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Abstract

This study revisits household water use behavior in Metro Manila by estimating residential water demand using the almost ideal demand system (AIDS) and the merged 2021 Family Income and Expenditure Survey-Labor Force Survey. The analysis examines how households respond to price, income, and cross-commodity changes under the two concessionaires, Manila Water (east zone) and Maynilad (west zone). Both have operational environments that differ substantially, particularly in non-revenue water (NRW), tariff structures, and service reliability. Results show that water demand is moderately price-inelastic in both zones. However, households serviced by Maynilad exhibit higher price and income elasticities, reflecting tighter expenditure constraints and greater exposure to inefficiencies. Cross-price elasticities reveal weak complementarity between water and essential goods, and substitution with electricity, situating water within the broader household consumption bundle. Interaction effects further demonstrate that households purchasing drinking water from refilling stations display distinct behavioral patterns. Overall, elasticity structures serve as behavioral indicators of utility performance. This means that lower elasticities in the east zone align with higher operational efficiency, whereas higher elasticities in the west zone reflect affordability pressures and elevated NRW. The findings provide evidence-based insights for tariff design, regulatory evaluation, and capital expenditure planning in urban water systems.

JEL Codes: Q25, L95, D12

Keywords: Philippines, water demand, Almost Ideal Demand System, elasticities, privatization

Urban water systems in rapidly growing cities face increasing pressure to deliver reliable, affordable, and efficient services amid rising demand, aging infrastructure, and widening socioeconomic disparities. The case of Metro Manila exemplifies these challenges. Despite major reforms following the 1997 water sector privatization, two concessionaires—Manila Water in the east zone and Maynilad in the west zone—continue to operate under markedly different conditions of network efficiency, non-revenue water (NRW), service reliability, and household affordability. These structural differences influence household behavior in terms of water use, responses to tariff signals, and the allocation of expenditures across essential goods. Understanding these behavioral responses is central to evaluating the performance of water utilities and designing tariffs that balance financial sustainability, equity, and conservation.

Empirical analysis of household water demand traditionally relies on single-equation models. Yet, such approaches are increasingly recognized as unsuitable under non-linear tariff structures and heterogeneous consumption patterns. Water prices are endogenous to consumption under increasing block tariffs (IBTs), and households face multiple substitutes for drinking water. In Metro Manila, water refilling stations are the most notable alternative source. Thus, complicating the interpretation of price responsiveness. The use of ordinary least squares (OLS), therefore, produces biased elasticity estimates because it does not account for simultaneity, cross-commodity interactions, and the structure of household budgets. The almost ideal demand system (AIDS) model of Deaton and Muellbauer (1980) provides a theoretically consistent alternative by modeling budget shares as functions of prices and total expenditure while satisfying the axioms of consumer theory. Its application to water demand has grown in recent years, demonstrating its ability to capture substitution patterns, income effects, and cross-price relationships. All of which are essential for tariff analysis and regulatory evaluation.

The study revisits household water use behavior in Metro Manila using the AIDS model and the merged 2021 Family Income and Expenditure Survey-Labor Force Survey (FIES-LFS). The dataset provides detailed accounts of household expenditures, socioeconomic characteristics, and drinking water sources. This enables a comprehensive demand-system analysis that incorporates both piped water services and alternative drinking water markets. As most households rely on refilling stations for drinking water rather than on what the concessionaires provide, the analysis introduces interaction variables that distinguish households that rely exclusively on piped water from those that combine piped water with purchased drinking water. This distinction is crucial for understanding substitution patterns and expenditure allocation.

By estimating own-price, income, and cross-price elasticities for each concession area, the study evaluates how household behavior reflects underlying operational efficiency and how affordability constraints shape responsiveness to tariff changes, while accounting for differences in NRW. Elasticities serve not only as behavioral indicators but also as diagnostic signals of allocative, productive, and regulatory efficiency. Further, elasticities reveal whether tariff reforms align with household welfare, whether operational losses distort price signals, and whether income growth translates into expanded consumption under varying levels of service reliability.

This study provides the first demand-system-based elasticity estimates for Metro Manila using nationally representative household microdata. It contributes to the literature by linking household behavior to utility performance, highlighting how structural differences between concessionaires translate into distinct consumption responses across the income distribution. Additionally, the analyses offer evidence-based insights for tariff design, demand forecasting, and capital expenditure planning.

