Overcoming Yangon's Sustainability Challenge: Policy Options for Sustainable Water Governance

Yay Chann*

Abstract

Urban water provision systems in developing countries are encountering sustainability challenges, especially in the face of megatrends such as rapid urbanization, population growth, and climate change. It is essential to govern the water provision to meet the increasing needs of urban dwellers while ensuring its sustainability. This study examines the sustainability of urban water service provision in Yangon City by applying a sustainability framework. The analysis underscores the importance of incorporating sustainable dimensions into policy planning and development for the city's water supply. This necessitates multi-level governance to enhance the sustainability of water provision. The study puts forward policy options to enhance the water provision's sustainability.

Keywords: Water provision, sustainability, governance, sustainable development, policy analysis, Yangon, Myanmar

* Graduate School of Public Policy, Chiang Mai University

E-mail: yaychann_y@cmu.ac.th

Received: February 9, 2024 Revised: June 9, 2024 Accepted: June 12, 2024

Introduction

The well-being of urban citizens and the social and economic development of cities rests on water, particularly water service provision of a city, as it is a basic need for every citizen. However, cities, especially in developing countries, are facing water shortages and scarcity, coupled with megatrends such as rapid urbanization, population growth, and climate change – e.g., extreme weather events – which have directly impacted water availability and accessibility in cities. The UN's sustainable development goal 6 emphasizes the need to ensure the availability and sustainable management of water and sanitation for all. Therefore, it is crucial to focus on the sustainability of urban water provision and develop policies and mechanisms to improve it, which is challenging.

As short-sighted policy decisions can have negative implications on sustainability in the long term, concerted policy planning and development is necessary, especially in light of the planning of urban water systems because of its complex nature between human needs and ecological limits (Aggarwal & Haglund, 2019). What is more, policies for developmental activities in the urban water sector need to reflect and consider the sustainability aspects. This is why it comes to re-assessing those policies and developmental activities to determine whether they align with sustainability or cover social, economic, and environmental considerations. In other words, the water service provision of a city can equally provide for all urban citizens regardless of social class; the provision is economically sustainable in providing services in terms of, for example, cost recovery for maintenance and operational functions; and the water resources of the provision is viable and renewable in long-term (Leigh & Lee, 2019).

The sustainability of urban water provision in Yangon City needs to be investigated. Municipal water can supply nearly 58% of the city's total population, while non-revenue water is high, with 66% of the total supply (Khiang, 2016). Furthermore, the city is experiencing the impacts of climate change, such as flooding, saltwater restrictions, and water shortages (Soe, 2018). In addition, groundwater depletion (Khaing, 2016) – and reservoirs' water catchment areas deforestation – are on their way as people heavily rely on it, coupled with the declining green areas of the city (Chann, 2019).

Yangon City Development Committee (YCDC, 2013, p.5) has a 25-year plan – till 2040 – to increase water service coverage, aiming "to provide potable water to all citizens with appropriate volume, pressure & price". However, the approaches to reach the goal are seen as 'the development

of more water resources; and expansion of water treatment plants' (YCDC, 2016, p.5). The policy of such 'investment in increasing supply' conflicts with the sustainability of water provision and pressures the long-term viability and renewability of water resources. Therefore, it is worth paying attention to exploring the sustainability of the city's water service provision.

Additionally, research related to urban water sustainability in a specific local context is a necessity as "current urban knowledge is predominantly shaped by research on and from the global north" (Aggarwal & Haglund, 2019, p.2). Little research has also been done on the sustainability of the water supply system in a specific context, particularly Yangon City. Although there were a number of reports and research related to Yangon water supply systems, such as Japan International Cooperation Agency's (JICA) technical report, it was found that they focused on technological aspects. According to Aggarwal & Haglund (2019), the dominant narratives on water scarcity or water crisis mostly focus on 'technological and/or economic aspects': for example, more control, predictability, investment in increasing supply, building more dams, and getting the prices right. Consequently, it can underscore the complexity of the urban water provision system and result in the pattern of unsustainability of water systems. Therefore, there is a need to study things beyond the technical aspect, as in the case of Yangon City.

In relation to that, this research aims to empirically explore the sustainability of urban water service provision in Yangon City, using the lens of sustainability framework, and then to provide policy options to the Yangon City Development Committee (YCDC) related to how to improve the sustainability of water provision of the city. To scope its boundary, this study mainly focuses on the Yangon municipal area, which comprises 33 townships, and the water service provision rather than the entire urban water system of the city.

Conceptualizing Sustainability and Urban Water Provision

Urban water systems are facing sustainability challenges. In other words, pressing driving forces influence the sustainability of the urban water sector. In 2012, United Nations Educational, Scientific and Cultural Organization (UNESCO) identified ten major drivers for water use and availability (to 2050), such as climate change and variability, water resources, including groundwater and ecosystems, infrastructure, agriculture, technology, demography, economy and security, governance and institutions, politics and

ethics, society, and culture (Cosgrove & Cosgrove, 2012). In addition, the Asia Development Bank (ABD, 2016) reported that the growing urban population (with 1.5% annually) and economic growth (with 80% of GDP generation from cities as of 2015) are the major driving forces in urban water security in Asia and the Pacific Region. Climate change will also be an all-time risk in this region in the coming decades. Along with climate change challenges, some Asian cities, including Yangon City, are at high risk of inland and coastal flooding (ADB, 2015). Therefore, policy and development related to urban water, particularly urban water provision, need to be based on the concept of sustainability while meeting the needs of all urban dwellers.

Since the 1980s, the concept of 'sustainability' or 'sustainable development' has dominated developmental activities as people came to become aware of an eminent ecological crisis (Jacobus, 2006) and realized that resources on the Earth have their limits. The concept of sustainable development or sustainability has then been contextualized in different sectors. In the water resource sector, synthesizing and presenting the concept was first found in two documents published by the American Society of Civil Engineers [ASCE] (1998) and United Nations Educational, Scientific and Cultural Organization [UNESCO] (1999), and followed by the conceptual discussion of Loucks (2000).

