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Socioeconomic and water resource status in upland Cavite: Basis for sustainable water use management

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Abstract

Access to clean and adequate water remains a seasonal problem in urban and coastal areas in the Philippines due to deforestation and other human activities in the watershed. Amidst the critical condition of water supply, the demand for water has been increasing tremendously due to an increase in the province's population. The challenge is to ensure water resource sustainability in the face of the above stresses. This paper aims to determine the households' water consumption in upland Cavite and determine the factors affecting their consumption. Multiple regression analysis was employed to identify the determinants of household's monthly water consumption. Most of the households asserted that water is still abundant and potable while a few revealed intermittent water supply and poor water quality. However, water districts revealed that extracting water is getting more difficult because the groundwater levels in these areas are already critical. The average household's cost of water usage amounted to PhP311.78/month with a mean per capita consumption of 78.88 liters/day. The water cost elasticity is inelastic and positive which implies that the households are not responsive to water rates change. Monthly income and household size were found to be an increasing function of the water usage. Women, who are usually stay-in member of the households, have the tendency to consume more water. The type of house also causes variation in water consumption. The results can be used as basis for effective decision-making and planning for sustainable water resources development in Cavite. The desire to have a sustainable water future is in close alignment with the water sustainability and reliability framework anchored from the Cavite Development Program of the De La Salle University-Dasmarinas.

Keywords: Upland Cavite; Water Consumption; Water Sustainability; Sustainable Water Use and Management

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1. Introduction

Water is an economic good and is equated to food security. It would be the single most important constraint to increased food production because agriculture is heavily dependent on water accounting for 85.27% of the total water supply, Water use within agricultural systems, primarily in irrigation, accounts for almost 70% of global water withdrawals (League of Cities of the Philippines, 2006). Water is not only essential in agriculture but there is also high demand for water supplies in the industrial sector which consumes 7.46% and domestic sector which uses the remaining 7.27% (World Bank, 2003; 2004). The JICA Master Plan on Water Resource Management in the Philippines estimated that only 1,907 cu m of fresh water would be available to each person each year, making the Philippines second to the lowest among Southeast Asian countries with fresh water availability (The World Bank Group, 2003). Most of the problems encountered in the water sector today arise from an issue of conflicts of use and water allocation. With the increase of population coupled with worsening pollution of water, lack of infrastructure and facilities result in allocation issues and conflicting rights over limited water supply.

Data from the Office of the Provincial Agriculturist showed that Cavite, a predominantly an agricultural province in the CALABARZON Region, depends heavily on water supplies since agriculture comprised about 49.38% or 70,466.53 hectares of the total land area of the Province. While some regions are endowed with high potential source of surface water, the Southern Tagalog Region, where Cavite belongs, has one of the lowest water supplies in the Philippines with only 7,780 (World Bank, 2003). A critical number of communities are perennially suffering less supply of water and some parts of the Philippines were already experiencing below normal rainfall leaving agricultural production at risk as well as domestic and industrial needs. The adverse effects on water and other vital components of the Earth system are evident due to the increasing pressure caused by increased production and urbanization resulting in environmental degradation. Cavite, being an industrialized and highly populated province, is not spared from this critical condition. The current trend of vertical development and urbanization in the upland parts of Cavite, especially in Tagaytay, is likely to cause a water crisis in the near future.

In anticipation for the serious water supply problem, Cavite Province conducted a comprehensive study on water resources management in 2012 which led to the development of the Cavite Integrated Water Resources Management Master Plan (CIWRMMP). The plan aims to bridge the widening demand and supply gap for groundwater, infrastructure backlog, and the irrational allocation of water resources in the province. The plan also identifies measures to address the demand and supply gap through the utilization of wells and major rivers and some tributaries. The development of the Cavite IWRMP is a good starting point towards developing effective water resources management strategies for the province (Partnerships in Environmental Management for the Seas of East Asia [PEMSEA], 2017). In 2017, the Cavite Provincial Government, in coordination with the Department of Environment and Natural Resources (DENR) and PEMSEA, has hosted the Cavite Water Summit in its effort to address and manage the water situation in the province amidst the burgeoning population. This Summit aimed to make all the multistakeholders aware of the current supply of water in Cavite and how to match it with the increasing water demand. This also aimed to promote integrated water resources management to achieve sustainable water supply in both the short-run and long-run periods.

The population of Cavite is projected to hit the 4.8 million mark by 2020 and the water requirement is forecasted to surpass 51 million liters per day (MLD) (PEMSEA, 2017). While Cavite has rich freshwater sources coming from the upland areas and may have just enough water for its households at the moment, the water availability is being threatened due to climate change, pollution, and improper management (Madrazo, 2002) as well as the rapid urban development in the uplands, especially in Tagaytay City. Iit is projected that the province will face challenges in securing freshwater resources in the near future due to the increasing demand for domestic use, agricultural purposes, industrial, and recreational purposes. A better understanding of household water use in these areas is imperative for efficient and effective management of water systems.

A vast literature is available on household demand for drinking water in both developed and developing countries which were mostly focused on water consumption for domestic use and tariff structures to formulate pricing policies in those countries (Nauges and Wittington, 2010; Abu Rizaiza, 1991; Nauges and Berg, 2009). In Wei River Basin in China, the average domestic water consumption were 71.3, 52.0, and 46.5 liters per capita per day for villages with continuous piped water supply, intermittent piped water supply, and public tap access, respectively. They normally used these for laundry, showering, personal hygiene, and vegetable gardening with significant difference in the indoor and outdoor water usage (Fan et al., 2013). Moreover, most studies have found that residential water consumers respond to changes in price and demand for water is generally inelastic ranging from -.02 and -.75. (Brookshire et al., 2002; Espey et al., 1997; Bauman et al.,1998; and Arbués et al., 2003).