Literature

Water Demand Estimation Using the Almost Ideal Demand System (AIDS)

The estimation of residential water demand has increasingly shifted from a single-equation approach toward demand-system models. Particularly, AIDS emerges as one of the most theoretically robust frameworks for analyzing household consumption behavior. Using OLS in estimating water demand has been recognized as biased due to water prices being endogenous, water tariffs being non-linear, and heterogeneous household preferences. Under IBTs, simultaneity between consumption and marginal price produces implausible OLS elasticity estimates, including upward-sloping demand curves (Olmstead, 2010). Deaton and Muellbauer (1980) introduced the AIDS model to

address such limitations by modeling budget shares as functions of prices and total expenditure that satisfy the additivity, homogeneity, and symmetry conditions. Thus, both compensated and uncompensated elasticities can be derived that are consistent with consumer theory, making AIDS estimates suitable for tariff analysis.

Although fewer studies apply AIDS to water demand than to energy or food markets, several important contributions demonstrate its relevance. A seminal work that applies AIDS to water demand is by Renzetti (1992), in which he estimated an AIDS model for industrial water demand in Canada. His results showed that water behaves as a substitutable input whose demand responds to both price and cross-price effects with production inputs. Insights from the study illustrated how AIDS captures substitution patterns that OLS cannot detect, thus providing utilities with richer behavioral information for industrial tariff design. Dalhuisen et al.'s (2003) study is another notable application of using a demand-system approach to synthesize global water demand elasticities. Their estimates argued that AIDS and QUAIDS are theoretically superior to single-equation models, especially under non-linear tariffs. More recently, Suàrez-Varela (2020) used a household demand-system framework for residential water consumption. He showed that system-based estimation using seemingly unrelated regressions (SUR) yields more reliable elasticities and allows water to be analyzed jointly with households' expenditure on other goods. Nauges and van den Berg (2009) employed a demand-system specification to analyze water demand in Africa. In a developing country context, the analysis showed that cross-price effects with sanitation and alternative water supply sources are essential to understanding household behavior. These effects are only observable and uniquely captured by the AIDS model.

Extensions of AIDS, such as the quadratic AIDS (QUAIDS), have been applied to water-related consumption analyses. Galvez et al. (2016) employed QUAIDS to analyze residential water demand under IBTs, demonstrating that non-linear Engel curves improve elasticity estimation. Their results showed that QUAIDS outperforms OLS and log-linear models in capturing heterogeneity in household responses to changes in prices and income. These water-utility-specific applications parallel methodological advances in other utility sectors. Although these works focus on electricity and other consumer goods, the methodological parallels are direct. This means that water utilities face non-linear pricing and heterogeneous consumers, making AIDS and QUAIDS equally appropriate for water demand estimation.

Taken together, the studies showed how AIDS and QUAIDS contribute to providing a rigorous framework for correcting OLS biases in water demand estimation. Considering the constraints of additivity, symmetry, and homogeneity, AIDS and QUAIDS produce elasticity estimates that are internally consistent, empirically credible, and suitable for utility and regulatory decision-making.

Water Demand Elasticities as Indicators of Efficiency in Water Utility Services

Water demand elasticities indicate efficiency or inefficiency in water utility services. Elasticities reveal how consumers adjust consumption in response to price signals, income changes, scarcity, and tariff design. When households are highly price-inelastic in their use of essential indoor services, utilities have limited scope for price-based conservation. Thus, efficiency gains must come from supply-side measures such as leakage reduction, pressure management, or network optimization. This pattern, documented in many residential studies reviewed by Whittington and Nauges (2010), often reflects structural constraints such as lack of substitutes or inadequate infrastructure, signaling inefficiencies in the broader water system. Inelastic demand can indicate that utilities have not provided adequate wastewater services or alternative sources, thus limiting the households' ability to adjust consumption and revealing inefficiencies in service coverage.

By contrast, more price-elastic water demand for discretionary or seasonal uses suggests that well-designed tariffs can reduce peak demand, defer costly capacity expansions, and improve operational efficiency. Structural and system-based studies, including Olmstead (2010), show that when elasticities are correctly estimated, utilities can target elastic consumption while protecting basic needs. This results in improved allocative and productive efficiency. Elasticities also inform financial and regulatory efficiency. Utilities rely on elasticity-based demand forecasts to assess revenue stability under alternative tariff structures. That is, if demand is highly inelastic, volumetric tariffs can secure stable revenue but fail to promote conservation. On the other hand, more elastic demand exposes utilities to revenue volatility unless fixed charges or two-part tariffs are introduced.