Moreover, water sustainability was seen in different concepts and definitions. The American Water Works Association posited sustainability in the water sector as resource uses through a triple-bottom-line approach (i.e., in an economically, environmentally, and socially responsible manner) to meet the needs of today while considering the ability of future generations to meet the needs of tomorrow (Richter et al., 2018). Schnoor (2010) generally defined water sustainability as "supplying or being supplied with water for life or, precisely, as the continual supply of clean water for human uses and for other living things" (Schnoor, 2010. p.1). It can be said that 'sustainable water provision' is also embedded in the concept of sustainability or the application of long-term consideration, meaning that the water supply is for the needs of urban society while protecting water resources and the environment. This can be seen in the International Water Association (IWA, n.d.) conceptualization, which defines sustainable water provision as "providing adequate water quantity and appropriate water quality for a given need, without compromising the future ability to provide this capacity and quality". They also state that it involves a wide range of combined actions and strategies, and it rests on many factors, such as individual willingness to save water, rules and regulations of the government, industrialization

patterns, and so forth. This can be translated as sustainable water provision balancing the ability to provide water service to meet the present and future demand.

Different dimensions have also been used to decide whether a water service provision is sustainable. The International Water Association (n.d.) recommended that various social, environmental, and economic aspects be considered to decide whether it is sustainable. In the review report of water sustainability assessment tools by Boulenouar et al. (2013), it was found that the common dimensions among assessment tools were financial, institutional, environmental, technical, and social factors of sustainability, but the provision level was largely focused with less attention to policy level, governance issues, and role, capacity, and practices of local government. Richter et al. (2018) also used the following dimensions: water governance, drought and other emergency preparedness, water monitoring, water affordability and social justice, water-use efficiency and conservation, water quality, and watershed protection plan. Joy and colleagues (2014) assert that acknowledging water issues as matters of justice necessitates a re-politicization of water. Mainstream approaches to water resources, governance, and legislation often normalize or naturalize their inherently political distributional assumptions and implications. In the context of developing countries, Carden and Armitage (2012) applied four indexes: environmental, social and technical, economic, and institutional. Therefore, it can be noted that different dimensions have been applied to understand and explore the sustainability of urban water provision.

What is more, regarding the management of the resource system, ASCE highlights that any approaches – for example, plans, facilities, and policies – should be physically, economically, environmentally, ecologically, and socially acceptable and beneficial to current and future generations. Loucks (2000) also states that one of the important guidelines for the planning and management of sustainable water resource systems is using approaches that “restore or maintain economic vitality, environmental quality, natural ecosystem, biodiversity, and health” (Loucks, 2000, p. 6). He then recommends that anyone related to resource systems development and management needs to balance the systems between providing sufficient quantities and qualities protecting the environment and preserving the biodiversity and health of ecosystems for future generations.

From the sustainability lens, the water service provision should, therefore, be broader than the purely technical aspects, but social, economic, and environmental considerations should also be

considered. Plus, the governance process, social justice, institutional capacity, and political setting play a major role in the sustainability of water service provision as it is a balancing between human needs and ecological limits (Aggarwal & Haglund, 2019) and embedded in the complex, socio-ecological system (Ostrom, 2009) as well as long-term perspective (Meene et al., 2011). It becomes more certain that the sustainability concept should be embedded in policy approaches and developmental activities regarding the water sector.

However, there remains, on the one hand, a lack of detailed knowledge related to the empirical application of the sustainability concept and, more importantly, the qualitative and exploratory approach of the concept in the water service provision context (for example, Marques et al. (2015) measure the sustainability of urban water services). On the other hand, there is an urgent need for sustainable water provision as it is facing megatrends. Therefore, this study will empirically explore the concept of sustainability in the context of water provision.

Table 1: Dimensions related to sustainable water provision in the literature

Authors	Dimensions/Criteria
American Water Works Association	Triple-bottom-line approach – an economically, environmentally, and socially responsible manner
Schnoor, 2010	The continual supply of clean water for human uses and for other living things
International Water Association	Social, environmental, and economic
Boulenouar et al., 2013	Financial, institutional, environmental, technical, and social
Richter et al., 2018	Water governance, drought and other emergency preparedness, water monitoring, water affordability, and social justice, water-use efficiency and conservation, water quality, and watershed protection plan
Joy et al., 2014	Justice – water provision is a matter of justice
ASCE	Physically, economically, environmentally, ecologically, and socially acceptable and beneficial to current and future generations
Loucks, 2000	Economic vitality, environmental quality, natural ecosystem, biodiversity, and health.
Aggarwal & Haglund, 2019	Governance process, social justice, institutional capacity, and political setting

Source: Adapted from Marques (2012; 2015).

Analytical Framework and Methods

Sustainability Framework as An Analytical Lens

An analytical framework is needed for this study to explore the sustainability of Yangon's water provision since it provides a way to organize and analyze the data collected (Chataigner, 2017). Based on the literature review, an analytical framework and guiding tool were developed throughout the data collection and analysis process. Particularly, this study follows the works of Marques et al. (2015); however, it aims for a qualitative examination. The framework was focused on three dimensions of the

sustainability concept: social, economic, and environmental, although there are many dimensions mentioned in the literature. The variables for each dimension were then set, but it was an iterative process, i.e., the predetermined variables were redefined or added back and forth. Additionally, the framework was used to address the following main questions:

- To what extent can the water service provision be equally provided for all urban people in the city?
- To what extent is the service provision economically sustainable in terms of cost recovery for maintenance and operational functions?
- To what extent are water resources sustainable, i.e., groundwater and service water from reservoirs?

An institutional setting was then added to briefly explore and understand its influence on the sustainability of water provision.

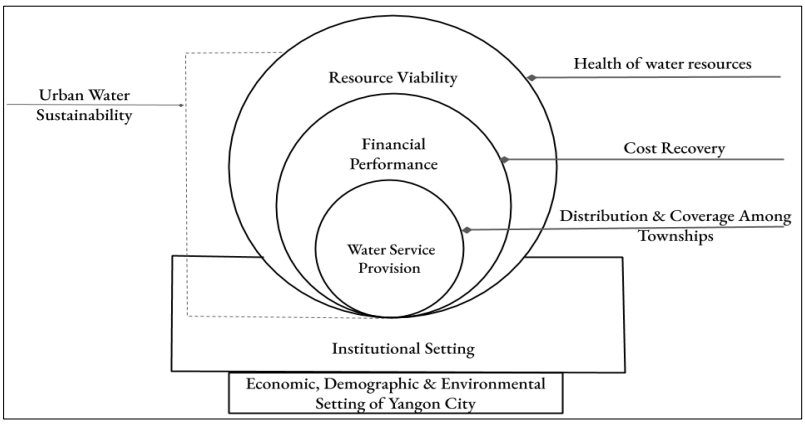


Figure 1. Adapted Sustainability Framework.