The allocation of water resources is essential for satisfying basic human requirements in consideration of economic efficiency and equity, and that allocations should be based on sustainability of the resource base. The desire to have a sustainable water future is in close alignment with the water sustainability and reliability framework anchored from the Cavite Development Program of the De La Salle University-Dasmarinas. The strategic challenge is to ensure sustainability of the water resource in the face of the above stresses. This research generally aims to establish a set of baseline data and information concerning the water consumption of households in Upland Cavite and identify the factors affecting their water consumption. This can be used as basis for effective decision-making and planning for sustainable water resources development in Cavite, preferably in the study areas.

2. Data description and analysis

The study covered the following upland municipalities in Cavite: Indang, Amadeo, General Emilio Aguinaldo, Alfonso, Ternate, Maragondon, Magallanes, Tagaytay City, Mendez, and Silang. Amadeo belongs to the sixth district while the rest of the municipalities belong to the 7th district. A pre-survey was carried out to conduct protocol and ocular survey of the upland municipalities included in the survey areas. Primary data were gathered from the sample households through personal interview, person-administered, and group-administered questionnaire methods. The instrument covered information on the households' socioeconomic profile, water consumption, water use patterns, water supply management systems, and water management services. This study did not determine the water consumption across various uses such as laundry, kitchen,

agriculture, bathing, washing, and the like but respondents were asked on the total household water usage. A sample size of 500 was randomly drawn from the 10 municipalities, covering those barangays near and far from the poblacion. However, due to some invalid questionnaires, only 469 respondents were included in the analysis.

To describe the respondents and household characteristics, water consumption, quantity and quality of water consumed, uses of water from various sources, water use patterns and behavior, and assessment of water management or water service providers descriptive measures such as mean, frequency distribution, percent, and standard deviation were used. The economic approach to water demand estimation uses econometric techniques to determine the effect of price of water and some identified explanatory variables on water consumption. In this case, Ordinary Least Squares (OLS) regression technique was employed with household's monthly water consumption as the dependent variable. The price of water was proxied by the daily household water consumption because the water rates across municipalities did not vary too much. Other independent variables include: monthly household income, household size, educational attainment, type of house, floor area, and lot area. Table 1 describes all the variables included in the model.

The model is given as follows:

$$Q_W = a + b_1P_W + b_2HS + b_3HI + b_4Ed + b_5Gen + b_6HT + b_7LA + b_8FA + e \quad (1)$$

where Q_W is the average daily household water consumption; P_W is the cost of water; *HS* is household size; *HI* is average monthly household income; *Ed* is the highest educational attainment of the household head-respondent; *Gen* is the gender of the household head-respondent; *HT* is type of house; *LA* is total lot area; *FA* is total floor area; b_{is} is the regression coefficients and *a* is the constant term.

The relationship between water price and water demand or consumption was determined by computing the price elasticity of water demand. The price elasticity of water demand measures the responsiveness (or elasticity) of the water use to a change in water price, all other things being equal. Simply put, it gives the percentage change in household water use in response to a 1% change in price (all other things being equal, i.e., holding all other determinants of demand, constant). The price elasticity of the water demand may be written as:

$$\varepsilon_{pw} = b_1 * Pw/Qw \quad (2)$$

From equation (1),

$$\varepsilon_{pw} = \partial Qw/\partial Pw * Pw/Qw \quad (3)$$

Demand theory states that, as the price of a good increases, the demand for that good will, *ceteris paribus*, decrease. Although water is a necessity good with inelastic demand and may not respond too much on its price, it is expected that price will negatively influence the quantity of water use from purchased sources (Renwick and Green, 2000. Household size is hypothesized as an increasing function of water consumption, such that the bigger the household size, the higher the water consumption (Haziq and Panezai, 2017; Ogden and Schnoebelen, 2005; Arbués et al., 2003; Nauges and Thomas, 2000, Renwick and Green, 2000; Zhang and

Brown, 2004). This is based on the findings of Keshavarzi et al. (2006) and Froukh (2001), that household size has been found to be the most important factor affecting water consumption.

Table 1. Description of Variables

Variable	Description	Remarks
Qw	Household's monthly water consumption (in gallons)	Dependent Variable
Pw	Monthly Cost of Water Consumption to represent the Price of Water (PhP)	
HS	Household Size	
HI	House Hold Monthly Income (Php)	
Ed	Highest Educational Attainment of Household Head	Years of Schooling
Gen	Gender of the Respondent	1 if Woman; 0 otherwise
HT	Type of House	1 if permanent; 0 otherwise
LA	Total Lot Area (in sqm)	
FA	Total House Floor Area (sqm)	

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In the case of education, it is expected that, as the level of education increases, the level of household awareness about the health benefits of water use (quantity and quality) also increases (Haziq and Panezai, 2017; Aho et al., 2016; Keshavarzi et al., 2006; Sandiford et al., 1990). It is, thus, hypothesized that education level will positively affect the level of water use. As a proxy for education level, we use the number of adults who have completed primary education in the household. For income, the literature has shown a positive relation between wealth and water use (Sandiford et al. 1990; Hussien et al., 2016). It is expected that income

negatively affects water use because poor people cook less and often have less clothing to wash. Moreover, a household with high income will have a bigger house, more appliances, and even own some vehicles hence, water consumption will be higher.

