DISCUSSION PAPER SERIES
No. 2025-50, December 2025

Philippine Institute for Development Studies

Securing Tomorrow's Water: Insights on Groundwater, Surface Water, and the Role of Water Districts in the Philippines

Adrian D. Agbon

The PIDS Discussion Paper Series constitutes studies that are preliminary and subject to further revisions. They are being circulated in a limited number of copies only for purposes of soliciting comments and suggestions for further refinements. The studies under the Series are unedited and unreviewed. The views and opinions expressed are those of the author(s) and do not necessarily reflect those of the Institute. The Institute allows citation and quotation of the paper as long as proper attribution is made.

CONTACT US:

RESEARCH INFORMATION DEPARTMENT
Philippine Institute for Development Studies

18th Floor, Three Cyberpod Centris - North Tower
EDSA corner Quezon Avenue, Quezon City, Philippines

https://www.pids.gov.ph
publications@pids.gov.ph
(+632) 8877-4000

Securing Tomorrow's Water: Insights on Groundwater, Surface Water, and the Role of Water Districts in the Philippines

Adrian D. Agbon

PHILIPPINE INSTITUTE FOR DEVELOPMENT STUDIES

December 2025

Abstract

As economies grow, environmental concerns also become more pronounced with issues related to water supply, water quality, and degradation of aquatic environments. The link between surface and groundwater is becoming more relevant as contaminated aquifers which discharge to streams can result in the contamination of surface water. This paper examines the current state and future challenges of potable water provision in the Philippines by focusing on three interlinked areas: groundwater resources, surface-water sources, and the institutional role of water districts. In recent years, increased studies on this aspect because of widespread concerns about water supply, contamination of ground water and surface water (lakes, streams, rivers, etc.) by toxic substances. This paper provides characterization of the groundwater and surface water in select areas in the Philippines. We then analyzed basic data from 532 water districts in the Philippines to estimate for demand and supply, water coverage and attempts to review some of the WDs' water tariff. We recommend a set of policy and operational measures: integrated source planning across jurisdictions, strengthened groundwater monitoring and licensing, targeted investment in treatment and distribution upgrades, capacity-building for WDs technical staff, and blended finance mechanisms to scale resilience projects. Implementing these measures can improve water quality, reliability, and equity of access while safeguarding groundwater and surface sources for future generations.

Key words: water security, groundwater, surface water, water districts, Philippines water quality, governance, climate resilience, potable water

Table of Contents

1. Introduction 1

2. Materials and methods 10

2.1 Conceptual Framework 10

2.2 Study area/water districts 11

2.2.1 Functions and Powers of a Water District 11

2.2.2 Philippine National Standards for Drinking Water of 2017 12

3 Results and discussion 13

3.1 GW and SW locations: some characterization 13

Luzon 14

Visayas 17

Mindanao 18

3.2 Water demand and supply analysis, coverage rates and sources of water of WDs 21

3.3 Review the water pricing (tariff) of selected water districts. 34

3.4 Policy strategies to promote sustainable management of GW and SW resources 40

3 Conclusions 41

4 References 43

Appendix 46

Groundwater extraction 46

Framework Water demand and supply analysis 47

Securing Tomorrow's Water: Insights on Groundwater, Surface Water, and the Role of Water Districts in the Philippines

Adrian D. Agbon*

1. Introduction

Fulfilling Sustainable Development Goal 6 (SDG 6)—ensuring access to safe water, sanitation, and hygiene—remains the most fundamental requirement for human health and prosperity. However, global water demand is escalating, driven by rapid urbanization, population surges, and the intensifying requirements of the agricultural, industrial, and energy sectors. Remarkably, the rate of water consumption has now surpassed the rate of population growth.

Since 2015, global water stress has plateaued at 18 percent, yet this figure masks a harsher reality: 10 percent of the global population now resides in areas facing high or critical water stress, with some regions exceeding a 75 percent stress level. Looking ahead, water scarcity is expected to worsen as rising global temperatures driven by climate change further disrupt the hydrological cycle.

As economies grow, environmental concerns also become more pronounced with issues related to water supply, water quality, and degradation of aquatic environments. The link between surface and groundwater is becoming more relevant as contaminated aquifers which discharge to streams can result in the contamination of surface water. The scientific and economic uncertainty of appreciating the benefits of groundwater and its inherent complexity makes it a major challenge to design policies that encapsulate all aspects of this very essential resource. The need to understand the interaction of ground water and surface water is essential to many stakeholders, particularly to water managers and to water scientists (Winter, T. et al. 1998).

In 2022, the United Nations Water Development Report emphasized making the invisible visible aptly referring to groundwater. The report added that groundwater accounts for approximately 99 percent of all liquid freshwater on Earth. Groundwater is a vital resource with the power to unlock significant social, economic, and environmental advantages for societies worldwide. Currently, it accounts for 50 percent of all domestic water usage globally, serving as a primary lifeline for rural communities without access to formal supply systems.

* PIDS, Supervising Research Specialist & Doctoral researcher, UC Louvain, Belgium

Additionally, it remains a cornerstone of global agriculture, supplying approximately 25 percent of the water used for irrigation. As can be described further, groundwater is an invisible resource and considered a vital component of our environment, often taken for granted and even exploited according to demands due to demographic pressures, economic and technological developments and other factors that put pressure on this resource. Despite its importance, groundwater is frequently misunderstood, leading to a lack of appreciation for its true value. This lack of awareness often results in poor management and, in many cases, outright exploitation or misuse of the resource. As there is a growing awareness of this resource being finite and vulnerable, groundwater management has been appreciated and embraced in many countries around the world. The relationship between groundwater and surface water is defined by a complex exchange of physical, chemical, and biological processes. These interactions are not uniform; rather, they are continuously shaped by the specific physiographic features (the physical geography and terrain) and the climatic conditions of a given environment. In recent years, increased studies on this aspect because of widespread concerns about water supply, contamination of ground water and surface water (lakes, streams, rivers, etc.) by toxic substances.[1]

Water security is a critical issue for many Philippine cities, which rank among the most vulnerable in Asia. This challenge is expected to intensify as climate change and rapid urbanization place mounting pressure on water supplies, creating a particularly severe strain on the country's vital groundwater reserves. The water sector in the Philippines has a myriad of challenges to overcome. Despite the country's abundant water resources, the country experienced water stress, an overall water availability per capita per year of 1,446 cubic meters. Moreover, approximately 87.7 percent of the national population have access to safe water supply while 12.3 percent or about 12.40 million people do not have access. It was also estimated that less than 50 percent of the population have piped water on their premises, and some families are still getting unsafe water from the tap. The country also has approximately 332 municipalities that are considered to have water-less, which means more than half of the residents do not have access to safe water.

In the Philippines, as the National Economic and Development Authority (NEDA)[2] puts it, the Philippine Water Supply and Sanitation Plan (PWSSMP) is a national action plan to achieve universal access to Water Supply and Sanitation (WSS) services by 2030. The masterplan sets the direction towards achieving water supply and sanitation-related targets. For example, the Philippine Development Plan 2023 to 2028 targets 97.48 percent of Filipino families will have access to safe water by 2028 (table 1) .

[1] Winter, T., Harvey, J., Franke, O., Alley, W., 1998. Ground Water and surface water a single resource. US. Geological Survey Circular 1139.
[2] Now the Department of Economy, Planning and Development (DEPDEV).

Table 1 PDP target for safe water supply coverage

Years	Annual targets: Safe water supply coverage increased (% families)
2025	94.96
2026	95.80
2027	96.64
2028	97.48

Source: PDP 2023- 2028, NEDA

Also, in the PDP 2023-2028 matrix establishing livable communities' outcome on environmental quality improved highlights the percentage of water bodies conforming with water quality guideline values for its intended uses such as for water supply, food production and primary contact recreation use. The table (2) below summarizes the targets by 2028.

Table 2 PDP target for water bodies conforming to water quality standards

Percentage of water bodies conforming with water quality guideline values for the following intended use	2025	2026	2027	2028
Water supply	33%	33%	50%	50%
Food production	25%	38%	38%	50%
Primary contact recreation use	62%	62%	69%	69%

Source: PDP 2023- 2028, NEDA Note: Baseline year is 2021 for WS= 0%; FP= 0%; PCRU= 50%

Traditionally, groundwater has received less attention than surface water in policy and law.[3] In many parts of the world, the lack of attention to groundwater is manifested by piecemeal legislative approaches, inadequate institutional set-ups, and even insufficient implementation of groundwater law. While it is acknowledged that legal frameworks play an important role in its governance, scientific knowledge and policy should complement each other. Modern water laws consider an integrative approach to surface water and groundwater resources defining clear rights and obligations, setting up management tools, and protecting both the quantity and quality. It also integrates stakeholders and ensures that they are matched with the institutions that take charge of their implementation. Other than regulation, among other issues include setting up the conditions for access to groundwater, protection of aquifers against depletion and pollution, the use of monitoring and planning tools, the modalities in which public interest and private interest must be balanced and lastly; how to involve the stakeholders in decision making

[3] Mechlem, K. (2016). Groundwater Governance: The Role of Legal Frameworks at the Local and National Level—Established Practice and Emerging Trends. *Water*, *8*(8), 347. https://doi.org/10.3390/w8080347

and management processes. The issues cited can typically be addressed through formal legislation, however in some countries informal and customary rules continue to play a significant role that must be both appreciated and acknowledged.

Generally, this paper aims to characterize groundwater and surface water in the Philippines and examine the role of water districts in ensuring safe, reliable, and sustainable potable water supply for present and future communities. *How can the Philippines strengthen the governance, monitoring, and sustainable use of groundwater and surface-water resources to enhance the reliability and safety of water services provided by water districts?*

From the lens of common pool resource economics and perhaps institutional economics to understand issues of overextraction, or exploitation of these water resources provides an impetus for the characterization of these water resources. Exploratory document analyses of data in several government agencies, namely in the Department of Environment and Natural Resources (DENR) and National Water Regulatory Board (NWRB) and will add to the literature on water economics but also provide some arguments on how to better allocate water permits, water pricing and the delivery of high-quality water to consumers.

General Objective. To characterize groundwater and surface water in the Philippines and examine the role of water districts in ensuring safe, reliable, and sustainable potable water supply for present and future communities. It further aims to generate insights and recommendations to strengthen the sustainability of water availability, accessibility, and affordability for households. *Specifically, the paper intends to:*

1. Characterize the identified GW and SW sources in selected areas of the Philippines.
2. Examine water production, consumption, and service coverage among water districts.
3. Review the water pricing (tariff structures) of selected water districts.
4. Propose policy strategies and institutional reforms to promote the sustainable management of GW and SW resources and ensure household access to affordable water.

Review of Literature . Ground water and surface water are the main sources of freshwater and drinking water in many parts of the world. The quality of these water sources should be preserved to guarantee the fulfillment of the different needs of humans and the ecosystem. As Zanotti, et al. (2019) explained, the quality of both surface and groundwater is shaped by a complex interplay of human activities, natural events, and the continuous interaction between these two water sources. To fully understand and protect these resources, it is essential to identify specific pollution sources and the underlying processes that influence

them. While establishing a robust monitoring network is a vital first step, the real value lies in the sophisticated management and interpretation of that data to uncover actionable insights.

The true scale of groundwater depletion remains obscured because data collection is infrequent, and public access to such information is limited (World Bank, 2010). Meanwhile, rapid urban growth and industrial expansion, coupled with deficient sanitation infrastructure, are severely contaminating the nation's water bodies. This pollution includes a hazardous mix of raw sewage, heavy metals, agricultural chemicals, and industrial oils.

Beyond surface pollution, the over-extraction of groundwater is triggering saline water intrusion, where seawater seeps into aquifers and renders them unfit for drinking or farming. According to Tabios (2020), the combination of degrading water quality and shrinking supplies—exacerbated by climate change—is steering the country toward a critical water scarcity crisis. Groundwater is essentially a common-pool resource, characterized by its "open access" nature; it is difficult to prevent individuals from using it, yet it remains a finite supply where one person's consumption directly reduces the amount available for others. Beyond its fundamental role in supporting human and animal life, groundwater is indispensable for maintaining the broader hydro-environmental balance of the planet. As it becomes increasingly rare, it shifts from a necessity to an economic good, carrying a specific market value driven by its scarcity (Charalambous, 2019).

According to estimates from the National Water Resources Board (NWRB), the Philippines has an annual groundwater supply of approximately 20,200 million m^3. When combined with the dependable surface water supply—estimated at 206,230 million m^3 per year at an 80 percent probability—the country's total mean water availability amounts to about 226,430 million m^3 annually. An estimated 83–85 percent of this resource is allocated to agriculture, with the remainder shared among industrial, commercial, and domestic uses.

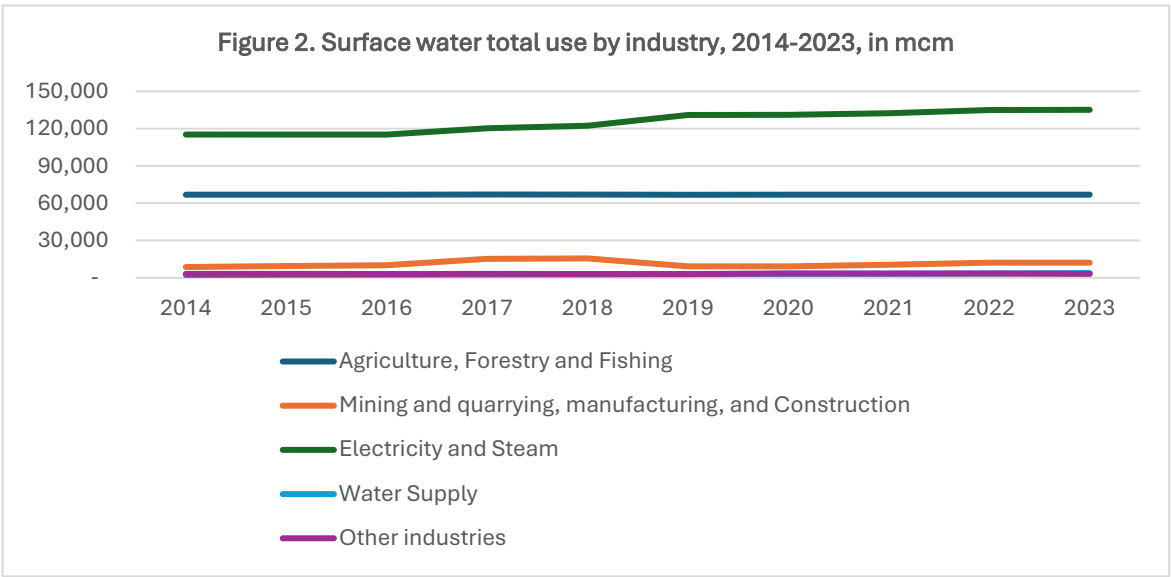
Despite this apparent abundance, the country's water supply is under significant pressure. Rapid urban population growth, widespread water pollution, and inefficient water use pose major challenges. These pressures are compounded by deforestation in critical watersheds and saltwater intrusion resulting from excessive groundwater extraction, particularly in highly urbanized areas such as Metro Manila, Cebu, and Davao City (ADB, 2013)[4] Figure 1 below shows the data from the Philippine Statistics Authority (PSA) on total ground water use from 2014 to 2023. An increase of 17.7 percent was observed from 2019 to 2020 in the total use of ground water. This increase was primarily attributed to the mining and quarrying, manufacturing, and construction industry. The water supply industry also showed an increase

[4] Asian Development Bank's Water Supply and Sanitation Sector Assessment, Strategy, and Road Map, published in January 2013. Accessed on 6 March 2024. https://www.adb.org/sites/default/files/institutional-document/33810/files/philippines-water-supply-sector-assessment.pdf

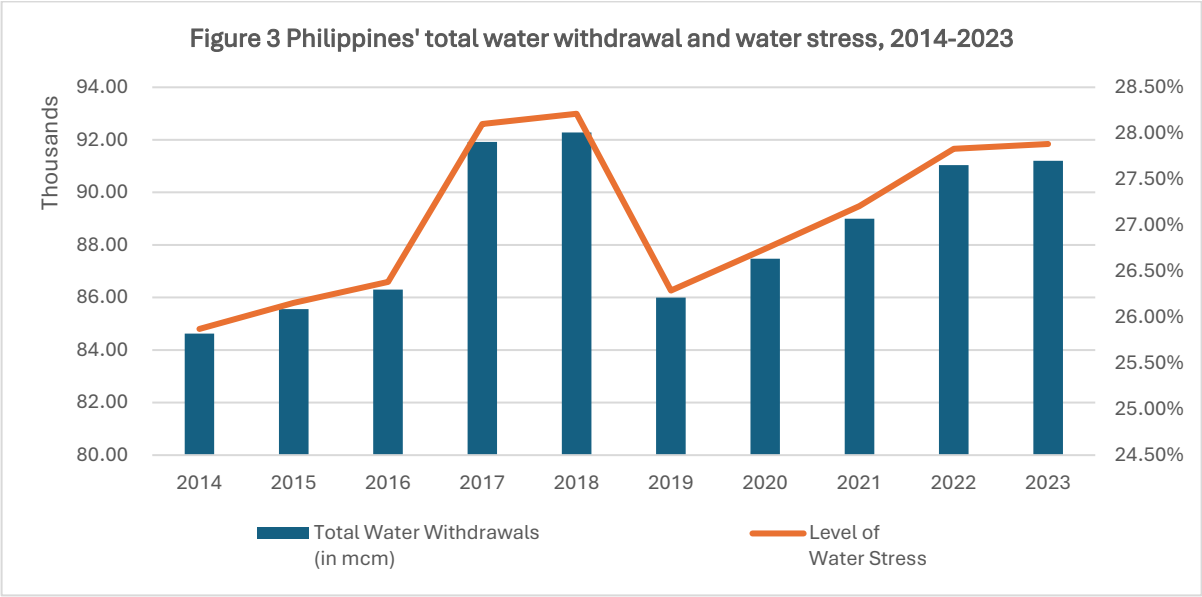
of 11.2 percent from 2022 to 2023. Overall, the average increase in the total use of groundwater is 3.8 percent from 2014 to 2023 while the average total use for the same period is 4.5 mcm.

