of private-sector urban water management and marking the return to public control. By 2012, the government had developed a new framework that was intended to guide urban water management practice until 2025.

This study examined this effort by conducting transdisciplinary research in collaboration with stakeholders to generate knowledge that could provide the necessary guidelines for water managers to tackle water management problems in the metropolis. The TDR offered a reflexive research process for building mutual learning through knowledge exchange between science and society. Through this research approach, the study was exposed a broader perspective of diverse opinions, professional and disciplinary backgrounds through the participation of different stakeholders in defining the research objectives, research questions, and strategies for the sustainable management of water resources in the metropolis.

Specifically, the study aimed to accomplish the following:

- To analyse the water management practices and transitions in the Accra metropolis
- To evaluate the water management interventions implemented as part of the PSM
- To examine the development and implementation of WSSDP in the Accra metropolis

- To propose a framework that could help support the sustainable water management planning in the Accra metropolis.

The study defined the following questions in line with the research objectives:

- What were the key challenges confronting water management practice in the Accra metropolis?
- To what extent did water management interventions under the PSM in the Accra metropolis help achieve sustainable outcomes?
- To what extent did the WSSDP plan improve upon the outcomes of the interventions under the PSM?
- What measures can be taken to help water managers think of new ways of managing the water system efficiently in the Accra metropolis?

In Chapter 1, this study brought to light how interactions among social, economic, political and environmental realities have complicated water management problems, prompting the call for alternative ways of dealing with complex water problems. By examining these realities and dynamics, the study highlighted the evolution of water management problems from simple issues – inadequate water supply system and ageing infrastructure – to a complicated problem that linked water and sanitation service delivery with the rapid urban population, urbanisation, economic growth, and associated environmental risks. The nature of water management problems made it difficult to maintain the existing management practice, prompting a call for reforms that manifested in the transition from public to PSM.

In Chapter 2, reviewed various concepts and approaches that informed the study was presented. By providing background knowledge of the different ideas and their implications, the study offered an insight into the emergence of the sustainable water management paradigm as an alternative water sector. This study brought to light the current dominant discourses around sustainable development and sustainability and their influence on the emergence of the SUWM. The chapter elaborated on the interpretation of the SUWM approach as an alternative idea to the conventional management approach and an approach through which water managers can define a set of interventions or strategies to respond to complicated water challenges in a holistic and integrated manner.

Following an in-depth exposition of the concepts and approaches in Chapter 2, the research design and research methodology for the study was presented in Chapter 3. The TDR process that aligned with the emerging mode of scientific enquiry and encourages interactions between researchers and society to generate scientific knowledge was employed. The TDR process accentuated two unique ideas - first, emphasis on the value of the participation of stakeholders by acknowledging the dimension of realities they represented, which might not be available in a traditional scientific enquiry. Second, knowledge produced through the TDR research process went beyond academic knowledge as it is co-owned with local society from where it was derived. Through the TDR process, a combination of different methods for data collection and analysis was adopted. In the next section, a summary of the findings of the study is presented.

8.2 Summary of Findings

8.2.1 Sustainable urban water management transitions in Accra metropolis

In Chapter 4, the water management dynamics, reactions and responses from various water stakeholders at different levels of interactions (regime, niche, and landscape levels) were examined using the MLP analytical framework. At the regime level, rules, social norms, belief systems, market preference and dominant practices that underlie strategies of organisations and institutions strongly shaped events and their outcomes. Here, the policies of public institutions under the regime were often designed to preserve the status quo, thereby limiting flexibility and opportunities for radical change. For example, within the water regime, the GWCL's sole mandate was to provide affordable and reliable water supply service for urban residents. This meant all efforts by the GWCL focused on achieving this goal irrespective of the financial and technical implications. Actors under the regime included the GoG, GWCL, PURC, and the WRC. At the landscape level, factors such as macroeconomic trends, natural disasters, population dynamics, and global ideologies operated beyond the direct control of the regime and niche. Actors at this level included global institutions such as the World Bank, IMF and donor/development agencies. The niche level gave way for innovative service provision and grassroots social coalition that responded to the changes in the regime and influence from landscape actors. Actors at this level included water consumer groups, advocacy groups and NGOs.

Between 2005 and 2011, Accra's water sector experienced a series of institutional, fiscal and regulatory reforms that resulted in the transition from public to PSM. With loans and aid mainly from the World Bank and IMF, these institutions recommended a set of interventions (including institutional arrangements, decentralisation, infrastructural expansion, subsidy removal, and water tariff adjustment) that were regarded as a panacea for establishing a financially self-sustaining water system, capable of addressing water challenges in the metropolis. Landscape actors such as the World Bank exerted its influence in water management decision-making in the regime due to the loans and aid support often bundled with "conditionalities", which the government was obligated to carry out. Such influence from landscape actors manifested in structural changes and institutional reforms that resulted in infrastructural expansion, the separation of water supply and sanitation and setting up new water institutions, among others. The implementation of water management interventions proved to be less successful according to a review by the GWCL and other stakeholders, thus deepening the instability in the urban water situation.

Based on deliberations on the learning platform, some fundamental issues emerged that had earlier received little attention before the implementation of reforms in the Accra metropolis. These issues included:

- The absence of a holistic framework that could support the planning and sequencing of management interventions in a way that would foster strong linkages and improve outcomes. For instance, improving the quality of freshwater at source tended to reduce the energy and chemical used for treatment at the same time, reducing the cost of water production.
- In the implementation process, there seemed to be oversight regarding the order of implementing the intervention. For instance, should the removal of subsidy precede tariff adjustment or vice versa?

- Water managers and policymakers appeared to have a limited appreciation of the dynamic linkages and relationships between the water management interventions, targets and the economic, socio-cultural and environmental realities that shape water management practices in the Accra metropolis.
- There seemed to be inadequate consultations and engagement with the actors at the niche level before the implementation of the management reforms.
- The intervention targeted mainly economic and institutional bottlenecks to optimise the performance of the urban water system and the GWCL.
- The interventions were less successful partly due to the misguided ideology based on experiences from developed world settings, and the failure to critically examine the socio-cultural and political context in which government carried out these reforms.
- The reforms maintained a linear metabolic pathway for water management instead of a shift towards a circular metabolic pathway that encouraged a closed loop.

From the transition perspective, the regime instability following landscape pressure and influence provided an opportunity and space for the occurrence of grassroots innovation, engagement of people, and the creation of a strong coalition that contested the regime practices and the dominant landscape influence. There seemed to be a strong indication of the deepening participation of water consumers and grassroot organisations in decision-making on water management in the Accra metropolis. It also served as a reminder for water managers not to ignore the concerns of low-level stakeholders in the development of interventions for the sustainable management of urban water resources. Socio-politically, there was a significant impact of bottom-up initiatives that strongly contested the implementation of interventions at the regime level. Such social resistance contends for the right for a more equal, inclusive, and participatory role in water management, which reinforces the power of grassroots mobilisation.

The interaction between the landscape and regime actors seemed to have raised two critical issues - power and influence on urban water management. According to some stakeholders such as civil society and non-governmental organisations, actors that contributed a significant share of the investments wielded control over the urban water system and thus dictated the types of management interventions to be implemented. A case in point is the role the World Bank played in the implementation of water management interventions in the metropolis. Some representatives of government agencies argued that even though the investments mainly came from external sources, the control of the urban water sector and implementation of interventions were solely the responsibility of government and associated agencies, with foreign donors playing advisory roles. However, in reality, actors in the regime such as government were at the mercy of landscape actors that provided funding and more than just advice.