The age structure of the household was also hypothesized to affect water consumption (Haziq and Panezai, 2017; Murdock et al., 1991). It can be surmised that young people, especially when there are babies, spend more water than the older people. Young kids are usually staying at home compared to older people who are usually spending most of their time outside for work. Moreover, older people usually manifest more saving attitudes compared to younger people who demand more water for laundry, washing, and bathing (Nauges and Thomas, 2000).

Though the relationship between water consumption is less studied, following Aho et al. (2016), Dagnew (2012) and Hussien et al. (2016), it was hypothesized that gender has significant effect on water consumption.

3. Empirical Results and Analysis

3.1. Brief profile of cavite province (Cavite Provincial Planning and Development Office [PPDO], 2016).

Cavite is one of the most progressive provinces in the Philippines. It is relatively small, occupying a land area of 142,706 hectares which is approximately 8.72% of CALABARZON's total land area, 2.74% of the regional land area and 0.48% of the total land area of the Philippines which is 299,404.00 hectares (Table 2). Cavite's land resources consist of forest lands, built-up areas, as well as production areas intended for urban and economic activities. Production lands can be in the field of agriculture and other related industries while built-up areas are land intended for urban development activities. Forest lands are rich in numerous flora and fauna that need to be protected and preserved. According to the Philippine Statistics Authority (PSA), in 2007, the existing forest area within the province totalled to 8,624.956 hectares. These forest areas were categorized as Protected Landscape under R.A.7586 otherwise known as National Integrated Protected Area System (NIPAS) and the unclassified forest (Non-NIPAS).

According to PPDO (2016), Cavite lands are divided into forest lands and alienable and disposable lands which are being used in agriculture, residential, pasture areas, and the like. The alienable and disposable lands are primarily intended for agriculture, fishery and mining while built-up areas are mainly for residential areas, commercial, industrial and tourism areas. Of these lands, about 50.33% of the total provincial land area is engaged into agriculture. It is dominated with production area that accounts for 50.33%of its total land area, followed by built-up areas that cover 39.99% of Cavite. Lastly, 9.33% of the province is considered protection lands such as natural parks and forests. In spite of rapid urbanization in the province, Cavite remains to be an agricultural economy that can contribute to food security, especially in corn, rice, coffee, coconuts, ornamentals, and vegetables. The climatic suitability of Cavite makes it ideal for diversified or integrated farming, having crops and livestock raising in one farm. Cavite is also rich in marine resources and long coastlines providing a good source of livelihood to the coastal population. The fishing industry also contributes

to the economic growth in Cavite which is a good source of oysters, mussels, shrimp and milkfish. The coastlines of Tanza, Naic, Cavite City, and Ternate were used to be seat of tourism for their popular beaches and have been a major source of income of Cavitenos. However, because of pollution caused by industrialization and urbanization, these beaches stopped their operation.

Table 2. Key Facts About Cavite Province

Item	Description
Land Area	142,706 ha (0.4% of the total land area of the Philippines)
Coastline Length	122.574 km
Water Area	93,679.3750 ha
Climate	Relatively Dry Season from November to April Wet Season from May to October
Population (as of 2010)	3,090,691
Capital	City of Imus
Seat of Provincial Government	Trece Martires City
Number of Cities	7
Number of Municipalities	16
Number of Barangays	829
Products	Food Products: Coffee, cocoa tablets, kaong (sugar palm) vinegar, mussel chips, smoked fish, and other processed seafood, processed fruits and vegetables, milk and milk products, native delicacies, etc. Other Products: Novelties and furnitures, ceramics, bags, wallets, novelty items, scented candles, virgin coconut oil.

Source: Cavite Provincial Planning and Development Office, 2016

Cavite is the most populous and the second most densely populated province in the country with a total population of 3,678,301 in the 2015 census and with a population density of 2,300/sq km (Table 3). This can be contributed mainly by migration due to its proximity to Metro Manila and its industrial zones which entice potential workers. It is classified as predominantly urban having 90.69% of the population concentrated in the urban areas, while 9.21% reside in the rural areas. The significant increase in the population has started in 1990 when investors started to establish their businesses in different industrial estates that enticed people from all over the country to migrate to Cavite for many job opportunities. Another factor in the population increase is the mushrooming of housing subdivisions in the lowland parts of Cavite and now being extended in the upland areas, particularly in Tagaytay City and Silang. Since Cavite is proximate to Metro Manila, people

working in the metropolitan area opt to live in the province together with their families. Natural increase also contributes to the increase in population. Among the cities and municipalities in Cavite, the City of Dasmariñas has the biggest population with 659,019 people while the municipality of Gen. Emilio Aguinaldo or Bailen has the smallest registered population with 22,220 people (Table 3).

Cavite has seven major rivers and its tributaries which generally flow from the highlands of Tagaytay and Maragondon to Manila Bay. The water systems in the upland areas have been developed for tourism which can boast of their springs, waterfalls, and rivers. In the lowland areas, however, water supply for both residential and irrigation purposes comes from artesian wells and deep wells.