Source of basic data: PSA, 2025

Figure 2 below shows how intensive the use of surface water (4.5 mcm) compared to groundwater (209.4 mcm) in 2014 to 2023. The biggest total use for surface water is from electricity and steam (125.3 mcm), followed by agriculture, forestry, and fishing (66.9 mcm). In terms of the overall percentage average increase in total use, groundwater is higher at 3.8 percent compared to surface water to only 1.8 percent for the same period.



Source of basic data: PSA, 2025



Source of basic data: FAO Aquastat Database, 2025

Figure 3 above is a glimpse of the level of total water withdrawals and water stress in the Philippines from 2014 to 2023. Water stress arises when the demand for water surpasses the accessible supply within a specific timeframe or when degraded water quality renders the resource unusable. This phenomenon results in the systematic decline of freshwater systems, impacting both quantity—through exhausted aquifers and depleted riverbeds—and quality, via issues such as nutrient-driven eutrophication, organic contamination, and the encroachment of saltwater.[5] Between 2014 to 2023, the highest water withdrawal was in 2018 at 92.3 mcm with the highest level of water stress at 28.21 percent. There was a reduction in total water stress 26.29 percent in 2019 with a corresponding decline in total water withdrawals at 85.9 mcm in 2019 at the onset of the Covid-19 pandemic.

For the purposes of national water regulation, planning, and development, the Philippines is organized into 12 distinct Water Resources Regions (WRR). As of 2008, the country's hydrological network comprised 623 recognized water bodies; this total includes 283 major principal rivers, while the remaining 340 consists of various lakes, bays, and smaller river systems. The four largest river basins in the Philippines are Cagayan River Basin (RB); Mindanao River Basin; Agusan River Basin; and the Buayan- Malungon River Basin. The major lakes in the country are Taal and Laguna de Bay in southern Luzon, Naujan lake in Mindoro and Lakes Mainit and Lanao in Mindanao (Tabios, G., 2020).

[5] Definition from the European Environment Agency

As far back as 1998, a JICA study highlighted that water availability in the Philippines is unevenly distributed across its 12 regions, driven by significant variations in local climate, geography, and physical terrain. Projections indicated that Cagayan Valley (II), Central Luzon (III), Southern Tagalog (IV), and Central Visayas (VII) are the most likely to face water deficits. Major urban centers—including Baguio, Metro Manila, Metro Cebu, and Davao—have already been identified as water-stressed. These vulnerabilities are further intensified by climate extremes like El Niño and La Niña, as well as long-term climate change, which create a volatile cycle of acute water shortages and catastrophic flooding across the archipelago. [6]

In the Philippines, any discussion regarding the quality and quantity of groundwater and surface water is inseparable from the complexities of governance. As noted by Rola et al. (2015), effective management requires a balanced recognition of both statutory (legal) and customary (traditional) systems. When customary practices are ignored or undermined, it creates a regulatory vacuum that formal government institutions—often hampered by limited administrative capacity—struggle to fill. While these two systems can conflict, there are successful instances where they coexist harmoniously, providing a stable framework for resource management. The authors added there are 30 public sector agencies (national and LGU-based) managing the water resources in the Philippines (Rola et al. 2012). Their regulatory mandates cover water quality and quantity, water resource, and water services. Institutional concerns as expected are also varied: water sanitation and quality, watershed management, integrated area development, data collection, flood management, irrigation, hydropower, water supply, research, and cloud seeding. While not all are present in every locality, the sheer number of potential actors and the assumed plurality of mandates.

Studies on water districts, water quality, and affordability. There is a vast literature on water studies in the Philippines. The topics vary from estimates of demand and supply in Metro Manila (Ebarvia, 1994; (Arellano, 1994); (David and Inocencio, 1996); (Inocencio et al, 1999); (Inocencio et al., 2001), water demand elasticity study in Metro Cebu (Largo et al. 1998). Water resources management and governance studies (David and Tabios, 2002) (Rola et al., 2004); water financing (Llanto, 2013) and Israel (2009) reviewed the local service delivery of potable water nationally and analyzed the same in the case study areas of Dumaguete City and Agusan del Sur. In a more recent PIDS paper authored by Velasco, et al (2021)[7], examined national governments' programs directed to improving access to water supply will also help decide, if there will be and how, future interventions will play out with strengthened decentralization and in responding and recovering from the pandemic. The paper also examined

[6] JICA, (Japan International Cooperation Agency) (1998) Master plan study on water resources management in the Republic of the Philippines, Report to National Water Resources Board. Nippon Koei Ltd./Nippon Jogesuido Sekkei, Ltd, Tokyo cited by Tabios, Guillermo Q. III in his book Water Resources Systems of the Philippines: Modeling Studies.

[7] The transformation of the water utility in Sta. Maria, Bulacan, serves as a prime case study of successful evolution from a locally managed government unit to a high-performing Local Water District (LWD). Today, the district boasts an impressive 93% service coverage and maintains a consistent 24/7 water supply. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps2033.pdf

Sta. Maria water district in Bulacan as a case study of successful LGU-run water district. In 2009 the World Bank published an analysis of 35 water districts in the Philippines and explained that through expansion of single systems or integration of service areas, most water district size could take advantage of increased scale. The report highlighted a counterintuitive finding: despite their potential for economies of scale, integrated water systems actually underperformed compared to non-integrated ones. Specifically, residents served by integrated systems face higher water costs, while these districts experience slower growth in new service connections than their non-integrated counterparts. [8]

Access to safe drinking water is a fundamental human necessity, as water quality directly dictates public health outcomes. Ensuring consistent quality standards is the primary defense against the transmission of waterborne illnesses (Lomboy et al., 2017). According to the authors, water service providers across the country are legally required to monitor ten mandatory parameters, which serve as the core indicators of safety. These include:

Microbiological/Chemical: E. coli (thermotolerant coliforms), arsenic, cadmium, lead, and nitrate.

Physical/Chemical: Color, turbidity, pH, total dissolved solids (TDS), and disinfectant residuals.

In addition to these core metrics, there are 55 primary parameters that are site-specific; these become enforceable during the development of new water sources or when a supply is at high risk of pollution. Finally, 11 secondary parameters focus on operational efficiency and the aesthetic characteristics (such as taste and odor) of the water supply.

Hutton (2012) identifies the normative pillars of the right to water and sanitation through five essential criteria: availability, quality, acceptability, accessibility, and affordability. Among these, affordability is a relative metric, defined by the cost of the service in proportion to the consumer's purchasing power. As highlighted in an OECD report on Egypt, water and sanitation are deemed affordable only if the combined monthly cost for these services remains below a specific percentage threshold of a household's average disposable income. In a recent study, Andres et al. (2020) argued that the traditional method of measuring affordability—calculating WASH (Water, Sanitation, and Hygiene) costs as a percentage of household income

[8] The World Bank examined the experience of service integration among municipalities and cities operating under a unified water district framework. Drawing on data from 35 integrated and 109 non-integrated water districts, the analysis highlights the potential cost advantages associated with increased scale, particularly in reducing unit costs. However, the findings also indicate that integrated water districts underperformed relative to non-integrated districts of comparable size, largely due to higher fixed costs and greater operational inefficiencies. https://documents1.worldbank.org/curated/en/320351468298445609/pdf/715230BRI0Box30rated0WS0Philippines.pdf

or spending—is fundamentally flawed. A primary limitation is the lack of a standardized "basket" of WASH services, making it difficult to define what is actually being measured.

The authors also noted that this calculation relies heavily on detailed household surveys that many countries do not possess. Furthermore, the data is frequently plagued by inaccuracies stemming from respondent recall errors and timing discrepancies between when payments are made versus when they are reported. Ultimately, this approach fails to provide policymakers with the granular data needed to understand whether high costs are driven by initial connection fees or recurring usage, making it difficult to design effective pricing reforms.

2. Materials and methods

2.1 Conceptual Framework

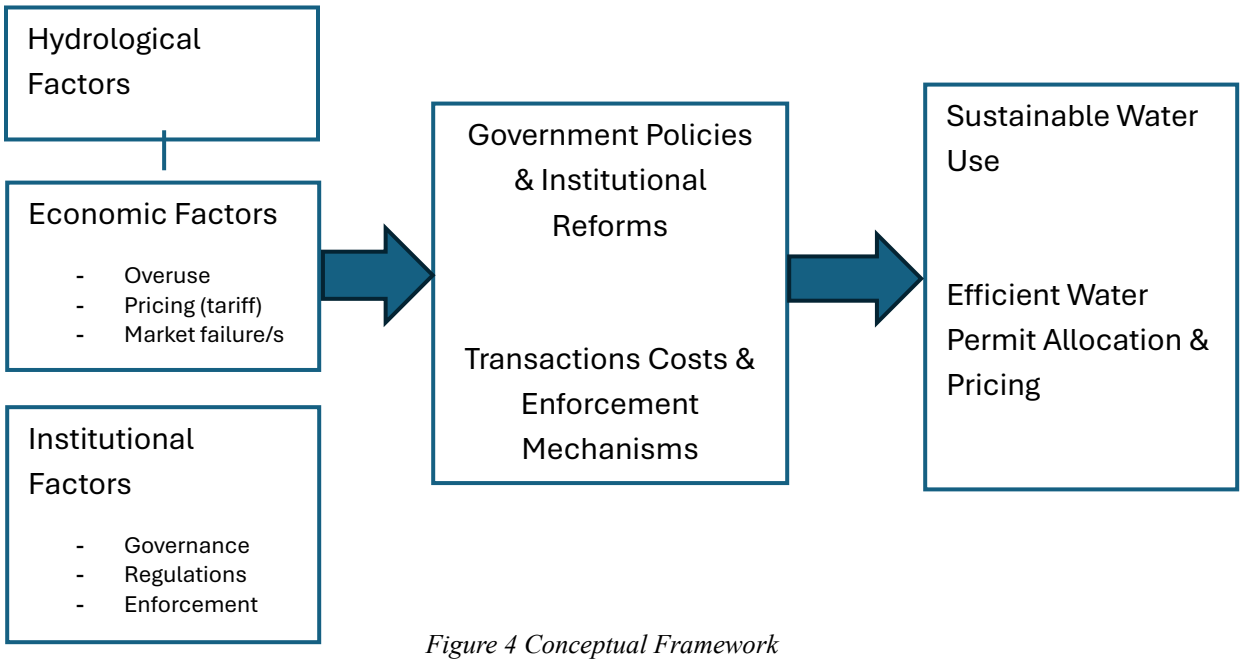


Figure 4 Conceptual Framework

The conceptual framework illustrated in Figure 4 outlines a multi-dimensional approach to water resource characterization. From a hydrological perspective, the study examines water quality (pH, contaminants, and salinity), water quantity (availability, extraction rates, and recharge), and regional geographic disparities.

To address the economic and institutional dimensions, the paper utilizes two primary theoretical lenses:

Common Pool Resource Economics: This view treats water as a potential "tragedy of the commons," focusing on market failures and allocation inefficiencies. It explores the link

between pricing mechanisms and the incentives for stakeholders to manage resources sustainably.

Institutional Economics: This perspective analyzes the regulatory roles of the DENR and NWRB in water permit allocation, alongside the influence of service providers and community participation in governance.

The framework also evaluates intervening variables, such as the Water Code, government regulations, and infrastructure investments. A key focus is placed on transaction costs and enforcement, specifically the expense of monitoring usage and the efficacy of penalties for over-extraction. These elements are contrasted with water markets, designed for trading water rights, and community-based management programs that prioritize local control.

2.2 Study area/water districts

Local Water Districts are government-owned and controlled corporations authorized to operate, manage, and maintain water systems in cities, municipalities, and provinces in the Philippines. LWDs are created via PD 198 or the Provincial Water Utility Act of 1973. The law creates the Local Water District, which is tasked to build, operate, and maintain water systems. Formation of Local Water Districts. The formation of a water district starts from the enactment of a resolution by the legislative body of any city, municipality, or province containing the following: a) The local water district's name shall include the name of the city, the municipality, or province, or region thereof, served by said system, followed by the words "Water District." b) A description of the boundary of the district. In a city or municipality, such boundaries may include all lands within the city or municipality. A district may consist of one or more municipalities, cities or provinces, or portions thereof: Provided that such municipalities, cities or provinces, or parts thereof, cover a contiguous area. c) A statement completely transferring all waterworks and sewerage facilities managed, operated by or under the control of such city, municipality, or province to such district upon the filing of resolution forming the district d) A statement identifying the purpose for which the district is created, e) The names of the initial directors of the district with the date of expiration of the term of office for each, f) A statement that the district may only be dissolved on the grounds and under the conditions set forth under PD 198, and g) A statement acknowledging the powers, rights, and obligations due to default. (Section 6, PD 198) Two or more cities, municipalities or provinces, or any combination may form a single water district.

2.2.1 Functions and Powers of a Water District

Under Section 6 of Presidential Decree (PD) 198, Local Water Districts (LWDs) are classified as Government-Owned and Controlled Corporations (GOCCs) dedicated to public

service. This unique status allows them to wield the rights and privileges of a private corporation while remaining bound by the regulatory framework of PD 198.

Broadly, Section 5 defines the three-fold mission of an LWD:

Water Infrastructure: Installing and managing supply systems for domestic, agricultural, and industrial use.

Sanitation: Operating facilities for wastewater collection and disposal.

Resource Development: Engaging in any incidental activities necessary for the sustainable use of water.

Notably, PD 198 mandates that LWDs fulfill the same water delivery obligations as Local Government Units (LGUs). Because an LWD can only be established via an LGU resolution, its creation represents a formal delegation of authority. Consequently, while the Local Government Code (RA 7160) and PD 198 create overlapping responsibilities, the LGU effectively transfers its primary service role to the Water District upon its formation. [9]

2.2.2 Philippine National Standards for Drinking Water of 2017

The PNSDW of 2017 shall apply to all drinking-water service providers including government and private developers and operators, bulk water suppliers, water refilling station operators, and water vending machine operators; ice manufacturers; all food establishments, residential, commercial, industrial and institutional buildings that use/supply/serve drinking water; water testing laboratories; health and sanitation authorities; the general public and all others who are involved in determining the safety of public's drinking-water. To ensure public safety, drinking water standards must adhere to the following strict criteria:

Sensory and Aesthetic Qualities: Water must be clear and entirely free from objectionable tastes, odors, or colors, making it palatable and pleasant for consumption.

Safety and Health: It must be devoid of all pathogenic organisms, hazardous chemicals, and radionuclides in concentrations that could pose any risk to human health.

Comprehensive Measurement: The integrity of the water supply is evaluated through a rigorous analysis of its microbiological, physical, chemical, and radiological properties. [10]

---

[9] Velasco, L.G., Diokno-Sicat, C.J., Castillo, A. F., Maddawin, R.B. The Philippine Local Government Water Sector. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps2033.pdf. Accessed on 28 October 2025.

