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Water Demand Projections for Metro Manila:

A Critical Review*

Cristina C. David

Projections of demand for urban water are key elements in water supply planning, intersectoral allocation decisions, and price policy formulation. There is widespread belief, however, that demand projections for urban water tend to be overstated (Young 1996, Munasinghe 1992).

In the United States, for instance, the 1970 forecast of a large growth in water demand for the 1990s and beyond was in sharp contrast to the decline in actual freshwater withdrawal experienced after 1990 (Rogers 1993, Solley et al. 1993). In Europe, a declining trend in water demand has also been observed in response to the wider application of metering devices and higher water charges (Bower et al. 1984). Among industrial users in developed countries, stricter regulations on water pollution coupled with higher effluent taxes have promoted the adoption of water-saving technologies and practices, such as recycling, that lower water consumption.

According to a recent World Bank study, demand projections of urban water of developing countries appeared to have been overstated based on the evaluation of 54 water supply projects completed between 1966 and 1980 which showed that more than 80 percent of the projects failed to attain the forecast number of new connections and level of water sales as envisioned in the feasibility studies (Garn 1987). Further analysis, however, also showed divergence in the expected and actual levels of water production and rate of nonrevenue water for the same projects (INU 1988). Thus, what could have been overstated were the projections of effective water supply and not necessarily the water demand. Alternatively, the price of water or its connection fee may probably have been set too high.

In the Metro Manila case, water demand projections conducted for the purpose of supply planning cannot be interpreted as overstated. In fact, the Metro Manila Water and Sewerage System's (MWSS) distribution is able to provide water only to about 60 to 70 percent of the

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total households and its service is generally characterized by low pressure and intermittent supply which average at only 16 hours per day. Whether the demand projections for the MWSS service area are overstated or understated may be determined only on the basis of a detailed evaluation of the methodology of estimation and the quality of data and assumptions used in the estimations.

The purpose of this paper is to evaluate the methodology and results of the various water demand projections undertaken since 1990 for the MWSS service area which consists of all the municipalities and cities in the National Capital Region and Rizal and the 5 municipalities and one city in Cavite.[1]

Demand Models

The basic underlying framework for demand projections are the behavioral models of water users. There are two categories of users characterized by two different theories of behavior: the households who use water to maximize their utility and the firms (industrial, commercial, or institutional) which use water in their production and administrative operations to maximize profits.

Household demand

Following the consumer's theory of utility maximization given an income constraint, household demand for water (D_H) may be specified as:

$$(1) \qquad D_H = f(P_W, P_O, Y_H, HS, t_H, Z)$$

where P_W is the price of water; P_O is a vector of prices of other related (substitutes or complements) goods; Y_H is household income; HS is household size; t_H represents a vector of household technologies affecting water use such as types of water closet, showers, and washing equipment; and Z is a vector of other variables affecting water demand such as season, weather or climate, or type of housing. For water demand of individual household members, D may be defined as per capita demand and HS may just be omitted from the equation. For aggregate household demand, D would refer to total households and HS would be replaced by the population number within the area coverage.

Firm demand

For industrial firms, water is an input in the production process and administrative support services. Based on the producer's theory of profit maximization, the firm's demand for water (D_I) is a derived input demand function specified as follows:

$$(2a) \qquad D_I = f(P_Q, P_W, P_i, T)$$

where P_Q is output price, P_W is price of water, P_i is a vector of prices of other inputs, and T represents technology characteristics of the production process. If water use is assumed to be separable from other inputs, the water demand function may simply be specified as a function of Q, the level of output, its own price, and technologies related to water use.

It should be noted, however, that industrial water use may involve four separate but interrelated decisions undertaken by the firm, namely:

- the quality of water to be purchased,
- the degree of purification and treatment required,
- the amount of water to be recirculated, and
- the form and quantity of water to be discharged

(Renzetti 1992).

Therefore, three other water-related prices are relevant besides P_W and the demand function is now written as:

$$(2b) \qquad D_I = f(P_W, P_t, P_r, P_d, Q, t)$$

where P_t is the unit cost of water treatment, P_r is the cost of water recycling, and P_d is the unit cost of water discharge or the effluent tax, if any, and t is a variable denoting availability of water-saving technologies. Presum-

[1] *These are Bacoor, Cavite City, Imus, Kawit, Noveleta, and Rosario.*

ably, water is also an input in the processes of service provision by institutions like commercial establishments, schools, hospitals, and other similar institutions. Thus, they would be expected to have similar basic structures of water demand.