Table 3. Basic Demographic Profiles by Municipality (as of 2015)

Municipality	District	Population	Area (sq km)	Population Density (/sq km)	Number of Barangays
Alfonso	7	51,839	66.58	779	32
Amadeo	6	37,649	36.92	1,020	26
General Emilio Aguinaldo	7	22,220	9.4	2,364	14
Indang	7	65,599	74	876	36
Magallanes	7	22,727	73.07	311	16
Maragondon	7	37,720	164.61	229	27
Mendez	7	31,529	43.27	729	24
Silang	5	248,085	209.43	1,185	64
Tagaytay	7	71,181	65	1,095	34
Ternate	7	23,157	59.93	386	10
Total		611,706	803.11	897.4	283
		[16.63%]	[51.02%]	[39.02%]	[34.14%]

Note: Figures in parentheses are percentage of total in Cavite
Source: Cavite Provincial Planning and Development Office, 2016

3.2. Socioeconomic profile of the respondents

Majority (24.1%) of the respondents belong to the older age brackets of 41 to 50 years old, followed by those who belong to 51 to 60 years age group (22.2%) (Table 6). The mean age is 45.07 years with a standard deviation of 13.38 years (Table 4). About 56.1% are female while only 37.5% are male. Conventionally, the males are usually out during daytime for work so the wives or the female members of the family are the ones

at home attending to the family needs. The respondents are mostly college graduates (46.9%) while about 9.2% are postgraduate degree This validates the fact that Cavite is one of the provinces in the Philippines with high educational attainment.

Majority of the respondents (72.9%) are married while the rest (12.8%) are single. Their household size ranged from 1 to 14 members with mean and standard deviation of 5.66 or approximately 6 and 2 members, respectively. Most of them (61.2%) were employed practicing their professions while 28.4% were self-employed. About 2.6% was retired from their previous work while only 7.8% was recorded unemployed. Other sources of income are agriculture and fishing.

The recorded mean monthly income of the respondents was relatively low at PhP17,022.78 with incomes ranging from PhP10.500 to PhP200,000. This was followed by those who fall under income bracket PhP15,001 to PhP30,000 at 33.9%. Only a small group of respondents can earn PhP31,000 and above every month recorded at only 9.6%.

Most of them own the house that they are currently occupying (85.7%). Also, a majority have permanent house structure (72.1%) while the rest have semi-permanent (6.8) and temporary houses (21.1%). Those respondents with permanent house structures are either long-time residents or natives of the areas studied. Those with semi-permanent or temporary house structures are either informal settlers or just caretakers of the land that they are occupying.

3.3. Household water usage

3.3.1. Main sources of water

Majority of the respondents (84.4%) said that the main source of their water supply comes from the faucet. On the other hand, 10.9% of the respondents asserted said that they get their supply of water from deep well. The rest rely on springs because they are living near a river and other sources (Table 5).

Water supply from faucets come from their municipalities' local water district. A few secured their water from barangay water districts and from privately owned water pumps. They are billed for water supply every month while those who get water from deep well and springs do not pay anything.

3.3.2. Availability of water from source

About 71% of the respondents revealed that their water supply is secured for 24 hours a day, an indication of adequate supply and service. Only about 20.1% has water supply for 11 hours or less while only 8.9% of the respondents reported that their water supply for 12 to23 hours per day. All respondents indicated that they are unaware of the reason why they have different time duration for their water supply. Although some surmised that it maybe because of the scarcity of water in their area.

3.3.3. Water usage

Respondents primarily use water for farming and other agricultural use. Specifically, they use water for crop production (38.6%) while 30.7% were into animal production. They use water basically for irrigation, cleaning, and washing of farm produce. Indeed, upland households are actively engaged in agriculture which is one of their sources of income. The remaining 30.7% of the respondents use water for their households and other business operation, like sari-sari store, *carinderia* or eateries, and the like.

3.3.4. Volume of water used per day (gallons)

The volume of water use ranged from 1 to 15 gallons per day per capita with a mean of 20.84 gallons or 78.88 liters. This is somewhat equivalent to daily consumption of 446 liters per household or 2.3658 m^3/capita per month or (13.39 m^3 per household). This daily water consumption is higher than the average daily domestic water consumption per household of 233.85 liters (61.78 gallons) or 27 liters per capita (7.13 gallons) in Benin, Africa (Arouna and Dabbert, 2009).

Table 4. Cont'd

Profile of the Respondents	Frequency n = 469	Percent
Household and Lot Ownership		
Yes	402	85.7
No	67	14.3
Type of House		
Permanent	338	72.1
Semi - permanent	32	6.8
Temporary	99	21.1
Lot Size (sq m)		
50 and below	25	5.3
51 - 150	218	46.5
151 - 250	94	20
251 - 350	74	15.8
351 and above	58	12.4
Mean = 269.49		
SD = 472.25		
House Floor Area (sq m)		
100 and below	171	36.5
101 - 200	65	13.8
201 - 350	20	4.3
351 - 450	13	4.9
No response	200	42.6
Mean = 95.83		
SD = 472.25		

3.3.5. Volume of water used per day (gallons)

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Most of the respondents (52.3%) reported that they normally use an average of 1 to15 gallons of water per day, 35.9% consumed 16 to 30 gallons, while the rest consumed 31 gallons to as much as 200 gallons (11.8%). Those people who consumed around 1to15 gallons are those who have difficulty in accessing water in their community, especially those who came from Amadeo, Mendez, and Ternate. On the other hand, those who consumed more than 46 gallons per day are those engaged in activities that need a lot of water like agriculture, business, car wash, and the like. Moreover, household size also contributes to volume of water consumption. The bigger the family size, the higher the water consumption.