[10] DOH Administrative Order No 2017-0010 https://www.fda.gov.ph/wp-content/uploads/2021/08/Administrative-Order-No.-2017-0010.pdf

Table 3 Data sources and description

Sources	Data description
Local Water Utilities Administration (LWUA)	532 Water districts in the Philippines (2019-2024) *Production* *Service connections* *Population served* *Average consumption*
National Water Resources Board (NWRB)	Water tariffs Water permits Water drillers
National Mapping and Resource Information Authority (NAMRIA)	All maps including abstraction, extraction and water Quality location sampling

3 Results and discussion

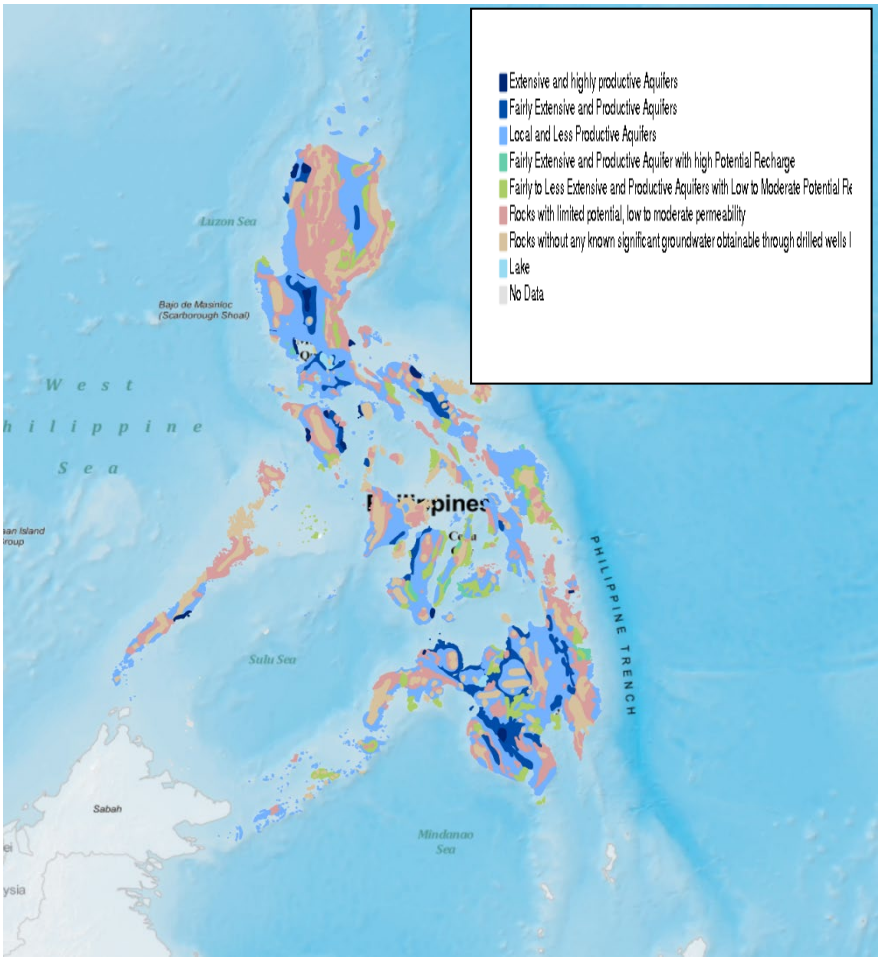
3.1 GW and SW locations: some characterization

The Philippines has an estimated total freshwater supply of approximately 146 billion m^3, of which surface water accounts for about 86 percent, and groundwater for the remaining 14 percent. Despite these resources, the country experiences pronounced water scarcity on a per capita basis. In 2000, when the population stood at around 77 million, per capita water availability was estimated at 1,907 m^3 per year—among the lowest in Asia, ranking second from the bottom. This level was well below the Southeast Asian average of 3,668 m^3 and only about one-third of the global average of 7,045 m^3.

By 2016, continued population growth to approximately 103 million further reduced per capita water availability to just 1,400 m^3 annually (Rongavilla, 2017). Water quality presents an equally serious challenge. Of the country's six Water Resource Regions (WRRs), only a very limited number of water bodies meet Class AA standards, which denote the highest level of potability. In contrast, 36 percent of the Philippines' 623 classified water bodies fall under Class C—suitable primarily for fisheries—while 33 percent are rated Class D, requiring substantial treatment before they can be considered safe for drinking. This deterioration marks a significant departure from conditions five decades ago, when most rivers were naturally potable and supported healthy aquatic ecosystems.

Figure 5 below shows groundwater availability based on the DENR NAMRIA geoportal mapping. The legend on the right side shows the different levels of productive aquifers in the different areas in the Philippines.

Figure 5 Philippines' groundwater availability



Source: https://www.geoportal.gov.ph/ Note: Map is generated using the Geoportal[11].

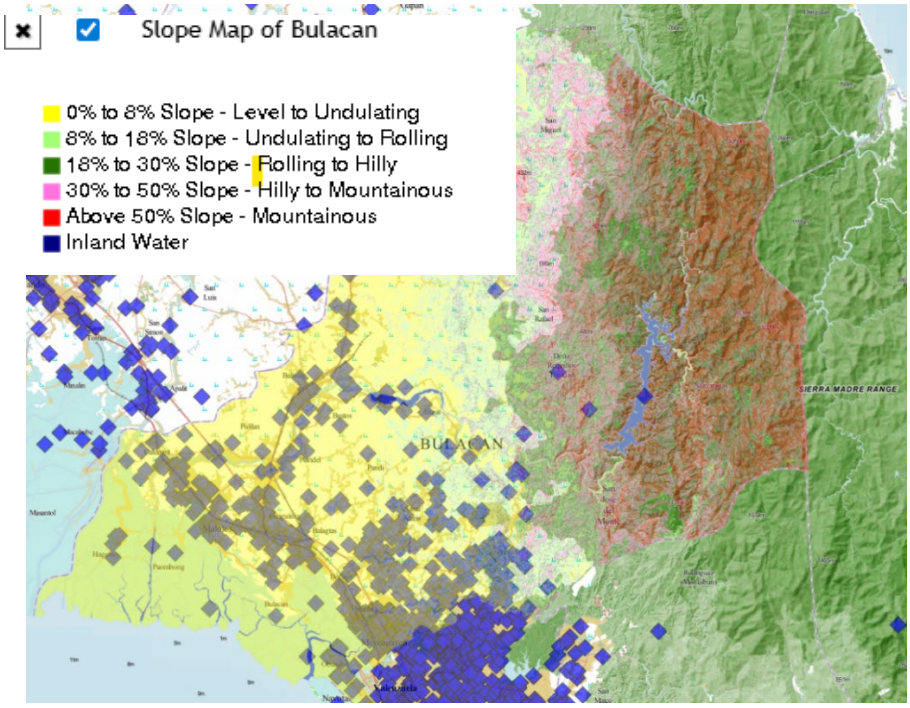
The proceeding sections map out the groundwater water extraction and surface water abstraction in selected areas in Luzon, Visayas and Mindanao. While there are no estimates of the volume of water abstracted and extracted, the maps elucidate the extent of activities related to water use and possible consumption in selected areas.

Luzon

Figure 6 below shows that ground water extraction is more concentrated along the lower slopes and more pronounced along the along coastal areas than in more inland and at higher slopes. As can be seen in Figure 7, surface water abstraction activities are not as pronounced compared to ground water abstraction.

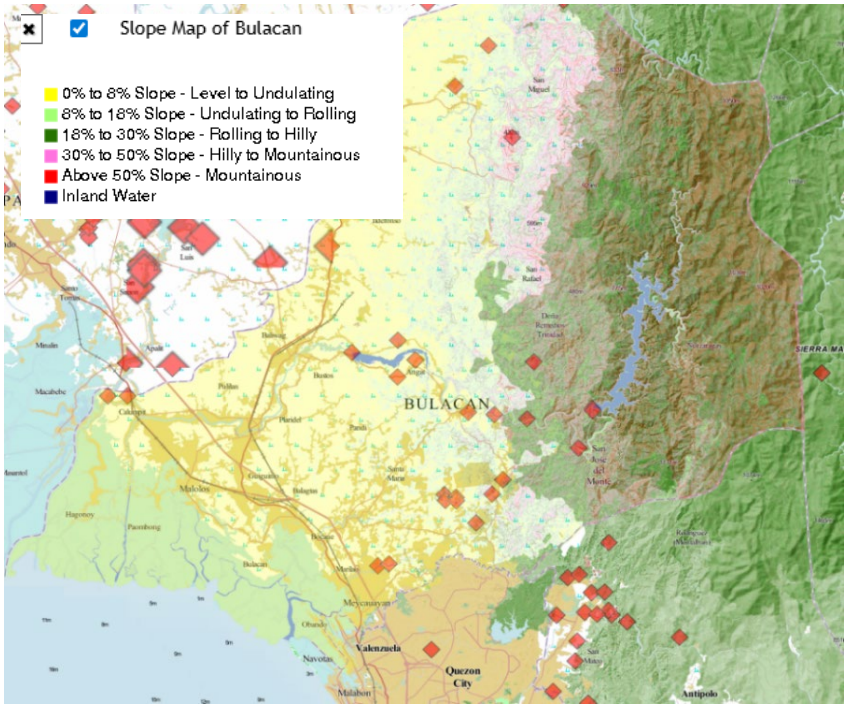
[11] This Geoportal is used to find and access geospatial data and services. The Geoportal Philippines also advocates the use of standard multiscale basemaps that serve as tools for strategic planning, decision making, situational analysis and other common requirements.

Figure 6 Groundwater water extraction in Bulacan



Source: https://www.geoportal.gov.ph/ Note: Map for the entire Philippines' groundwater extraction is available in the appendix.

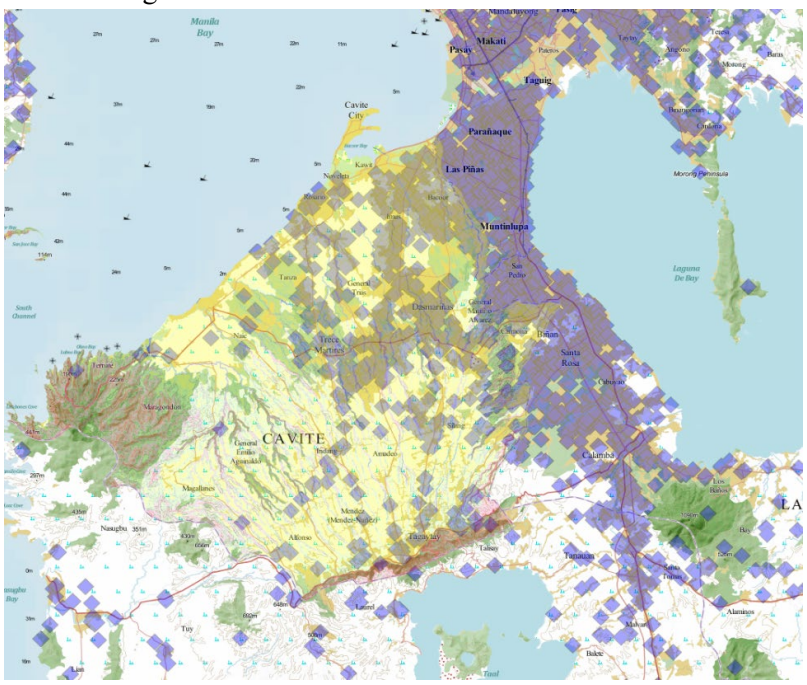
Figure 7 Surface water abstraction in Bulacan



Source : https://www.geoportal.gov.ph/

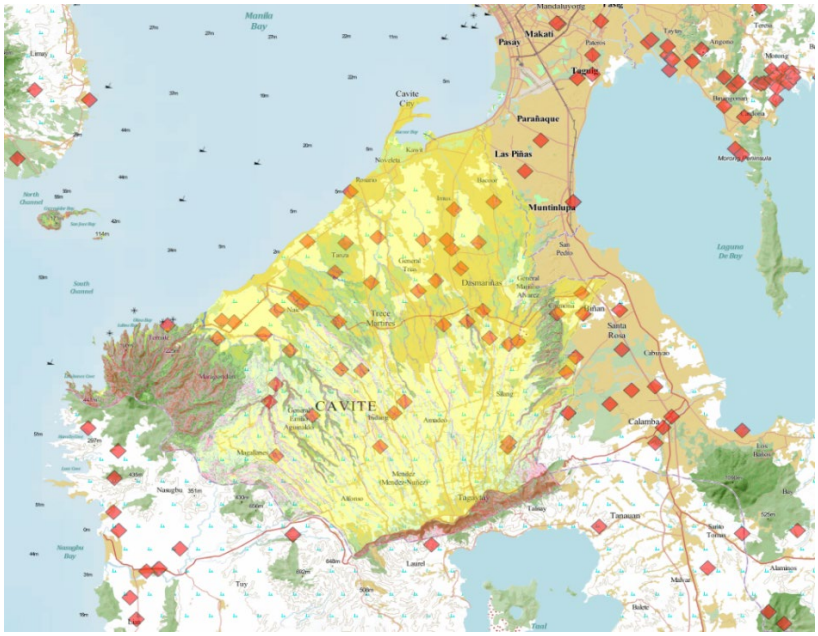
Figures 8 and 9 show groundwater extraction and surface water abstraction in Cavite. Groundwater extraction activities are highly concentrated and more pronounced in along the coastal side of Laguna de Bay. On the other hand, surface water extraction activities are as not pronounced compared to groundwater abstraction.

Figure 8 Groundwater water extraction in Cavite



Source : https://www.geoportal.gov.ph/

Figure 9 Surface water abstraction in Cavite

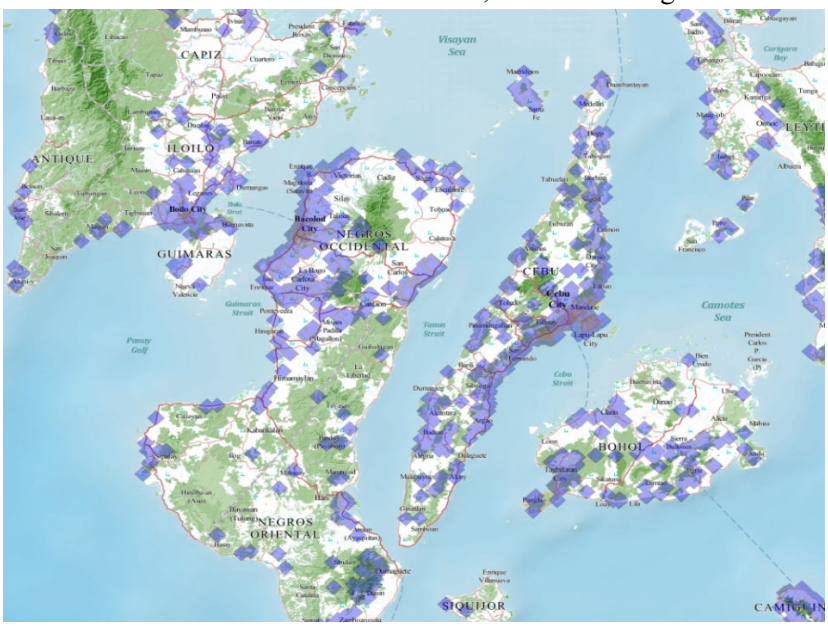


Source: https://www.geoportal.gov.ph/

Visayas

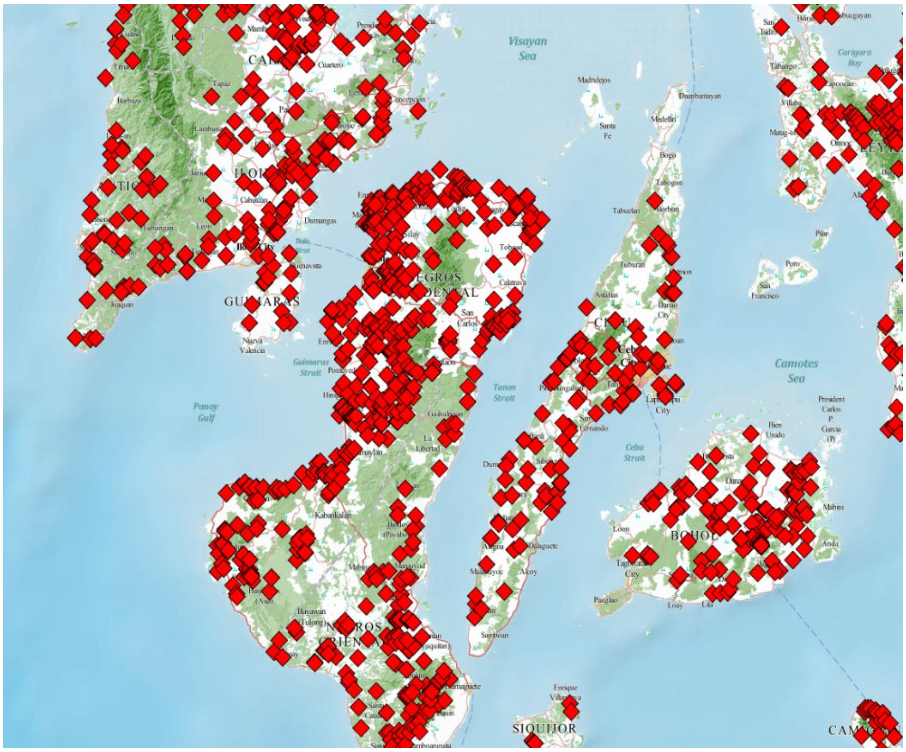
Figures 10 and 11 also show the groundwater extraction and surface abstraction in the Visayas particularly in the islands of Negros, Cebu, Bohol and some provinces in Panay Island. As can be gleaned from figure 10, most of the groundwater extraction activities are highly concentrated along coastal areas in Metro Cebu including the island of Lapu-lapu. The same can also be said in Bacolod City in Negros Island Region and in Iloilo city. On the other hand, surface water abstraction is also common in all islands in the Visayas region and more pronounced in the northern part of Negros Island region.

