Part V

Philippine Water Resources

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

A. INTRODUCTION

It is necessary to re-examine the standard national accounting techniques in order to accurately identify and include environmental concerns into macroeconomic analyses and policy formulation. The commonly used measure for growth is the gross domestic product (GDP), of which a number of shortcomings have been raised, e.g., neglect of explicit distribution, and most importantly, environmental degradation and natural resource depletion. To overcome this shortcoming in the currently used accounting system, there is a need to come up with a System of National Accounts (SNA) that yields environmentally adjusted net domestic products. The United Nations has developed a framework referred to as the System of Integrated Environmental and Economic Accounting (SEEA). Its objective is to integrate environmental data sets with the existing national accounts information, while maintaining SNA concepts and principles (Munasinghe, 1993).

This study looks into the existing stocks of water resources in the country and measures the usage of, additions into, and withdrawals from, those stocks, i.e., the determination of both the natural supply and consumption patterns. Accounting for the water resources will identify the areas of possible depletion, as well as the degradation of water quality, factors that will have impacts on the country's development plans and on the people's welfare.

B. WATER RESOURCES

B.1. Characteristics

Ebarvia (1996) enumerates the water's different characteristics, which make it different from the other natural resources. First, water production involves economies of large scale; and these are evident in water storage, conveyance, and distribution. Secondly, water is mobile. Water occurs both as stock and as flow. Surface water tends to flow, evaporate, transpire, and seep, while groundwater exists as a stock usually subject to recharge flows.

Third, water is not entirely consumed by any particular user but by many and varied entities. Lastly, water is nearly a universal solvent. It assimilates water and pollutants.

B.2. Hydrological Concepts

Everything is connected to everything else in an ecosystem, which makes the analysis more difficult (Rogers, 1993). Climate shapes the physical and biological environments (e.g., freshwater ecosystem), which, in turn, influence the state of the atmosphere. It also affects human activities, as well as economic and social conditions (non-climatic factors), which consequently affect the climate, e.g., weather and moisture cycle and other geochemical cycles. There exists a relationship between land use and water resources.

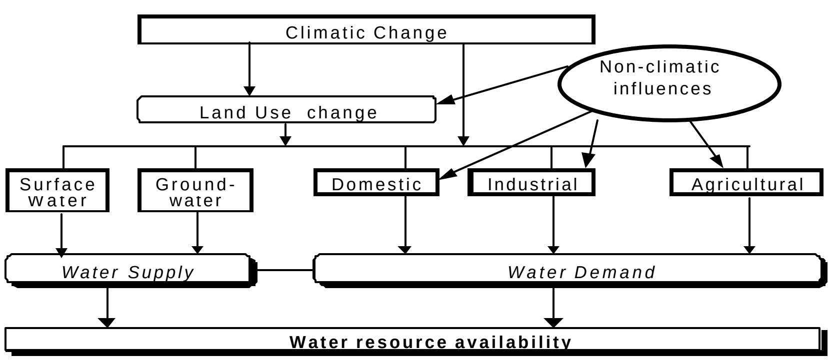
As opposed to the man-made resources, Howe (1979) points out that "traditional usage confines the term [natural resources] to naturally occurring resources and systems that are useful to humans or could be under plausible technological, economic, and social circumstances." Thus, resources are only resources when they are useful to people – when their existence or possession, or use is of value to some human beings, where value includes aesthetic and spiritual values. (Rogers, 1993, p. 75)

The world's supply of freshwater is maintained through the *hydrologic cycle*, which involves the processes of transferring water from the sea and other bodies of water to the land and back to the sea again.

This concept is fundamental to the understanding of the freshwater ecosystem. The first stage in the hydrologic cycle is the *evaporation* of water from the oceans. Through the moving air masses, the vapor is carried over the continents. If the vapor is cooled to its dew point, it condenses into visible water droplets, forming clouds or fog. Under favorable meteorological conditions, these droplets grow large enough to fall on earth as *precipitation*. About two-thirds of the precipitation that reaches the land surface is returned to the atmosphere by evaporation from water surfaces, soil, and vegetation, and through the plant transpiration. The remainder of the precipitation returns ultimately to the ocean through surface or underground channels.

From these two types of sources, groundwater and surface water, available supplies are derived. *Surface water* consists of freshwater that flows and collects in rivers, lakes, or reservoirs. *Groundwater*, on the other hand, collects in porous layers of underground rocks, known as aquifers. A great portion of this water is accumulated over geologic time and is renewed by rain percolation. Because of its location, groundwater cannot be easily recharged (or not at all), once it is depleted. Thus, resource sustainability depends on proper management so that the available water supply will not be withdrawn above the replenishment levels.