3.4. Availability of water supply

3.4.1. Access to water source

Table 6 shows that households can access their water from various sources, with most of them serviced by the Local Water Utility Administration (LWUA). There were some households whose water is supplied by the barangays, cooperative, and neighbors who seemed to be well off because they have installed their own deep well and provided big tanks within the perimeter area. For some households, they find this more practical because they are very near or accessible to the water source and can always be assured of regular supply.

Majority or 84.1% of the respondents confirmed that they have full access to the water point. Only few, specifically 15.9% of the respondents, said that they do not have an easy access to the water point. Nevertheless, it seems plausible that households in the upland areas are not yet encountering any difficulty in terms of water accessibility.

Table 5. Household Water Usage, Upland Cavite

Water Usage	Frequency n = 469	Percent
Main Source of Water		
Faucet	396	84.4
Deep Well	51	10.9
Spring	7	1.5
Others	15	3.2
Availabilty of Water From Source (Number of Hours)		
1 to 11	94	20.1
12 to 23	42	8.9

24	333	71
Mean = 19.81		
SD = 8.09		
Water Usage		
Crop Production	181	38.6
Animal Production	144	30.7
Household Use	144	30.7
Volume of Water Use/Day/Capita (Gallons)		
1 to 15	245	52.3
16 to 30	168	35.9
31 to 45	25	5.2
46 and above	31	6.6
Mean = 20.84		
SD = 21. 18		

3.4.2. Sufficiency of water supply

Still a majority of respondents (95.6%) were enjoying abundant water supply in the upland part of Cavite, claiming that the supply was sufficient for their daily needs. Only a bare 4.4% of them have some problems or constraints on water supply. This is specifically a problem in Indang where there has been a critical issue on the alleged laying of pipes in Barangay Kayquit and construction of an intake and filtration system by PTK2 sometime in 2012. Indang households stressed that this project will directly destroy the major protected watershed areas in Cavite because it will lead to the dissipation and drying up of water resources, hence, water supply will not be enough for their daily needs. Some of the respondents who consumed few gallons per day have difficulty accessing water because of the absence of a steady supply of water from water districts and other entities that distribute water.

Table 6. Water Supply Condition in Upland Cavite

Water Supply Condition	Frequency n = 469	Percent
Access to Water Source		
Yes	394	84.1
No	75	15.9
Sufficiency of Water Supply		
Yes	448	95.6
No	21	4.4
Water Use Restriction		
Yes	78	16.7
No	391	83.3
Adequacy of Water Supply During Dry Season		
Extremely inadequate - Inadequate	76	16.3
Adequate - Extremely Adequate	393	83.7

Adequacy of Water Supply During Wet Season		
Extremely inadequate - Inadequate	49	10.3
Adequate - Extremely Adequate	420	89.7
Alternative Source of Water		
No	197	58.1
Yes	273	41.9
Quality of Water from the Source		
Potable	327	69.7
Not Potable	142	30.3
Distance of Alternative Source from Residence (meters)		
10 - 100	245	89.7
101 and above	28	10.3

3.4.3. Water use restriction

A vast majority or 83.3% of the respondents were allowed to use water without limit. This simply means that water has been continuously supplied any time of the day. The rest (16.7%%) were constrained with water usage or there were some restrictions interruptions in the daily water supply. For instance, water supply is only up to 12 midnight and will bring back at 6:00 a.m.

There are three reasons for no limitations on water usage. First, water supply in their areas are relatively abundant and service of the water supplier is excellent. Second, water rates are relatively cheap and the amount of water corresponding to the minimum rate is more than enough for their consumption every month. On the other hand, those with limits in water consumption are having problems paying the minimum charge or water supply service is very limited in their place.

3.4.4. Adequacy of water supply

Most of the respondents (83.7%) revealed that the quantity of water available from their sources during the dry season was rated adequate to extremely adequate. The dry season starts in late November and ends in May. The rest reported that the available water during this season was inadequate to extremely inadequate. During rainy or wet season, which starts in June and lasts till October, water was found to be more adequate since 89.7% of the households reported it to be adequate to extremely adequate. This means, therefore, that water supply in most areas surveyed is adequate and not yet a problem to most of the households.

3.4.5. Alternative sources of water supply

Data show that water supply coming from water districts and other water suppliers has been adequate, more than enough, and seldom fail to provide water services to the majority of the respondents. When asked if they have other sources of water supply when the water systems in their respective community fail to provide supply or when there is a shortage of tap water, 48.9% asserted that they have alternative means. About 29% of them sourced out from deep wells or *balon*, 13.6% mentioned springs, while the rest mentioned other

sources. These sources were from water purifying stations and other private groups, as well as public and private artesian wells.

As regards the accessibility of the water source, they reported a distance ranging from10 m to as far as 1,500 m or 1.5 km. It is still very fortunate that most of them are near the alternative water source. About 89.7% said that they have to walk a distance between 10 m to 100 m to reach the alternative source of water. This number shows that the alternative source of water is very near the residence of the respondents. Others, however, walk a distance of 500-1500 meters from their residence to fetch water from the river springs up to three times a day while some are living very near water springs and rivers that are used as other sources when supply from water districts becomes problematic.