Figure 10 Groundwater water extraction in Cebu, Bohol and Negros Island



Source : https://www.geoportal.gov.ph/

Figure 11 Surface water abstraction in Cebu, Bohol and Negros Island

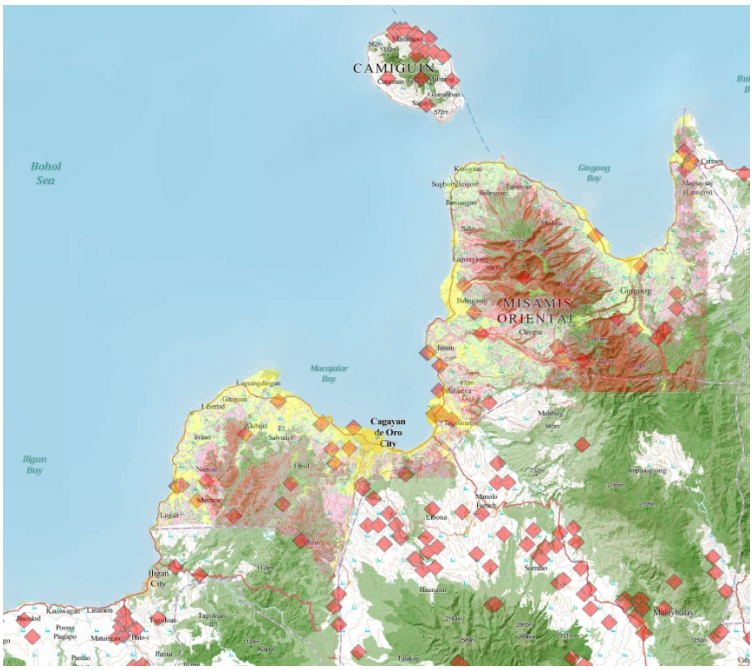


Source: https://www.geoportal.gov.ph/

Mindanao

Figures 12 and 13 indicate both the surface and groundwater extraction in Northern Mindanao. While it can be observed that there is no surface water abstraction in the region except perhaps on the island of Camiguin. Also, surface water abstraction activities happen on a higher slope near Mt. Balatukan Range National Park in Misamis Oriental.

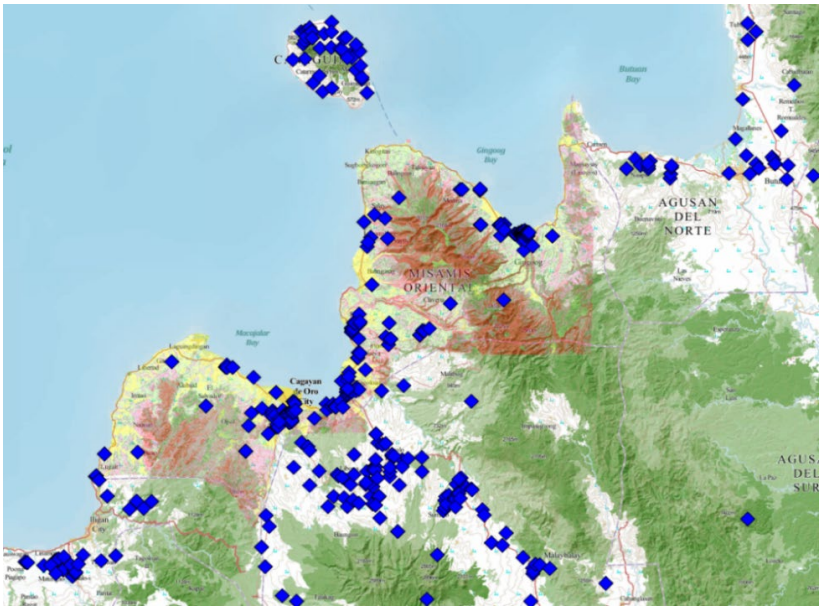
Figure 12 Surface water abstraction in Misamis Oriental



Source: https://www.geoportal.gov.ph/

Ground water extraction in Misamis Oriental is also concentrated in the coastal along the Cagayan de Oro facing the Macalajar bay. The extraction activities also are apparent in Bukidnon areas.

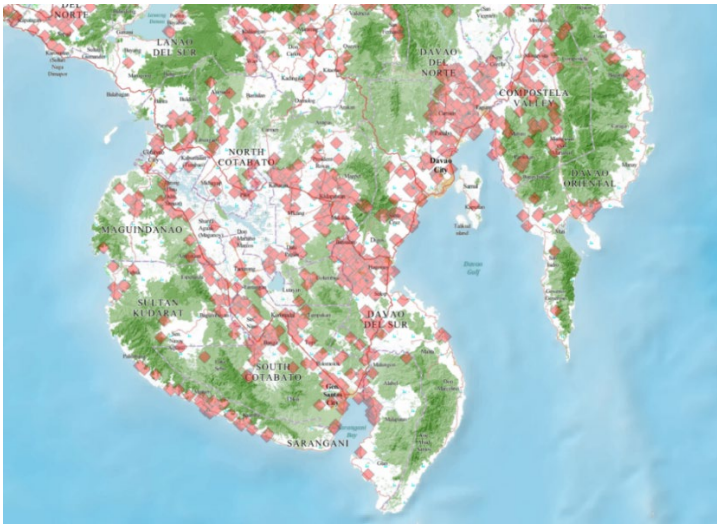
Figure 13 Groundwater extraction in Misamis Oriental



Source: https://www.geoportal.gov.ph/

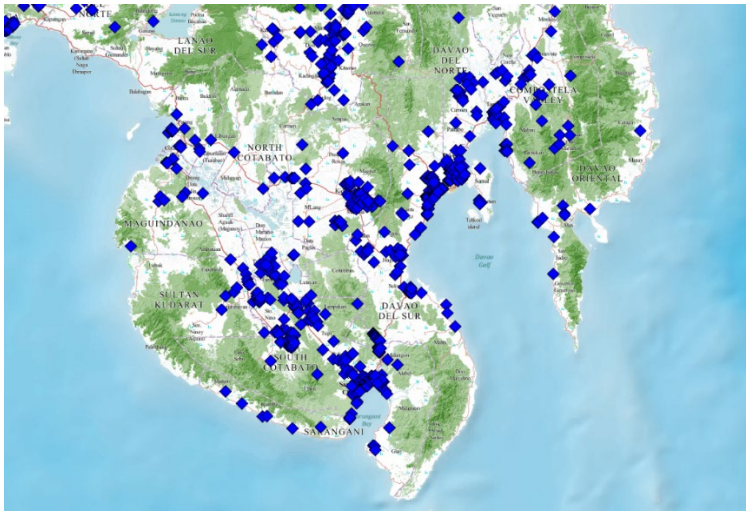
Figures 14 and 15 show surface water abstraction and groundwater extraction in the southern part of island of Mindanao particularly in the Davao. Surface water abstraction activities are not just pronounced along the coastal areas Davao City, Davao del Norte, Davao del Sur but also in Sarangani, and in General Santos City. For groundwater extraction, it can also be observed that activities are more pronounced along the coastal zones of Davao City and in some parts of South Cotabato and in General Santos City.

Figure 14 Surface water abstraction in Davao



Source: https://www.geoportal.gov.ph/

Figure 15 Groundwater extraction in Davao



Source: https://www.geoportal.gov.ph/

The previous discussions provided a glimpse of the extent of abstraction and extraction of water from the ground and surface in selected areas in the Philippines noting that there were no estimates of the volume, recharge rates of the different aquifers and other hydrological data. Figure 16 below indicates the specific areas where water quality sampling is undertaken. These

water quality sampling sites are concentrated Luzon areas specifically in Laguna, Cavite, Bataan, Bulacan, Pampanga and Nueva Ecija.

Figure 16 Water quality sampling sites in Manila Bay Environmental Atlas (MBEA)

Source: https://www.geoportal.gov.ph/ Note: Map is generated using the Geoportal. This Geoportal is used to find and access geospatial data and services. The Geoportal Philippines also advocates the use of standard multiscale basemaps that serve as tools for strategic planning, decision making, situational analysis and other common requirements.

3.2 Water demand and supply analysis, coverage rates and sources of water of WDs

This section discusses some of the performance indicators of the 532 water districts in the Philippines in terms of water production, consumption, coverage rates from 2019 to 2024. For the complete analytical framework used please refer to Appendix part of this paper. Moreover, to compute for the effective supply the author uses 30% non-water revenue based on the literature. Table 4 below shows the different water service providers in the Philippines in terms of level of the provision of water. The different levels water supply is categorized into three levels: Level 1 (point source, like a well or spring), Level 2 (communal faucet system with a piped network), and Level 3 (waterworks system with individual house connections). While level 3 is ideal for household use there are still level 1 water supply provision in Region 3 (1,516), Region 5 (1,228), Region 6 (1,866), Region 7 (1,790).

Table 4 Water service providers (WSP) in the Philippines

REGION	LEVEL 1	LEVEL 2	LEVEL 3	TOTAL*
ARMM - Autonomous Region in Muslim Mindanao	226	134	18	378
CAR - Cordillera Administrative Region	801	345	198	1,344
NCR - National Capital Region	2	47	313	362
REGION I (Ilocos Region)	927	232	177	1,336
REGION II (Cagayan Valley)	848	156	144	1,148
REGION III (Central Luzon)	1,516	102	458	2,077
REGION IV-A (CALABARZON)	902	409	823	2,135
REGION IV-B (MIMAROPA)	462	264	248	974
REGION V (Bicol Region)	1,228	543	223	1,994
REGION VI (Western Visayas)	1,866	559	327	2,752
REGION VII (Central Visayas)	1,790	252	727	2,769
REGION VIII (Eastern Visayas)	996	766	436	2,198
REGION IX (Zamboanga Peninsula)	354	335	201	890
REGION X (Northern Mindanao)	602	305	334	1,241
REGION XI (Davao Region)	499	366	212	1,077
REGION XII (Soccsksargen)	258	226	107	591
REGION XIII (Caraga)	400	455	165	1,020
Total	13,677	5,496	5,111	24,286

Source: Source: http://listahangtubig.cloudapp.net/ Accessed on June 8, 2018
*Based on data uploaded by water utilities in 1,458 participating cities/municipalities, out of a total of 1,634.

Table 5 below also provide a glimpse of the water service providers in the Philippines in terms of management type. Among the different type of WSP's, according to *Listahangtubig*, unnamed WSP accounted for 32%, while barangay based WSP accounted for 27%. In terms of level 3 water service supply, water districts accounted for 11%, this lower than barangay water service (21%) and LGU run utility (27%).

Table 5 Water service providers in the Philippines by management type

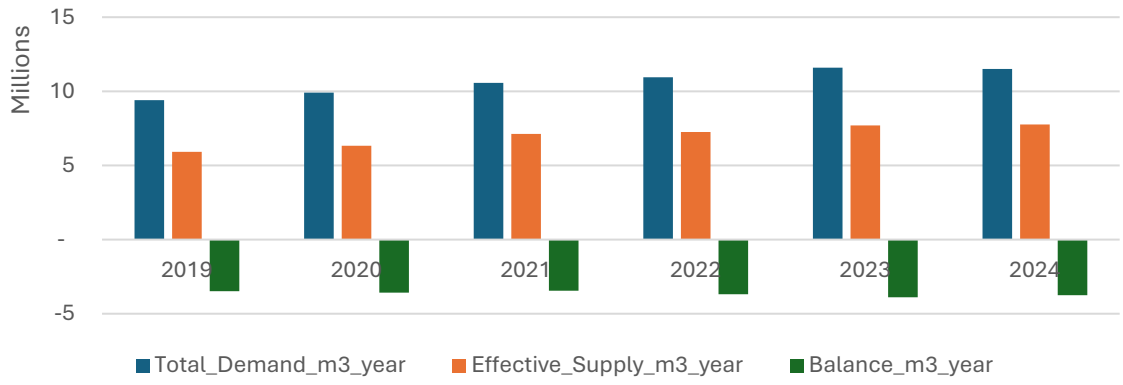
Management Type	LEVEL 1	%	LEVEL 2	%	LEVEL 3	%	Total	%
BWSA	2,975	21.75	2,456	44.69	1,060	20.74	6,491	26.73
RWSA	62	0.45	613	11.15	722	14.13	1,397	5.75
Cooperative	**46**	**0.34**	**85**	**1.55**	**258**	**5.05**	**389**	**1.60**
Unnamed Water Service Provider	7,390	54.03	284	5.17	53	1.04	7,727	31.82
LGU-Run Utility	1,123	8.21	1,596	29.04	1,403	27.45	4,122	16.97
Water District	**2**	**0.01**	**3**	**0.05**	**565**	**11.05**	**570**	**2.35**
Home Owners' Association	168	1.23	75	1.36	127	2.48	370	1.52
Real Estate Developer	8	0.06	8	0.15	83	1.62	99	0.41
Industrial Locator	3	0.02	3	0.05	39	0.76	45	0.19
Peddler	106	0.78	79	1.44	22	0.43	207	0.85

Ship Chandler	1	0.01	2	0.04	1	0.02	4	0.02
Other Private Operators	686	5.02	268	4.88	763	14.93	1,717	7.07
Refilling Stations	1,107	8.09	24	0.44	15	0.29	1,146	4.72
Grand Total	13,677	100.00	5,496	100.00	5,111	100.00	24,284	100.00

Source: http://listahangtubig.cloudapp.net/ Accessed on June 8, 2018

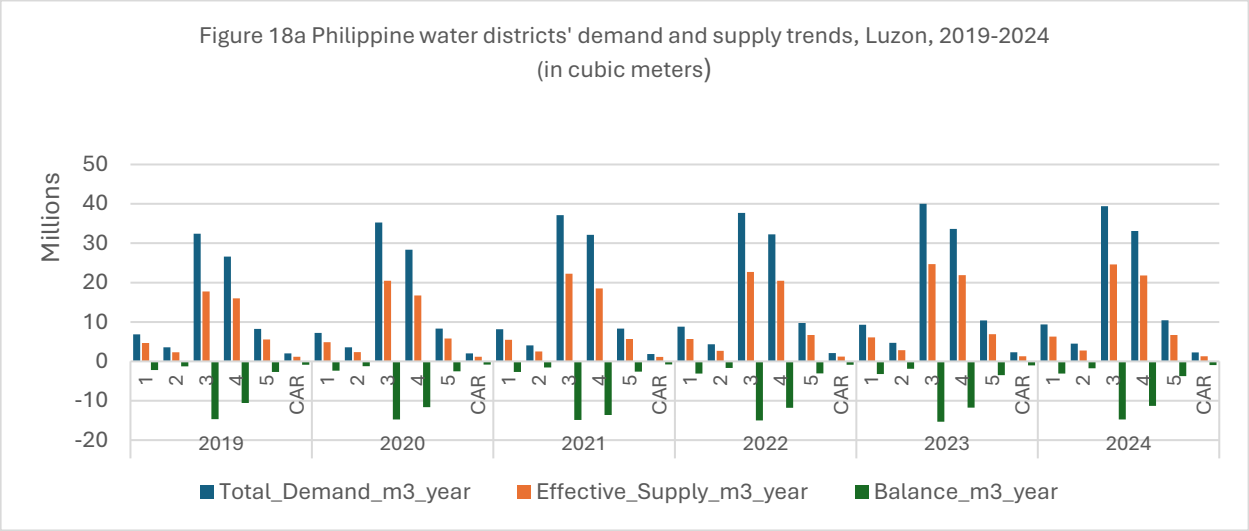
The section provides the analysis of the demand and supply of water of 532 water districts in the Philippines. From 2019 to 2024 the average total demand was 10.6 million cubic meters while the average effective water supply was only about 7 million cubic meters. The average negative balance for the was 3.6 million cubic meters for the same period. Given this negative balance, this strongly suggest that water districts in different regions in the Philippines cannot provide the full demand from the consumers. Aside from documented water shortages in many parts of the country especially during dry seasons this also suggest that for many consumers there could be other sources of water depending on the uses within the household. A water source and specific use have become a normal situation among households, for instance water for drinking comes from water refilling stations, water for cooking and or bathing may also come from both water refilling stations and or from the tap.