As a city in transition, understanding the dynamic processes, driving factors (both external and internal), and pattern of interactions among the factors and processes that shape urban water management practice should be a priority of water managers. A more sustainable pathway to managing water resources in the Accra metropolis might perhaps require a holistic assessment of the dynamic settings in which water managers would implement

interventions. The outcome of such an evaluation was likely to inform the design of specific interventions that were well interrogated and accepted by all stakeholders and suited to the context of the metropolis.

8.2.2 Evaluation of water management practice in the Accra metropolis

The implementation of interventions under the private water reforms in the Accra metropolis were intended to achieve one primary goal – to establish a technically functional and financially self-sufficient urban water system. These interventions included institutional arrangements, decentralisation, subsidy removal, water infrastructural expansion, and water tariff adjustment. The expected management outcomes included - increased water supply efficiency and water availability, improved governance, improved water coverage and access, increased water savings and reduced water-related health risks.

These reforms seemed to have presented a myriad of responses from various stakeholders regarding their outcomes and impact on societal needs, economic development and ecosystem protection. For instance, advocates for the water reforms viewed the results of the interventions as positive on infrastructure and water coverage, governance, and the quantity of daily water production. On the other hand, evidence of successful implementation of interventions acclaimed by advocates was strongly contested by civil society groups and non-government stakeholders, revealing some lack of clarity about the outcomes of the water management interventions. Instead, civil society groups and NGOs saw mixed results since the interventions could not comprehensively deal with some challenges confronting the water system, including high non-revenue losses, high rate of water pollution, and unreliability of water supply, among other problems. In this regard, the extent to which the water management interventions were able to achieve the five outcomes using a well-defined set of the determinants of these outcomes was evaluated. The positive or negative functionality of these determinants provided a good indication of the extent to which the city achieved desired results. The determinants were defined by a group of experts on the learning platform who represented different water institutions in the metropolis. Based on the discussions on each determinant vis-a-vis the outcomes, participants on the platform rated from low to high the extent of achievement.

The analysis showed that of the eight determinants evaluated for improvement in water governance, five of them were rated low or unfavourable. The five determinants included – (i) integrated planning; (ii) capacity for knowledge production and information management; (iii) public-private partnership; (iv) decentralisation; and (v) subsidy removal and tariff adjustment. On the other hand, three determinants, including stakeholder participation; institutional coordination and collaboration; and management capacity and competence scored fair ratings for improving water governance in the Accra metropolis. Participants on the platform viewed the lack of integrated planning for water management as a hindrance to defining a comprehensive set of interventions for water management in the Accra metropolis. Some participants also opined that while knowledge production and information for water management might be lacking, it might not necessarily be due to lack of capacity but rather a matter of priority and the relevant impact on water management in the context of the metropolis.

The intended purpose for subsidy removal and tariff adjustment was supposed to facilitate the increase in water supply for all residents of Accra metropolis through the establishment of an efficient water system with expanded water treatment capacities. Low-income households were affected by high water tariffs imposed through this option. The worrying outcomes of this intervention, particularly in low-income areas were water theft and illegal connections to the pipe network. Another determinant that was expected to improve governance and bring transformation to the urban water sector was the decentralisation process. However, experts on the platform rated this determinant low as its implementation appeared to exposed the unpreparedness, limited financial, human and technical capacities of water-related institutions in the metropolis.

One of the outcomes of the interventions was to improve the availability of water resources to the Accra metropolis. The determinants for this outcome included – (i) total water extracted (ii) total volume of treated water produced per day, and (iii) alternative water sources. From the results, all the determinants were rated positively even though participants raised concerns about certain occurrences that could threaten the availability of water resources in the future, including climate change and human activities such as mining, deforestation, and agricultural activities

Improving access to potable water was considered as an essential outcome of interventions in the Accra metropolis. Data from the GWCL indicated an increase in water coverage in the metropolis, which should have translated into improved access to affordable potable water. However, the rapid pace of urban expansion has outpaced the increased water supply coverage, thereby leaving a significant proportion of the residents without access to treated water.

Five determinants to assess the extent of improvement in water savings in the Accra metropolis were evaluated. These determinants included– (i) reducing leakages, (ii) wastewater recycled and reused, (iii) exploiting alternative water sources, (iv) smart metering system, and (v) awareness creation and education. Of the five, the first two determinants were rated low in terms of their contribution to water savings in the metropolis. The remaining three were rated as average regarding their contribution to improving water savings. Water losses through leakages remained very high, making it difficult for water managers and consumers to save water. The contribution of wastewater recycling and reuse to water savings was said to be very minimal. Due to the growing concerns around surface water use, several water institutions created awareness about the use of alternative water sources. As part of the national water conservation effort, the government instituted a ban on the use of potable water for non-drinking purposes such as commercial car washing, industrial cooling, and urban irrigated agriculture. At the household level, many households were not only storing water in facilities but had become purposeful in the use of water. At the large scale, these efforts were yet to make the desired impact.

Four determinants to determine how the implementation of interventions helped to reduce water-related health risks were evaluated. These determinants included – (i) sewage/ wastewater system coverage, (ii) extent of polluted water, (iii) flooding events, and (v) waterborne disease. From the findings, the domestic sewage system coverage was inadequate, with the majority of urban residents not having a direct connection to the

sewage system. Over the past decade, sewage coverage has dwindled significantly due to broken systems and rapid urban expansion. The quality of treated water from the pipe network system generally conformed to WHO quality standard for potable water. In spite of this, there were incidences of bacteria and opportunistic pathogens resident in the water supply chain. The occurrence of flooding in the Accra metropolis remains very high with an average of four major, severe flooding events yearly. High flooding occurrence was known to correlate with a high incidence of cholera outbreaks in certain parts of the city. The use of untreated wastewater for urban irrigation agriculture in the city posed severe health risks to vegetable consumers because of the high content of toxic materials, bacteria and pathogens found on the vegetables.

Based on the evaluation of these determinants, it was fair to conclude that the implementation of interventions, to some extent, provided positive contributions toward improving the water system in the Accra metropolis but generally fell short of achieving the expected outcomes. The orientation of interventions implemented in the municipality seemed to be more inclined toward institutional governance and financial recovery. Chances were that such an orientation obscured other vital considerations that were fundamental to the effective functioning of the urban water system. For example, water managers often neglected the maintenance of the freshwater source and the ecological value of water use (key principles of SUWM), which were fundamental to the sustenance and support of the ecosystem and the urban water cycle. Another example was the lack of emphasis on sanitation and stormwater management as part of the reforms.

The water reforms between 2006 and 2011 brought some positive changes to the Accra water system. However, these changes were not adequate to fully transform the water system into a technically functional and financially self-sufficient one capable of delivering the set goals. As the water management returned to public control, the WSSDP, a new framework was developed to guide the implementation of interventions that would address the limitation of past PSM and improved on existing urban water management practice.