Demand Projections

Problems encountered

Ideally, projections of water demand are based on empirically-estimated water demand functions of the different types of users and accurate assessments of the changes in the factors affecting water demand over time. Demand projections for households should logically be estimated separately from industrial firms and other users. An aggregate household demand function, which implicitly assumes a common demand response to changes in price, income, and other factors across household population, may be an adequate basis for projections of household demand. For industries and services, however, the parameters of water demand function as well as growth rates of output and water-related technologies tend to differ significantly across their various types. Thus, the use of more disaggregated demand models in their projections is called for.

In practice, demand projections often use relatively simple methodologies because of the limited availability of data, time constraint, and dearth of prior empirical analysis and econometric estimation of water demand functions in developing countries. In some cases, the projection methodology suffers from faulty conceptualization and assumptions, thus leading to misguided policy implications.

With the exception of David and Inocencio's (1996a) water demand study for Metro Manila based on a cross section of 500 households, there has been no rigorous characterization and econometric estimation of household water demand functions. Recently, Ebarvia (1997) estimated a water demand function for industry based on a cross section survey of 100 firms. However, there has been no similar study on commercial users. Although the MWSS Corporate Planning Office uses its own estimates of price, income, and output elasticities which have been subsequently adopted in other studies, there has been no published explanation of the methodologies used in the estimation of these parameters so as to evaluate their accuracy.

Demand analysis and projections have been greatly hampered by the lack of time series data on actual water consumption by households, industrial and commercial establishments, and other users. Available annual data of water use pertain only to the sales of MWSS water to households, industries, and commercial establishments. Yet, the most recent estimates of groundwater abstraction (JICA 1992) indicate that in 1990, private wells accounted for more than 40 percent of total water consump-

Table 1
Estimated Water Consumption by Type of Use and Source of Water Supply in the MWSS Service Area, 1990 (000 cum/day)

	Households	*Industry*	*Commercial*	*Total*
MWSS[a]	785.0	74.6	303.7	1,163.3 (58)
% of MWSS	68	6	26	
% of user	69	19	76	
Private wells	379.0	354.9	106.8	840.7 (42)
% of PW	45	42	13	
% of user	31	81	24	
Total	1,164.0 (58)	429.5 (21)	410.6 (20)	2,054.4 (100)

[a]Refers to billed water only.
Note: Figures in parenthesis are percentage shares to total.
Source of basic data: JICA 1992.

tion and as high as 80 percent of industrial consumption (Table 1). Moreover, the estimated rate of groundwater abstraction of 930,700 cubic meter per day (cum/d), where 840,700 cum/d is by private wells and 90,000 cum/d by MWSS, has been way above the estimated recharge rate of 523,000 cum/d, indicating that substantial groundwater mining has been taking place in the past three decades (Munasinghe 1992, JICA 1992, NHRC 1993, and Haman 1996).

It should be emphasized that the rate of groundwater abstraction must have risen dramatically since then. Between 1990 and 1996, MWSS water sales increased at an annual rate of only 2.1 percent. In contrast, the growth rate of population in the service area was nearly 4 percent, which suggests that a significant growth in the proportion of water consumption must have been supplied by private wells. The sales figure also suggests that the volume of MWSS nonrevenue water that is actually lost through meter tampering, illegal connections and others has likewise risen substantially.

There are reasons to believe that the reported sales of MWSS water do not fully reflect the actual use of water produced by MWSS. *First*, public faucets and other legal connections such as those for fire protection purposes are not billed. In 1995, unbilled water was estimated to be around 360,000 cum/d, representing almost 30 percent of billed water and 13 percent of produced water.[2] *Second*, part of the nonrevenue water due to tampered meters and illegal connections represents water that has actually been utilized although there are no definitive or official estimates of this ratio. The study of David and Inocencio (1996a), however, showed that approximately 30 percent of households in the MWSS service area depend on private water markets whose water supplies originate mostly from MWSS pipes or connections but are unbilled. Preliminary results of the industry and commercial water use survey currently being conducted by this project also indicate significant use of MWSS water by private water vendors.

[2]The Binnie-Thames study (1996) reported that for 1995, the total water delivered by MWSS to customers, including public faucets and legally unbilled water, is estimated at 1,565 mld (58 percent of water produced). The volume billed was 1,207 mld, of which 1,098 mld was the amount effectively paid for by revenue collected, with allowance for arrears.