Figure 17 Philippine Water Districts Average Water Demand vs Supply, 2019-2024



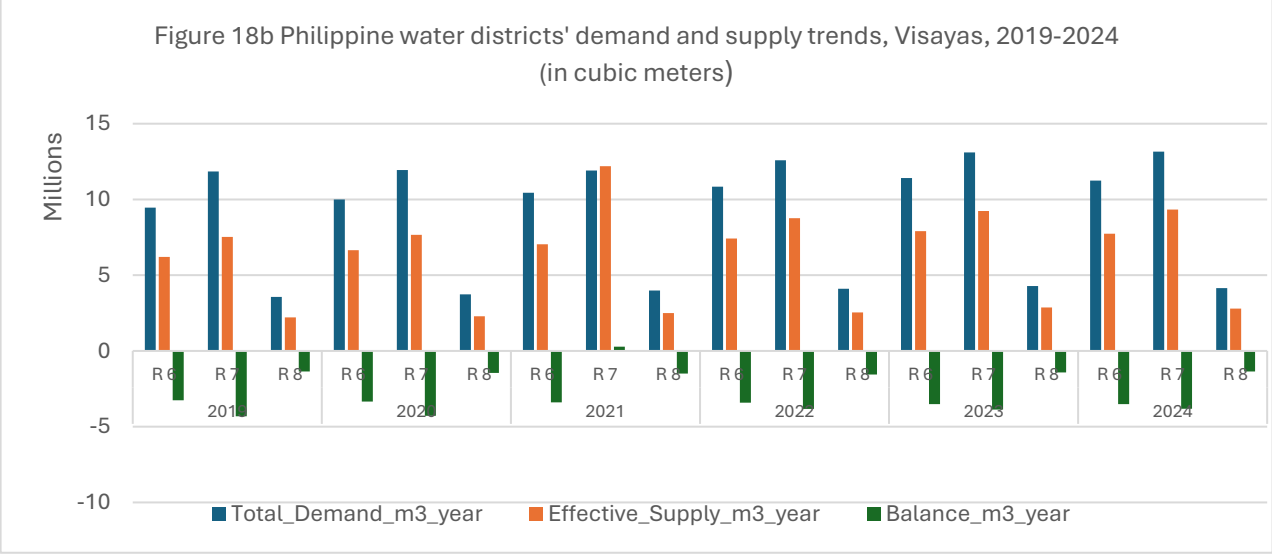
Source of basic data: Local Water Utilities Administration (LWUA); Note: Author's calculations foe 532 water districts in the Philippines. Note: 30% NRW was used in the estimates of effective water supply.

Figure 18a examines closely the water demand and supply among WDs in different regions in Luzon. From 2019 to 2024, the average demand for water among Luzon's WD was 15.3 million cubic meters while the average effective was supply was only 9.5 million cubic meters resulting in negative balance of 5.8 million cubic meters from 2019 to 2024. The highest average negative balance or water deficit is in region 3 with 14 million cubic meters for the same period.



Source of basic data: Local Water Utilities Administration (LWUA)

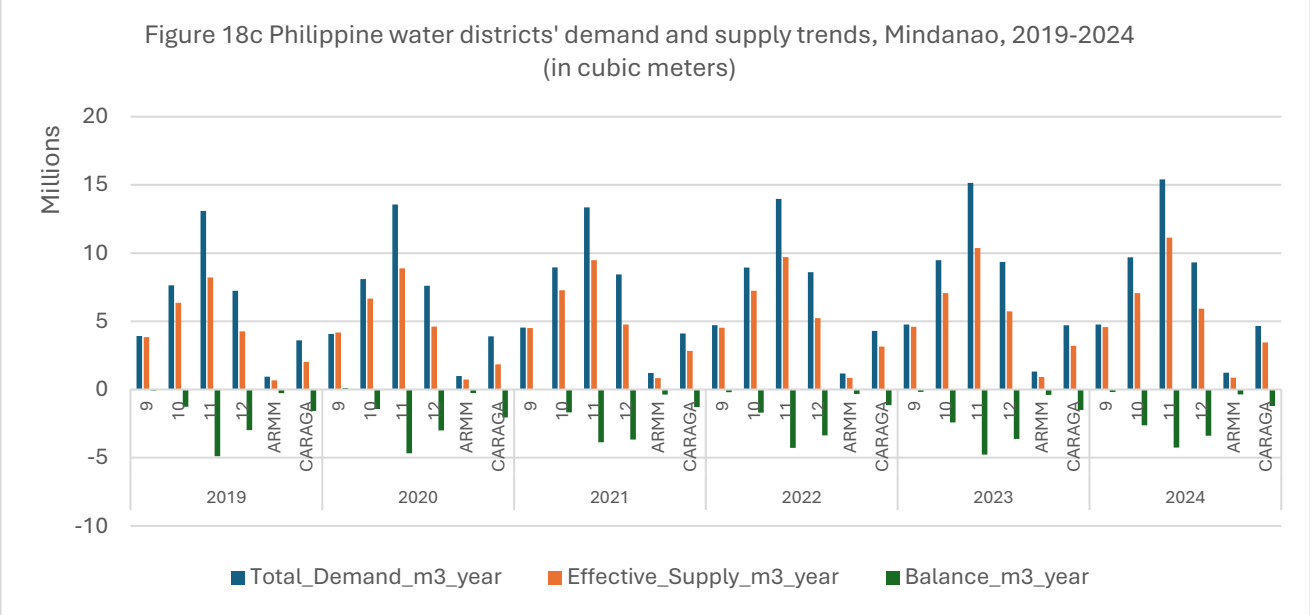
The demand and supply for water estimates for WDs in the Visayas region are show in figure 18b. From 2019 to 2024, the average total demand among all WDs was 8.9 million cubic meters while the average effective supply was 6.3 million cubic meters, this result to a average negative water balance of 2.7 million cubic meters. Region 7 had the highest total demand above 10 million cubic meters while region 8 had the lowest total demand of about 4 million cubic meters. Effective water supply was also highest in 2021 in region 7 at 12 million cubic meters. The negative average water deficit was also highest in region of about 4 million cubic meters.



Source of basic data: Local Water Utilities Administration (LWUA)

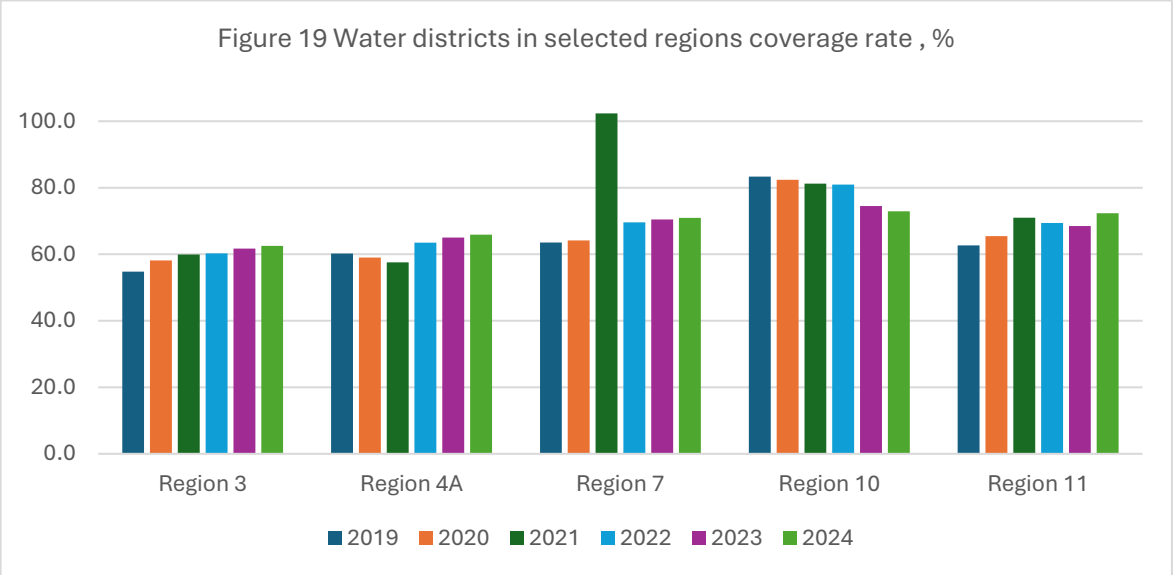
Figure 18c also shows the demand and supply of water from WDs in the Mindanao. The average total demand from 2019 to 2024 was 6.8 million cubic meters while the average total effective supply was 4.9 million cubic meters resulting in a water deficit of 1.9 million cubic

meters. The highest average total demand was in region 11 which was about 15 million cubic meters while the effective water supply was only around 11 million cubic meters. In terms of lowest negative water deficit, region 9's average water deficit was only less than 200,000 cubic meters from period 2019 to 2024.



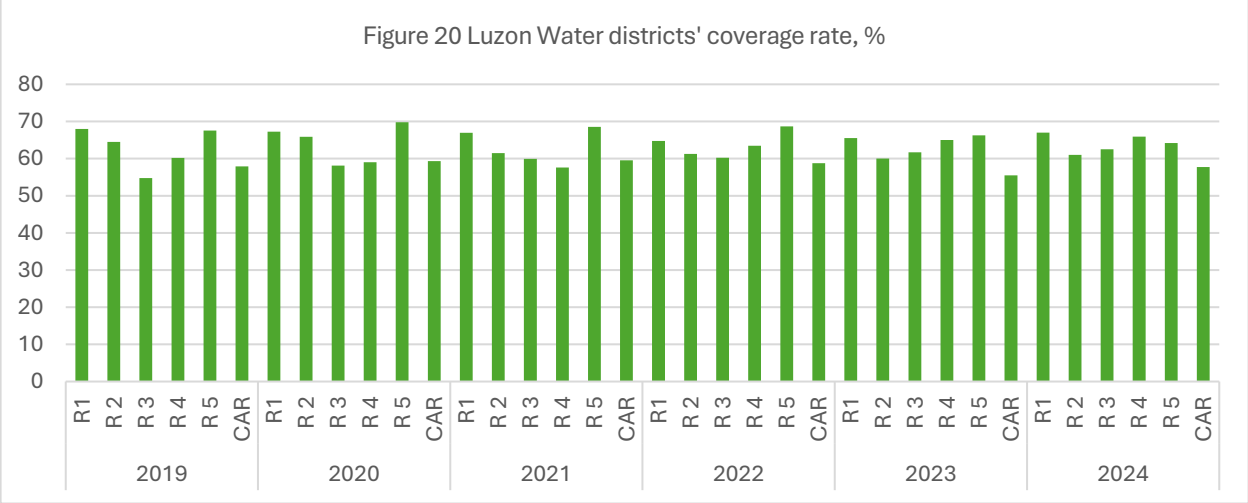
Source of basic data: Local Water Utilities Administration (LWUA)

The proceeding discussions expound the coverage rates of WDs in different areas in the Philippines. This performance indicator captures the ratio of water production relative to total water demand, which can be interpreted as when greater than or equal to 100%, the supply is sufficient but if the ratio is 100% below that simply means supply shortfall provided by the WDs. Figure 19 shows clearly that regions 3, 4A, 7, 10 and region 11 had a coverage rate of between 48% to 80% except for region in 2021 with 100% coverage rate. The literature suggests that WDs should at least have an 85% coverage rate.



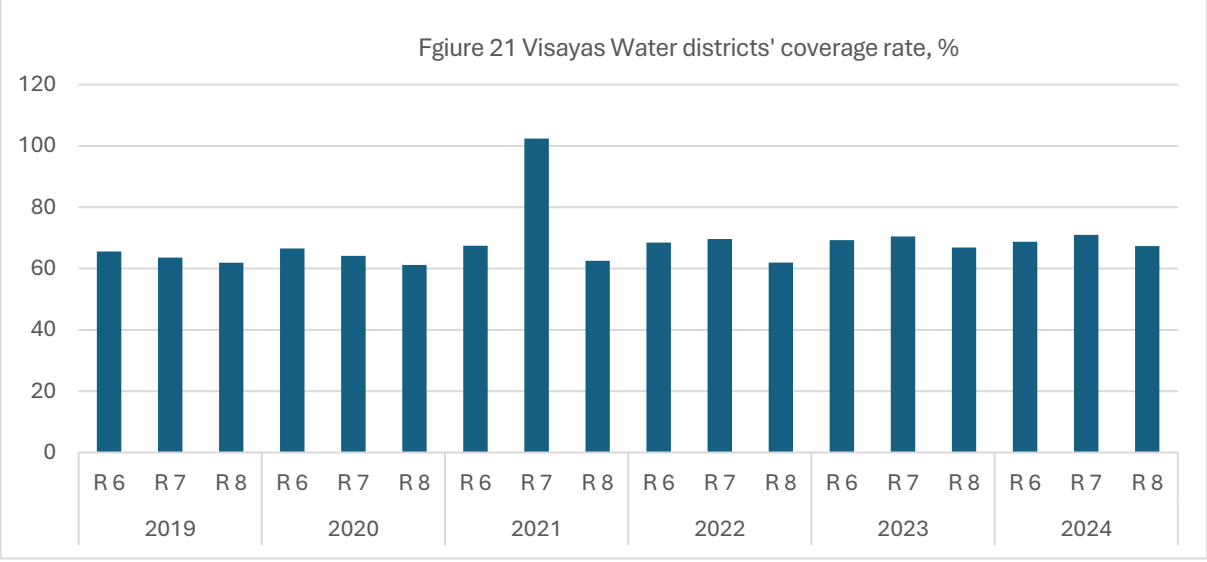
Source of basic data: Local Water Utilities Administration (LWUA); Source: Author's calculations

Figure 20 shows the coverage rates of WDs in select regions in Luzon. Overall, the coverage rate for the entire Luzon WDs from 2019 to 2024 was 63%, this is way below than the 85% ideal coverage rate for WDs. Among the select regions in Luzon, region 5 had the highest coverage rate, which was 65%, still indicates of very low supply of water provided by the WDs.



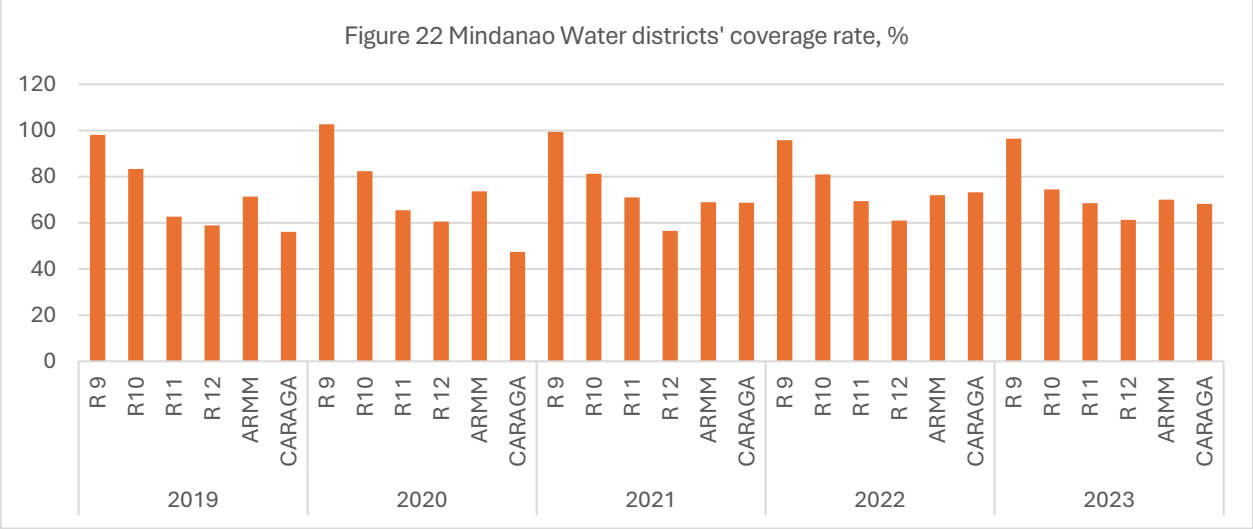
Source of basic data: Local Water Utilities Administration (LWUA); Source: Author's calculations

Figure 21 shows the coverage rate of WDs in the Visayas region. Except for region 7 with 100% coverage rate, other WDs in the Visayas region only had a coverage rate of 68%, still lower than the ideal coverage rate of at least 85% for WDs. The lowest coverage rates are in region 8 with only about 60%.