Elasticities are equally central to regulatory efficiency. Regulators closely examine whether proposed infrastructure investments are justified by long-run demand projections. Elasticities that are under- or overestimated can lead to over-investment and stranded assets. It can also lead to under-investment and reliability problems and is a clear indicator of inefficiency. Cross-price elasticities from AIDS further reveal distributional and affordability impacts by showing how changes in water prices affect expenditure on other goods. Thus, they allow utilities to detect whether tariff reforms disproportionately burden low-income households and to design lifeline blocks or social tariffs accordingly. Behavioral studies by Garrone et al. (2019) showed that scarcity perceptions and environmental attitudes can push higher price responsiveness. As a result, this enhances the effectiveness of tariffs without additional capital expenditure. Elasticities can guide efficient tariff design in utility sectors, with lessons directly applicable to the water sector (Di Cosmo 2010).

Method

Given the criticisms of OLS models for estimating water demand, the study uses the AIDS model. The AIDS framework allows water to be included in modeling the household's budget. The analysis follows the share of Deaton and Muellbauer (1980), which used the budget share but focuses on water expenditures.[1] To estimate the water demand elasticities, the study adopts the model that Di Cosmo (2010) introduced. Blanciforti and Green (1983) pointed out that although water use is marginal relative to total expenditures, it is an important component of the consumer budget and that its demand depends on expenditure patterns.

Literature points out that sociodemographic characteristics are important for estimating water demand. The study incorporates key household characteristics, including family size, income decile, and the age and gender of the household head. Additionally, the analysis introduces interaction variables that capture whether a household relies exclusively on concessionaire-provided piped water or combines piped water with purchases from water refilling stations for its drinking supply. Equation (1) shows the structural form of the AIDS model equation with the inclusion of the sociodemographic characteristics, D_h The dependent variable,w_h represents the total household expenditure that is devoted to the use of water services. The prices of goods in the household consumption bundle, p_{jh}, and the translog price index, P_h, represent the prices aspect of the AIDS model.

$$w_h = (\alpha_w + \sum D_h) + \sum_j \gamma_{wj} lnp_{jh} + \beta_w \ln\left(\frac{X_h}{P_h}\right) \quad (1)$$

To calculate the elasticities, the study uses Equations (2) and (3) for the Marshallian (uncompensated) elasticity and the income elasticity for AIDS models. The study only considered the uncompensated elasticities as the analysis does not consider the change in utility of households. Only the behaviour of the household on water use with respect to income and prices were reported.

$$\varepsilon_h = -1 + \frac{\gamma_h}{w_h} - \beta_w \frac{\ln(X_h/P_h)}{w_h} \quad (2)$$

$$\eta_h = -1 + \frac{\beta_w}{w_h} \quad (3)$$

Assuming there is a utility-maximizing consumer, estimating the elasticities using the AIDS model requires the constraints of homogeneity and symmetry. The restrictions on the parameters imply that Equations (4) to (7) hold a system of demand functions that should be homogeneous of degree one. Meanwhile, the demand functions are homogeneous of degree zero in prices and income to satisfy the additivity constraint and the Slutsky symmetry restriction.

$$\sum_{i=1}^{n} \alpha_i = 1, \qquad \sum_{i=1}^{n} \gamma_{ij} = 0, \qquad \sum_{i=1}^{n} \beta_i = 0 \quad (4)$$

[1] The full specification of the AIDS model is laid out in the paper by Deaton and Muellbauer (1980).

$$\sum_{j=1}^{j} \gamma_{ij} = 0 \quad (5)$$

$$\gamma_{ij} = \gamma_{ji} \quad (6)$$

$$\sum w_i = 1 \quad (7)$$

Data and Discussion

Dataset: 2021 Family Income and Expenditure Survey-Labor Force Survey

The analysis draws on the merged 2021 Family Income and Expenditure Survey-Labor Force Survey (FIES-LFS) by the Philippine Statistics Authority (PSA). The FIES is a nationally representative household survey conducted every three years using a stratified multi-stage sampling design. Households are interviewed to record detailed expenditure patterns across all commodity groups present in the Philippine market. The LFS collects micro-level labor market information quarterly, mainly through in-situ interviews using the same sampling frame. In 2021, PSA integrated the two instruments, creating a unified dataset that links household expenditures to sociodemographic and labor characteristics at the micro level. This merged dataset provides granular information on household spending, including disaggregated expenditures on water supply services and the identification of primary water. Thus, this enables the construction of a complete expenditure system suitable for demand-system modeling. Additionally, the study employs the said dataset in the absence of micro-level household data coming directly from both Maynilad and Manila Water. Table 1 shows the descriptives of the households in Metro Manila by concession area.