The development of the framework involved five stages including (1) the establishment of a multi-stakeholder platform, (2) diagnosis of the current water management challenges, (3) a vision for urban water management, (4) strategising and risk analysis and (5) development and validation of the WSSDP. This plan targeted an ambitious goal of delivering sustainable access to clean water and basic sanitation for all citizens by 2025. To achieve this goal, the following objectives and target were outlined in the plan:

1. To reach universal coverage for water and sanitation services by 2025:
    - increase urban water coverage from 59 per cent in 2009 to 85 per cent in 2015 and 100 per cent in 2025;
    - contribute to improving the national sanitation coverage from 13 per cent in 2008 to 53 per cent in 2015 and 100 per cent by 2025;
2. To ensure sustainable financing for investments, operation and maintenance of water services:
    - increase sector investment to US$350 million annually for water and sanitation services
    - ensure full recovery of rehabilitation, operation and maintenance costs of urban water service by 2015;

- secure at least five per cent of the water and sanitation sector investment financing from other sources including private sector financing and internally generated funds for investments by 2020;

3. To ensure that water sector institutions have the required expertise, information, equipment, logistics and funding to perform their functions efficiently and effectively in a transparent and well-coordinated manner by 2025
4. To ensure sustainable harnessing, utilisation and management of water resources by 2025:
   - Develop a framework for managing and protecting water resources for improved water security and enhanced adaptation to climate change;
   - Strengthen water resource planning, decision-making and operational capacity through improved access to knowledge and expertise in integrated water resource management;
   - Ensure that effective institutional coordination and collaborative mechanisms for water resource management were in place; and
   - Strengthen and improve trans-boundary and international cooperation in the management of shared water resources.

In the next chapter, an analysis of the implementation of the WSSDP in the Accra metropolis in the era of public control of urban water management is presented.

8.2.3 Implementation of Water Sector Strategic Development Plan (WSSDP)

The development of the WSSDP following the take-over of the water system management by the government appeared to have brought some optimism among a section of water stakeholders who vehemently opposed PSM. At the same time, critics questioned the preparedness of government institutions to transform the system into one capable of providing safe water and sanitation for all residents by 2025 as stipulated in the plan. In Chapter 6, the PAM was employed as an analytical tool to develop a set of indicators for evaluating the outcomes of interventions under the WSSDP. The WSSDP was designed to focus on two intervention packages, namely service delivery and cross-cutting soft components. Under the service delivery, interventions aimed at improving water supply by building new water treatment plants and rehabilitating old ones. Four issues were addressed namely – (1) institutional capacity development and governance, (2) finance, (3) knowledge management, gender and monitoring and evaluation; and (4) water resource management. The interventions targeted the strengthening of the policy, regulatory, financial, and institutional frameworks to support the efficient operation, maintenance and delivery of water and sanitation services.

Based on the interpretation of the SUWM approach in the WSSDP, stakeholders identified six outcomes that could reflect a sustainable water system in the Accra metropolis. They were (i) self-reliant water system, (ii) water resource security, (iii) water quality, (iv) stormwater management and sanitation service delivery, (v) water system data, and (vi) governance. Guided by these elements, 26 indicators were identified and used to evaluate the progress and extent to which outcomes of interventions under the WSSDP have been achieved in the Accra metropolis so far.

Interventions under the WSSDP have been implemented in the Accra metropolis since 2012. Overall, the outcomes of some of the interventions were described by the majority of stakeholders as encouraging. In terms of water infrastructure, there has been rehabilitation and expansion of the water treatment plants at the Kpong waterworks as well as improvements in the water network. These improvements resulted in increased production capacity and the volume of water supplied. Through a public-private-partnership mechanism, the sewage and wastewater subsector was witnessing some capital injection from private enterprises. According to the majority of stakeholders, there has been some improvement in governance, stakeholder engagement, and efforts to streamline institutional roles in water management in the metropolis. Despite these improvements, stakeholders identified several gaps and limitations that required further attention. These included fixing water systems leakages, addressing NRW, efforts toward full cost recovery, wastewater recycling, access to water data, and water-related health issues, among other issues.

According to stakeholders on the learning platform, water managers working at the metropolitan levels often found it a hurdle to adapt national-level policies and strategies to the context of the metropolitan and municipal levels. Two probable explanations emerged from the discussion – the first was that national-level priorities were sometimes at variance with priorities at the metropolitan or municipal level. This was because some national preferences were sometimes derived from the political party's manifestos, and these occasionally deviated from the national plan as well as the priorities of the metropolis. Second, national averages figures were often lower than figures for the Accra metropolis due to the difference between cities in the country. For example, Accra had a very high population compared to the rest of the country, and therefore, national figures can sometimes be misleading when used as a benchmark for planning or decision-making. Stakeholders argued that the development of a strategic plan that detailed specific interventions for the Accra metropolis could help reduce the disparities that often arose when relying on public documents at the metropolitan level. This, of course, should be guided by the national plan.

The process of defining and applying the set of indicators brought into the limelight the issue of inadequate data in the Accra metropolis. Throughout the study, it had been quite challenging to access comprehensive data from different water institutions. The reality was that consistent social, economic, environmental and physical data for water were lacking. In cases where there were data, they were either in patches or outdated. Several datasets were obtained had been during research or project activities, which meant they were for short term purposes. For example, data on water quality and health were obtained during research studies over a limited period. Long term regular water quality data for the metropolis was lacking

The absence of a long term program on knowledge management and water data collection tended to hamper the accurate assessment of the performance of water management interventions in the metropolis. Implementing interventions is a continuous process, and therefore, for outcomes to be measured more accurately, the data must be collected regularly and presented in a way that reveals the areas of strength and shortcoming of the implementation. Therefore, indicators must be consistently fed with accurate data to provide a reliable and precise depiction of the outcomes of water management interventions. This set of indicators used in the Accra metropolis helped participants to understand the status of water management as

to help develop strategic interventions that could assist in improving on current outcomes and address limitations of interventions under the WSSDP.

8.2.4 Framework for supporting urban water management planning in the Accra metropolis

So far, an insight into the implementation of the WSSDP in the Accra metropolis as a response to PSM has been presented. The WSSDP came against the backdrop of the under-par outcomes of the interventions implemented under the PSM. The WSSDP, which is set to end by 2025 has been under implementation for the past seven years. Based on the analyses of the outcomes so far, stakeholders on the learning platforms rated the progress of implementation as encouraging but also identified some limitations and gaps in the implementation of the WSSDP as follows:

- The NRW remained extremely high – around 50 per cent which was more than twice the level set by international best practice.
- Water production cost far exceeded the revenue generated and thus hindered effort towards full cost recovery and a financially-sufficient water system.
- Absence of demand management interventions such as economic incentives and subsidies for the adoption of water-saving technologies, water use restrictions, and penalties for excessive use (quotas) to limit the water demand, created consciousness about water saving and wise water use.
- Limited attention towards wastewater and stormwater management and ecological integrity.
- Struggles with adapting national-level policies and strategies to the situation at the metropolitan level.

A framework to guide water managers and policymakers to understand the interlinked nature of water problems and support a vision for 100 per cent sanitation and water coverage by 2034 in the Accra metropolis was developed by the study. A participatory-scenario building (PSB) process was used to construct three scenarios based on which the feasibility of interventions identified over the next 15 years:

- In the worst-case scenario, water management occurred under very challenging situations, including a weak economy, poor leadership, inadequate water infrastructure, and excessive demand for water from an overpopulated city.
- In the medium-scenario, water management occurs under a robust economic situation, improved political leadership, and improve infrastructure. However, limited financial resources coupled with environmental factors including pollution, deforestation, and climate change, were contributing to a reduction in water resources. High water demand also posed a significant threat to the sustainable water supply to the city.
- The best-case scenario depicted an environmentally sound, economically, and socially well-managed city. In this scenario, the city had addressed peripheral challenges including power outages, pollution and deforestation, among others. Consumers were pleased and willing to pay for water and wastewater services, and water demand is well-managed to ensure equitable access.