Figure 1 shows the impacts of natural (climatic) influences and man-made activities on the availability of water resources.



Source: Newson, 1994 (after Arnell, *et al*., 1990)

FIGURE 1. INFLUENCES ON WATER RESOURCES

Table 1 presents the major differences between the two types of water resources cited above.

TABLE 1. MAIN DIFFERENCES BETWEEN SURFACE WATER AND GROUNDWATER

CHARACTERISTICS	SURFACE WATER	GROUNDWATER
Temperature	Varies with season	Relatively constant
Turbidity, SS (true or colloidal)	Level variable sometimes high	Low or nil (Except in karst soil)
Colour	Due mainly to SS (clays, algae) except in very soft or acidic waters	Due to dissolved solids (e.g. humic acids)
Mineral Content	varies with soil, rainfall, effluents, etc.	Largely constant, generally and appreciably higher than in surface water from the same area
Divalent Iron (Fe) and Manganese (Mn)	Usually none, except at the bottom of lakes or ponds in the process of eutrophication	Usually present
Aggressive Carbon Dioxide (CO_2)	Usually none	Often present in quantities
Dissolved Oxygen (O_2)	Often near saturation level. Absent in very polluted waters	Usually none at all
Hydrogen Sulfide (H_2S)	Usually none	Often present
Ammonia (NH_4)	Found only in polluted water	Often found, without being a systematic index of bacterial pollution
Nitrates	Level generally low	Level sometimes high
Silica	Usually moderate Proportions	Level often high
Mineral and Organic Micropollutants	Present in the water of developed countries but liable to disappear rapidly once the source is removed	Usually none, but any accidental pollution lasts a very long time
Living Organisms	Bacteria (some pathogenic), viruses, plankton (animal and vegetable)	Iron bacteria frequently found
Chlorinated Solvents	Rarely present	Often present
Eutrophic Nature	Often, increased by high temperature	None

Source: Cuaderes, 1995

C. SIGINIFICANCE OF PHILIPPINE WATER RESOURCES

The Philippines is abundantly endowed with water resources. The country has about 421 principal rivers, with drainage areas ranging from 40 to 25,469 square kilometers, 59 natural lakes, numerous individual streams and four major groundwater reservoirs, whose areas range from 6,000 to 10,200 square kilometers, which, when combined with other smaller reservoirs identified, would aggregate to an area of about 50,000 square kilometers.

If one were to add up the available supply of freshwater and compare it with the demand, supply will exceed the demand. Though encouraging, this is also misleading because it masks the impact of the growing demand. However abundant the water resources in the country may be, there is still a tendency for them to become scarce. There is a need to properly manage them so as to optimize their development in meeting the changing patterns of consumption and increased use. Certain areas are already experiencing water scarcity. Due to temporal and geographic variations, water may not be available at the right time and place and seasonal water shortages may, therefore, occur. As a result, the dependable streamflow of water that would be available 80-90 percent of the time will be lower than the total runoff.

Furthermore, changes in the land use patterns, e.g., conversion of watersheds, rapid urbanization, and increasing discharges of untreated wastes and various pollutants also affect the availability of water for human consumption. For example, the rivers in Metro Manila are heavily polluted and are fit only for navigation. Hence, their potential as sources of water supply is then forfeited. Therefore, the Metropolitan Waterworks and Sewerage System (MWSS) has to get its water supply from Angat River, which is located in another river basin. Metro Manila, Cebu, Bulacan, Pampanga, Capiz, and Sorsogon are considered as representative areas where the range of problems, regarding the deterioration of water quality in wells yielding saline water, is present (NEPC, 1987).

The result of the First National Assessment (FNA) on Philippine Water Resource, 1976[1] reveals that the estimated water withdrawals for 1990 was 287 mcm/day. The water withdrawals per sector were as follows: agricultural, 249 mcm/day; industries, 23 mcm/day; domestic and municipal, 15 mcm/day. The projected water demand for the year 2000 is estimated to be 507 mcm/day distributed as follows: agricultural, 402 mcm/day; industries, 83 mcm/day; and domestic and municipal, 22 mcm/day (Villenas, 1996).