Table 1

Descriptive Statistics of Households in Metro Manila Per Concession Area (Mean Values)

Characteristics	Manila Water	Maynilad
Family size	4.03	4.09
	(1.953)	*(1.846)*
Household head age (in years)	50.50	49.67
	(14.212)	*(14.091)*
Household income decile	7.578	7.138
	(2.120)	*(2.169)*
Average annual total household income (in Php)	451,691.7	390,741.9
	(393,710.5)	*(273,597.3)*
Average annual total household expenditure (in Php)	343,727.7	297,457.4
	(259657)	*(187,844.8)*
Average annual total expenditure on food (in Php)	127,686	122,037.2
	(72,057.55)	*(64,009.26)*
Average annual total expenditure on health-related goods/services (in Php)	8,219.774	7,301.181
	(21,804.27)	*(31,222.61)*
Average annual total expenditure on electricity (in Php)	22,725.85	19,492.78
	(20,893.28)	*(18,742.91)*
Average annual total expenditure on other goods (in Php)	178,319.2	141,766
	(189,109.3)	*(123,658.3)*
Average annual total expenditure on water supply (in Php)	6776.824	6,860.201
	(7,036.781)	*(6,437.076)*
Average monthly expenditure on water supply (in Php)	564.736	571.683
	(586.398)	*(536.423)*
Average monthly volumetric water us (in cubic metres)	13.319	12.482
	(5.270)	*(3.268)*
Share of water expenditure to total expenditure	0.022	0.025
	(0.016)	*(0.015)*
Share of food expenditure to total expenditure	0.398	0.433
	(0.115)	*(0.116)*
Share of health expenditure to total expenditure	0.022	0.022
	(0.033)	*(0.037)*

Share of electricity expenditure to total expenditure	0.066	0.065
	(0.034)	*(0.035)*
Share of expenditure on other goods to total expenditure	0.492	0.456
	(0.115)	*(0.111)*
Number of household samples	**8,056**	**11,844**

Source: FIES-LFS 2021 ((Philippine Statistical Authority [PSA], 2023) Italicized values are standard deviations

The descriptive statistics reveal that households in both concession areas have similar demographic profiles, but their socioeconomic and expenditure patterns differ in ways that meaningfully shape water use and affordability. Households in the east zone are slightly smaller and headed by marginally older individuals. Yet, they occupy higher positions in the income distribution and report substantially higher annual incomes and expenditures. The higher purchasing power is reflected in larger budgets for food, electricity, health, and other goods, all consistent with Engel's law. Although families under Manila Water consume more water volumetrically, their annual and monthly water expenditures are slightly lower. This implies that differences in tariff structures, minimum charges, or consumption patterns favor affordability. The lower budget share devoted to water among households further reinforces the notion that water services impose a lighter financial burden relative to overall consumption.

In contrast, households under Maynilad operate with tighter expenditure constraints. Table 1 reflects that families in the west zone have lower incomes, smaller total budgets, and higher proportional spending on essential goods such as food and water. Despite consuming less water on average, consumers devote a slightly higher share of their total expenditure to water. This suggests that water services represent a more significant budgetary commitment. This pattern is consistent with the broader socioeconomic gradient observed between the two concession areas and has implications for tariff sensitivity. Households with lower incomes and higher budget shares for essential goods usually exhibit greater price responsiveness, particularly in discretionary water use. These differences underscore the importance of modeling water demand using expenditure-based systems, such as AIDS, that explicitly incorporate budget shares, income effects, and cross-commodity interactions.

Elasticity Estimates

Own-Price and Income Elasticities

Table 2 presents the household water demand elasticity estimates using the AIDS model for both east and west zones. A clear understanding of price, income, and cross-price elasticities is central to evaluating household water demand and the efficiency of water service provision. The study used the STATA syntax introduced by Lecocq and Robin (2015) to estimate the AIDS model and the uncompensated elasticities. The uncompensated elasticities are reported because the study only considers household behavior in response to changes in prices and income, and not utility. The estimated own-price elasticities of water demand for both water utilities indicate that demand is moderately inelastic. These values are within the short-run residential price elasticities that Dalhuisen et al. (2003), Jegnie et al. (2026), and Whittington and Nauges (2010) estimated. The slightly higher elasticities for those served by Maynilad are consistent with its lower-income, more expenditure-constrained consumers, for whom water represents a larger budget share. Thus, price signals tend to have stronger behavioral effects. This pattern is similar across structural and discrete-continuous choice models under non-linear tariffs that show greater price sensitivity among households facing tighter constraints or more salient marginal prices (Olmstead et al., 2007; Olmstead, 2010).