Review of previous demand projections

Five water demand projections for the MWSS service area had been conducted since 1990, with each one undertaken as a component of water supply planning or operational strengthening studies of the MWSS central distribution system. Only three of these projections are substantially different: the 1992 assessment of groundwater development (JICA92) and the 1996 development of a master plan for water and sewerage system (JICA96), both funded by the Japanese International Cooperation Agency or JICA, and the 1995 version of the regular demand projections conducted by the MWSS Corporate Planning Office (Corp95). The other two are studies on the MWSS Operational Strengthening (MOSS) and water supply improvement project (WSIS) funded by the Asian Development Bank (ADB), which simply modified the household demand projections of the Corp95 while leaving the projections for industrial and commercial establishments basically the same.

In all of the above studies, separate projections were made for the household, industrial, and commercial sectors but none considered the water demand of government agencies. The studies were either silent on future changes in water prices or simply assumed constant prices during the projection period.

With the exception of JICA92, demand projections pertained to demand for MWSS water and were estimated by assuming a rate of future expansion in the MWSS coverage area and limiting the base year estimate to the consumption of MWSS water. The 1992 JICA study is unique in the sense that water demand is first projected regardless of source, whether MWSS or private wells. Second, the level of projected demand expected to be supplied by MWSS is separated from that to be provided by private wells.

Table 2
Assumed Rates of MWSS Service Coverage of Household Connections (HH) and Public Faucets in the Corp95 and JICA96 Demand Projections
(In percent)

	Corp95		*JICA96*	
	Total[a]	*HH*	*Total*[a]	*HH*
1995	67	60	67	60
2000	93	84	74	67
2005	99	90	80	74
2010	97	85	88	83
2015	93	80	95	90

[a]Includes coverage of household connections and public faucets.

Household demand

The future household demand for water in all the demand projections was computed by multiplying projected levels of population by the projected average daily per capita water consumption. In the JICA92 study, population was defined as the total population in the service area. In the other studies, population referred to the number of people expected to be served by MWSS by assuming a certain expansion rate of service coverage (household connections and public faucets) based on a notion about the pace of future water supply expansion projects. Table 2 indicates significant differences in the trends in service coverage between the Corp95 and JICA96 projections. Whereas JICA96 assumed a gradually increasing coverage of household connection and decreasing reliance on public faucets, the Corp95 assumed a sharply rising coverage of household connection between 1995 and 2005 that then declines until 2015 and an increasing coverage of public faucets.

Separate projections were made for the general population (those with household connections) and the blighted population (those who are dependent on public faucets) by assuming different growth rates of population and of per capita water demand. In JICA92, the ratio of the blighted to total population was arbitrarily assumed to be constant at 20 percent between 1995 and 2010. This ratio was assumed to be much lower among MWSS consumers in the CORP95 and JICA96 studies.

Population. Accuracy in the household demand projections depends critically on the reliability of population projections. Unfortunately, because of the relative importance of migration rates in the growth of population in metropolitan areas and the difficulties in predicting such movements accurately, population projections have often been subject to significant errors. Indeed, a comparison of actual and projected rates of population growth between 1960 and 1995 within the MWSS service area shows a significant underestimation which could most likely be true for other projections beyond 1995 (Table 3). The two JICA studies used higher rates of projected population growth (2.4 percent) compared to the other studies which were based mainly on “moderate” official NSO projections. However, these relatively high estimates have proven to be even lower than the actual population growth of 4.0 percent between 1990 and 1995. The low 3.3 percent population growth rate in the 1980s may have misled analysts. On hindsight, though, this was actually below trend and was caused by the drop in the net in-migration rates due to the contraction of the economy during this period.

The potential for accelerated in-migration in the fringes of the MWSS service area continues to be strong, as the rate of industrialization is expected to increase and be more geographically dispersed with the rapid infrastructure investments in the CALABARZON area. In fact, successful development of urban water supply in these areas will further promote industrialization and in-migration. Fears that land supply would be a constraint to in-migration seems unwarranted as Cavite and Rizal continue to be less densely populated compared to the more urbanized areas in the NCR (Table 4).