With a better understanding of the problems and the prevailing conditions, different interventions might be suitable under different scenarios. For example, water tariff adjustments under the worst-case scenario might not be feasible or might struggle to make an impact in the medium-case scenario.

8.2.5 Prioritising water management interventions

In table 8.1, a summary of five options for water management interventions (A – E) with the associated cost and benefit is presented. These options were derived from the list of multiple interventions identified in chapter 7. An analysis of the intervention with the optimal benefit and impact as measured in the volume of water saved in monetary terms.

The options are described as follows:

- Option A: Reducing unaccounted for water (UFW) – An intervention aims to reduce unaccounted water through the rehabilitation of the entire water transmission and distribution network. This also involves eliminating illegal and unauthorized pipe connections to the mains.
- Option B: Cost recovery and tariffs adjustment – Water audits in the Accra metropolis revealed that a large volume of water supplied and billed was not accounted due to error in meter readings, old meters, manipulations by consumers, household water theft, and non-payment of water bills. The intervention aimed to improve cost recovery and facilitate upward tariff adjustments through the replacement and installation of new smart meters in 500,000 households in the Accra metropolis over a 5-year period.
- Option C: Public participation and awareness campaign – Water audits in the metropolis showed that a large proportion of the water loss was attributed to domestic losses and misuse. It also revealed public apathy towards water savings and efficient water use. A public participation and awareness campaign aimed at encouraging public participation in water management decision-making and social acceptance of willingness to pay for water and sanitation services delivery.
- Option D: Expansion of water treatment plant capacity – with a growing demand for water in the metropolis, the construction of a 350,000 m^3 water treatment plant capacity at the Weija waterworks could sufficiently meet the growing water demand.
- Option E: Rehabilitation of wastewater treatment plant – With the majority of wastewater treatment plants were shut down, the rehabilitation of a 2500m^3 wastewater treatment plant capacity could help reduce the volume of untreated wastewater disposed into nearby lakes and sea.

From the outcome of the cost-benefit analysis presented in table 8.1, four out of five of these options (A - D) have shown positive beneficial outcomes over a 15-year period. All these options may be deemed viable and complementary in addressing different problems in the water system. For example, the reduction in UFW would no doubt free up water that could be made available for reallocation (Murugan & Chandran, 2019; Tortajada & Buurman, 2017).

Options	Costs (US$'000)	Benefits (US$'000)	B-C ratio
A	301,222	690,875	2.29

B	277,298	1,030,495	3.72
C	36,877	238,514	6.47
D	309,181	582,785	1.88
E	84,056	67,977	0.81

Table 8.1 Options for pursuing a sustainable urban water system in the Accra metropolis

8.2.6 Determining the optimal intervention

Given that financial resources are scarce, the need arises for water managers and policymakers to prioritise these water management interventions and implement which ones are cost-effective and have the capacity to provide the maximum benefits. However, the interventions could be programmed and prioritised in order of their optimal benefit but also taking into account the urgency of the problem. For example, UFW remained the "Achilles' heel" of the GWCL as it represented a huge financial loss to the GWCL and a serious economic loss to Ghana's economy. In this case, it is worth venturing into interventions that could address this dilemma rather than expanding water infrastructure to increase water supply. To do this, the benefit-cost ranking of multiple options was conducted to determine the best alternative for implementation.

The first step was to rank the options (A – E) in order of increasing benefits or cost. In this case, the options were ranked in order of increasing benefits as shown in table 8.2. Checking for simple dominance, Option B had a cost[4] of US$277,298 and a benefit of US$1,030,495. The cost of Option B was lower than Options D and A but the benefit outweighed those of Options D and A. So by simple dominance, Options D and A were omitted. Option E was omitted from the list because it is not a viable option.

Option	**Costs (US$'000)**	**Benefits (US$'000)**	**B-C ratio**
E	84,056	67,977	0.81
C	36,877	238,514	6.47
D	309,181	582,785	1.88
A	301,222	690,875	2.29
B	277,298	1,030,495	3.72

Table 8.2 Ranking in order of increasing benefits

The remaining options included C and B. To determine the best option, the changes in cost and benefits between the two options were calculated. To do this, these formulae below were employed:

$$\Delta C = Cost\ of\ B - Cost\ of\ C$$
= 277,298 – 36,877
= 240,421

$$\Delta B = Benefit\ of\ B - Benefit\ of\ C$$
= 1,030,495 - 238,514
= 791,981

$$Net\ Benefit = \Delta B - \Delta C$$
= 791,981 – 240,421

[4] Cost in US$'000

= **551,560**

Base on the net benefit results, the study concludes that Option B is the best alternative to be prioritised by water managers in the Accra metropolis. This option is likely to generate more benefits in revenue at a relatively lower cost than the remaining options. However, a significant positive impact could be made if an additional investment could be made to implement public participation and awareness campaign along with Option B.

8.3 Linking the study to political ecology theory

The application of the political ecology theory in this study explored the relationship between water system changes (at the city level) and the political, economic, ecological, and socio-cultural realities that shape water management practices. The political ecology theory provided a framework to help understand how the interactions among these realities influence changes in the urban water system. It helped to uncover the impact of the causes and realities that create inequalities and environmental changes in the management of water resources in the Accra metropolis. The political ecology theory is regarded as an inherently historical theory because it was used to construct contemporary socio-political, and economic arrangement through past trajectories, processes, transformations, and dynamics that prevailed in the Accra metropolis

Modern rationality has built a complicated world of water resource unsustainability, with evidence being the resource and environmental crises. Through the lens of political ecology theory, an analysis of the interactions among the political, social, economic, and environmental factors that characterised water management challenges in the Accra metropolis has been presented. The call for sustainable management interventions signified a management transition era where participatory and inclusive political processes underlined the development and implementation of interventions.

The struggle to make environmental and social issues relevant to water management in the metropolis discourse revealed the inherently political and highly contested nature of water. From the political ecology perspective, the emphasis on the environmental and social aspects of water management depict a paradigm shift in social equity in water allocation and sustainability of water's environment that has gained political currency.

The analyses of the politics and governance of water use in the light of rapid urbanisation, economic growth, population growth and environmental degradation were presented. It highlighted how the socio-economic status, area of residence and access to water infrastructure network defined water access and the frequency of water supply to households. The study also brought to light how an increase in water supply could contribute to over-abstraction and ecosystem dysfunction, and echo the role of the environment as a "legitimate water user". The uneven distribution of existing water infrastructure networks and the extremes in the urban spectrum, from well-established residential areas (with adequate water pipe networks) to the informal settlements (slums) (limited or non-existent pipe network) allowed for the contestation among water users.

8.4 Contribution to knowledge production

The methodological approach used in the study sought to provide a way of understanding the water system as a socio-political system that was characterised by uncertainty and a multiplicity of challenges. In this study, the integration of diverse disciplines with different linguistic and conceptual attributes to navigate through the various concepts, methods, and approaches was carried out. Guided by the TDR process, different methods were employed for data collection and analyses. This TDR offered a useful overall framework for an integrated analysis of the different dimensions and aspects of the study. This pathway provided an excellent avenue for exploring multi-level interactions (metropolitan, national and external levels) with different stakeholders (e.g. policymakers, scientists, civil society, and organisations) on a learning platform from which the researcher has benefited immensely. Overall, approximately 234 individuals participated in various activities on the learning platform. The number represents about 20.8 per cent of the total number of stakeholders in the water sector in the Accra metropolis (according to data from making it a statistically significant representation of stakeholders that could contribute effectively to water management decision-making in the Accra metropolis. Participants involved in the TDR process also comprised various water experts as mid-level and senior-level officials from various water-related agencies engaged in policy and decision-making on urban water management.