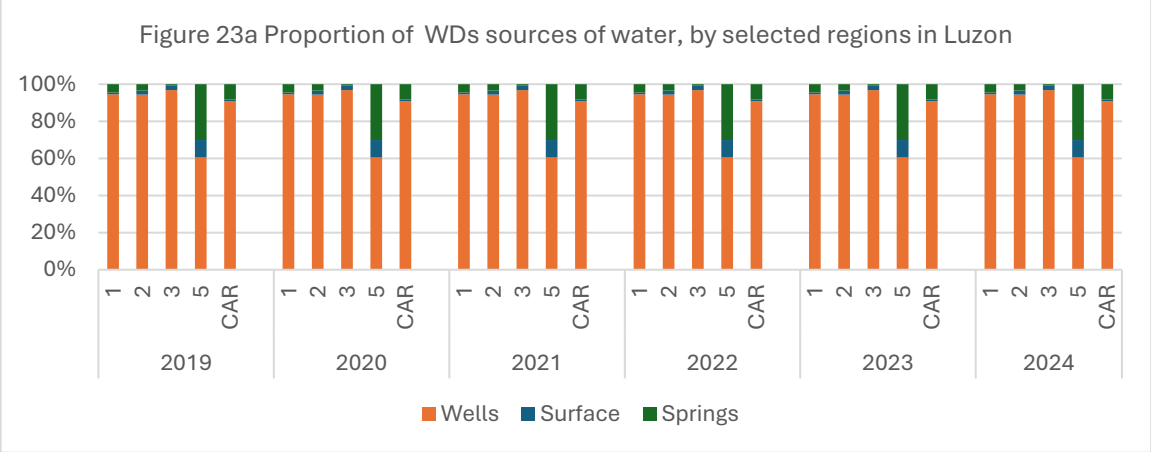
Source of basic data: Local Water Utilities Administration (LWUA); Source: Author's calculations

Figure 22 shows the coverage rates of WDs in Mindanao. The overall coverage rate for WDs in Mindanao is 73%, highest among all WD's coverage rates in Visayas and Mindanao. Region 9 had the highest coverage rate consistently above the 95% which is above the 85% indicator of good performance of a WD's coverage. The lowest coverage rate of WDs is in region CARAGA which is below 60%.



Source of basic data: Local Water Utilities Administration (LWUA); Source: Author's calculations

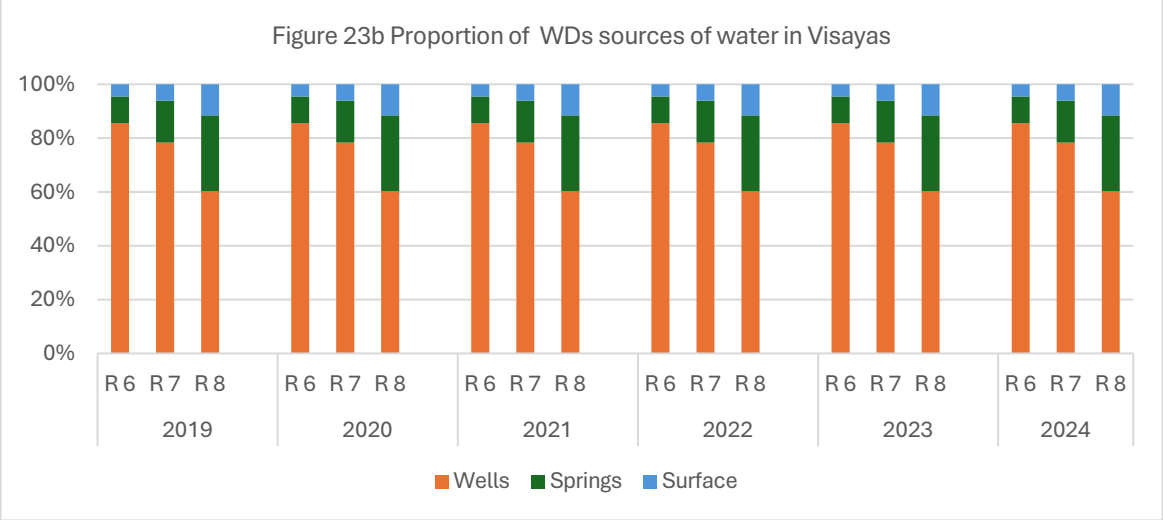
This section presents the sources of water used by the 532 water districts in supplying water to their consumers from 2019 to 2024. This part supports the previous discussions that groundwater can be considered as good sources of potable water for consumers. Surface water is almost absent as a source of water among the water districts in the identified regions in Luzon.



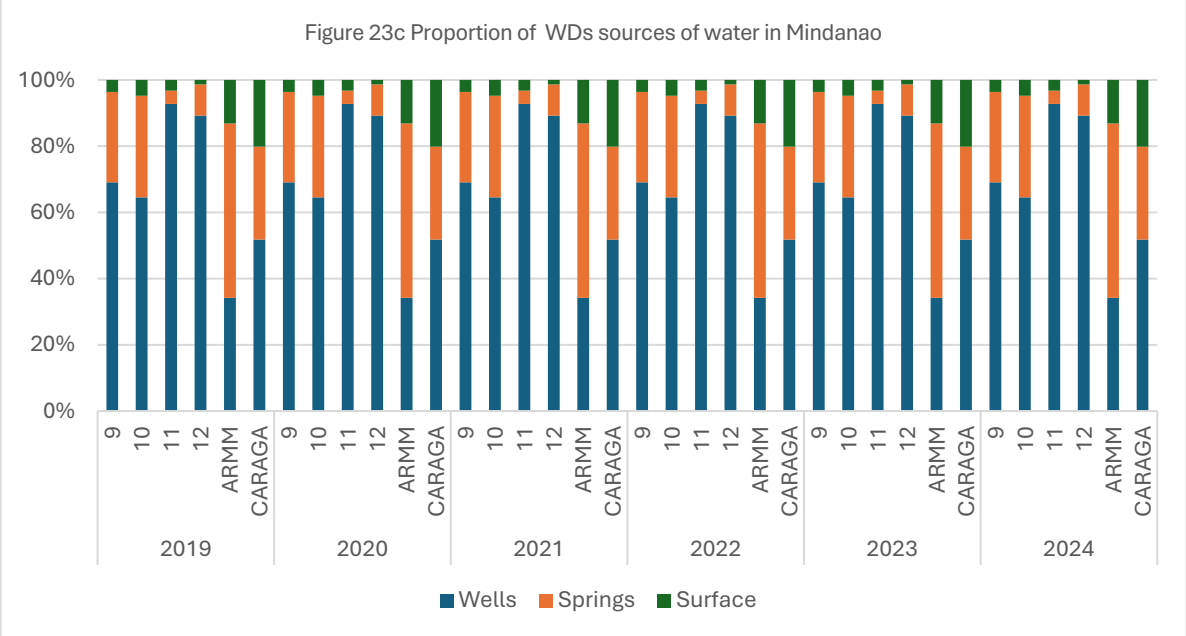
Source of basic data: Local Water Utilities Administration (LWUA; Author's calculations Note: as of end year data

Figure 23a above shows that the primary source of water among WDs in regions 1,2,3, and CAR are sourced from wells, accounting for almost 98%. Water districts in region 5 on the other hand also sourced water from its springs (about 40%).

Figure 23b indicates that majority of the WD's in Visayas also used wells (60%) as major source of water for distribution to its consumers. Springs are also a source of water and surface water is also utilized as a source of water for distribution among WDs.



Source of basic data: Local Water Utilities Administration (LWUA Author's calculations; Note: as of end year data



Source of basic data: Local Water Utilities Administration (LWUA; Author's calculations Note: as of end year data

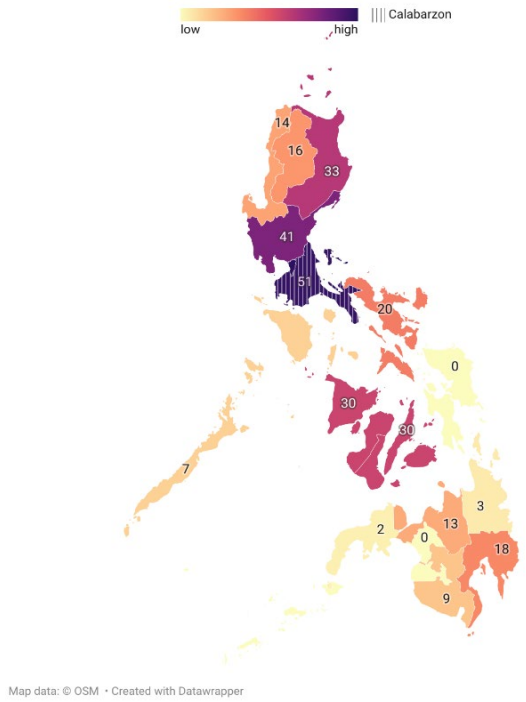
Figure 23c clearly shows that WDs in the different regions in Mindanao utilized both wells and springs in the provision of water supply among its consumers. It can also be deduced that ARMM relies on a bigger proportion of its water supply from springs. Use

of surface water is also common in CARAGA region and while groundwater is also utilized, it only accounts for about 65% as water source in Mindanao.

Figures 24 shows the concentration of number of drillers in the Philippines as of 2025. These drillers are considered important players in the provision of services to ensure the availability and quality of water from the ground. However, without the scientific knowledge in the hydrological characteristics of the aquifers may pose a danger of overextraction that may will potentially result in land subsidence, where the ground sinks, and lowered water tables, making wells run dry and requiring more energy to pump water. It can also cause seawater intrusion in coastal areas, reduced surface water supplies like rivers and wetlands, and water quality deterioration.

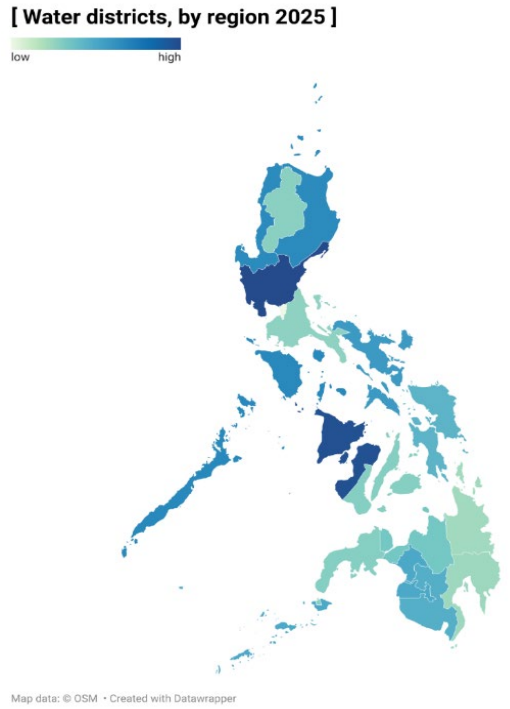
Figures 25 and 26 provide a wider perspective on the presence of water districts in the different regions in the Philippines. As can be seen, there are more WDs operating in Northern Luzon, Panay Island, Negros Occidental (old classification). Other areas in the country potentially have other water service providers like, LGU run utility, or private water service providers.

Figure 24 Water drillers in the Philippines



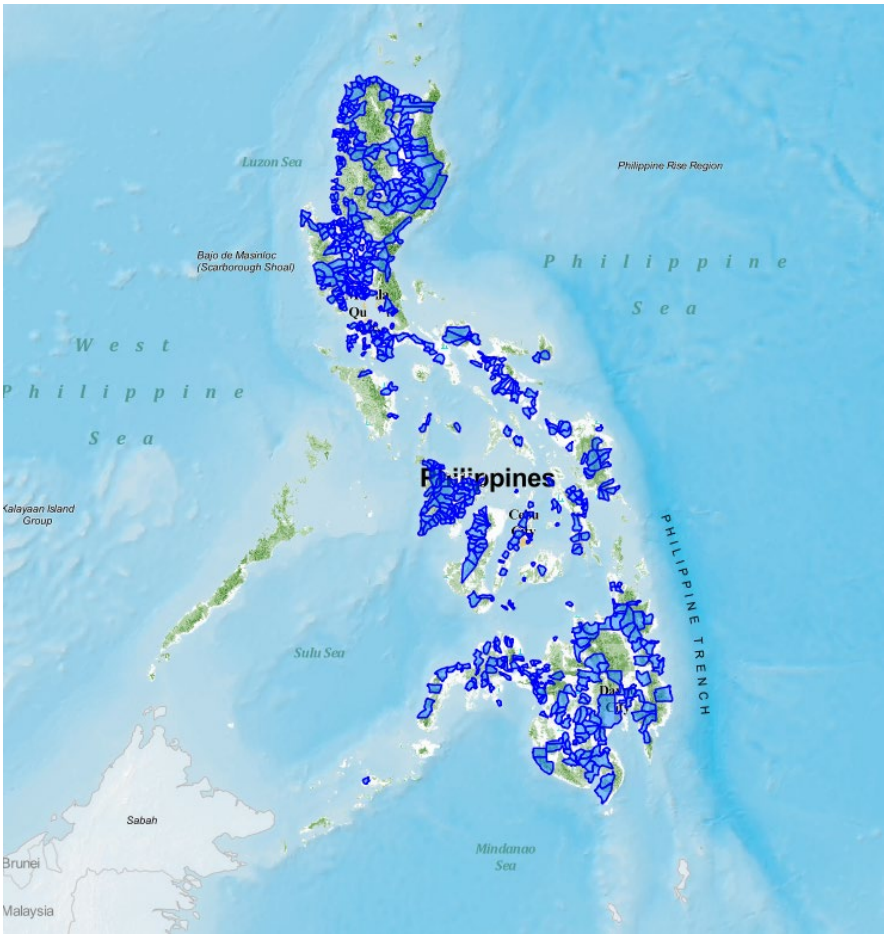
Source of basic data: NWRB, 2025

Figure 25 Water districts in the Philippines



Source of basic data: NWRB, 2025

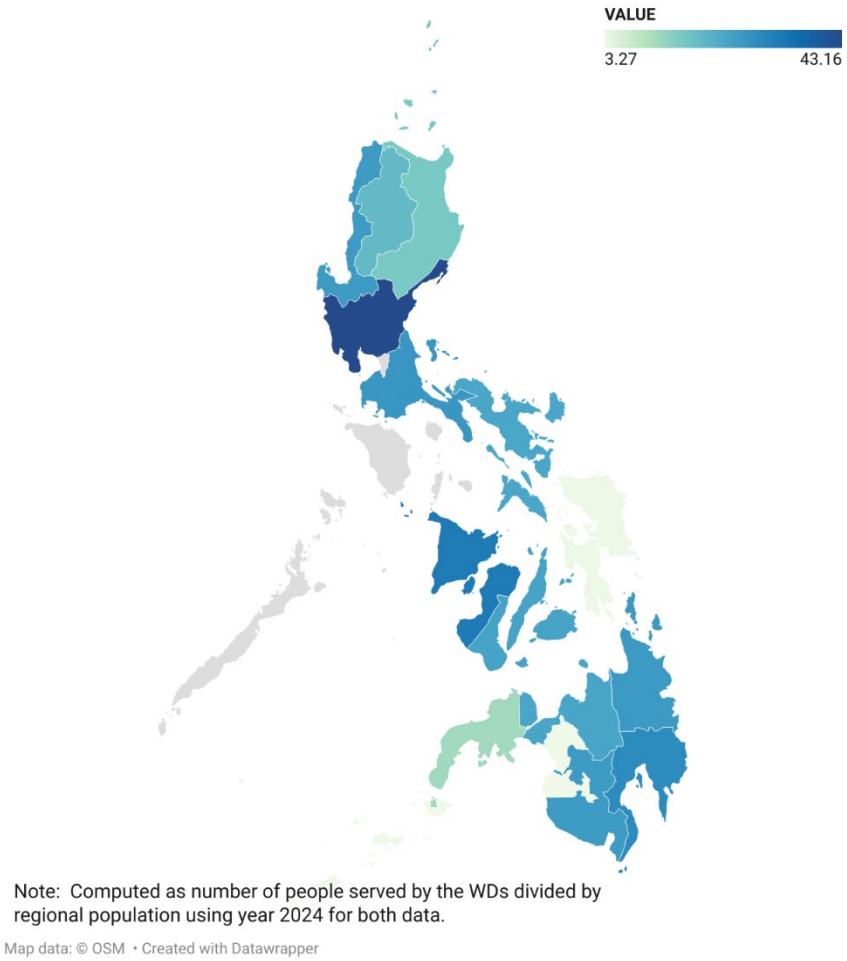
Figure 26 Water districts in the Philippines



Source: https://www.geoportal.gov.ph/

Figure 27 below shows the ratio of the population served by the water districts relative to the actual population among different regions in the Philippines. The highest ratio served by the water districts are in Central Luzon (43.2%), Western Visayas with 32.74%, and Davao region (29.17%). The lowest ratio of water served by the water districts are found in Western Visayas (3.58%) and in the Bangsamoro Autonomous Region in Muslim Mindanao (3.27%). However, the major limitation in figure 27 is the possibility that population in these regions are served by other water service providers as LGU based water utility and or barangay-based water distribution systems.