Per capita demand. Estimates of per capita water demand presented in Table 5 appear to be understated, particularly in the base year of 1995, primarily because the base levels used for both the general and the blighted population have been estimated under a situation of severe water rationing. The average per capita water consumption of households (about 130 to 140 liters per capita per day [lcpd]) used in most of the studies and based on MWSS billing records reflects a suppressed demand at the average income levels and at current water prices. The David and Inocencio (1996b) study estimates the average unsuppressed water consumption based on households with 24 hours MWSS service at 200 lcpd. This figure is still higher than the JICA92 assumption which was already adjusted upwards to take into account the suppressed demand by using the average water consumption in high-income municipalities.

While the assumed per capita water demand for the blighted population may be a reasonable estimate of actual consumption given their income, the lower levels can be explained in part by the very high implicit prices of vended water paid by poor households without house connections. Thus, strictly speaking, water demands of the general and the blighted population should not be simply added together because they refer to two very different prices.

The changes in the per capita water demand over time would depend on the estimated price and income elasticities, and the projected changes in per capita income and water prices. All the projections except for JICA92 relied on the estimated price and income elasticities provided by the CORPLAN office which, for the general population, turned out to be essentially the same as David and Inocencio's estimates of 0.3 and -0.2 for income and price elasticities, respectively. However, lower estimates of both elasticities were used for the blighted population, which should be expected to have greater elasticities of water demand, especially with respect to income elasticities. In any case, water prices were assumed to remain con-

Table 3
Actual and Projected Growth Rates of Population in the MWSS Service Areas
(In percent)

	Actual	*Projected*						
		NSO80[a]	*JICA92*	*Corp95*	*NSO90*[b]			*JICA96*
					Low	*Med*	*High*	
1960-1970	4.896	-	-	-	-	-	-	-
1970-1980	4.212	-	-	-	-	-	-	-
1980-1990	3.263	3.007	-	-	-	-	-	-
1990-1995	4.016	2.472	3.043	2.482	-	-	-	-
1995-2000	-	2.071	2.208	2.082	2.059	2.267	2.444	2.412
2000-2005	-	1.732	1.868	1.742	1.712	1.964	2.064	1.951
2005-2010	-	1.419	1.540	1.427	1.624	1.672	1.862	1.746
2010-2015	-	1.203	-	1.209	1.435	1.445	1.602	1.508

[a] NSO80 and NSO90 refers to the official population projections estimated after the 1980 and 1990 population census by the National Statistics Office under the National Economic and Development Authority.

[b] Used in the MWSS Operation Strengthening Study (MOSS).

Table 4
Land Area, Population and Population Density of Cities and Municipalities in the MWSS Service Area, 1995

	Area (sq.km)	Population (000)	Population Density (000/sq.km)
MWSS Service Area	2,125.6	11,424.6	5.4
NCR	636.0	9,453.0	14.9
Manila	38.3	1,654.8	43.2
Mandaluyong	26.0	286.9	11.0
Marikina	38.9	357.2	9.2
Pasig	13.0	471.1	36.2
Quezon	166.2	1,989.4	12.0
San Juan	10.4	124.2	11.9
Calookan	55.8	1,023.2	18.3
Malabon	23.4	347.5	14.8
Navotas	2.6	228.0	87.7
Valenzuela	47.0	437.2	9.3
Las Piñas	41.5	413.1	10.0
Makati	29.9	484.2	16.2
Muntinlupa	46.7	399.8	8.6
Parañaque	38.3	391.3	10.2
Pasay	13.9	408.6	29.4
Pateros	10.4	55.3	5.3
Taguig	33.7	381.4	11.3
Cavite	185.7	659.1	3.5
Bacoor	52.4	250.6	4.8
Cavite City	11.8	92.6	7.8
Imus	97.0	177.4	1.8
Kawit	13.4	57.0	4.3
Noveleta	5.4	27.3	5.0
Rosario	5.7	54.1	9.5
Rizal	1,303.8	1,312.5	1.0
Angono	26.0	59.4	2.3
Antipolo	306.1	345.5	1.1
Baras	23.4	20.1	0.9
Binangonan	72.7	140.7	1.9
Cainta	10.2	201.6	19.8
Cardona	31.2	35.5	1.1
Jala-Jala	49.3	19.9	0.4
Montalban	312.8	79.7	0.3
Morong	37.6	36.0	1.0
Pililla	73.9	37.1	0.5
San Mateo	64.9	99.2	1.5
Tanay	243.4	69.2	0.3
Taytay	33.7	144.7	4.3
Teresa	18.6	23.9	1.3

stant over the projection period while income per capita was assumed to increase at a high annual rate of 6 percent. The JICA92 study abandoned the preceding methodology because of difficulties in specifying future rates of income growth (recent years show a declining trend) and simply assumed an arbitrary increase in per capita demand from 170 lcpd in 1990 to 200 lcpd by 2010.