The income elasticities indicate that water is considered a normal but non-luxury good by households in both concession areas. Estimates are consistent with the evidence of Dalhuisen et al. (2003), and the typical elasticities range between 0.2 and 0.8. Additionally, the results are also consistent with demand-system applications such as Galvez et al. (2016) and Suárez-Varela (2020), where water is included in the AIDS framework and found to be a normal and necessity-like good. The slightly higher income elasticity in the west zone suggests that income growth in lower-income areas activates previously unmet or constrained demand for improved service quality and discretionary water uses. This pattern mirrors evidence from African and other developing country contexts, where rising household incomes are associated with a shift toward more reliable piped water services and increased water volumes used (Nauges & van den Berg, 2009). Compared with studies reporting very low income elasticities in high-income, fully saturated markets, such as by Garron et al. (2019), the estimates of Metro Manila reflect a middle-income context. That is, both price and income continue to exert meaningful influence on household water demand.

Table 2
Elasticity Estimates Using the AIDS Model for Each Concession Area

Elasticity estimates	Manila Water	Maynilad
Water demand own-price (ε_D)	-0.399***	-0.453***
	(0.010)	*(0.009)*
Food cross-price elasticity (ε_F)	-0.017***	-0.016***
	(0.001)	*(0.001)*
Health cross-price elasticity (ε_H)	-0.030	-0.033
	(0.016)	*(0.018)*
Electricity cross-price elasticity (ε_{elec})	0.066***	0.068***
	(0.003)	*(0.003)*
Other goods cross-price elasticity (ε_G)	-0.020***	-0.022***
	(0.003)	*(0.001)*
Income elasticity (ε_I)	0.579***	0.618***
	(0.016)	*(0.014)*

Statistical significance: *p<0.05, **p<0.01, ***p<0.001; Italicized values are standard deviations.

Cross-Price Elasticities and the Household Demand System

The cross-price elasticities provide insight into how water is situated within the broader household consumption bundle. The small but statistically significant negative cross-price elasticity of food with respect to water suggests weak complementarity. Increases in food prices slightly reduce water demand. This is likely due to the income effects and overall budget reallocation rather than direct technological substitution. This is consistent with demand-system studies that find essential goods, like food and water, to be weak complements rather than strong substitutes (Galvez et al. 2016; Suàrez-Varela, 2020). Health cross-price elasticities are negative but not statistically significant, indicating that changes in the prices of health-related goods do not necessarily affect water use, given the relatively small share of the budget allocated to health expenditures.

In contrast, the positive and highly significant electricity cross-price elasticities, with respect to water services, indicate that water and electricity are economic substitutes. This reflects the substitution between energy-intensive appliances and water-intensive activities, or broader reallocation of spending away from electricity toward other uses, including water. Similar substitution patterns between utilities are consistent with demand-system analysis, in which cross-price elasticities capture interactions between electricity, gas, and other services (De Stercke et al., 2018). The negative cross-price elasticities for the other consumption goods reinforce the interpretation of water as a necessity that is weakly complementary with the broader consumption bundle. That is, when the prices of other goods rise, households slightly reduce water use, which is consistent with overall budget contraction rather than targeted substitution.

Elasticities as Behavioral Indicators of Efficiency and Inefficiency

The elasticity structure of household water demand provides insights into the efficiency of Manila Water and Maynilad. The higher sensitivity of those in the west zone becomes relevant when considering operational inefficiencies such as NRW, water theft, and connection problems. This is because inefficiencies amplify the cost burden on households that are already more price responsive. Water theft and illegal connections are major contributors to NRW. Illegal tapping increases physical losses, reduces pressure, and distorts metering accuracy. Thus, illegal connections weaken the link between tariffs and consumption because households with illegal access do not face marginal price signals. As a result, this reduces allocative efficiency and undermines conservation incentives. Grafton et al. (2011) showed that illegal access reduces the effectiveness of price-based policies. This, in turn, shifts the burden onto compliant households, increasing their effective price elasticity.

Table 3
Reported Non-Revenue Water (NRW) of Concessionaires, 2020-2025

Year	Maynilad (West Zone)	Manila Water (East Zone)
2020	36.0%	12.5%
2021	38.0%	13.4%
2022	43.0%	12.7%
2023	39.9%	13.5%
2024	38.4%	13.5%
2025	34.9%	14.4%