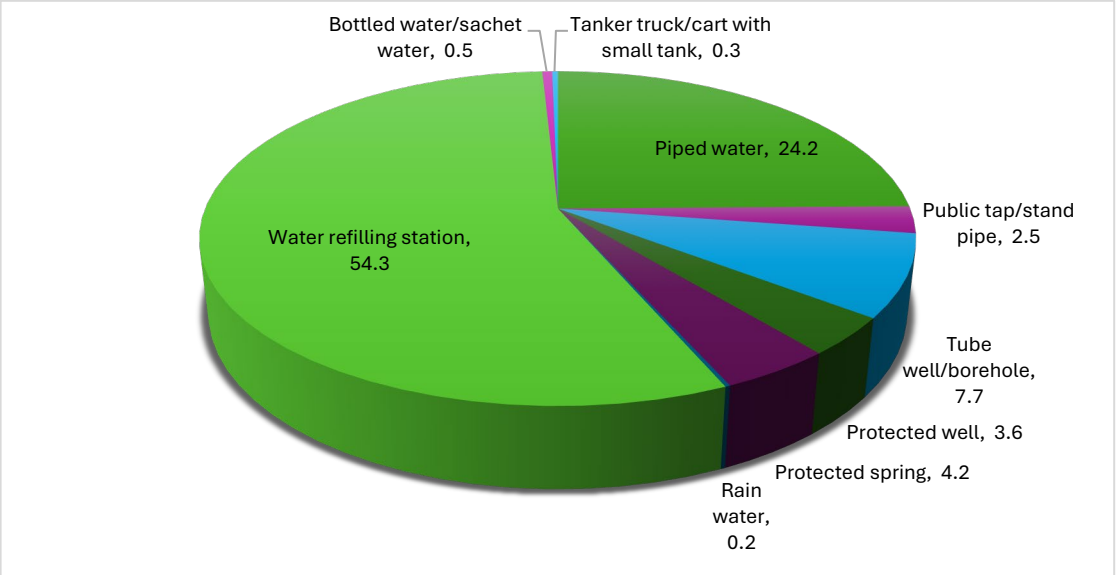
Figure 27 Proportion of population served by water districts, 2024



Source of basic data; Population served by WDs; NWRB, Regional Population; PSA

As mentioned in the beginning of this section, water sources and specific uses are common among consumers in the Philippines, figure 28 below shows the different sources of water for drinking among Filipinos.

Figure 28 Source of water for drinking, 2022



Source of basic data: APIS 2022

3.3 Review the water pricing (tariff) of selected water districts.

One of the ways to improve water allocation and encourage consumers to conserve water is through water pricing. Water price must accurately reflect water economic or scarcity; value gives information to consumers which is relevant in terms of making consumption choices (Dinar and Subramanian, 1997). Water pricing serves as a key instrument for aligning sound water resources management with the reliable delivery of water services and sustained investment in infrastructure. Consequently, water pricing serves a diverse set of functions. Its effectiveness is determined by three distinct dimensions: the actual price level (the base cost), the tariff structure (how rates are categorized or scaled), and the accompanying measures (supportive policies or subsidies that ensure fairness and efficiency).[12][13]

Every form of water utilization incurs specific expenses. To achieve economic efficiency, users must pay a price that fully accounts for both the direct costs (such as extraction, treatment, and infrastructure) and the indirect costs (such as environmental damage or the loss of water for future generations). From different sources of water, there is a high chance that water is pumped into water tanks from either groundwater or surface water. This alone simply requires a pumping system and electricity to run these water

[13] OECD. (2010). *Pricing water resources and water and sanitation services* (OECD Studies on Water). OECD Publishing. https://doi.org/10.1787/9789264083608-en

pumps. Another cost is the delivery of the water to households and to other customers (business) that are connected to the water system. These costs can be fixed capital costs that are building the network, pumping, treatment and storage costs. The variable costs which depend on the volume of water that is treated and delivered, this refers mainly to billing and collection of the water provider or commonly known as operation and maintenance costs (OPEX). To ensure the viability of the water service provider, the price of that is charged to consumers should cover OPEX as well as the costs that it will incur in the future known as CAPEX that includes the building and maintenance, renewal of new infrastructure namely, replacement of worn-out pipes, pumping and treatment plants, and storage facilities.

In the Philippines, fees and annual charges for water permits are determined using an administrative cost-recovery approach. As a result, these charges fail to reflect the true economic value of water use. As illustrated by the pricing models reviewed in this paper, economically efficient water rights pricing should instead be grounded in the marginal value, or benefit, derived from water use (Grabador, M.F.M. 2024).

Increasing block tariffs (IBTs), which are widely applied in developing countries, are often justified on the grounds that they facilitate income redistribution, discourage wasteful consumption, enhance economic efficiency, and ensure access to adequate water for basic sanitation. However, these assertions are frequently overstated or incorrect. In practice, IBTs tend to generate inefficiencies, inequities, perceptions of unfairness, revenue instability, and other adverse outcomes. As an alternative, a uniform price combined with a rebate (UPR) is proposed. A revenue-neutral comparison using data from developing countries demonstrates that the UPR consistently outperforms IBTs across these dimensions, while avoiding several of the inherent drawbacks associated with block tariff structures (Boland, J. J., & Whittington, D. 2002).

Table 6 Types of tariff structure and its objectives

Tariff structure	**Objectives**			
	Cost recovery	Economic Efficiency	Equity	Affordability
Fixed Charge	(+) Provides stable cash flow if set at appropriate level, but utility may be vulnerable to resale of water and spiraling consumption	(-) Does not send a message about the cost of use of additional water	(-) People who use large quantities of water pay the same as those who use little	(+) If differentiated by ability to pay, but households are unable to reduce their bills by economizing on water use
Uniform Volumetric Charge	(++) If set an appropriate level, moreover revenues adjust automatically to changing consumption	(++) If set at or near marginal cost of water	(++) People pay according to how much they actually use	(++) Can be differentiated by ability to pay, and people can limit their bills by reducing consumption
Increasing Block Tariff	(++) But only if the size and height of the blocks are well designed	(-) Typically little water is actually sold at marginal cost	(-) People do not pay according to the costs their eater use imposes on the utility	(-) penalizes poor families with large households and/or shared connections
Decreasing Block Tariff	(++) But only if the size and height of the blocks are well designed	(-) Typically little water is actually sold at marginal cost	(-) People do not pay according to the costs their water use imposes on the utility	(-) Penalizes poor families with low level of consumption

Source: Wheeler, S. A., Nauges, C., & Grafton, R. Q. (2023). Water pricing, costs and markets.

Figure 29a Obando Bulacan WD's tariff (P367)

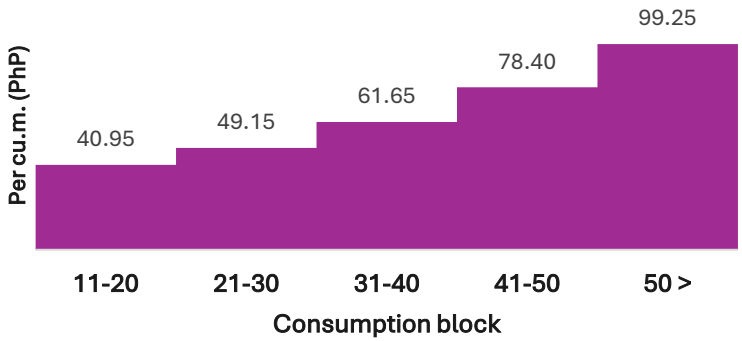


Figure 29b Metro Cebu WD's Tariff (P157)

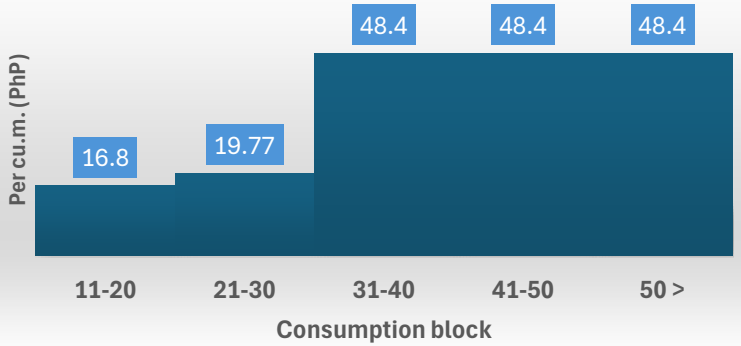


Figure 29c Cagayan De Oro WD's tariff (P218)

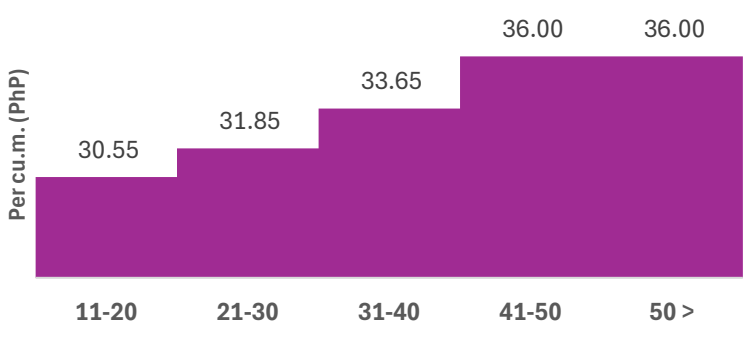
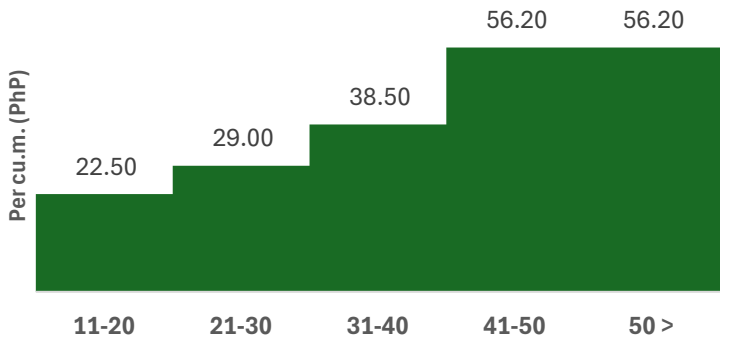


Figure 29d Davao City WD's tariff (P214.20)



Figures 29a, b, c, and d above show the different water prices, water consumption blocks of selected water districts in the Philippines. Figure 29a is the Obando Water District (WD) in Bulacan with a highest minimum charge of 367 PhP per month for the lifeline consumption of water that is 10 cubic meters or below per month. The water tariff has 5 blocks and can be considered increasing block tariff structure (IBT). Figure 29b exhibits the water pricing of Metro Cebu Water District with a minimum charge of 157 PhP the lowest among the WDs in comparison. Metro Cebu WD also has the simplest water tariff block with only three blocks and can also be considered IBT. Figure 29c shows the tariff structure of Cagayan de Oro WD with a minimum fee per month at 218 PhP and has 4 block structure. The tariff design can also be considered an IBT. Figure 29 d shows the tariff structure of Metro Davao WD, with a minimum charge per month of 214.20 PhP. It also follows a 4-block tariff structure and is also an IBT. Overall, the marginal increase in prices per increase in consumption per cubic meter varies among water districts. Metro Cebu WDs has the simplest pricing per block and shows higher charges in the 3rd to 4th block (48.4 PhP). Among the 4 WDs, the highest pricing is Obando WD. Tables 7a, 7b, 7c, 7d, and 7e show more detailed water tariffs among the selected WDs in Bulacan, Cavite, Region 7, Region 10 and Region 11.

Table 7a Region 3, Bulacan WDs, minimum charge, and marginal price

Cons	**Norzagaray**		**Sta Maria**		**Obando**		**San Miguel**	
Cu.m.	***P 245***	Δ	***P240***	Δ	***P367***	Δ	***P 143***	Δ
11-20	25.30		25.55		40.95		15.50	
21-30	27.10	1.80	27.70	2.15	49.15	8.20	16.75	1.25
31-40	29.50	2.40	30.80	3.10	61.65	12.50	18.25	1.50
41-50	32.45	2.95	34.85	4.05	78.40	16.75	20.00	1.75
50 >	35.75	3.30	39.35	4.50	99.25	20.85	22.00	2.00

Source: Local Water Utilities Administration (LWUA)

Table 7b Region 4A Cavite WDs, minimum charge, and marginal price

Cons	Dasmarinas		Gen Mariano Alvarez		Tagaytay City		Trece Martires	
Cu.m.	**P 173**	Δ	**P 280**	Δ	**P 254**	Δ	***P 170***	Δ
11-20	20.80		29.65		28.00		18.25	
21-30	24.95	*4.15*	32.35	*2.70*	31.00	*3.00*	19.55	*1.30*
31-40	29.35	*4.40*	35.7	*3.35*	35.00	*4.00*	20.90	*1.35*
41-50	33.80	*4.45*	40.65	*4.95*	38.00	*3.00*	23.50	*2.60*
50 >	33.80	-	40.65	-	43.00	*5.00*	23.50	-

Source: Local Water Utilities Administration (LWUA)

Table 7c Region 7, Selected Water districts, minimum charge, and marginal price

Cons	Talibon, Bohol		Metro Cebu		Toledo city		Bogo City	
Cu.m.	**P 175**	Δ	**P 152**	Δ	**P 200**	Δ	**P 231**	Δ
11-20	20.40		16.80		23.30		26.00	
21-30	23.40	3.00	19.77	2.97	27.15	3.85	29.75	3.75
31-40	27.60	4.20	48.40	28.63	31.60	4.45	34.40	4.65
41-50	32.15	4.55	48.40	-	37.15	5.55	40.30	5.90
50 >	32.15	-	48.40	-	37.15	-	40.30	-

Source: Local Water Utilities Administration (LWUA)

Table 7d Region 10 Selected Water districts, minimum charge, and marginal price

Cons	Cagayan de Oro		Gingoog City		Balingasag		Tagoloan	
Cu.m.	**P 218**	Δ	**P 194.0**	Δ	**P 213**	Δ	**P 208**	Δ
11-20	30.55		22.75		30.65		22.00	
21-30	31.85	1.30	26.30	3.55	40.60	9.95	24.00	2.00
31-40	33.65	1.80	30.10	3.80	51.25	10.65	26.00	2.00
41-50	36.00	2.35	34.10	4.00	62.55	11.30	28.00	2.00
50 >	36.00	-	34.10	-	62.55	-	28.00	-

Source: Local Water Utilities Administration (LWUA)

Table 7e Region 11 Selected Water districts, minimum charge, and marginal price

Cons	Davao City		Panabo City		Tagum City		Digos	
Cu.m.	P 214.20	Δ	P 194.35	Δ	P 221.6	Δ	P 183.9	Δ
11-20	22.50		19.60		23.90		20.50	
21-30	29.00	6.50	20.60	1.00	25.75	1.85	23.35	2.85
31-40	38.50	9.50	23.35	2.75	31.65	5.90	26.95	3.60
41-50	56.20	17.70	26.25	2.90	38.25	6.60	31.25	4.30
50 >	56.20	-	26.25	-	45.00	6.75	31.25	-

Source: Local Water Utilities Administration (LWUA)

3.4 Policy strategies to promote sustainable management of GW and SW resources

Given the crucial role of water districts in providing level 3 water supply to its consumers and a negative balance in the available supply relative to the demand from their consumers, reveals the inherent limitations of institutions particularly water districts and perhaps other water supply providers in dealing effectively with the problems related to water resource allocation, management and development of these water sources. The long-standing view of water as a free good is gradually being replaced by an understanding of water as both an economic and social good. Consequently, water pricing, water project selection, and related policy decisions must be aligned with this evolving perspective. In the old paradigm, the primary users of waters were considered "beneficiaries" in the era of surplus water, but times have changed and are now coined as 'customers or clients' in the water scarcity era (Saleth and Dinar, 2004).

Grafton et al. (2020) outline a framework for designing an effective and efficient water pricing system, emphasizing the need to understand: (i) what the value of water across alternative uses; (ii) what are the private and external costs associated with providing water services; and (iii) what are the range of available approaches for setting appropriate water tariffs. Considering the four key dimensions of water pricing—uniform versus variable tariffs and flat charges versus volumetric pricing—there exists an almost limitless set of possible pricing structures. Within this broad choice set, the selection of a preferred tariff depends on several factors, including the objectives of water pricing, the institutional and operational capacity of water service providers to allocate costs, set prices, and collect revenues, the price responsiveness of consumers, and prevailing notions of what constitutes a fair and just water tariff.