Source: Adapted from Leigh & Lee (2019) and Carden and Armitage (2012)

Table 2. Adapted Analytical Framework

Dimension	Objectives	Qualitative Examination
Institutional Setting (Governance)	Public participation	Public participation in service planning and delivery
	Transparency	Availability and accessibility of information and written documents
	Clearness in roles and responsibilities of governing bodies	Clearness of roles and responsibility
		Horizontal and vertical coordination among levels of government
Social	Access to urban water services	Physical service accessibility
		Economic service accessibility
Economic	Ensure economic sustainability of the urban water services	Investment
		Efficiency
Environmental	Ensure the viability of water resource	Viability and renewability of water sources

Source: Adapted from Marques et al. (2015).

Methods

The case study method was applied as the approach, in general, was suitable for answering 'why' or 'how' questions about a contemporary set of events (Yin, 2003). First, a literature review was done to gain insights into concepts related to the topic with the designated research questions. Then, based on the review, the analytical framework was developed. Second, qualitative data related to the case were collected online. Third, those data were analyzed using a sustainability framework to explore the sustainability of Yangon water service provision.

Documents, as the sources of data (Bryman, 2016), were used as the main instrument for the collection of data, which was collected from secondary data sources. The data involved published and unpublished documents and documents obtained by retrieving the Yangon municipality website related to the case, policy documents, public utility reports, and census data. Further documents were external bodies' documents such as audit reports, non-government organizations' reports, research papers, books, newspaper articles from different sources related to the case, and reports of public media interviews and speeches by government officials and key persons in water supply projects.

Findings: Sustainability of Yangon Water Provision

Economic, Demographic, and Environmental Setting of Yangon City

Geographically, Yangon is located in the southern part of the country – Myanmar- and is confluent with two rivers: the Yangon and Bago Rivers. The city was the country's capital from colonial times until it was relocated to Nay Pyi Taw in 2007, and the town's design was intended for a small population of around 36,000 during the colonial era. According to the 2014 census, however, Yangon became the largest city with a population of 5.2 million, 35 percent of the country's urban population (YCDC, 2016). Along with the growing population, developmental challenges such as low water service coverage have arisen, and the city has now become a megacity without proper planning.

Yangon, as Myanmar's commercial capital and trading hub, is also the largest urban agglomeration city while contributing 22 percent of the country's GDP (YCDC, 2016) and has become the main driver of the country's economic growth. The city is also considered the gateway for tourism since the economic and political reforms of the country, and international tourist arrivals to the city have grown from 0.8 million in 2013 to 1.4 million in 2019 (Ministry of Hotels and Tourism, 2019). Related infrastructure and facilities, including hotels, guest houses, and restaurants, have also increased.

At the same time, Yangon is the most densely populated area among cities in Myanmar: more than 10 percent of the country's population lives in the city. The population of the city is also increasingly growing along with internal migration: from about 3.1 million in 1993 (Khaing, 2016) to 5.2 million in 2014, and it is also expected that the city will have more than 10 million of the population in 2040 (YCDC, 2016). Along with the population growth, urban area expansion is also increasing at a rapid rate – the total area of the city reached 947 km2 in 2014 from 578 km2 in 1993 (YCDC, 2016).

On the other hand, as a coastal city, Yangon is highly vulnerable to rising sea levels, floods, and climate change-related impacts. Meanwhile, some portions of the city are in the flood plains of four major rivers: Yangon River, Bago River, Pan Hlaing River, and Hlaing River. What is more, the city has been experiencing frequent flooding (Global Times, 2018) – along with record-breaking rainfall (Department of Meteorology and Hydrology, 2019), high temperature (Horton et al., 2017), and seawater intrusion (Myint, 2019). It has also witnessed the city facing the impacts of natural disasters – the cyclone Nargis in 2008.

Therefore, Yangon is facing the most pressing challenges, such as the growing population and economic growth, along with the rapid rate of urbanization and industrialization. At the same time, the city has been stressed with environment-related challenges, including rising sea levels, extreme weather events, frequent floods, and so forth. As such, the sustainability of the city's water provision comes under pressure, along with these combined challenges.

Institutional Setting of Water Provision

Yangon City, in terms of administrative units, covers 33 townships out of the 45 townships of the Yangon Region. Three policy actors are typically involved in managing service delivery at local levels: union government agencies, regional government ministries, and the Yangon City Development Committee. However, the roles and responsibilities are sometimes less clear and may overlap (United Nations Development Program [UNDP], 2015). In other terms, it comes to question the effectiveness of the service provision of these actors combined with a lack of coordination and collaboration among and within the agencies. Accordingly, the same is true regarding the city's water provision. Three layers or levels, which influence the service provision of the town, are found – union level, regional level, and city level and several actors are then involved in these three layers; however, responsibilities still need to be clearly delineated and effective coordination among agencies is less common.

To some extent, national-level government agencies can influence policy and planning in the city, such as water resources-related governance (Groot & Bayrak, 2019). However, YCDC is under the full authority of the mayor/minister of development affairs (Arnold et al., 2015), who is accountable to the regional chief minister. The relationship between them is dynamic, and the former can also shape the governance process. However, YCDC is primarily responsible for municipal-related activities,

especially social services, including water supply and sanitation. The authorities, roles, and responsibilities of YCDC come from the 2008 Yangon City Development Committee Law. YCDC is financially self-sufficient to some extent – its revenue accounts for around 68 percent of each fiscal year in the region (UNDP, 2015), and it is also the most decentralized institution among local government bodies of the country in terms of authority and responsibilities. However, within the organization, it is fair to say that it tends to be a centralized institution: municipal-related policy and planning mostly come from the top-down process.

Under the YCDC, the Engineering Department (Water and Sanitation) is the city's main body responsible for water service provision. At the same time, the Pollution Control and Cleansing Department (PCCD) performs pollution-related monitoring functions, including water-related ones (Groot & Bayrak, 2019). However, it can be said that they are at an operational level rather than water provision-related policy making, which is mostly done by the YCDC. As technocrats, JICA mainly involves city urban planning. The involvement of the public in planning is limited (Sabrie, 2019), and the same is true in the case of water provision-related policy planning and development.