There appears to be a growing momentum around the use of TDR process to find innovative ways of adding value and relevance to research among scientists and other stakeholders. As stated earlier, a vital element of the TDR process is its ability to produce transformative knowledge that can bring meaningful impact on the outcomes of the management interventions. One crucial question raised among scholars had to do with the contribution of the TDR process to societal change. In an attempt to answer this question, Belcher et al. (2016: 8) identified three principles - relevance, credibility and legitimacy- as the essential attributes of TDR to produce useful information that can cross boundaries between disciplines, across scales, and between science and society. They also defined these principles in terms of the content of the research, not in terms of the involvement of stakeholders, except under legitimacy (referring to effective collaboration, genuine, and explicit inclusion) (Belcher, Ramirez, Davel & Claus, 2019: 9-10).

In a study on the usefulness of these principles to the linkage between the TDR process and impact by Hansson and Polk, (2018), the results suggested that even though these principles provided vital insights into the links between quality of the TDR process and impacts, they were not sufficient to provide a reliable evaluation of TDR's contribution to societal impact. The study instead found out that certain qualities of the TDR process contributed to building internal relevance, credibility and legitimacy of the outcome of the process that raised the chance for impact on practice and policy. Such qualities included gaining a broader perspective, more profound exchanges of expert knowledge, appreciation of expertise background, flexibility, motivation and perceived importance attached to the topic.

In this study, an analysis of the contribution of the TDR process to change in attitude and mindsets of participants was carried out. The research method included one-on-one consultations and focus group discussions with some experts who participated in activities on the learning platform. In total, 30 people from government agencies (10), research institutions (5), academic institutions (4), NGOs (4), civil society groups

(4) and development partner agencies (3). participated in focus group discussions (30 minutes) and one-on-one session (15 minutes per participants). Based on the action-value attribution framework, the study examined among other issues participants' active engagement, participants' new knowledge from this process, the contribution of participants' knowledge, how to participants would approach decision-making on urban water management, and the integration of varied sources of knowledge and experience in water management practices.

The analysis revealed that participants gained a more in-depth perspective and appreciation for individual and collective roles and behaviours of key stakeholders in water management. For example, representatives of GWCL only realised the vital contribution of NGOs in creating awareness of water use and savings among deprived communities in the metropolis. Several water NGOs have been supporting communities with alternative sources of water as well as sanitation facilities, which according to reports from the Ghana Statistical Service contributed to improving water supply coverage and sanitation service delivery in low-income residential areas in the metropolis.

The analysis showed no clear linkage between the intensity of participation by stakeholders and the impact on the outcomes of management interventions. Instead, the results showed that characteristics of the TDR process, including heterogeneity of the participants, institutional cultures of participants, and political contexts were influential on the results of the discussions held on the platforms. In the TDR process, participants did not just situate themselves within their institutional boundaries and individual expertise but moved beyond the boundaries to understand the positions of other participants from different organisations. This result proved vital in changing behaviours and the way water experts framed discourses around water management in the metropolis.

There are some examples of the contributions of TDR to knowledge production and system transformation. For example, according to Zscheischler et al. (2018), a study on the application of TDR for sustainable land use resulted in a strong tendency for the practice of recommended outcomes. According to the study, through the engagement of various stakeholders in the TDR process, land use issues gained wide popularity and high commitment from stakeholders to translate research results into practice. In another study on TDR on sustainable urban development in Kisumu, Kenya, Hansson et al. (2018) concluded that the in-depth participation of local people in the research process, as well as the integration of context-specific knowledge and urban development practice in Kisumu, provided communities with the requisite capacity to initiate sustainable urban projects.

The TDR process is a research methodological framework whose impact on the outcomes of water management practice in the metropolis may not be immediate or direct. However, the impact of this process may be in the form of attitudinal and behaviour change of stakeholders and their motivation to do things differently from the way it has been done for all this time. For example, some participants indicated that they had gained a holistic perspective about the multiple challenges that confronted the water sector in the Accra metropolis and this was likely to influence the kind of management decisions taken.

8.5 Reflections on the TDR process

The use of the TDR in this study could be described as interesting in terms of the application of a set of skills, including facilitation skills, negotiation skills and mediation skills acquired in the course of this studies. The TDR process transcends beyond the researcher seeking to produce knowledge towards the collective production of experience with diverse stakeholders. Below, the researcher reflects on some critical observations during the application of the TDR process.

- Perhaps the most challenging aspect of the TDR process was the building of a collaborative group of experts through the establishment of multiple learning platforms over 12 months. Before establishing a learning platform for this study, the research participated in the national learning platform for water and sanitation for six months in the Accra metropolis. During this period, valuable networks with various stakeholders and individuals working in the water sector in the Accra metropolis were established. This exposure also gave the researcher the opportunity to understand the functioning and dynamics of setting up a platform for diverse stakeholders. The establishment of a learning platform comprising of diverse stakeholders in the metropolis with divergent views, interests, professional and academic orientations was more intricate compared to the linear process of conducting research. Due to the history of transitions in water management, water service delivery in the metropolis has been a contentious issue among stakeholders with differing views. Issues about water supply and access to can be political as seen in the PSM era. With this knowledge, the researcher became cautious about how to initiate discussions on the platform. To set the right tone for each meeting, the researcher had to find innovative ways of engagement. One way of establishing a common ground for discussions was to bring up unrelated hot topics of common interest such as sports, breaking news, and exciting story that occurred during the period to allow for some 5 minutes of deliberations. This approach proved to be very useful in creating a conducive atmosphere for discussion on the substantive water topics at hand.
- Perhaps the sticking point of the platform was a declaration made by the researcher on the first platform that “water management in the Accra metropolis will continue to fail if water managers do not take a multi-dimensional look at the prevailing issues confronting the water sector”. The statement generated both interest and opposition among water stakeholders, with opponents calling for facts and evidence to support this assertion. The subsequent questions and interest laid the foundation for engagement and interactions with many stakeholders from different categories over the course of 12 months. To set up an engaging learning platform, the researcher needed to put into use of my facilitation skills. The researcher acquired both academic and professional skills by taking some courses on facilitation and experience from facilitating experts’ workshops on water for sustainable cities in Accra (2014), urban water security and climate change in Abuja (2015), water demand in a rising African cities in Nairobi (2015), and transboundary river basins in Lilongwe (2016). To avoid linear or skewed discussions, an effort was made by the researcher to create a well-balanced team of diverse participants with different professional backgrounds and from various institutions. The effort produced smooth

interactions among participants that set the tone for useful discussions on multidimensional issues associated with water management in the metropolis over 12 months.