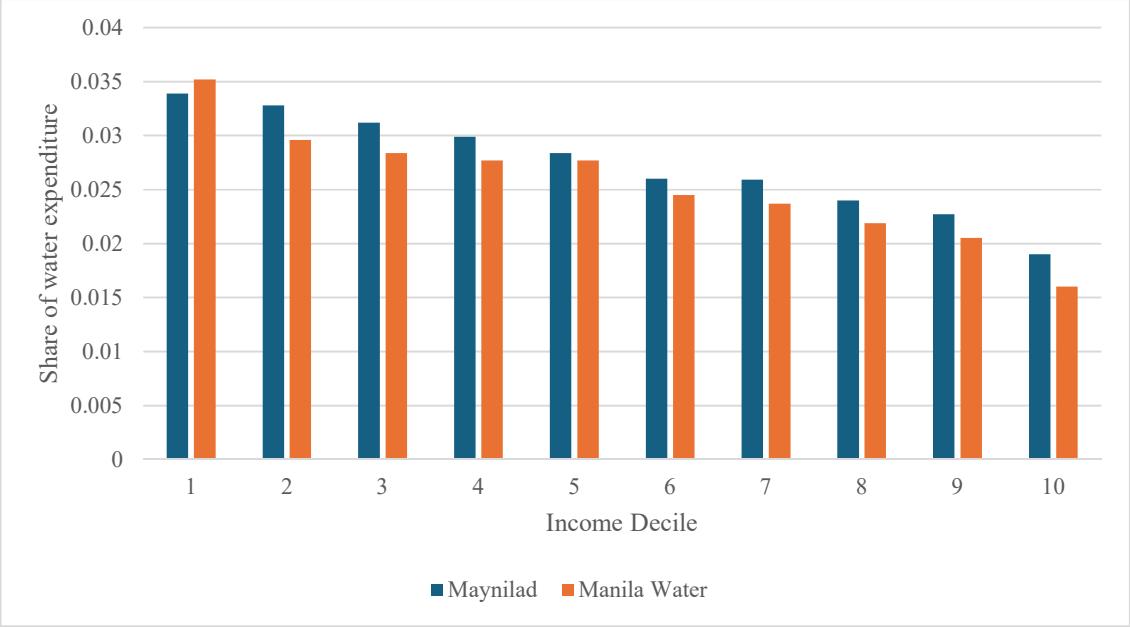
Source: Compiled by the author from Manila Water Company Integrated Reports (2020-2025) and Maynilad Water Services Integrated Reports (2020-2025).

Price responsiveness of households reflects how each concessionaire reduces inefficiency by addressing NRW problems. The operational differences, as shown in Table 3, shape household behavior and, in turn, elasticity estimates. In systems with low NRW, such as Manila Water's, tariffs more closely reflect true marginal cost and scarcity. Households face stable pressure, reliable supply, and accurate metering, allowing consumption decisions to respond predictably to price changes. This aligns with consumers in the east zone having slightly lower price elasticity and a lower budget share, indicating that they experience water services as relatively affordable. Additionally, they respond to tariffs in a stable, efficiency-consistent manner. According to Suárez-Varela (2020), utilities that can maintain low losses and high service reliability tend to result in moderate and stable price elasticities. This supports allocative efficiency and credible demand forecasting.

The west zone, however, reflects a more constrained environment. High NRW reduces operational efficiency and distorts tariff signals because households pay for water lost through leaks, illegal tapping, or inaccurate meters. This inflates the effective costs for paying consumers, especially in lower-income areas where water represents a larger budget share (see Figure 1). As a result, households are more sensitive to price changes. Not because water is less essential, but because inefficiency worsens the financial burden of consumption.

Figure 1

Share of Household Water Supply Expenditure Per Income Decile Under Each Concession Area (Mean Values)



Source: 2021 FIES-LFS (Philippine Statistical Authority [PSA], 2023)

Income elasticities also reveal efficiency implications. Households in the west zone have higher income elasticities, which suggests that they would consume more water if service reliability improved or affordability constraints were relaxed. The high NRW suppresses water demand because households face unreliable supply and metering problems that limit consumption regardless of income decile. Results are consistent with findings from developing country water systems where income growth increases demand only when service reliability is high (Nauges & van den Berg, 2009). In contrast, Manila Water's lower NRW influences income elasticity to reflect behavioral expansion. Thus, this supports dynamic efficiency in demand forecasting and capital expenditure planning.

Elasticities and Sources of Drinking Water

Both concessionaires are tasked to provide not only water for domestic activities but also for drinking purposes. However, the 2021 FIES-LFS revealed that most households still source their drinking water from water refilling stations rather than from the water services of Maynilad and Manila Water (see Table 4 and Figure 2). The study looks deeper into how the elasticities are influenced when households must pay for both the water services of the concessionaire and those that source their drinking water from water vendors. Figure 2 reveals a significant disparity between households that use the concessionaires' water services as their primary source of potable water and those that obtain drinking water from alternative sources. The findings indicate that access to piped water services does not necessarily eliminate reliance on supplementary water sources for consumption purposes. As a result, many households bear additional financial costs by purchasing or sourcing potable water elsewhere, increasing overall household expenditures beyond payments made to Maynilad or Manila Water for domestic water services.