Table 6 presents the projections of household demand for MWSS water. The figures in parentheses indicate JICA92 estimates of demand from all sources. Because of adjustments in per capita consumption to correct the suppressed demand and indirect accounting of MWSS coverage, JICA92 provides the highest projected level of household demand. In 1995, it was at least 40 percent higher than the three lowest projections and even twice as much if the demand expected to be supplied by deepwells is included. The projections tended to converge by 2010 because of the assumed expansion of MWSS coverage as stated in the other studies. Note however

Table 5
Projected per Capita Household Consumption of Water in MWSS Service Area (lcpd)

	JICA 92		JICA 95		Corp 95	MOSS	
	HH	PF	HH	PF	HH	HH	PF
1995	188*	35	134**	30	170	127**	30
2000	193	35	148	30	141	143	32
2005	197	35	161	30	145	160	35
2010	202	35	173	30	152	169	38
2015	-	-	186	30	174	180	40

* Based on estimated per capita consumption from MWSS billing records in high income municipalities of Quezon City and Makati.

** Based on the average derived from MWSS billing records of all households.

that by 2010, the JICA92 figures show private wells providing for about 25 percent of projected household demand.

Industry and commercial demand

Projecting industrial and commercial water demand is even more difficult in comparison to household demand. *First*, the methodology is more complicated in concept because of the inherent heterogeneity in behavioral responses across industries and service subsectors. *Second*, there are no empirically determined demand models that may be used to predict the potentially important indirect effects of environmental policies and water-related technical changes. And *finally*, benchmark data on actual water use are quite weak and virtually nonexistent at the subsectoral level.

Only the billed consumption of MWSS water, which is a relatively small proportion of total water use for industry, is available annually. The only available estimate of water use from private wells is for 1990, and there is none for water use supplied by private water vendors. At present, there are no empirical studies that may be used for the adjustment of suppressed demand and unbilled use of MWSS water by these sectors. Consequently, the projections of industrial and commercial water demand would be even weaker and the degree of error more difficult to evaluate than those for household demand. This is quite unfortunate since these sectors account for 40 to 50 percent of total water use.

Table 7
Assumptions on Price and Output Elasticities and Growth Rates of Output and Water Price Used in Projections of Industrial Demand for Water

	Elasticities		*Growth rates in real terms (%)*	
	Price	*Output*	*Price*	*Output*
JICA92[a]	-0.11	0.78		
1995-2000			-1.11	4.1
2000-2005			-0.16	3.4
2005-2010			-0.14	2.9
Corp95[b]	-0.10	0.78		
1995-2000			0	7.5
2000-2005			0	5.6
2005-2010			0	4.2
2010-2015			0	4.2

[a] Assumptions on elasticities and growth rate in water prices were obtained from the Corp95 projections as reported in Haman (1996).

[b] Also adopted in the MOSS and WSIS demand projections.

Table 6
Projected Household Demand for MWSS Water from the Various Studies Conducted during the 1990s (thousand cum/d)

	1995	*2000*	*2005*	*2010*	*2015*
JICA92	1218 (1654)	1596 (1902)	1879 (2145)	2136 (2382)	- -
Corp95	1079	1397	1662	1783	2044
JICA96	863	1201	1585	2090	2635
MOSS	849	1162	1562	1926	2408
WSIS	845	1193	1608	2075	2588

Note: Figures in parenthesis include demand for private well water.

The demand projections for industrial and commercial establishments of the JICA92 study referred to total demand as provided by any source of water while projections in the others pertained to demand that is supposed to be supplied by MWSS. Whereas the JICA92 and Corp95 projections were based on demand models that consider changes in water price (though assumed equal to zero in Corp95) and growth in output, the JICA96 projections were simply derived by assuming historical trends.

Table 8
Assumptions on Price and Output Elasticities and Growth Rates on Output and Price Used in Projections of Commercial Demand for Water

	Elasticities		*Growth rates in real terms (%)*	
	Price	*Output*	*Price*	*Output*
JICA92[a]	-0.11	1.06		
1995-2000			-1.20	3.7
2000-2005			-0.20	3.1
2005-2010			-0.15	2.7
Corp95[b]	-0.11	1.06		
1995-2000			0	7.0
2000-2005			0	5.6
2005-2010			0	4.7
2010-2015			0	4.7

[a] Assumptions on elasticities and growth rate in water prices were obtained from the Corp95 projections as reported in Haman (1996).