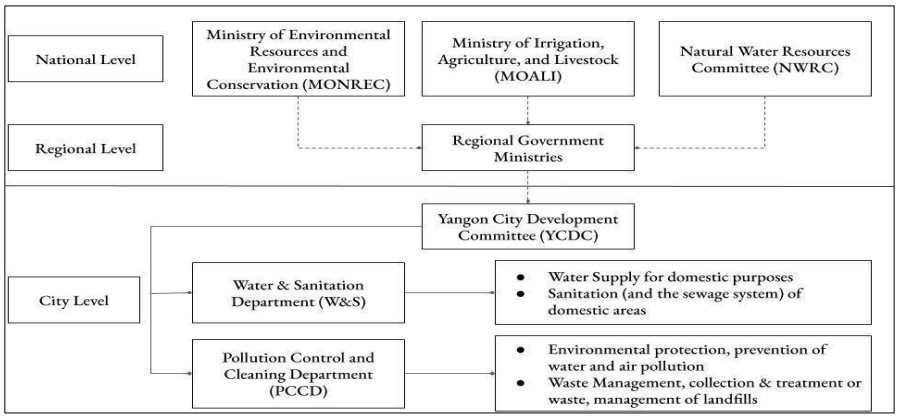


Figure 2. Government Agencies and Responsibilities.

Source: Groot & Bayrak (2019)

Water Service Provision – Distribution & Coverage

In Yangon City, water provision can be generally categorized into municipal-supplied and non-municipal-supplied water. Historically, the former – municipal water provision – was started in 1842. First, there were 30 wells in the center of the city. In 1879, the system was operated using pumps and conduit pipes from lakes, and water was then distributed to the households through pipes. Since 1904, however, new reservoirs have been developed to meet the city's growing demand. To date, there are

four reservoirs in the city's water provision, and YCDC is increasing the number to cover the growing needs (JICA, 2018).

Regarding water service coverage, 58 percent of the city's total population can be supplied, and more than 85 percent of YCDC's total provision comes from reservoirs, while the rest is supplemented by tube wells (Khaing, 2016; Consult Myanmar, 2017). The city's estimated average water consumption per capita is 160 Liters per capita/day (lpcd) (Khaing, 2016). According to the YCDC report, the municipal water service connection in the downtown area, especially the central business area (CBD), is relatively far enough from the average needs of their households – meaning that they have a regular supply of municipal water provision. However, on the other hand, the connection in some townships, especially in peri-urban areas, is significantly low: some share, for example, 2 percent of the total households (YCDC, 2016).

Overall, it is found that the water usage per household is directly proportional to income – water usage is higher in high-income families compared to low-income ones (YCDC, 2016). Additionally, the duration of the water supply is highly variable, and the water availability from the services depends on the distance of townships from the water sources: the townships that are close to the main water distribution pipelines can access more water in terms of duration and amount (Another Development, 2019). Further, out of four reservoirs, two – Hlawga and Phyu Gyi – do not have water treatment plants (JICA, 2018). This can be translated as the city's water service quality is also questionable.

What is more, physical infrastructure is a pressing issue in the city's water provision. The old distribution pipes – since colonial times – are still operating, especially in the central city area, and the extension of the pipeline network is still limited in the city to meet the present and growing needs. Given the challenges above, 30 percent of total water service connections are also not equipped with water meters (JICA, 2014; Another Development, 2019), and 66 percent of total daily water is lost as non-revenue water in the city (JICA, 2018) due to pipelines' leakages, illegal water connection, and poor maintenance among others.

In non-municipal serviced areas or the lowest service connection townships, people have to rely on various alternative sources such as tube wells, rainwater storage, streams, ponds, bottled water, water vendors, public tube wells and taps, and small public water supply systems (JICA, 2018). In other

words, people in these townships have to spend their daily income – to some amount – to buy water (Su, 2020). However, it has been found that the city government does not give priority to these areas (Groot & Bayrak, 2019). For example, the implementing supply improvement project – mostly – goes to the central parts of the city, industrial zones, and the new city – which is still under planning; some townships (for example, Hlaing Tayar Township, where most of the residents are migrants or informal settlers) are considered for industrial purposes, and public service provision is hardly considered; even in the service improvement project, the ones who can provide required information and documents including land ownerships may be accessed the municipal water services (Su, 2020). In other words, this creates a significant barrier for informal settlers. It is fair to say that migrants or informal settlers are overlooked in the YCDC's plan of 'providing potable water for all citizens.'

Financial Performance – Cost Recovery

It is indicated that investment in the city's water supply system is needed as, for example, the existing physical infrastructure of the system needs to be upgraded, and the extension of the pipeline network is necessary to meet the growing demand. However, the lack of financial resources (JICA, 2018; Sabrie, 2019; Groot & Bayrak, 2019) is one of the main challenges for YCDC in this regard. At the same time, the Department of Water and Sanitation has to rely on the revenue of the main institution – Yangon City Development Committee (YCDC) – as the department cannot cover its department's expenditures. The expenditure on the city's water service provision was found to exceed the department's revenue (JICA, 2018). It can, therefore, be interpreted as the reason – among others – for underinvestment in the water provision sector. A government official relates it to the low water charges:

> *"So, the main objective is to supply water to our people. But the problem is that our water price is so low that handling our operations, maintenance, and future development is difficult. So that is why we will also try to increase the water price a little bit to balance the costs"* (Groot & Bayrak, 2019: 990).

In the billing system of water services in Yangon, two charged rates can be seen: fixed rate per unit and flat rate billing system; metered connections are charged by fixed rate per unit billing system in every month while unmetered connections are collected by flat rate system in every quarter of the year – every three months. The flat rate billing system charges the amount depending on the estimated monthly water consumption. Considering customers of the services, they can be categorized into four

types: residents, industries or commerce, departments, and FOC (free of charge). However, there are only two types of tariff rates: 110 kyats per m^3 for commercial connections and 88 kyats per m^3 for other connections – residents and departments (Aung, 2014). It was found that the rates of water service in the city for residents are low compared to 200 kyats per unit in Mandalay City and 110 kyats in Nay Pyi Taw City (Myanmar Times, 2019).

While the improvement of water tariffs can be considered – JICA also recommended in its report – as one of the solutions to improve the situation mentioned above, the city's water service tariff collection process is also questionable. The existing process has been resource-consuming in terms of time, money, and human resources, and it has also created conflicts between service providers and service users. In an interview, a township officer (personal communication, 2018) stated the challenges of the tariff collection process:

> *"We handle the solutions with our capacity..... We have limited capacity, although we would like to. There are 40 staff for this township. We have to collect water tariff for 12,000 households... We have a limited budget, capacity, and facility.... It still needs more staff to operate the system effectively."*

On the other hand, a service user (personal communication, 2020) raises a complaint about the tariff collection:

> *"Normally, they (Water Supply Department) have to come at least two or three times for water tariff collection: water meter reading, bill voucher distribution, and money collection. But they cannot come three times. They, therefore, kind of estimate the meter and come and collect after three or four months. Sometimes, it happens after six months. But the problem is that the amount of the bill is not different between small and large households. I feel like it is unequal."*

It is fair to say that these financial challenges create a kind of loop: underinvestment to low service coverage as well as high non-revenue water and water leakages. In addition, there has been limited capacity to collect the tariffs properly.