Table 4

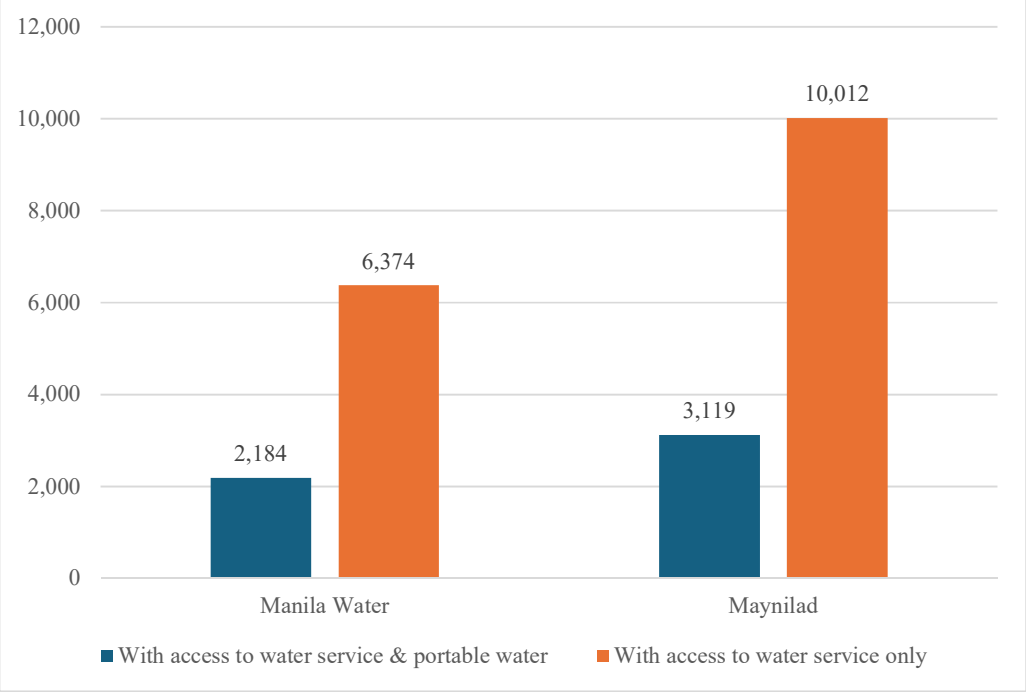
Sources of Drinking Water by Concession Area

Main source of drinking water	Manila Water		Maynilad	
01 - Piped into dwelling	2,115	24.71%	1,470	11.19%
02 - Piped to yard/plot	113	1.32%	107	0.81%
03 - Piped to neighbor	24	0.28%	62	0.47%

04 - Public tap/Stand pipe	2	0.02%	2	0.02%
05 - Tubed well/borehole	0	0.00%	0	0.00%
06 - Protected well	0	0.00%	9	0.07%
07 - Unprotected well	0	0.00%	0	0.00%
08 - Protected spring	0	0.00%	0	0.00%
09 - Unprotected spring	0	0.00%	0	0.00%
10 - Rainwater	0	0.00%	0	0.00%
11 - Tanker-truck	1	0.01%	6	0.05%
12 - Cart with small tank	1	0.01%	0	0.00%
13 - Water Refilling Station	6,180	72.21%	11,433	87.07%
14 - Surface Water (River, Dam, Lake, Pond, Stream, Canal, Irrigation Channel)	0	0.00%	1	0.01%
15 - Bottled water	16	0.19%	13	0.10%
16 - Sachet water	0	0.00%	0	0.00%
19 - Other, please specify	106	1.24%	28	0.21%
Total	**8,558**		**13,131**	

Source: 2021 FIES-LFS (PSA, 2021)

Figure 2
Households domestic and potable water access



Source: PSA (2023) and author's estimates

The elasticity estimates in Table 5 evidently show that household behavior changes when piped water from Manila Water or Maynilad is consumed alongside water refilling stations. When households rely on the combination of both water sources, the own-price elasticity is slightly more elastic for households under Manila Water but slightly less elastic for consumers under Maynilad compared with analyzing piped water alone, as shown in Table 2. This pattern suggests that the presence of refilling stations introduces a partial substitution effect. Households become more responsive to changes in the tariffs of Maynilad and Manila Water because they have an accessible alternative drinking water.