The first assessment also reveals that the country has adequate water resources to meet the projected demands up to the year 2000. The water quantity situation is generally good and agriculture would then be the heaviest water user among the water-using sectors. Comparison of surface water flows as against the projected withdrawals showed that only three regions, the Central Luzon, Western Visayas and Central Visayas Regions, will have long-run surface water problem. Rain and groundwater would then extensively be used in Visayas and Mindanao Regions.

[1] The objective of this report is to assess the water supply-demand situation of the country's Water Resources Regions in order to keep the government and the public informed of the current and projected regional and national water and related land resources developments. The assessment was approached basically on a quantitative dimension, by comparing available statistics on water supplies with that of current and projected water requirements. The comparisons were made, using 1975 as the base year and the year 2000 A.D. as the time horizon.

The Water Code of the Philippines and its implementing rules and regulations incorporate the basic water policies. The following are the basic water policies being implemented:

1. The authority and responsibility for the control, conservation, protection, development, and regulation of the utilization of the country's water resources belong to the state. These water resources include, among others, groundwater, surface water, and water in the atmosphere.

2. Priorities in the use and development of water resources shall reflect current water usage and also be responsive to the changing demands for water occurring under developing conditions.

3. All water development projects shall be undertaken on a multipurpose concept, using the river basin, or closely related river basin approach. Single-purpose projects shall be implemented only when they are compatible with the multipurpose concept and can be incorporated into the contemplated basin-wide development program.

4. The identifiable beneficiaries of water resources development projects shall bear an equitable share of repayment costs, commensurate with the beneficial use to be derived from the project.

5. A continuing program of basic data collection, manpower development, and research shall be maintained since these are indispensable components of water resources development.

6. The NWRB shall formulate the guidelines, procedures, programs, rules and regulations to implement the policies on water resources.

D. CONCEPTUAL FRAMEWORK

D.1. Scope and Coverage

This study on water resources accounting is limited to freshwater only. Coastal water will be dealt with after the freshwater asset accounts are completed. Marine water in the Philippines is identified to have more use for navigation and, therefore, not considered in this preliminary undertaking.

The compilation of the asset accounts for water resources covers the physical, i.e., both the quantitative and qualitative aspects of water, and the monetary accounts. The accounting period for the groundwater resource started in 1988 and ended in 1994, while only the years 1988 to 1993 are covered for the surface water.

D.2. Asset Account

D.2.1. Physical Accounts

Figure 2 shows the physical accounts framework for surface water and groundwater.

ACCOUNT	SURFACE WATER	GROUNDWATER
Opening Stock	**Volume** - runoff or streamflow	**Volume** - depth of water table
Changes in Quantity Reduction or Withdrawals	Water Diversion for Consumptive Uses - agricultural - domestic - industrial	Water Withdrawal For Consumptive Uses - agricultural - domestic - industrial
Other Accumulation **Addition (or recharge)**	**Basin Recharge** - dependable streamflow	**Recharge**
Other Volume Changes	**Due to Natural Disasters** - volcanic eruption - earthquakes	**Due to Natural Disasters** - volcanic eruption - earthquakes
Closing Stock	**Volume** - runoff or streamflow	**Volume** - depth of water table
Changes in Quality	- siltation and sedimentation - contamination by pollutants	- salt water intrusion - contamination by pollutants

FIGURE 2. PHYSICAL ASSET ACCOUNTFRAMEWORK FOR WATER RESOURCES

D.2.1.1. Opening and Closing Stocks

The opening and closing stocks refer to the volume of water available at the beginning and ending of the accounting period, respectively. For groundwater resources, the aquifers' hydrogeological characteristics determine the water-bearing capacity and the safe yield. In the streamflow stage of the hydrologic cycle, water from a given drainage basin is usually concentrated in a single channel. It is, therefore, possible to measure the entire quantity of water in this phase of the cycle as it leaves the basin. For the surface water resources, the runoff in the basin is the basis of the mean water supply and dependable streamflow.

D.2.1.2. Changes in Quantity and Other Accumulation

Changes in stock of water are brought about by abstraction (withdrawal) of water for industrial, agricultural or household use, and other accumulation. The latter includes transfer of water from the environment to economic use and replenishment by natural recharge or human activity (artificial recharge).

a) Groundwater - The concept of *safe yield* has been used to express the quantity of groundwater that can be withdrawn without impairing the aquifer as a resource, causing contamination or creating economic problems from increased pumping lift. Lowering the water table during dry periods is not a clear evidence that the safe yield has been exceeded; but a continuing decline even during rainy periods warns of excessive withdrawals.[2] The growing demand in the face of low recharge rates indicates that the resource is being *mined*, eventually leading to the depletion of the resource. In coastal areas, over extraction causes the recharging or influx from the sea or salt-water intrusion, resulting in the abandoning of existing wells, digging deeper in search of freshwater aquifiers, or in additional treatment costs.