Resource Viability – Health of Water Resources

Generally, the city's water provision has two main water resources: surface water – from reservoirs – and groundwater. The city's service provision mainly comes from four reservoirs – Gyo Phyu, Phu Gyi, Hlawga, and Nga Moe Yeik – (and the YCDC is planning to utilize the river water for the supply lately, but it might be expensive). At the same time, the rest is complemented by groundwater by installing tube wells. At the same time, as the inadequate water supply from the reservoirs to meet the needs of the whole city, groundwater becomes an important source not only for the municipal water provision but also for the whole city's use, and the city comes to rely on it heavily. It is estimated that 53.5 percent of the city's total water use comes from groundwater, mostly through tube wells (Khaing, 2016).

Different driving forces have stressed the city's water resources. Yangon City generally benefits from its 2500-2700 mm annual rainfall as rainwater fills the existing four reservoirs and recharges the groundwater. However, the city is facing rainfall variability and intensity along with decreasing rainy days since 1970 (Khaing, 2016). What is more, the city was at the top of the list among different regions of Myanmar in terms of average daily maximum temperature from 1980 to 2005. It is also projected that the annual mean temperature of the city will rise by between 0.6 and 1.0 degrees per year in 2011-2040 and between 1.2 and 2.4 degrees per year in 2041-2070 (Horton et al., 2017). In other words, this has implications for the viability of water in the reservoirs and the replenishment of groundwater resources in the city's underground water layers.

Moreover, the forest cover of the Yangon Region – which can generally absorb and maintain rainwater and gradually release it into the reservoirs in summer – is shrinking with the highest deforestation rate of 1.96 percent – after the Ayeyarwady region of 1.99 percent – during three decades from 1988 to 2017: the coverage is decreasing from 2,600 km2 to 200 km2 (Yang et al., 2019). This can be translated into low refill of water and high sedimentation to reservoirs – along with the shrinking of reservoirs' watershed areas – leading to the high variability of the viability of supplied water from reservoirs. Nga Moe Yeik Reservoir – one of four reservoirs – for example, is facing sedimentation, which can, in other words, reduce the reservoir's water storage capacity, affecting the city's sustainable provision.

Yangon's groundwater environment, on the other hand, is also facing the pressing driving forces of population growth, urbanization, and industrialization, the growing tourism industry along with other factors such as land cover change and reduction in recharge areas, as well as overexploitation of groundwater resources (Khaing, 2016). For example, while concreting over the city, an increase in the number of impervious surfaces such as roads, sidewalks, parking lots, and ports are contributing to groundwater depletion of the city coupled with the 40 percent decrease in green areas over the course of 25 years (Chann, 2019). This partly explains that the city's groundwater – especially aquifers – is being depleted and degraded. There are 14 townships with a negative balance – the groundwater extraction exceeds the recharge rate –and most of these townships have to rely on alternative water sources, especially groundwater, as the result of limited service provision (Khaing, 2011; Another Development, 2019). It can also be said that groundwater resources in the city are on the way to further depletion, along with the driving forces.

Additionally, this groundwater extraction and the resulting depletion of aquifers has been leading to land subsidence in the Yangon – there has been a correlation between ground exploitation and land subsidence in the city (Horst et al., 2018). However, it was found that there was still lacking a regulating body regarding the construction of tube wells and the rate of groundwater extraction (Khaing, 2016). It can also be interpreted that the respective decision-makers are considering groundwater in the city's land use project for urbanization (Myint, 2019). Therefore, it is fair to say that water resources' long-term viability and renewability are discounted in the city's water provision's policy planning and implementation process.

Discussion and Policy Options

The literature review suggests that every policy and developmental activity should reflect sustainability. However, this study reveals that the opposite is true in Yangon: the city's water provision-related policy and implementation does not appear to be based on sustainable dimensions. In other words, the existing '25-year water supply improvement plan of YCDC' conflicts with the sustainability concept, challenging the sustainability of the city's water provision.

The water provision coverage for the city is still low, along with a high share of non-revenue water. At the same time, on the other hand, the city's water service provision has been stressed by

pressing challenges, including the growing population, economic growth, and climate change-related problems. In addition, water is not equally distributed among townships. Plus, in some communities, water service provision is less prioritized, along with limited pipeline networks. In other words, there are deep inequities (– and exclusion) in water access, especially for poor residents of informal settlements; their daily incomes are spent on water use. Further, there is a lack of financial resources to invest more in the water provision sector; low water service charges and its ineffective collection system partly explain the underinvestment of the city government in this sector.

Thinking of water resources as a constant factor – they can be withdrawn all the time – has also resulted in several implications: the reservoirs start facing sedimentation, decreasing water storage capacity, while there has been deforestation in its watershed areas. The groundwater is being stressed as the city heavily relies on the groundwater. At the same time, groundwater depletion and land subsidence in the city are happening. However, the sustainability of water resources is overlooked, and regulations are yet to be implemented. The role of public participation is being underscored in the city's urban planning process, and the lack of it has created an ineffective top-down governmental regime. Along with technocratic and elite-led planning processes, the gap between the city government and the public tends to widen further, and public participation is barely seen in water-related planning and management of the city.

Based on the analysis, the following policy options that could improve the sustainability of the city's water service provision are proposed. They could be included, as Yangon City Development Committee (YCDC), in water provision-related policy planning and implementation.

First, the barriers that have created exclusion and inequities in water access – in some communities – must be broken down. On the one hand, this can be seen as an opportunity to achieve one of the sustainable development goals: "achieving (ing) universal and equitable access to safe and affordable (drinking) water for all by 2030" (United Nations, n.d.). On the other hand, it could be possible for the city government to plan and implement it. The pipeline networks from one of the improvement projects, for example, will be across Hlaing Taryar Township – where most migrant workers of informal settlements are living – to provide service to households and industries, but – the problem here is – it can be assessed for those who can show legal documents including land ownership (Su, 2020). The city government should, therefore, facilitate access for the informal settlers. The solution would be a short-

term and long-term approach. In the short term, the municipality can build, for example, a communal tap water system or set up a small communal water provision system, and the community can govern both. In the long-term, inclusive urban policy and planning is necessary – and a must – to be able to include all communities regardless of their social and economic status. Additionally, this kind of city government solution could ease the water-related social and financial burdens of around one million informal settlers in the city (Dobermann, 2016).