3.4.6. Quality of water from the source

Still, majority of the respondents or about 69.7% confirmed that the quality of the water direct and from the alternative source is potable and did not use any form of mechanism to filter the water. While they have adequate supply of water about 30.3% of the respondents find their water not drinkable or potable, even those coming from the water district. In the event of shortage or temporary shut off of water system due to brown out and other reasons, a few revealed that the water supply from alternative sources is not potable, especially those coming from deep wells or *balon* and private artesian wells.

They have conventional ways of filtering the water they drink or use in cooking. Basically, most of them use simple filtering system like the use of clean cotton-made textile (old T-shirt) and a small simple equipment installed on a faucet. Others use water filters sold in department stores to further filter the water. Some households incur additional expenditures on filtered water for drinking. Such expenditures add up to their daily expenses which can be about 30 to 35% of their water utility bills. A container costs around PhP25 toPhP30 and they can consume 3 to 4 containers a month. This suggests that households also spend a substantial amount on filtered water which explains the proliferation of "drinking water stations" all over the community. This further implies that households find water supply not safe for drinking, hence, filtered water consumption reflects lifestyle choice and not environmental concerns (York et al., 2011).

3.5. Management of water supply

3.5.1. Water service providers

In general, water requirements of the households are provided by the regulated piped system of the Water District (Table 7). A water district is a local corporate entity that operates and maintains a water supply system in one or more provincial cities or municipalities. It is established on a local option basis and is classified as a government-owned and controlled corporation or GOCC. In general, a water utility is a natural monopoly. Economic theory asserts that unregulated private utilities, be it electric, water, or telephone, set the price of their products at the level where they can obtain monopoly profit.

Table 7. Management of Water Supply in Upland Cavite

Management of Water Supply	Frequency n = 469	Percent
Water Service Providers		
Water district	378	80.7
Cooperative	8	1.7
Barangay	49	10.4
Private Water Operators	34	7.2
Satisfaction With the Management of the Water System		
Yes	362	77.2
No	107	22.8
Water Management Service		
Poor	17	3.6
Fair	40	8.5
Satisfactory	169	36
Very Satisfactory	213	45.4
Excellent	30	6.4
Mean = 3.42		
Frequency of Management Failure		
Not at all	82	17.5
Seldom	191	40.7
Sometimes	128	27.3
Often	43	9.2
Very Often	25	5.3
Mean = 2.35		
Response to Complaints		
No	202	43.1
Yes	267	56.9

Majority of the respondents or about 378 (80.7%) said that the respective water districts of their municipality or city were responsible for the day to day management water supply in their area. On the other hand, 49 or 10.4 % of the respondents said barangay water districts manage their water supply. The remaining 42 or 8.9% of the respondents mentioned that other water suppliers like cooperatives and private water operators are their sources of water.

3.5.2. Satisfaction with the management of the water system

Satisfaction on the management of the water system will depend on whether the water providers supply the water regularly and meet the demands of the family. So far, majority (77.2%) of the respondents are satisfied with the management operation of their respective water service. It is worth noting that only few of them (22.8%) are not satisfied with the management of their water supply service. The reasons could be intermittent water supply and poor water quality. In some instances, there were few respondents who complained of

discoloration of water at some period of time. Only less than 10% of the respondents have issues about the health problems caused by poor water quality.

3.5.3. Functionality of water service management

Obviously, a big majority considered the water management service as very satisfactory sharing 45.4% of the respondents while 36% rated them as satisfactory. It seems plausible that the Water District, which is the main supplier of water in the survey areas is functioning excellently because they are providing water regularly. Some households also surmised that other water suppliers are functioning very well in supplying water, hence, they are satisfied with their services. Only a small percentage responded that the services of their water supplier is fair (8.5%) and poor (3.6%). About 6.4% of the respondents rated the functionality of the management as excellent.

In general, most respondents see that their respective water districts are doing their job well and are satisfied with the services offered to them with a mean rating of 3.42. In fact, a good number of respondents asserted that overall, the management was not remiss of their job. Only few of them said that management often or very often failed to do their work throughout the year. This can be attributed to the efficient management of these local water districts in upland Cavite.

When asked how often the water district fails in their responsibility in supplying water, 40.7% responded *Seldom*, 27.3% rated it as Sometimes, while only few experienced it *Very Often* (5.3%). Basically, respondents mentioned that the quality of supplied water is very acceptable and they have no fear that they might get sick consuming the water supply.

3.5.4. Response to complaints

More than half (56.9%) of the respondents reported that the personnel of their respective water districts responded quickly to their complaints while the rest said otherwise (43.1%). Those who opined positively based their response on how fast the water district's personnel responded to their complaints. At the same time, the personnel would have time checking the connections and other potential complaints of the households. When they were asked if there is regular monitoring of the connections and the water quality, they revealed that there is no regular monitoring due to rare appearances made by water district's personnel.

3.6. Cost of water supply

Water rates vary across municipalities and across service providers, with the private utilities setting the price of water. Since water utilities are monopolistic in nature, they are deriving monopoly profits although, not in all cases that they set the price above average cost. Table 8 shows the water rates per cubic meter and the minimum charge across municipalities as of June 30, 2016. The highest minimum rate is in Tagaytay amounting to 254/m^3, followed by Silang (PhP229), and Amadeo (PhP211), with General Emilio Aguinaldo charging the lowest minimum rate at PhP163. On average, the households consume about 20.61 m^3 per month with the

highest average consumption in Tagaytay City (27.77 m^3) and the lowest in General Emilio Aguinaldo (15.22 m^3).