The *safe* withdrawal from a groundwater reservoir is equal to the annual recharge, less the unavoidable natural discharge:

$$\textit{Safe yield} = P - R - E_{act} - G_0$$

where P and E_{act} are the mean annual precipitation and evapotranspiration, respectively, from a tributary to the aquifer; R is the mean annual runoff from the tributary area, and G_0 is the net mean annual subsurface discharge from the aquifer. The general problem cases (Newson, 1994) are:

- aquifers in which safe yield is limited by the availability of water for recharge
- aquifers in which safe yield is limited by the transmissivity of the aquifer
- aquifers in which safe yield is limited by potential contamination.

A model of an aquifer is given by the following equation:

$$A \cdot S \cdot \frac{\Delta H}{\Delta t} = R + aW - W$$

where A is the area of the aquifer; S is the storativity coefficient; H is the depth of the water table; α is the return flow coefficient; R is the recharge; and W is the withdrawal or pumping from the aquifer (Gisser, 1983). Any changes in the recharge rates or in the volume of withdrawals will affect the depth of the water table, H. During the period Δt, the water table had been lowered by ΔH. The vertical distance between the water table, H, and the pumping elevation, P_E, termed the *lift*, increases over time as the water level declines. Correspondingly, the wells' pumping efficiency declines as the lift increases. Thus, the falling water levels result in rising marginal pumping cost.

---

[2] Economists define *overexploitation* as any extraction or pumping rate in excess of that which yields the maximum present value of net benefits. Thus, annual recharge (or safe yield) does not define the economic optimum pumping rate. Economic approaches call for some utilization of groundwater stocks if demand so requires, but scaling back extraction rates as the aquifer becomes depleted, or as long as the present value of net benefits (benefits less costs) is maximised (Young, 1992). The present value of the water resource is estimated as:

$$PV_0 = \sum_{t=0}^{T} \frac{N_t \cdot Q_t}{(1+r)^t}$$

, where PV_0 is the present value of the resource; N_t is the total unit value (benefits less costs) of the resource; Q_t is the quantity exploited at period t, r is the discount rate, and T is the life of the resource or asset.

1. Withdrawals - Extraction or pumping activities are the main causes of large outflows from the aquifers. Because of lower initial capital costs (as compared to the construction of reservoirs and distribution systems in the case of surface water), groundwater has traditionally been used to meet the demand of domestic, commercial, and industrial sectors.

2. Recharge - The main source of groundwater is precipitation (or rainfall), which may penetrate the soil directly to the groundwater, or may enter surface streams, and percolate from these channels to the groundwater. It should be emphasized that the groundwater has the lowest priority on the water from precipitation. This low priority is an important factor in limiting the utilization rates of the groundwater. Depression storage and soil moisture must be satisfied before any large amount of water can percolate to the groundwater. Moreover, geologic conditions determine the path by which water from precipitation reaches the saturation zone or the water table. If the water table is near the surface, there may be a considerable percolation through the soil. Only prolonged periods of heavy precipitation can supply large quantities of water for groundwater recharge. Relatively impermeable layers above the water table may also prevent such direct percolation. In some cases, however, groundwater systems may be seasonally recharged from surface streams.

b) Surface Water - A river basin is the area tributary to a given point on a stream and it is separated from adjacent basins by a *divide* or *ridge*, which can be traced on topographic maps. Catchment and watersheds are areas that supply storage reservoirs. For catchment calibration, the following components require measurement:

- streamflow
- precipitation
- evaporation
- soil moisture
- groundwater

1. Withdrawals - Those types of human uses of water which normally take place away from the natural hydrologic system may also be called *offstream* uses. Since they typically involve consumption, they may further be distinguished as *consumptive* uses. The dependable streamflow is used as the basis for the water volume that would be available for withdrawal or consumptive uses. Other types of water usage that may not require the water to leave the natural hydrologic system are labeled *instream* water uses. Hydroelectric power generation and waterways transportation are some examples of these. Since instream uses often involve little or no physical loss of quantity of water, they are also called *non-consumptive* uses.