Second, underinvestment in physical infrastructure has created a vicious cycle in water service provision: for example, this underinvestment has resulted in low service coverage, high non-revenue water share, and a resource-consuming tariff collection process. It needs to break this cycle. Therefore, two areas should be paid attention to: reducing the non-revenue water (NRW) rate and designing an effective service charges collection process. As for the former, according to JICA's (2018) report, YCDC has started working on it in some townships (however, downtown areas with old pipelines are less prioritized), and the plan would be a 25% reduction in 2040. This is a welcome step, but arguably, less attention has been given to NRW compared to the expansion of water sources and treatment plants, and even more so to the latter – tariff collection process. As mentioned above, the NRW rate is relatively high. This means, in other words, that the reduction of NRW could be a chance to increase the quantity of supplied water and service coverage while building the resilience of the city's water provision service. It is, therefore, necessary for the city government to wisely consider investing in either pipeline infrastructure development or water resources expansion. At the same time, the integration of ICTs in the tariff collection process could be an option to break the cycle. Designing the existing door-to-door water tariff collection system into ICT-based payment systems would play a key. What is more, it will also have positive implications in reducing the workload of the department.

Third, the application of future thinking in policy planning can be considered when it comes to long-term water resource viability and renewability: for example, considering the long term in shorter-term policy planning and decision-making and visioning designing for the future. Institutional setting for city water resource governance (or urban water governance) would be another area for future attention, and diversification of water resources should also be given special attention in the future. This is how to shift from traditional static governmental mechanisms in water provision to a more flexible and collaborative form of policy interventions. In other words, taking a broader view, there is a need for urban water governance for the city, which can govern water 'in a sustainable, integrated and inclusive

way' – to borrow the Organisation for Economic Co-operation and Development's (OECD, 2015, p. 5) words in water governance. Two tasks would have to be done to improve the governance: assessing the current water governance performance and adopting a multilevel governance approach, as shown in Appendix (I). As for the former, the OECD Water Governance Indicator Framework could be a tool to improve water governance-related policy and strategies, and it could also be used as an entry point to do so (OECD, 2018). For example, the National Water Resources Committee (NWRC) would play as a leading institution. As a leading actor, additionally, they could focus on three main parts: scanning the existing conditions related to the water sector; visioning or setting up the designated outcomes; and action or implementation (plan) to be taken, and the framework would be a guiding tool to implement the process. On the other hand, when it comes to the multilevel governance approach, there would be four levels: union level, regional level, city level, and local level. Vertical and horizontal coordination and collaboration among and within levels should be improved. Further, the role of non-state actors and community-level governance (self-governance) should also be acknowledged.

Meanwhile, in the short-term, several options can be considered: building strong coordination and cooperation with other institutional actors – for example, the Forest Department in watershed areas governance and the Department of Hydrology and Meteorology in timely reservoirs' discharge measurements and related operations. As for groundwater, the incremental improvement of water provision from reservoirs and other new sources would reduce groundwater use in the city. However, before moving to those sources, urgent regulations and guidelines can be put in place for all users' groundwater use.

Fourth, the top-down governmental process must be reversed, and a participatory, deliberative process could be a possible option for the city. At the same time, special attention should be given to the role of deliberative public participation. Much research also reveals that the government's provision and management of the service could not be efficient and effective without participation. In other words, public communication and engagement – which are hardly practiced in government agencies in Myanmar – would be necessary. For example, public participation could play an important role in reducing NRW for the city: the respective official can get the information about where the water leakage is happening through citizens' reporting, or the official would not need to go there; the community itself could fix the problem if within their capacity. On the other, this could be a kind of public engagement through encouraging participation, empowering their roles, and promoting their sense of ownership in

the city's water provision. The following interview notes reveal why the participatory process can be considered an option. The former was from the response of the head of a ward of the city (personal communication, 2018):

> *"It would be better if the community knows where the pipe bar is. We can save the water leakages then. Water leakages are more often in every ward."*

The latter was from the head of another ward (personal communication, 2018):

> *"A supervision committee was formed with 13 people in this ward to deal with water supply problems. We collaborate with the township water supply department to solve the problem in our ward."*

Fifth, the development of an integrated water supply policy and planning should be considered. This study also reveals the need for holistic thinking in service planning and delivery. Otherwise, it would not be translated into sustainable water provision and does not reflect the sustainability concept. Water service provision policy and plan can come from the application of future thinking while reflecting the sustainability concept at the same time. More importantly, it could be developed through a participatory, deliberative process in which a wide range of actors – decision-makers, experts, different interest groups, and citizens – are involved in the decision-making process at each stage of the policy process in different forms of participation, but policy decisions come from deliberative process. If contextualized for the city, for example, there might be four actor groups (but not limited) – decision makers such as union, regional, and city agencies; experts including JICA, ADB, UN-Habitat; interested groups from the private sector, and civil society, think tanks, as well as research and academic institutions; the public who are interested and affected as well as unrepresented actors including women and youth, etc.

Conclusion

Along with megatrends, urban water provision systems, especially in developing countries, are stressed with sustainability challenges, and sustainability has become a trending concept and important these days. As such, policy and planning related to it come to play an essential, and more importantly,

those need to reflect the sustainability concept. This study reveals that the same is happening in Yangon's water service provision. In the existing policy and planning, sustainable dimensions have been overlooked.

This study, I believe, could somehow offer policy options to reflect the sustainability concept in Yangon City's water service provision. More importantly, water supply-related policy planning and implementation should be broader than a purely technical perspective – expansion of more water resources, building more water treatment plants, and so forth. Different dimensions, including social, economic, environmental, and political considerations, should be considered as well.

It has been a long time since the practices (and culture) of public participation have been seen in the circle of the policy-making process of Myanmar. It is, therefore, time to nurture this kind of practice, starting from the city's policy-making process to the country, and Yangon should play the leading role in it. In addition, I believe this study will reflect the challenges that are happening in the city. However, there are some limitations regarding data – as data come from secondary sources, and less research has been done on this issue. There are many more studies to be explored. For example, it would be best if it could study how water governance is happening at the community level or ward level and its process. Another example would be investigating the institutional capacity of the governing body, such as the Yangon City Development Committee (YCDC).