- The researcher aimed to deliver pragmatic results capable of addressing water problems in the Accra metropolis. Achieving this goal meant taking a step back as a researcher, paying attention and listening to the submissions of participants and respondents during the TDR process. An interesting observation made among participants was their ability to engage and provide valuable responses when they felt valued by receiving undivided attention. Participants expressed their excitement about this research process as they described it as unique, flexible and holistic in capturing their perspectives. The measure of the impact of the TDR process on urban water management decisions in the Accra metropolis was beyond the scope of this study. However, what became visible was the impact of the TDR process on stakeholders who participated in the learning platforms. Participants expressed positive remarks about practical outcomes of their participation in the TDR process, in terms of knowledge exchange with other participants, a novel way to thinking more holistically about water issues and the impact of the outcome of the process in influencing their actions on water issues in the Accra metropolis.
- Developing trust between the researcher and the stakeholders was prominent in the application of the TDR process in this study. Over a year of engagement with over 230 practitioners, researchers and policymakers led to the establishment of mutual trust, which was beneficial to the study. This gave the researcher the opportunity access to some vital information, which under normal circumstances, would not be accessible to the researcher. The outcome of the deliberations on the sustainable management of water resources in the Accra metropolis during the TDR process was well received and validated by the stakeholders, possibly because of the trust built over the period.
- Based on the dynamic settings in the Accra metropolis, undertaking a TDR process demanded that the researcher had an open mindset and flexibility as the process progressed, and the need for adjustments based on the submissions of stakeholders became apparent. The researcher had the privilege of interacting with water experts and practitioners who were conversant with existing realities and were better positioned to provide deeper insights into water management issues in the metropolis. Entering this space as a researcher with an open mind proved to be beneficial to the study as data and information gathered shaped the direction of the study.

8.6 Trade-offs in water management interventions

The selected water management interventions in the Accra metropolis are supposed to be guided by the three broad desirable goals: economic efficiency, social equity and ecosystem protection. Efficiency is interpreted as the technical efficiency, which deals with the ability of the water system to support continuous water supply with minimal water losses and economic efficiency where the water resource is used to maximise economic growth (Chenoweth, López-Avilés, Morse, Druckman, Plepys, Nebelius, Mont & Kaufman, 2013; Fried, Lovell & Schmidt, 2008). Equity refers to the allocation of resources based on historical injustice or deprivation (attaining more distribution to those with less or disenfranchised households) or merit (more to those who invest more) (Daigneault, Greenhalgh & Samarasinghe, 2017; Roa Garcia, 2014). Ecosystem

protection means maintaining a water resource base within the sustainable threshold such that water sources and sinks can retain their regenerative capacity following water extraction (Roa-García & Brown, 2017). These societal goals appear to be in constant contestation, a situation that allows for one or two goals to dominate. Essential to this study are the trade-offs between the three goals, and how the metropolis can deal with the trade-offs in the implementation of water management interventions.

As the metropolis seeks to achieve a financially self-sufficient water system, chances are that efforts may tilt towards achieving economic efficiency goals. For example, water managers would prioritise water tariff adjustments to improve cost recovery and financial self-sufficiency. However, this move might come at the expense of water equity and ecosystem protection. Even though water equity appears as a consistent theme for water access for the pro-poor, how to deliver it remains undefined. The effort towards pursuing water equity goal through increased water access for low-income households seemed to conflict with the implementation of economic instruments, including the tariff increase and water subsidy removal.

In sum, achieving a balance between efficiency, equity, and sustainability goals in urban water management in the Accra metropolis might seem unrealistic at the moment. However, with the water sector still evolving, water managers must strive to implement interventions that are capable of achieving a balance between the three goals. For example, the reclassification of "compound houses" away from the high tariff block and subsequent implementation of a lifeline tariffs targeting these houses in low-income areas could significantly increase access to affordable water and perhaps increase revenue by boosting the willingness of residents to pay. Installing new smart meters, replacing error-ridden meters, and fixing leakages could significantly reduce water losses, save water, and improve water revenue while safeguarding freshwater sources through the reduction of raw water abstraction.

8.7 Conclusion

The Accra metropolis continues to expand following rapid economic growth, population growth, and urban expansion. The implications are that over the next decade or two, the demand for water and sanitation services is expected to grow. With the knowledge that current water management practices may not be adequate to address the growing challenges, water managers and policymakers in the metropolis must find innovative ways of dealing with the problems and supporting the effort towards achieving water and sanitation management goals.

The expectation of the government under the WSSDP for the Accra metropolis was to achieve a 100 per cent water and sanitation coverage by 2025. However, water stakeholders on the learning platform reckoned that it would take at least 15 years for the Accra metropolis to achieve a self-sufficient water system capable of ensuring safe water and decent sanitation service to all residents. The argument is that existing interventions might be limited in addressing some aspects of the water management issues, including NRW, wastewater recycling, stormwater management, and preservation of the catchment areas.

A framework consisting of five prioritised interventions has been presented. Of this five, the study identified interventions for cost recovery and tariff adjustment as the best optimal solution based on the results of benefit-

cost analysis for all selected interventions. The framework is intended to stimulate water managers and policymakers about possible viable interventions that may be considered the planning of water management in the Accra metropolis.

In the metropolis, there seems a strong willingness among key water stakeholders, including government, to embrace long-term optimal solutions. This raises optimism for the transformation in the water sector of Accra metropolis. Investing in mass replacement and installation of new smart water meters could greatly improve cost recovery from water users and increase management efficiency. As current water revenues barely cover recurrent costs and make a very minimal contribution to investment, water tariffs will need to increase. However, tariff adjustment must come with innovative application of subsidies and lifeline tariffs that specifically target the urban poor to make cost recovery acceptable, reasonable, and therefore, sustainable.

An important observation based on the past water management experience in the Accra metropolis was that decisions on development and implementation of interventions must be informed by evidence, experience, shared knowledge and the views of stakeholders affected by these decisions. The process of implementing new water interventions must allow for creativity and innovation and flexibility to increase the chances of being well-received by the public. Even though the engagement of multiple stakeholders with conflicting views and interests might prolong the process, when appropriately managed, their involvement can serve as a solution to the inherent politics and inequality barriers to water management practices.

8.8 Subject to further research

With an effort to achieve a financially stable and viable water system, it has become inevitable for water users in the Accra metropolis to pay for a more realistic price for water service. However, getting water users to cover the cost of water may not be the only option for achieving cost recovery. The study recommends that further research could examine the following areas that have the potential of dealing with issues of financial stability, improvement in water quality services and sustainability of the urban water system.

- Decoupling the regulatory institution, PURC from political influence and granting it more autonomy to allow for realistic pricing of water service delivery.
- With a major portion of low-income residents accessing water service from secondary water service providers and paying much more (4 to 5 times) the price charged by the GWCL, it seems there would be an incentive for even low-income resident to pay for water from the GWCL. Therefore, an assessment of the willingness to pay for pipe-water service is critical in extending water supply to low-income unconnected areas.
- Rewarding scheme for households committed to regular payment of water service.
- Adjusting water tariffs structure to include multiple payment options, targeted subsidy for low-income households and low connection fees.
- Measuring the impact of educational campaigns and customer relations for improved service delivery.
- Feasibility of the introduction of technologies and innovations such as prepayment technology and remote billing system.

- Examining innovative ways of reducing operational and maintenance cost for water production.
- Any area of opportunity for communities not connected to the reticulation system is the exploration of groundwater as a primary water source for mini or small water treatment system for households and communities. The GWCL could consider a social franchising model for the development, operation and management of these small water treatment systems.

At the current rate of 17.5 per cent sewage coverage, achieving 100 per cent sewage and wastewater service for all residents in the Accra metropolis. The metropolis is characterised by locked-in infrastructure that would hinder any physical effort to connect households and communities to existing medium-scale centralised wastewater treatment plants. This implies that any solution to address sewage and water management challenges will have to be decentralized at the household or community levels.