Establishing integrated source-planning units at regional or even at the provincial level to coordinate groundwater and surface-water allocation, protection, and emergency response must be part of the reforms in the water sector. Another way forward is to scale a national groundwater monitoring network with standardized data reporting and open access for water districts, other water service providers, and researchers ensuring a more science grounded approach in understanding the dynamics water modelling and its link to various economic activities in different areas both urban and areas in the Philippines. Moreover, the use of water resources system modeling for planning, design, and management remains limited, particularly within government agencies responsible for water governance. This constraint largely reflects insufficient investment in science-based management and decision-support tools. Most water-related agencies lack dedicated technical or scientific units capable of conducting continuous hydrologic, hydraulic, or systems modeling. In the same vein, mandating source-protection zones and enforce pollution controls around intakes and critical recharge areas, pairing regulation with community-based stewardship can also enforce to ensure the quality and safety of water for different uses especially at the household level. Compounding this challenge is the absence of sustained and systematic investments in the long-term monitoring of hydrologic, groundwater, water quality, and demand-side data, which undermines the reliability of modeling outputs and evidence-based decision-making.

Water consumption at the household level seems to follow a certain degree of specialization in terms of use, for instance water use for drinking comes from water refilling stations, water for bathing and other household use comes from network or from the water district. There is an apparent perception that water from the network is of poor quality.

For water districts and other water service providers, creating blended finance windows (public grants combined with low-cost loans) for water districts to invest in treatment upgrades, distribution leak reduction, and climate-resilient infrastructure this to ensure a more efficient operation, reducing the high Non-Revenue Water (NRW) to lowest possible level. Moreover, for water districts and water service providers to invest in capacity-building and technical assistance for water-district operations (asset management, hydrogeology, smart metering, NRW reduction, and financial modelling). This strategy can be best undertaken with continuous partnership with private and multilateral agencies learning best practices and sharing technologies and innovation strategies.

3 Conclusions

Securing the Philippines' water future requires shifting from fragmented, source-specific responses toward integrated planning, stronger monitoring, and better-supported

water service providers. Water districts are a practical vehicle for implementing many of these changes, but only with clearer authority, reliable data, predictable finance, and partnerships across government, communities, and the private sector. While most of the sources of water among districts are from ground water, it being an “invisible” makes it more challenging to design a suitable “pricing mechanism”. Most if not all water districts are pricing through IBT, this is promoted because IBT is designed to enhance equity by requiring higher-income households to cross-subsidize lower-income households; to promote “equity” by obliging firms to subsidize household consumers; (3) discourage wasteful and inefficient water use; and (4) implement marginal cost pricing principles, thereby improving economic efficiency. However, an examination of the objectives and considerations underlying utility tariff design suggests that cross-subsidies are typically motivated by subjective notions of fairness rather than true equity, and that some forms of cross-subsidization may adversely affect their intended beneficiaries. For instance, imposing high tariffs on industrial users can drive large consumers off the system, ultimately harming residential users and remaining firms. Moreover, effective incentives for efficient water use do not require prices to exceed the marginal cost of supply, and block tariff structures are fundamentally inconsistent with marginal cost pricing principles.

Implementing an Increasing Block Tariff (IBT) framework presents several significant practical hurdles. Key challenges include:

Political and Institutional Pressure: Determining the size of the initial, subsidized block is often influenced by political interests rather than objective data.

Price Misalignment: IBT rates frequently fail to reflect actual marginal costs.

Conflicting Objectives: There is a constant tension between ensuring revenue adequacy for the utility and maintaining economic efficiency.

Complexity: These systems often lack the transparency and simplicity needed for consumer trust.

Unintended Consequences: IBT designs often penalize the poorest households who share water connections or rely on vended water, as their combined volume pushes them into higher, more expensive price blocks.

Due to these systemic shortcomings, an alternative model—Uniform Price with a Rebate (UPR)—is often proposed. A UPR can satisfy the same social and financial policy goals as an IBT while bypassing its inherent structural flaws

The modeling of water resource systems is essential for generating the evidence-based and scientific insights required to guide effective policy, infrastructure design, and daily operations. Modern water models have evolved significantly; they no longer focus solely on isolated physical or ecological data. Instead, they are increasingly sophisticated

frameworks that integrate environmental components with complex socioeconomic factors and human behavioral systems to provide a holistic view of water management.

4 References

Arellano, F. 1994. Metropolitan Waterworks and Sewerage Systems (MWSS): responding to the water needs of a Mega City. Philippine Institute for Development Studies Development Research News. Volume XII No. 5. September-October 1994

Asad, Musa S. C.; Azevedo, Luiz Gabriel; Kemper, Karin E.; Simpson, Larry D. *Management of water resources : bulk water pricing in Brazil (English).* World Bank technical paper ; no. WTP 432 Washington, D.C. : The World Bank. http://documents.worldbank.org/curated/en/805021468781782646

Boland, J. J., & Whittington, D. (2002). *Water tariff design in developing countries: Disadvantages of increasing block tariffs (IBTs) and advantages of uniform price with rebate (UPR) designs*.

Charalambous, A. N. (2019). Groundwater and its economic nature. *Quarterly Journal of Engineering Geology and Hydrogeology, 53*(2), 176–188. https://doi.org/10.1144/qjegh2019-068

David, C. C. and A. B. Inocencio. 1996. Understanding household and supply of water: the Metro Manila case. Policy Notes No. 9004, Philippine Institute for Development Studies, Makati City, Philippines: 11 p.

Dinar, Ariel; Subramanian, Ashok [editors]. *Water pricing experiences : an international perspective experiences.* World Bank technical paper ; no. WTP 386 Washington, D.C.: The World Bank. http://documents.worldbank.org/curated/en/580151468768597034

Ebarvia, M. C. M. 1994. Outlook of supply and demand: Metro Manila and the Philippines Water! Philippine Institute for Development Studies Development Research News. Volume XII No. 5. September-October 1994.

FAO 2016. Thematic Papers on Groundwater. https://water.igad.int/resources/i6040e-kenya.pdf Accessed on 3 March 2025.

Grabador, Maria Francesca Mercedes D. (2024): Water rights pricing in the Philippines: Issues, challenges and way forward, UPSE Discussion Paper, No. 2024-02, University of the Philippines, School of Economics (UPSE), Quezon City

Israel, D. C. (2009). *Local service delivery of potable water in the Philippines: National review and case analysis*. Philippine Institute for Development Studies. Discussion

paper series no. 2009-39
https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps0938.pdf

Inocencio, A. B., J. E. Padilla and E. P. Javier. 1999. Determination of basic household requirements. Discussion Paper Series No. 99-02, Philippine Institute for Development Studies, Makati City, Philippines

Inocencio, A. B. and C. C. David. 2001. Public-private-community partnerships in management and delivery of water to urban poor: the case of Metro Manila. Discussion Paper Series No. 2001-18, Philippine Institute for Development Studies, Makati City, Philippines.

Le Blanc, D. (2008): A Framework for Analyzing Tariffs and Subsidies in Water Provision to Urban Households in Developing Countries. New York: DESA Working Paper n°63. URL: http://www.un.org/esa/desa/papers/2008/wp63_2008.pdf

Largo, F. M., A. B. Inocencio and C. C. David. 1998. Understanding household water demand for Metro Cebu. Discussion Paper Series No. 98-41, Philippine Institute for Development Studies, Makati City, Philippines.

Llanto, G. (2013). Water financing programs in the Philippines are we making progress. PIDS discussion paper series no. 2013-34. https://doi.org/10.62986/dp2013.34.

Mechlem, K. (2016). Groundwater Governance: The Role of Legal Frameworks at the Local and National Level—Established Practice and Emerging Trends. *Water*, *8*(8), 347. https://doi.org/10.3390/w8080347

Nsoh W. Achieving Groundwater Governance: Ostrom's Design Principles and Payments for Ecosystem Services Approaches. *Transnational Environmental Law*. 2022;11(2):381-406. doi:10.1017/S2047102522000164

OECD. (2010). *Pricing water resources and water and sanitation services* (OECD Studies on Water). OECD Publishing. https://doi.org/10.1787/9789264083608-en

Prévôt, A. S. H., Leoni, B., & Bonomi, T. (2019). Groundwater and surface water quality characterization through positive matrix factorization combined with GIS approach. *Water Research*, *159*, 122-134.

R Quentin Grafton, Long Chu, Paul Wyrwoll, The paradox of water pricing: dichotomies, dilemmas, and decisions, *Oxford Review of Economic Policy*, Volume 36, Issue 1, Spring 2020, Pages 86–107, https://doi.org/10.1093/oxrep/grz030

Rola, A. , Liguton, J. , and H. Francisco. 2004. Winning the Water War: Watersheds, Water Policies and Water Institutions. Philippine Institute for Development Studies.

Rola, A.C. Pulhin, J.M. David, C.C., Wensley, C., Paragas, V.C., Tabios, G.Q. III, Lizada, J.C. Gazmen, P.G., Dayo, M.H.F. (2012). Towards Good Water Governance in the Philippines. Trans. Nat. Acad. Sci. Tech. 9Philippines) 34(2) 299-323.

Rola, A.C., Pulhin, J.M., Tabios, G.Q., Lizada, J.C., Dayo, M.H.F. (2015). Challenges of water governance in the Philippines. Philippine Journal of Science, 144 (2), 197-208.

Saleth, R. M., & Dinar, A. (2004). *The institutional economics of water: A cross-country analysis of institutions and performance*. Edward Elgar Publishing / The World Bank.

Tabios, G., David, C. (2002). Competing uses of water; the cases of Angat, Laguna, Batangas and Cebu City. Development research news. PIDS Vol XX no. 6 November-December 2002. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdrn02-6.pdf

Tabios, Guillermo G. III (2020). Water Resources Systems of the Philippines: Modeling Studies. World Water Resources, Volume 4 Springer, Switzerland.

Velasco, L.G., Diokno-Sicat, C.J., Castillo, A. F., Maddawin, R.B. The Philippine Local Government Water Sector. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps2033.pdf. Accessed on 28 October 2025.

Wheeler, S. A., Nauges, C., & Grafton, R. Q. (2023). Water pricing, costs and markets. In A. Dinar & K. Schwabe (Eds.), *Handbook of water economics* (pp. 119–137). Edward Elgar Publishing. https://doi.org/10.4337/9781800379988.00014

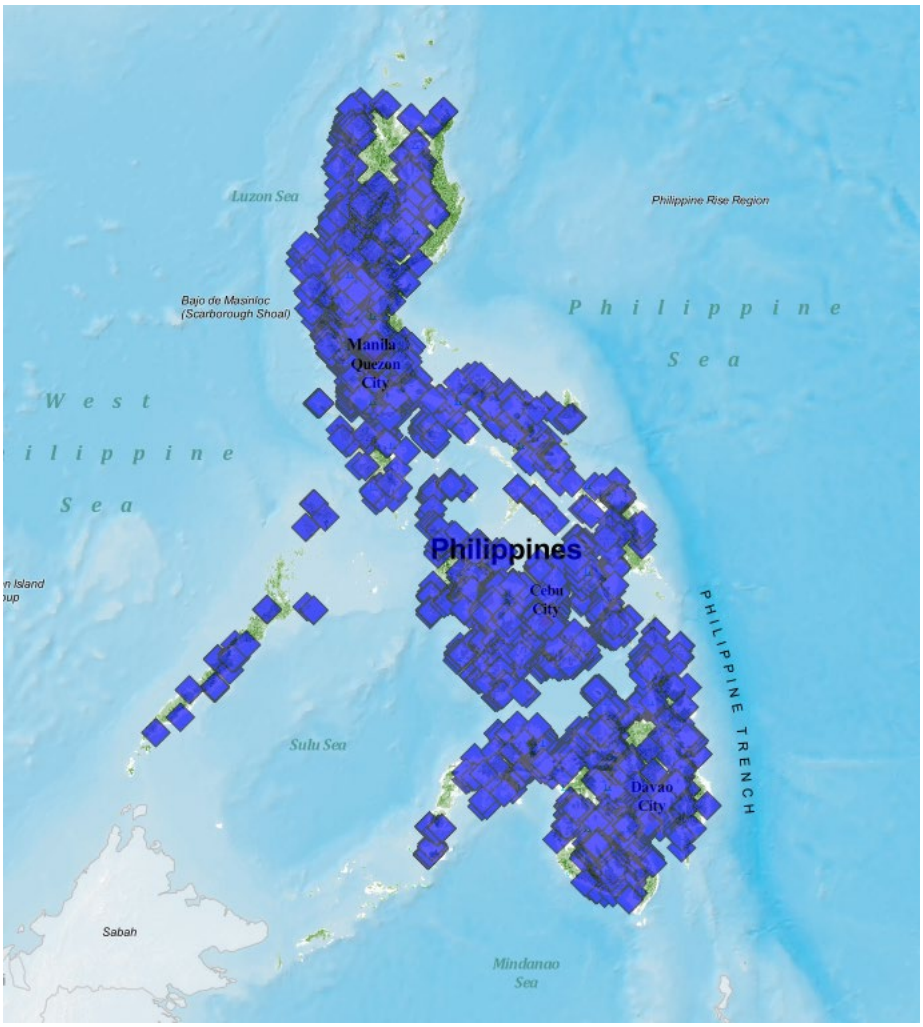
Winter, T. C., Harvey, J. W., Franke, O. L., & Alley, W. M. (1998). *Ground water and surface water: A single resource* (U.S. Geological Survey Circular 1139). U.S. Geological Survey.

World Bank. (2010). Water rights and water allocation: Issues and challenges for developing countries. The World Bank. https://documents1.worldbank.org/curated/fr/359131468338472634/pdf/558350PUB0Wate1C0disclosed071221101.pdf

Zanotti, C., Rotiroti, M., Fumagalli, L., Stefania, G. A., Canonaco, F., Stefenelli, G., Prévôt, A. S. H., Leoni, B., & Bonomi, T. (2019). Groundwater and surface water quality characterization through positive matrix factorization combined with GIS approach. *Water Research, 159*, 122–134. https://doi.org/10.1016/j.watres.2019.04.058

Appendix

Groundwater extraction



Framework Water demand and supply analysis

Given data on water production in cubic meters yearly, population served, and average water consumption), here's the framework you can apply:

1. Define the Variables

- **Water Production (Supply side):**

  $Water_{prod} = total\ annual\ water\ produced\ in\ cubic\ meters, m^3/year)\ by\ the\ water\ district$

- **Population Served:**
  - $P = number\ of\ people\ served\ by\ the\ water\ disctrict$
- **Average Consumption:**
  - $Cons_{ave} =$ $average\ water\ consumption\ per\ person, in\ liters\ per\ capita\ per\ day, or$
  - $lpcd\ or\ \frac{directly \frac{m^3}{person}}{year}$.

2. Estimate Water Demand

- **Per Capita Annual Demand (m³/person/year):**
- $D_{capita} = Cons_{ave}\ x \frac{365}{1{,}000}$

Note: conversion: 1,000 liters = 1 m³)

- **Total Demand:**
- $Demand_{total} = Pop\ x\ D_{capita}$

3. Compare Demand vs. Supply

- **Water Balance:** $\boldsymbol{Balance = Water_{prod} - Demand_{total}}$
  - If **Balance > 0** → surplus (supply > demand).
  - If **Balance < 0** → deficit (demand exceeds supply).

4. Key Performance Ratios

- **Coverage Ratio (Supply/Demand):**
- $\text{Coverage} = (W_{prod} / \text{Demand}_{total}) 100$
  - *≥100% = supply sufficient*
  - *<100% = supply shortfall*

- **Per Capita Production (supply efficiency):**
- $W_{capita} = W_{prod} / Pop$
- Compare W_{capita} $with$ D_{capita}

5. Consider Water Losses (Non-Revenue Water, NRW)

If you know the percentage of system losses (leakage, theft, unbilled use):

- **Effective Supply:**
- $W_{eff} = W_{prod}\ x\ (1 - NRW)$

Use of W_{eff} instead of W_{prod} in the above calculations for a realistic picture.

6. Interpretation Example

Give the following information:

- $W_{prod} = 10{,}000{,}000\ cu.m\ /\ per\ year$
- $Pop = 500{,}000$
- $Cons_{ave}$ = 120 lpcd
- $NRW = 25\ \%$

Step 1. Per Capita Annual Demand:

- $D_{capita} = [(120\ x\ 365)/\ 1{,}000)] = 43.8\ cu.m\ per\ person/year$

Step 2. Total Demand:

- Demand $_{\text{total}} = 500{,}000\ x\ 43.8 = 21{,}900{,}000\ cu.m\ /\ year$

Step 3. Effective Supply:

- $W_{eff} = 10{,}000\ x\ (1 - 0.25) = 7{,}500{,}000\ cu.m/\ year$

Step 4. Balance:

- Balance = 7,500,000 – 21,000, 000 = - 14,000, 000 cu. m/ year

Step 5. Coverage Ratio:

- $Coverage = (7{,}500{,}000/\ 21{,}900{,}900)\ x\ 100 = 34\ \%$ The WSP can only supply ~34% of demand, indicating a **serious water deficit**.