References

Aggarwal, R. M., & Haglund, L. (2019). Advancing water sustainability in megacities: Comparative study of São Paulo and Delhi using a social-ecological system framework. *Sustainability, 11*(19), 5314. https://doi.org/10.3390/su11195314

American Society of Civil Engineers. (1998). *Sustainability Criteria for Water Resource Systems*. Reston, VA: ASCE Publications.

Another Development. (2019). *Access to Clean and Safe Water in Yangon: A Case of Municipal Water Provision in Insein Township* (Working Paper). Seoul, South Korea: East Asia Institute.

Arnold, M., Aung, Y. T., Kempel, S., & Saw, K. P. C. (2014). *Municipal Governance in Myanmar: An Overview of Development Affairs Organizations*. Yangon: MDRI-CESD and The Asia Foundation.

Asia Development Bank. (2016). *Asian Water Development Outlook 2016: Strengthening Water Security in Asia and the Pacific*. Manila: ADB Publications

Asian Development Bank. (2017). *Asia's Booming Cities Most at Risk from Climate Change*. Retrieved from https://www.adb.org/news/features/asias-booming-cities-most-risk-climate-change.

Aung, Z. W. (2014). *Water Supply Options for the Growing Megacity of Yangon Scenarios with the WEAP Model*. Unpublished Master's Thesis, Leibniz University Hannover, Hannover, Germany

Boulenouar, J., Schweitzer R., & Lockwood, H. (2013). *Mapping Sustainability Assessment Tools to Support Sustainable Water and Sanitation Service Delivery* (Working Paper No. 6). Hague, Netherlands: International Water and Sanitation Centre.

Carden, K., & Armitage, N. (2013). Assessing urban water sustainability in South Africa – not just performance measurement. *Water SA, 39*(3). https://doi.org/10.4314/wsa.v39i3.1

Chann, Y. (2019). The concreting over of Yangon. *The Myanmar Times*. Retrieved from https://www.mmtimes.com/news/concreting-over-yangon.html.

Chataigner, P. (2017). *Analytical Framework Review Report: A Framework Analysis of Analytical Frameworks*. Retrieved from https://sheltercluster.s3.eu-central-1.amazonaws.com/public/170902%20Analytical%20Framework%20Review.pdf.

Chnoor, J. L. (2010). *Water Sustainability in a Changing World*. Paper presented at the meeting of the 2010 Clarke Prize Lecture, Cosa Mesa, CA.

Consult Myanmar. (2018). *YCDC to Reduce Groundwater Pumping*. Retrieved from https://www.consult-myanmar.com/2017/05/24/ycdc-to-reduce-groundwater-pumping/.

Cosgrove, C. E., & Cosgrove, W. J. (2012). *The Dynamics of Global Water Futures: Driving Forces 2011–2050*. United Nations Educational, Scientific and Cultural Organization. Paris, France: UNESCO

Department of Meteorology and Hydrology. (2019). *New Rainfall Record*. Retrieved from https://www.moezala.gov.mm/new-rainfall-record-5.

Dobermann, T. (2016). Urban Myanmar. *International Growth Centre*. Retrieved from htts://www.theigc.org/wp-content/uploads/2017/01/IGC-Urban-Myanmar.pdf.

Du Pisani, J. A. (2006). Sustainable development – historical roots of the concept. *Environmental Sciences, 3*(2), 83–96. https://doi.org/10.1080/15693430600688831

Global Times. (2018). *People Affected by Flooding in Yangon, Myanmar*. Retrieved from http://www.globaltimes.cn/content/1115440.shtml.

Groot, R., & Bayrak, M. M. (2019). Achieving water security in peri-urban Yangon: exploring the local governance processes. *Water Policy, 21*(5), 980-998. https://doi.org/10.2166/wp.2019.058

Horst, T. V. D., Rutten, M. M., Giesen, N. C. V. D., & Hanssen, R. F. (2018). Monitoring land subsidence in Yangon, Myanmar using Sentinel-1 persistent scatterer interferometry and assessment of driving mechanisms. *Remote Sensing of Environment, 217*, 101–110. https://doi.org/10.1016/j.rse.2018.08.004

Horton, R., De Mel, M., Peters, D., Lesk, C., Bartlett, R., Helsingen, H., et al. (2017). Assessing climate risk in Myanmar: Technical report. *World Wild Fund for Nature*. Retrieved from https://www.worldwildlife.org/publications/assessing-climate-risk-in-myanmar-technical-report.

International Water Association. (n.d.). *Sustainability in Water Supply*. Retrieved from https://www.iwapublishing.com/news/sustainability-water-supply.

Japan International Cooperation Agency. (2014). *Preparatory Survey Report on the Project for the Improvement of Water Supply, Sewerage, and Drainage System in Yangon City in the Republic of the Union of Myanmar* (Vol. 3). Retrieved from https://openjicareport.jica.go.jp/pdf/12175618_01.pdf.

Japan International Cooperation Agency. (2018). *The Updated Strategic Urban Development Plan of the Greater Yangon* (Report No. 1). Retrieved from https://openjicareport.jica.go.jp/pdf/1000038957_01.pdf.

Khaing, K. K. (2011). Groundwater utilization and availability in Yangon City. *Universities Research Journal, 4*(5).

Khaing, K. K. (2016). Groundwater environment in Yangon, Myanmar. In Shrestha, S., Pandey, V. P., Shivakoti, B. R., & Thatikonda, S. (Eds.). *Groundwater Environment in Asian Cities*. Oxford: Butterworth-Heinemann.

Leigh, N., & Lee, H. (2019). Sustainable and resilient urban water systems: The role of decentralization and planning. *Sustainability, 11*(3), 918. https://doi.org/10.3390/su11030918.

Loucks, D. P. (2000). Sustainable water resources management. *Water International, 25*(1), 3–10.

Loucks, D. P., & Gladwell, J. S. (1999). *Sustainability Criteria for Water Resource Systems*. Cambridge: Cambridge University Press.

Marques, R. C., da Cruz, N. F., & Pires, J. (2015). Measuring the sustainability of urban water services. *Environmental Science & Policy*, *54*, 142-151. https://doi.org/10.1016/j.envsci.2015.07.003

Meene, S. V. D., Brown, R., & Farrelly, M. (2011). Towards understanding governance for sustainable urban water management. *Global Environmental Change, 21*(3), 1117–1127. https://doi.org/10.1016/j.gloenvcha.2011.04.003.

Ministry of Hotels and Tourism. (2019). *Myanmar Tourism Statistics*. Retrieved from https://tourism.gov.mm/statistics/.