[b] Also adopted in the MOSS and WSIS demand projections.

Tables 7 and 8 present the assumptions in price and output elasticities, and real growth rates in price and output as utilized in the various studies for industrial and commercial establishments, respectively. The assumed output elasticity for industrial water demand is comparable to Ebarvia's estimates based on a survey of 100 firms in Metro Manila, but the price elasticity is far below her -0.798 estimate. Compared to other estimates available in developed countries, the assumed price elasticity is also relatively low while the output elasticities are relatively high. Aggregate estimates for U. S. manufacturing (William and Suh 1986) show the average values of price elasticities of water demand ranging from -0.437 to -0.974 and value-added elasticities from 0.176 to 0.296. Estimates of price elasticities for Canadian manufacturing range from -0.152 for plastics and rubber, to -0.588 for pulp and paper (Renzetti 1992). Demand elasticities for industrial and commercial use of water may, of course, differ widely among countries due to differences in the relative size of industrial and commercial subsectors, technological processes, and environmental regulations and policies.

Projections of industrial and commercial demand shown in Table 9 varied even more widely than those for households because of the greater variations in methodology and assumptions used, thus raising major concerns about the reliability of these projections. The use of a simple trend analysis in JICA96, for example, implied a greater demand projection growth for the industrial sector as compared to projections relating water demand to output changes.

Similarly, the JICA92 reported the highest level of projected demand in the early period despite the fact that no adjustments were made for suppressed demand and unbilled use of MWSS water. The fact that the JICA92 study has 1990 as its base year in contrast to 1995 for the other studies indicates a more severe problem of water rationing during the 1990s. The JICA92 results also indicate that the industrial sector will continue to rely heavily on groundwater for more than 70 percent of its water demand.

Total demand

The standard procedure for computing total water demand in the reviewed studies is to add the estimate of water losses (or nonrevenue water) during distribution to the sum total of household, industrial, and commercial demand projections. Table 10 summarizes the total demand projections categorized by revenue and nonrevenue water while Table 11 shows the rates of nonrevenue water assumed in the various studies.

Differences in total demand projections may be explained in part by wide variations in the assumptions of nonrevenue water rates. Thus, JICA92 showed the lowest projected total water demand despite having the highest demand for revenue water because the rate of nonrevenue water was assumed to be only 25 percent in contrast to over 50 percent in 1995 used by the other studies. The revenue and total projections, as in household demand, tend to converge in later years since MWSS coverage was assumed to have expanded. What is disturbing is the implied growth in groundwater use to a little more than 1200 ml (1000 ml from private wells and 210 ml from MWSS or 5 percent of its production) by 2010, according to JICA92 as shown in Table 12, which would definitely exacerbate the problem of groundwater depletion. If MWSS coverage will expand as per the lower rates assumed in other studies, the rate of groundwater abstraction in the future would be even higher.

Summary and Conclusions

Water demand projections for Metro Manila have been characterized by analytical flaws, crude methodologies, and faulty assumptions that led to underestimation of demand projections particularly in the early part of the projections period. These problems have often been caused by limited availability of data, dearth of prior empirical characterization and econometric estimation of demand relationships, and time constraints faced by analysts.

Table 9
Projected Industrial and Commercial Demand for MWSS Water from Various Studies Conducted During the 1990s (thousand cum/d)

	1995	2000	2005	2010	2015
Industry					
JICA92	118	153	188	224	-
	(537)	(635)	(728)	(819)	-
Corp95	79	105	130	153	180
JICA96	76	173	266	272	278
MOSS	76	177	187	193	198
WSIS	76	178	189	195	200
Commercial					
JICA92	455	570	685	801	-
	(574)	(702)	(829)	(958)	-
Corp95	344	493	659	842	1078
JICA96	308	349	385	397	409
MOSS	312	472	549	618	686
WSIS	312	477	558	627	695

Note: Figures in parenthesis include demand for private well water.