Table 8. Water Districts Rates Per Cubic Meter in Upland Cavite

Municipality	Number of Wells	Number of Springs	Minimum Charge	Average Consumption Cubic Meter/Month
Alfonso	-	-	n. d.	n. d.
Amadeo	-	211	17.66	n. d.
General Emilio Aguinaldo	-	2	163	15.22
Indang	10	2	188	20.66
Magallanes	-		n. d.	n. d.
Maragondon	5	-	168	23.23
Mendez	3	-	195	19.15
Silang	68	2	229	20.59
Tagaytay	15	3	254	27.77
Ternate			n. d.	n. d.
Total/Mean	101	9	201.14	20.61

Source: Philippine Water Districts (2014)
Note: n. d. means no data

Table 9. Monthly Water Payment of Households in Upland Cavite

Monthly Water Payment (PhP)	Frequency n = 469	Percent
50 - 100	14	3.0
101 - 150	33	7.0
151 - 200	155	33.0
201 - 250	37	7.9
251 - 300	79	16.8
301 - 350	28	6.0
351 - 400	43	9.2
401 - 450	9	1.9
451 and above	71	15.1

Mean = 311.78
SD = 199.20
Min = 50.00
Max = 2,000.00

For the monthly payments, Table 9 shows that majority or 33% of the respondents are shelling out PhP151 to 200 per month, followed by 16.8% who are paying PhP251 to PhP300, and 15.1% who are paying PhP451 and above. On average, households pay PhP311.78 for monthly water consumption with payments ranging from PhP50 to PhP2,000. Those who are paying as low as PhP50 and as high as PhP2,000 are abnormally few. They are those who are living alone while others are those who have their own well, hence, they are not

maintaining a monthly water bill. Those who are paying as high as PhP2,000 are those who have bigger household size and those who maintain some businesses that require a lot of water, such as those involved in agriculture, pet shop, and car wash.

3.6.1. Opinion about the cost of water consumption

Water as economic good is relatively cheap and is still affordable by many households. But as water becomes scarcer, the price will escalate as water distribution to burgeoning population becomes more difficult. As discussed previously, water supply in Upland Cavite is still adequate and still meeting the households' water demand. Although an interview with their respective water districts revealed that extracting water is getting more difficult, still they find a way to supply the water requirements of the households. During the time of the survey, the Managers of the Water Districts asserted that "groundwater water extraction is now strictly prohibited throughout Metro Manila and certain parts in Bulacan and Cavite provinces is prohibited because the groundwater levels in these areas are already critical". It can be noted that severe water extraction from groundwater is also causing seawater intrusion into groundwater as well as land subsidence, which could damage buildings, bridges, and highways due to sudden changes in ground elevation (CNN Philippines, 2015).

Table 10. Opinion About the Cost of Water Consumption of Households in Upland Cavite

Opinion	Frequency	Percent
High	119	25.4
Reasonable	320	68.2
Low	20	4.3
Very Low	10	2.1
Total	469	100

A majority or about 68.2% of the respondents believed that the water rates are reasonable while 25.4% found the rates high as shown in Table 10. Most of those who answered high are the low-income respondents with relatively. For the high-income respondents, they find it low to reasonable. The water rates as shown in Table 9 vary across municipalities. It was also reported that Tagaytay City has the highest water rate while General Emilio Aguinaldo has the cheapest. It seems plausible because the former is a tourist and a highly commercialized city while the latter is laid back and households are usually devoid of the cosmopolitan way of life.

3.7. Factors affecting water usage

From the results of the regression analysis, it was revealed that monthly income was the most significant variable ($p < .01$) which implies that an increase in income by PhP1,000 per month will increase water consumption by 9 gallons or 34.065 liters (Table 11). This conforms with the findings of Arbués and Villanua, 2006; Gaudin et al., 2001; Hoffmann et al., 2006; Renzetti, 2002; Romano et al., 2014) that domestic water

consumption is positively correlated with income. It may be because higher levels of income means an increase in living standards, which could imply an ownership of vehicles which requires regular car washing, higher quantity of water-consuming appliances and a higher probability of the presence of high-water demanding outdoor uses such as lawn gardens and swimming pools (Cole, 2004). Household size or the number of people living in a household was also found to be significantly affecting water consumption ($p < .05$) (Arbués et al., 2003; Hamilton, 1983; Höglund, 1999; Nauges and Thomas, 2000, Renwick and Green, 2000; Zhang and Brown, 2004). The higher the number of people living in a household is, the larger the aggregate demand is supposed to be. Nonetheless, economies of scale regarding the optimization of water use could not be generally achieved in small households (Arbués et al., 2000). In addition, Arbués et al. (2003) and Zhang and Brown (2005) argued that there is an optimum household size , and that beyond this threshold, these economies of scale tend to vanish. and type of house were also found to be significantly affecting water consumption ($p < .05$). It is expected that the number of household members is an increasing function of water consumption. However, Aho et al. (2016) revealed otherwise. They found that household size and number of children negatively affected per capita water consumption.