The study recommends further research into the feasibility of developing sewage and wastewater treatment technologies at the household or community levels. The emergence of small-scale domestic aerobic/ on-site wastewater treatment plants offers an innovative solution for households' wastewater management in the Accra metropolis. The initial cost for the installation of this solution may be high but the long-term benefit may far outrun the cost. Water managers and policymakers must review the current policy or strategy on large to medium-scale wastewater management plants towards incentivizing the adoption of household-level wastewater treatment technologies.

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Appendix

Appendix I

Publications of a chapter in international peer-reviewed journals

1. Acheampong, E.N., Swilling, M. and Urama, K., 2016. Sustainable urban water system transitions through management reforms in Ghana. Water resources management, 30(5), pp.1835-1849.

Water Resour Manage
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Sustainable Urban Water System Transitions Through Management Reforms in Ghana

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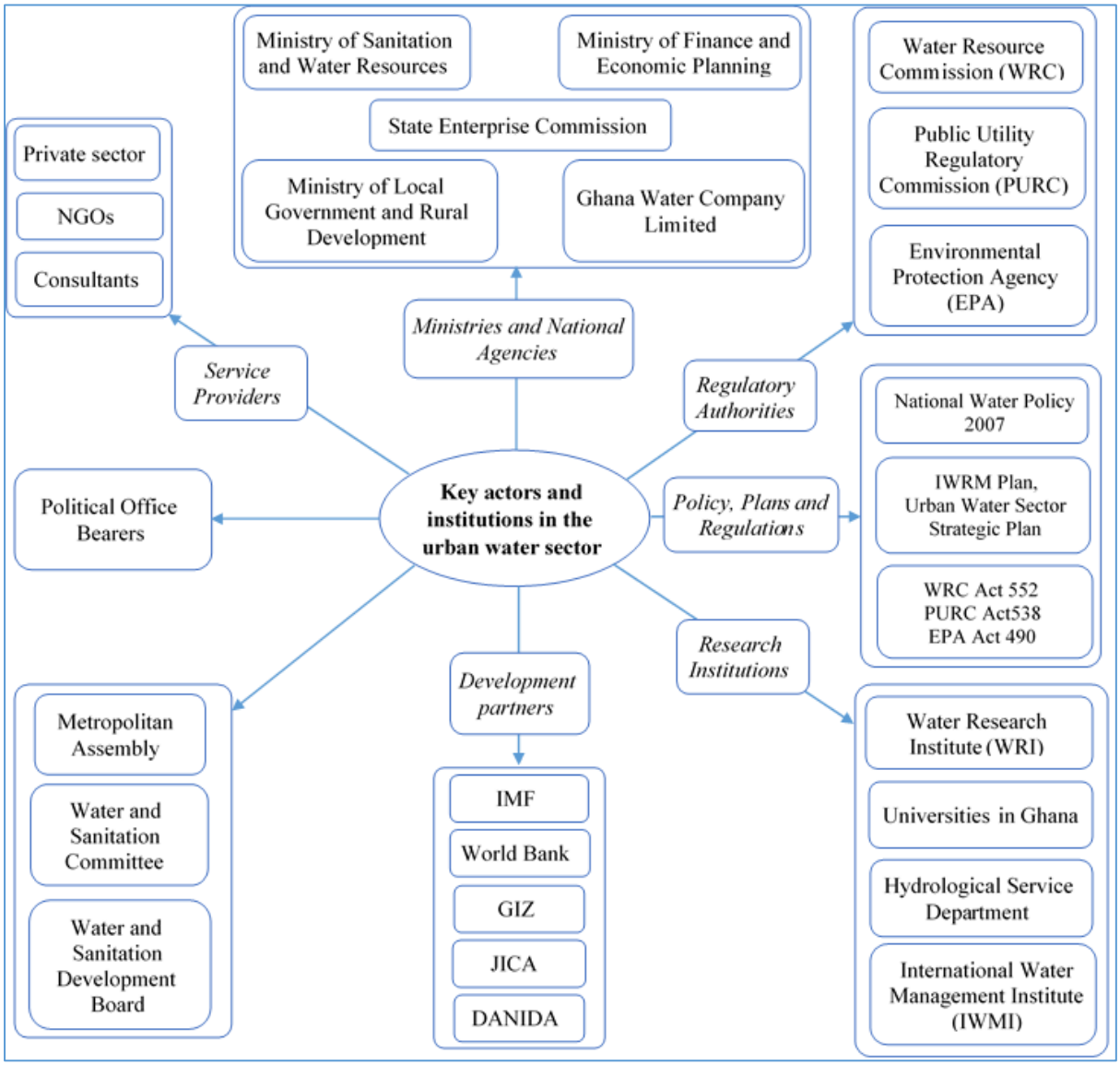
Abstract Despite decades of water reforms, Ghana's struggle to achieve sustainable urban water system is deepened by complex interactions of multi-layered political, socio-economic and managerial characteristics, leaving a rationing system of water supply in major cities like Accra. Using a multi-level perspective framework, the paper examines the dynamics of urban water system transition through management reforms. The study showed how external pressure at the landscape level influenced policy direction within urban water regime through the implementation of neo-liberal economic policies, paving way for resistance and grassroots innovation at the niche level. The implementation of such policies in the reform process did little to help achieve the desired sustainable urban water system goals. The paper suggests a blend of public and private financing with support for grassroots to improve urban water system management. However, subsequent urban water policy reforms must be informed by knowledge of social, economic, and political realities rather than imported generic "best policies and practices" that often conflict with local realities.

Keywords Multi-level perspective · Reforms · Policies · Management · Transition · Urban water system

Appendix II

Key actors and institutions in the urban water sector



Appendix III

Urban water governance

Evaluation questionnaire

Dear Participants,

Based on our discussions on this learning alliance platform, we are have formulated a set of questions that would allow us to assess the governance of urban water in the Accra Metropolis. These questions have been categorised under five governance themes. It is expected that we would carefully deliberate on these questions and provide a candid rating based on the existing realities and your experiences as water professionals, researchers, policymakers and consumers in the Accra Metropolis.

Section 1. Strategic planning

- Does the Accra Metropolis have a water resource strategic plan?
- Does the strategic plan comprehensively capture strategies and activities that effectively address water problems in the Accra Metropolis?
- To what extent do water professional and policymakers implement the strategies and activities in the strategic plan?
- Do water professional and policymakers link urban water strategic planning to urban development?
- To what extent does evaluate the progress of implementation of the urban water strategic plan?
- Kindly provide additional responses to other relevant strategic planning issues but not included here.

Based on the outcomes of these questions, kindly rank level of the quality, suitability and comprehensiveness of the water sector strategic planning for the Accra Metropolis. On a scale of 1-5, with 1 depicting the non-existence of strategic planning and 5 depicting suitability, comprehensiveness and effectiveness of the water sector strategic planning for the Accra Metropolis?

Score:

Section 2. Management capacity

- Does the Accra Metropolis have sufficient human resource and technical capacity to manage water supply and demand?
- Does the Accra Metropolis have adequate infrastructural and technological capacity to manage wastewater and stormwater?
- To what extent does current management practice contribute to sustainable urban water management?
- Kindly provide additional responses to other aspects of management capabilities that are relevant but not included here

Based on the outcomes of these questions, kindly rate the level of managerial competence on water management in the Accra Metropolis. On a scale of 1-5, with 1 depicting the inadequate management capacity and 5 depicting high and sufficient management capacity in the Accra Metropolis?

Score:

Section 3. Knowledge development and information management

- Are the sufficient water data and information, particularly water quality, water pricing and water availability, among others to develop a SUWM plan?
- To what extent does research on SUWM contribute to policy-making and strategic planning in the Accra?
- To what extent do knowledge and information on urban water management good/best practices inform the implementation SUWM plan in the Accra Metropolis?
- Kindly provide additional responses to other aspects of knowledge development capabilities and information management that are relevant but not included here.