2. Recharge - For surface water, the volume of runoff can be estimated by the following equation:

$$R = P - L - G; \qquad \text{therefore} \qquad L = P - G - R$$

where R is direct runoff; P is precipitation; L is basin recharge; and G is groundwater accretion, all in units of depth over the drainage area. The runoff available for consumption may be distinguished into the *mean water supply* with 50 percent probability of occurrence; and the *dependable streamflow* which has 80 percent probability of occurrence.

D.2.1.3. Other Volume Changes

Other changes in the water volume may be a result not of man-made activities, but are due to the impacts of natural disasters (e.g., earthquakes, volcanic eruption, flooding, etc.), which are non-economic in nature.

D.2.1.4. Change in Quality

Water bodies provide environmental service using them as receptacle of wastes as a non-consumptive use. However, this leads to the deterioration of the water quality, which further aggravates the availability of water for consumptive purposes. The following are the main problems affecting the water resources:

a. groundwater -- salt water intrusion, leachate from wastes
b. surface water – pollution, siltation, and sedimentation.

D.2.2. Monetary Accounts

The monetary accounts consider both the quantitative and qualitative changes of water resources. Under this type of account, the opening and closing stocks and other volume changes are the counterparts of the same items in the physical accounts, valued in peso terms. Depletion is the equivalent value of the difference between water withdrawal and recharge. If withdrawal is greater than the recharge, then there is depletion; otherwise no depletion is recorded. Degradation, on the other hand, reflects the change in market value of water due to change in quality. Lastly, revaluation records the holding gains and losses due to changes in price.

Figure 3 presents the monetary asset accounts for water resources.

Opening Stock

Depletion (-)
Changes in Quantity (-)
Other Accumulation (+)

Degradation (-)

Other Volume Changes (+/-)

Revaluation

Closing Stock

FIGURE 3. MONETARY ASSET ACCOUNTS FRAMEWORK

E. OPERATIONALIZING THE FRAMEWORK

E.1. Sources of Data

The 1976 FNA was the base data for the country's water stock. The streamflow data from the 1990 National Economic Development Authority (NEDA) study was used to update the FNA result. The surface water stocks were also updated using the Bureau of Research and Standards, Department of Public Works and Highways (BRS, DPWH) streamflow data. The Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) provided the basic data for recharge. Water distribution by major sector was taken from LWUA. Per-capita requirements for Metro Manila and the other regions were derived from MWSS and LWUA respectively. The price of water used are from LWUA, MWSS and NWRB.

A number of reports and data from various agencies have been reviewed but most of the information found relevant to the study have been derived from a smaller number of key documents and most of them need some refinements and assumptions. These assumptions are also lifted from some studies.

To enable the management units, which have been tasked with the comprehensive planning of water resources development, to support the regional basins, the then National Water Resources Council (NWRC), now National Water Resources Board (NWRB) divided the Philippines into 12 water resources regions (see Appendix Figure 1, page 215). Major considerations in this regionalization are the hydrological boundaries defined by physiographic features and homogeneity in the climate of different parts of the country. Generally, these water resources regions correspond to the country's existing political regions that have been drawn from institutional considerations. Minor deviations, dictated primarily by hydrological boundaries, affect only the Ilocos, Cagayan Valley, and Central Luzon regions in Luzon and the Northern Mindanao region in Mindanao. The present study made use of these 12 regions in the compilation of the asset accounts. Appendix Figures 2 and 3 (pages 217 and 218) show the regional average annual runoff (50 and 90 percent availability, respectively) while Appendix Figure 4 (page 219) shows the groundwater resources map.

E.2. Estimation Methodology

E.2.1. Physical Asset Accounts

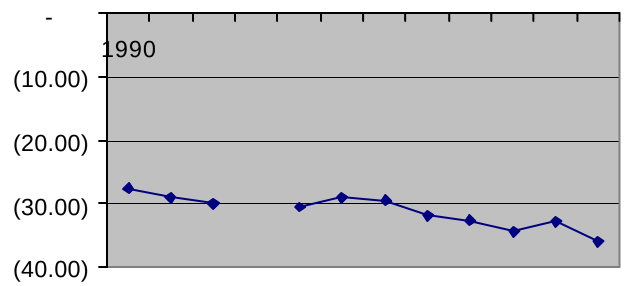
In dealing with the physical accounts, the water resource, classified into the groundwater stocks and surface water flows, was estimated for each region before assembling the environmental accounts at the national level. This procedure will determine, first, which type of water resource faces quantity or quality problems or both, and second, exactly where depletion is likely to occur.