The increase in elasticity among those under Manila Water reflects the fact that substitution is more feasible in a system with high service reliability and low NRW. The consistently low NRW levels ensure stable pressure, predictable water supply, and accurate metering, enabling households to adjust consumption smoothly across sources when prices change. In demand system theory, elasticity rises when switching costs are low and substitutes are technologically accessible. Refilling stations provide treated water at stable prices, allowing households in the east zone to reallocate marginal consumption away from piped water without compromising quality. The results are consistent with evidence that reliable primary services amplify price change responsiveness when there are substitutes (Dalhuisen et al., 2003; Whittington & Nauges, 2010).

Table 5
Elasticity Estimates of Households Under Each Water Supply Source Scheme

Elasticity estimates	**Manila Water**	**Maynilad**
Domestic Water service + Water Refilling stations		
Water demand own-price (ε_D)	-0.429***	-0.433***
	(0.010)	*(0.010)*
Food cross-price elasticity (ε_F)	-0.016***	-0.016***
	(0.001)	*(0.001)*
Health cross-price elasticity (ε_H)	-0.031	-0.032
	(0.0017)	*(0.017)*
Electricity cross-price elasticity (ε_{elec})	0.067***	0.067***
	(0.003)	*(0.003)*
Other goods cross-price elasticity (ε_G)	-0.021***	-0.021***
	(0.001)	*(0.001)*
Income elasticity (ε_I)	0.601***	0.603***
	(0.015)	*(0.015)*
Domestic Water service + Potable water		
Water demand own-price (ε_D)	-0.409***	-0.450***
	(0.010)	*(0.009)*
Food cross-price elasticity (ε_F)	-0.017***	-0.016***
	(0.001)	*(0.001)*
Health cross-price elasticity (ε_H)	-0.030	-0.033
	(0.017)	*(0.018)*
Electricity cross-price elasticity (ε_{elec})	0.067***	0.067***
	(0.003)	*(0.003)*

Other goods cross-price elasticity (ε_G)	-0.020***	-0.021***
	(0.001)	*(0.001)*
Income elasticity (ε_I)	0.587***	0.615***
	(0.015)	*(0.014)*

Statistical significance: *p<0.05, **p<0.01, ***p<0.001; Italicized values are standard deviations.

In contrast, the slightly lower elasticity of those in the west zone when refilling stations are included reflects structural constraints due to high NRW. High NRW generates intermittent supply, pressure fluctuations, and metering inaccuracies, limiting consumers' ability to adjust piped water consumption in response to tariff changes. When consumption is already constrained by unreliable service, households rely on refilling stations out of necessity rather than as a marginal substitute. Thus, it reduces the incremental behavioral response to changes to piped water services. This aligns with evidence of Jegne et al. (2026) that operational inefficiencies suppress elasticity by weakening the link between tariffs and actual consumption. Lower household incomes further dampen substitution responsiveness, as budget constraints limit the ability to increase refilling station purchases when tariffs increase. Thus, although refilling stations introduced a theoretical substitute for both concessionaires, the practical ability to substitute is shaped by underlying service reliability. That is, Manila Water's efficient system enhances elasticity whereas Maynilad's high NRW and constrained supply reduce it.

Conclusion and Policy Insights

Metro Manila's water demand patterns reflect both household socioeconomic conditions and the operational performance of its two concessionaires. Using the AIDS demand system and the FIES-LFS, the study shows that water demand is moderately price-inelastic overall. However, households in the west zone are more price- and income-responsive. The higher elasticity is driven by tighter household budgets, greater reliance on refilling stations for drinking water, and significantly higher NRW. On the other hand, Manila Water's lower NRW and more reliable service correspond to more stable and less elastic consumption behavior. Elasticities, therefore, serve as behavioral indicators of utility efficiency, revealing how operational conditions shape household responses to tariffs.

Cross-price elasticities further situate water within the broader household consumption bundle. Weak complementarity with food and other essential goods suggests that budget reallocation, rather than technological substitution, drives behavioral responses. The positive electricity cross-price elasticity indicates substitutability between water-intensive and energy-intensive activities. All of which are consistent with demand-system evidence from other utility sectors. Importantly, the analysis shows that households that source drinking water from refilling stations exhibit different elasticity structures, underscoring the role of alternative water markets in shaping household water-use behavior.

AIDS-based elasticity estimates reveal that household behavior in Metro Manila is shaped not only by prices and income, but by the structural efficiency of water utilities. Tariff reforms, regulatory oversight, and capital expenditure planning must be grounded in behavioral evidence. Improving NRW, designing equitable tariffs, and recognizing the role of alternative drinking water markets are important steps toward achieving a more efficient, equitable, and resilient urban water system.

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Statements and Declarations

Author certifies that he has no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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