Based on the outcomes of these questions, kindly rate the adequacy of knowledge and information on water management in the Accra Metropolis. On a scale of 1-5, with 1 showing the limited knowledge products and information and 5 showing sufficient knowledge and information on water in the Accra Metropolis?

Score:

Section 4: Institutional capacity and effectiveness

- Does the Accra Metropolis have the institutional capacity to manage water supply and demand?
- To what extent do the current policies and legislation support the effective coordination among water institution
- Kindly provide additional responses to other aspects of institutional capabilities that are relevant but not included here

Based on the outcomes of these questions, kindly rate the institutional capacity and effectiveness on water management in the Accra Metropolis. On a scale of 1-5, with 1 depicting the low institutional capacity and 5 depicting adequate institutional capacity in the Accra Metropolis?

Score:

Section 5: Public-private partnerships

- Does the Accra Metropolis have a public-private partnership (PPP) in urban water service delivery?

- To what extent do PPPs contribute to the implementation of a sustainable urban water management plan?
- To what extent do PPPs facilitate urban water strategic planning in the Accra Metropolis?
- To what extent do PPPs strengthen the management capacity of urban water managers and policymakers in the Accra Metropolis?
- To what extent do PPPs support knowledge development and information management in the urban water sector in the Accra Metropolis?
- To what extent do PPPs strengthen institutional capacity for sustainable urban water management?
- Kindly provide additional responses to other aspects of PPPs that are relevant but not included here.

Based on the outcomes of these questions, kindly rate the role of public-private partnerships in sustainable urban water management in the Accra Metropolis. On a scale of 1-5, with 1 showing a low level of public-private partnerships and 5 showing a high level of public-private partnerships in SUWM in the Accra Metropolis.

Score:

Water management in the Accra metropolis, Ghana
(Public Officials)

Survey form

Date: …… **Time:**……..

Name of Organisation: ……

What roles or activities do your organization carry out in relation to water management in Accra metropolis?

What are the main sources of water for urban uses in Accra metropolis?
a) Surface water
b) Groundwater
c) Rainwater
d) Other sources (please specified): _____

What is the percentage distribution of water among different water users?
a) Domestic uses _____*%*
b) Industrial uses _____*%*
c) Institutional uses _____*%*
*d) Agricultural uses*_____*%*
*e) Commercial uses*_____*%*
d) Other uses _____*%*

In your view, does Accra metropolis have enough water resources for its economic and social development (including domestic, industrial, institutional, commercial and agricultural uses)?

a) Adequate water resources
b) Inadequate water resources
c) Adequate for a specific use, specify
d) Inadequate for a specific use, specify

How do you rate the current state of water quality and quantity for domestic consumption in Accra metropolis?

*a) High quality, but inadequate quantity*_____
*b) Poor quality, inadequate quantity*_____
*c) High quality, adequate quantity*_____
*d) Poor quality, adequate quantity*_____
*e) Others*_____

How do you perceive water by the way it is currently managed in the Accra Metropolis? (please tick appropriate boxes):
a) Water is an open natural resource
b) Water is an economic good
c) Water is an environmental good
d) Water is both a political good
e) Other _____

In your view, what are the main water management problems facing the Accra metropolis? *(Please provide in details of your comments):*

_____

What do you think has contributed to the challenges confronting the water system in the Accra metropolis? *(please provide in details of your comments)*:

_____

What are the interventions that have been implemented to address the water management in the Accra metropolis? *(please provide in details of your comments)*:

_____

__

What were the main targets of the interventions implemented in the Accra metropolis? *(please provide in details of your comments)*:

_____

In your view, did the intervention(s) succeeded in addressing the water management challenges or achieving the targets? *(please provide in details of your comments)*:

_____

Are there any current programs on water management in the Accra metropolis? *(Please provide in details your comments)*:

_____

To what extent do you agree that these factors might have influenced the development and management of water in the metropolis?

Factors	**Strongly Disagree (1)**	**Disagree (2)**	**Partially agree (3)**	**Agree (4)**	**Strongly agree (5)**
Continued reliance on external financial assistance and donor support					
The rapid development of unplanned housing;					
Rapid urban population growth due to migration					
High fiscal deficit in water resources development and management					
The growing dominance of donor/ multilateral institutions					
Change in government and strong political influence					

What actions should be taken to increase water savings in the metropolis?

_____

What actions should be taken to improve water distribution and supply in the metropolis?

_____

What actions should be taken to protect and water resources from the primary sources?

_____

What action should be taken to increase the impact of stakeholder participation in water governance?

_____

What actions should be taken to build a self-sufficient water system in the Accra metropolis?

_____

Water access, use and management in the Accra Metropolis, Ghana

(Urban Residents)

Survey form

Date: …… **Time:**…….. **Gender:** Male**.....** Female……

PART ONE: RELATED WATER SUPPLY ISSUES

What are your main sources of water for domestic activities? *(please tick one appropriate box)*:

a) Household pipe water
b) Borehole/ groundwater
c) Pipe water and borehole
d) Sachet/ bottled water
e) Pipe water and sachet/ bottled water
f) Community standpipe
g) Vendor

In your view, does Accra metropolis have enough water resources for its economic and social development (including domestic, industrial, institutional, commercial and agricultural uses)?

a) Adequate water resources
b) Inadequate water resources
c) Adequate for a specific use, specify
d) Inadequate for a specific use, specify

How do you rate the current state of water quality and quantity for domestic consumption in Accra metropolis?

*a) High quality, but inadequate quantity*_____
*b) Poor quality, inadequate quantity*_____
*c) High quality, adequate quantity*_____
*d) Poor quality, adequate quantity*_____
*e) Others*_____

How do you perceive ***water by the way it is currently managed in the Accra Metropolis?*** (please tick appropriate boxes):

a) Water is an open natural resource
b) Water is an economic good
c) Water is an environmental good
d) Water is both a political good
e) Other _____

In your view, what are the main water problems facing you in the metropolis? ***(Please provide in details of your comments):***

a) Inadequate water
b) Irregular water supply
c) Low quality water
d) High water charges

*e) Others*_____

What do you think has contributed to the water challenges confronting affecting you in the community? ***(please provide in details of your comments)***:

_____

How much do you pay per month for water supply (GHC/cubic meter)?

_____

What is your view about the water fee being charged? *(Please tick one appropriate)*

a) Expensive _____

b) Affordable _____

c) Moderate _____

d) Other, please comment _____

Is there a specific program in place to subsidize water supply in your community?

_____

What is the level of satisfaction with the water delivery service rendered by the GWCL?

_____

Are you willing to pay more for better improvement in managing water quality, services and supplies in the future?

_____

What are the interventions that have been implemented to address the water management in the Accra metropolis? ***(please provide in details of your comments)***:

_____

What were the main targets of the interventions implemented in the Accra metropolis? ***(please provide in details of your comments)***:

_____

In your view, did the intervention(s) succeeded in addressing the water management challenges or achieving the targets? ***(please provide in details of your comments)***:

_____

Are there any current programs on water management in the Accra metropolis? ***(Please provide in details your comments)***:

_____

In your view, what should be done to address water problems in the Accra metropolis?

_____

How long have you been living in Accra metropolis?

2-5 years	5-10 years	10-15 years	15-20 years	More than 20 years

Thank you