Table 10
Projected Total Demand for MWSS Water from Various Studies Conducted during the 1990s by Revenue and Nonrevenue Water (thousand cum/d)

	1995	2000	2005	2010	2015
Revenue					
JICA92	1792	2320	2752	3161	-
	(2765)	(3239)	(3702)	(4159)	
Corp95	1503	1994	2451	2778	3301
JICA96	1247	1723	2236	2759	3322
MOSS	1237	1811	2298	2737	3292
WSIS	1233	1848	2355	2897	3483
Nonrevenue					
JICA92	763	779	909	1042	-
Corp95	1952	1734	1739	1971	2342
JICA96	1524	1656	1619	1552	1424
MOSS	1433	1884	1807	1586	1279
WSIS	1437	1923	1865	1701	1388
Total					
JICA92	2554	3099	3661	4203	-
	(3528)	(4018)	(4612)	(5201)	
Corp95	3454	3728	4190	4748	5643
JICA96	2770	3379	3855	4301	4745
MOSS	2670	3695	4105	4323	4571
WSIS	2670	3771	4220	4597	4871

Note: Figures in parenthesis include demand for private well water.

The basic analytical flaw in the standard procedures of water demand projections stems from a confusion on what the proper demand and supply factors are. This has been reflected in at least two ways, namely:

❄ *Addition of estimated nonrevenue water to demand*. Whereas the proportion of nonrevenue water actually utilized by consumers through tampered meters, illegal connections, theft, unbilled legal connections should be part of actual water consumption and thus demand during the benchmark year, future water losses or unaccounted water which will not benefit consumers should not be considered part of projected demand. Unaccounted water is more appropriately viewed as part of raw water input in the production and distribution of finished water received by consumers. The problem of high rates of nonrevenue or unaccounted water is a supply issue; it raises the cost (or lowers the revenues) per unit of water sold (or produced). By treating nonrevenue water as part of demand, benefit-cost ratios of supply-expansion projections are artificially raised and higher water charges to consumers are promoted over management reforms and investment projects that will minimize the rate of nonrevenue water.

❈ *Projecting MWSS-specific water demand*. Water demand should be specified in relation to a specific quality of water but not necessarily according to source of water, unless source is equated with quality. Consumers' choice of source of supply depends on the relative cost of a specific quality of water such as measures of reliability of supply and pressure. Thus, analytically, water demand should initially be projected regardless of source of water. How much of that demand would be supplied by MWSS or by private wells would be determined by consumers on the basis of relative price.

In all of the projections, the assumed rates of coverage expansion of MWSS seem to have been based on some notion of feasible investments in MWSS water supply expansion projects, rather than on relative cost of alternative supply source or explicit targets with respect to reversing the unsustainable trends in groundwater abstraction. In fact, except for the JICA92 study, no analysis of the implications of such demand projections on groundwater abstraction rates was made.

Contrary to conventional belief, water demand projections for Metro Manila tend to be understated. While the degree of error may be lower beyond the year 2010, the underestimation of the supply gap in the early years does not represent the urgency of instituting reforms to improve efficiency in the MWSS operations, investing in water supply expansion projects, and controlling the groundwater abstraction since the MWSS has failed to provide adequate supply of water to its service area. The consequences of such weak planning are clearly evident with the widespread water rationing and rapid groundwater depletion in the greater Metro Manila area.

Table 11
Assumed Rates of Nonrevenue Water Used in Demand Projections for MWSS Water (In percent)

	JICA92	*Corp95*	*JICA96*	*MOSS*	*WSIS*
1995	30	57	55	54	54
2000	25	47	49	51	51
2005	25	42	43	44	44
2010	25	42	36	38	37
2015	-	42	30	30	28

Table 12
Actual and Projected Share of Water Demand to be Served by MWSS Based on the JICA 1992 Study (In percent)

	Total	*Domestic*	*Industry*	*Commercial*
1990*	58	69	19	76
1995	72	74	22	79
2000	77	84	24	81
2005	79	88	26	83
2010	81	90	27	84

*Actual
Source of basic data: JICA 1992

Accurate water demand analysis and projections are also critical elements in establishing an efficient water price structure which is even more imperative as the government expands private participation in water resource management. This review paper points out the urgent need for greater efforts in developing the basic data requirements, estimating demand functions of various users, and improving the methodology for reliable water demand projections.

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For further information, please contact

The Research Information Staff
Philippine Institute for Development Studies
NEDA sa Makati Building, 106 Amorsolo Street
Legaspi Village, Makati City
Telephone Nos: 8924059 and 8935705;
Fax Nos: 8939589 and 8161091
E-mail: cdavid@pidsnet.pids.gov.ph
jliguton@pidsnet.pids.gov.ph