Table 11. Regression Results for the Factors Affecting Household Water Consumption

Variable	Coefficient	Standard Error	t-Value	P-Value
Constant	269.788	182.8	1.476	0.142
Pw	0.563	0.289	1.952	0.053
HS	51.619	22.165	2.329	0.021
A	-0.058	0.15	-0.386	0.701
HI	0.009	0.003	2.948	0.004
Ed	4.054	2.129	1.893	0.063
Gen	7.325	3.333	2.198	0.032
HT	231.171	107.422	2.152	0.033
LA	0.002	0.003	0.457	0.649
FArea	0.021	0.012	1.81	0.076
R^2 = .318				
F = 4.454				
Prob = .000				

Gender is another variable that was found to be significantly affecting water consumption in Upland Cavite ($p < .05$). This implies that women are indeed consuming more water than men by 7.32 liters. This is quite logical since women are mostly staying at home. This conforms with the result of Hussien, Memon, and Savic (2016) that per capita water consumption increases with the number of adult female members in the household. Moreover, the type of house which was categorized as permanent, semipermanent, and temporary also causes variation in water consumption. Practically, those who are occupying permanent housing consume more water than the rest who live in other types of house structure.

This paper also estimated the price elasticity of water demand. It was revealed that the water cost elasticity is 0.302 which implies that the households are not responsive to an increase in their monthly water cost. Moreover, the elasticity coefficient is positive which explains that an increase in the cost of water consumption by PhP10 will still increase household water consumption by 3.2 liters. Indeed, water demand is inelastic and considered as a source of life of the people.

4. Summary, conclusions, and policy implications

In general, upland households find their water supply still abundant and potable since they are not yet encountering any difficulty in terms of water access even during the dry season. Majority were very satisfied with the services of the water districts while only few were not satisfied with the water management due to intermittent water supply and poor water quality. At any rate, however, water has been continuously supplied any time of the day in most of the upland areas. For those who find their water not drinkable or potable, they are buying filtered water from water stations which explains the proliferation of "drinking water stations" all over the community.

Water rates vary across municipalities and across service providers with a mean water usage cost of PhP311.78 per month which they found to be still reasonable. On average, the households consumed about 20.84 gallons per day (78.88 liters) or 625.2 gallons per month (2,366.82 liters). This is equivalent to daily consumption of 446 liters per household or 2.3658 m^3/capita per month or (13.39 m^3 per household). They primarily use water for agricultural purposes such as irrigation, cleaning, and washing of farm produce.

It was revealed that the water cost elasticity is inelastic and positive which implies that the households are not responsive to an increase in their monthly water cost. Moreover, this suggests that an increase in the cost of water consumption will still increase household water consumption. This is quite logical and in conformity with the literatures. Water is considered as a source of life and households prioritize this good more than anything else. In addition, water is relatively cheaper in comparison with other expense items, hence, households are not so responsive with the water rates change.

Other variables that positively affect water consumption are monthly income and household size. These variables are increasing function of the water usage such that those with higher level of income and bigger household size would have the tendency to consume more water. Moreover, as consistent with the literature, women are indeed consuming more water than men since women are mostly staying at home. Hence, per capita water consumption increases with the number of adult female members in the household. The type of house which also causes variation in water consumption, wherein those who are occupying permanent housing, consumed more water than the rest who live in other types of house structure.

The households in Upland Cavite still find water supply as adequate but not in the Municipality of Indang owing to the issues on water extraction in the main river source in Barangay Kayquit. The respective water districts revealed that extracting water is getting more difficult, though they can still find a way to supply the water requirements of the households. Since household size positively affects water consumption, increase in the upland population will critically affect sustainability of water supply. Groundwater water extraction is now

strictly prohibited not only in other parts of the country but also in Cavite because the groundwater levels are already critical. Severe water extraction from groundwater will cause seawater intrusion into groundwater as well as land subsidence, which could damage infrastructures due to sudden changes in ground elevation.

The Cavite Provincial Government should continue to demonstrate its commitment to adopt an integrated approach for sustainable development and protection of water points in Cavite especially in the upland areas. There is a need, therefore, to assess various sectoral plans and programs on water sustainability at the municipal level to facilitate coordination and management interventions, not only in the upland areas but at the lowland areas as well. The water crisis challenged being experienced by the Indang populace is an example of a remiss on the side of the government in terms of monitoring the water resource. Building a partnership with the communities should be strengthened to improve the people's problem solving capacities which would lead to water sustainability. They can coordinate in planning, managing, maintaining and protecting their respective coastal areas and rivers, riverbanks and easements, as well as the mangroves and other natural resources in the watershed.

The looming water crisis is the result of rapid population growth and destruction of natural resources. Hence, an aggressive community education and campaigns to make the public aware of the Cavite's critical water supply problem in the very near future should be undertaken by the local government. This can be complemented by tree planting activities to sustain the water supply in the province. The households or the community should realize that once the water supply becomes very critical, water distribution rates will be more expensive. An increasing population will be competing with and chasing after meager water supply which will result in shortage and increase in the price of water. Communities will choose to consume at a given higher price which will make them worse off. If they will feel the need for safe and low-priced potable water supply, then they will become more responsive to the community plans and projects towards water sustainability development. Literatures have shown that water supply sustainability is positively associated with community participation where water users are involved in planning, implementation, maintenance, and protection of water supply systems (Davis and Liyer, 2002; Beyene, 2012; Haq, Hassan, and Ahmad, 2014).

From the foregoing results, the challenge in water sustainability research needs is strong collaborations among disciplines like environmental science, ecology, engineering, and economics with emerging areas of climate change, natural resource economics, education, and human dimensions of decision making. Hence, there is a need to enhance data collection for improved forecasting and water resources operations. A study on the determinants of water use in the agricultural, domestic, commercial, public, and industrial sectors can also be done to develop more efficient water use and optimize the economic return for the water used.

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