Myint, T. (2019). *Ground Water Myanmar* [Presentation]. Retrieved from https://www.myanmarwaterportal.com/repository/1310-groundwater-myanmar-some.html.

Myanmar Times. (2019). *Despite Wastage and Losses, YCDC has No Plans to Raise Water Tariffs*. Retrieved from https://www.mmtimes.com/news/despite-wastage-and-losses-ycdc-has-no-plans-raise-water-tariffs.html.

Organization for Economic Co-operation and Development. (2015). *OECD Principles on Water Governance*. Retrieved from https://www.oecd.org/cfe/regionaldevelopment/OECD-Principles-on-Water-Governance.pdf.

Organization for Economic Co-operation and Development. (2018). *OECD Water Governance Indicator Framework*. Retrieved from https://www.oecd.org/regional/OECD-Water-Governance-Indicator-Framework.pdf.

Ostrom, E. (2009). A General framework for analyzing sustainability of social-ecological systems. *Science, 325*(5939), 419–422. https://doi.org/10.1126/science.1172133

Richter, B. D., Blount, M. E., Bottorff, C., Brooks, H. E., Demmerle, A., Gardner, B. L., et al. (2018). Assessing the sustainability of urban water supply systems. *Journal - American Water Works Association, 110*(2), 40–47. https://doi.org/10.1002/awwa.1002

Sabrié, M. (2019). Yangon “emerging metropolis”: Challenges for the authorities and resilience of the Yangonites. *Moussons, 33*, 33–64. https://doi.org/10.4000/moussons.4892

Soe, H. K. (2018). Dala's water woes. *Frontier Myanmar*. Retrieved from https://frontiermyanmar.net/en/dalas-water-woes.

Su, E. T. (2020). Yangon water supply upgrade may bypass the poorest. *Frontier Myanmar*. Retrieved from https://frontiermyanmar.net/en/yangon-water-supply-upgrade-may-bypass-the-poorest.

United Nations. (n.d.). *Goal 6: Ensure Access to Water and Sanitation for All*. Retrieved from https://www.un.org/sustainabledevelopment/water-and-sanitation/.

United Nations Development Program. (2015). *State of Local Governance: Trends in Yangon*. UNDP Myanmar.

Yang, R., Luo, Y., Yang, K., Hong, L., & Zhou, X. (2019). Analysis of forest deforestation and its driving factors in Myanmar from 1988 to 2017. *Sustainability, 11*(11), 3047. https://doi.org/10.3390/su11113047.

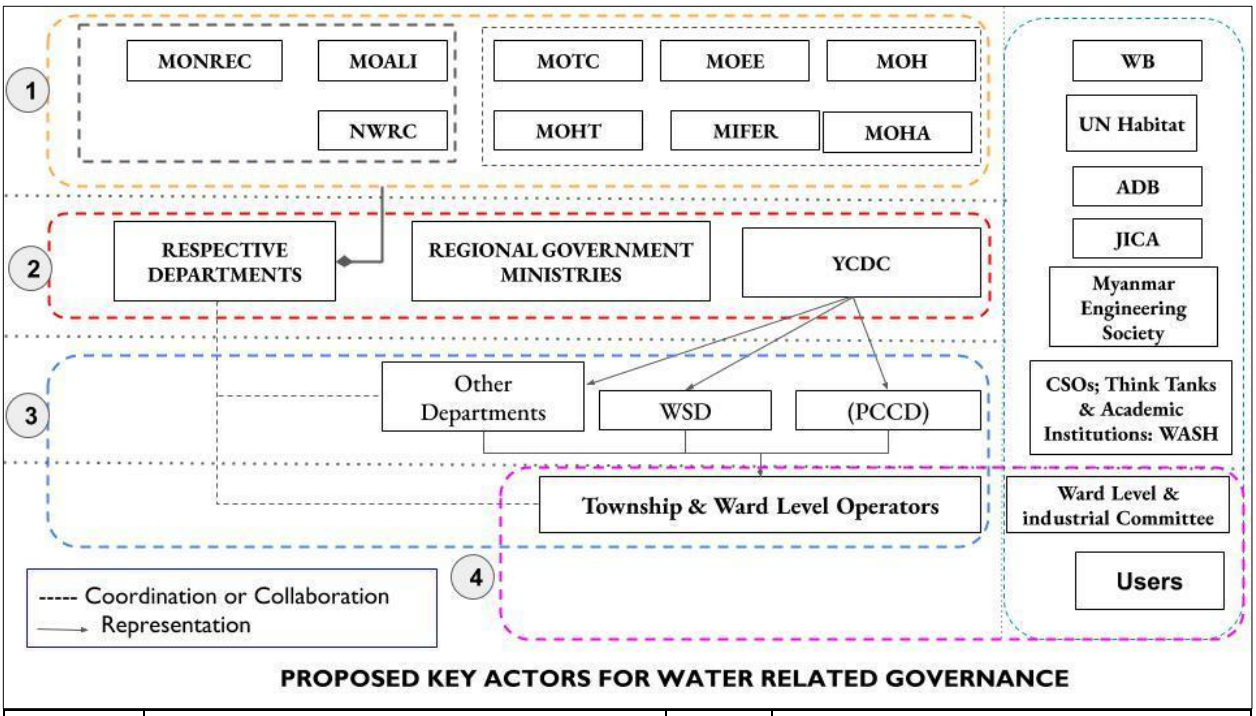
Yangon City Development Committee. (2013). *The Strategic Urban Development Plan of the Greater Yangon*. Yangon Regional Government Document.

Yangon City Development Committee. (2016). *Comprehensive Development Plan of Yangon: Basic Data and Recommendations*. Yangon: YCDC.

Yin. (2003). *Case Study Research: Design and Methods.* 3rd ed. California: SAGE Publications.

Appendix

Proposed Multi-level Governance Approach



MONREC	Ministry of Natural Resources and Environmental Conservation	MOHA	Ministry of Home Affairs
NWRC	National Water Resource Committee	MOH	Ministry of Health and Sports
MOHT	Ministry of Hotels and Tourism	WB	World Bank
MOALI	Ministry of Agriculture, Livestock, and Irrigation	ADB	Asia Development Bank
MOTC	Ministry of Transport and Communications	JICA	Japan International Cooperation Agency
MOEE	Ministry of Electricity and Energy	YCDC	Yangon City Development Committee
MIFER	Ministry of Investment and Foreign Economic Relations	WSD	Water Supply and Sanitation Department
		PCCD	Pollution Control and Cleaning Department

Source: Author