E.2.1.1. Groundwater

a) ***Opening Stock*** - In Metro Manila, the volume of water available from the aquifers underlying the area is determined by using the storativity coefficient, transmissivity, area and depth of the aquifer, called the Guadalupe Formation, measured by the Water Resources Management Model (WRMM) for Metro Manila (IDRC-UPNHRC, 1993). Hydrologists from MWSS also provided maps and data on annual pumping and static water levels.

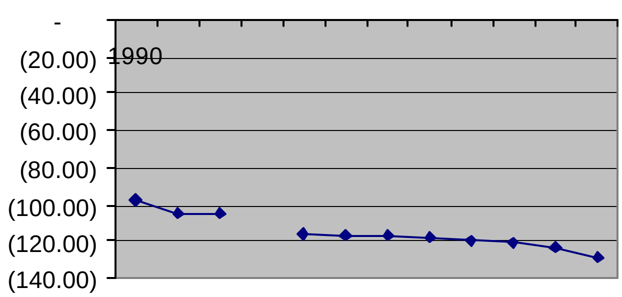
For the other regions, such data were not available, so the estimated storage capacity, reported in the FNA and conducted by the NWRC, was used as the opening stock in 1988, the first accounting period.

***b) Changes in Quantity and Other Accumulation* -** The depletion is estimated as the difference between the water volume that recharges the groundwater reservoirs (aquifers) and the volume of water withdrawn or pumped. Complementary to the measurement of changes in quantity is the cognizance of changes in the water table that have direct economic impacts. Figures 4 and 5 show the trend of the static water level in Makati City and Parañaque. These are sample cases where over-pumping of the aquifers is being experienced.



Source: MWSS

FIGURE 4. STATIC WATER LEVEL WELL (IN MGBS): MWSS PUMP #8 IN MAKATI CITY, 1990-1996



Source: MWSS

FIGURE 5. STATIC WATER LEVEL (IN MGBS) WELL: BF HOMES, PARAÑAQUE, 1990-1996

1. Recharge - The water balance computations presented in the IDRC-UP-NHRC (1993) study show that only about 5.8 percent of the rainfall recharges the aquifer. For the period 1981-1990, an annual average of 206 million cubic meters (mcm) replenished the existing stock. This was the same figure used as the recharge value in 1988. For the succeeding years, the rainfall data provided by PAGASA were used.

In the case of other regions, the estimated inflow was based on the assumption that 10 percent of rainfall recharged the aquifers, but 50 percent of this mixed with salt water (NEDA, 1981). These assumptions and the changes in rainfall were used for the Net Recharge Account. The 50 percent of the gross inflow was used for the volume of water affected by salt water intrusion.

2. Withdrawals **-** The water volume abstracted from the groundwater resources is estimated by computing the demand requirements of the various sectors (e.g., agriculture, domestic, industrial, commercial), using these resources for consumptive purposes. Appendix Table 1 (page 208) presents the water consumed by each sector from the regions. The agricultural demand for groundwater was not considered in the estimation because data were not available.

The following charts show a comparison between the 1988 and 1994 groundwater demands:

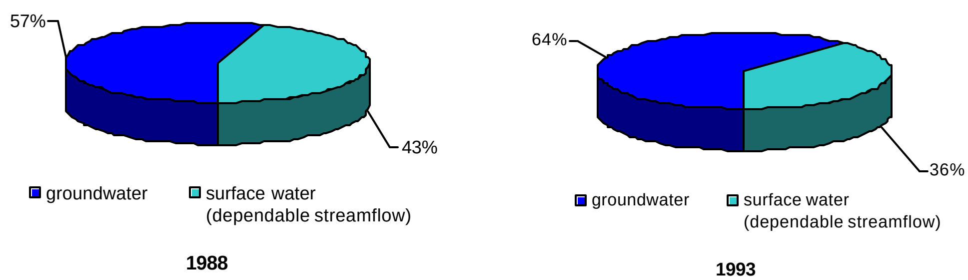


FIGURE 6. GROUNDWATER DEMAND, 1988 AND 1994

Initially, the water demand of each sector in the different regions was estimated. The proportion of the water consumers using surface water and those using groundwater was identified from the data provided by LWUA. These showed the water distributed by the water districts and the corresponding water supply sources. Domestic demand was estimated by multiplying the population figure with the water requirement per person. Population data, by region, were obtained from the National Statistics Office (NSO). The per-capita water requirement was 103.4 litres per day for the regions (LWUA's estimate) and 180 litres per day for Metro Manila (MWSS's estimate). The estimated domestic demand is shown in Tables 2 and 3. The computation for the industrial and commercial water demands followed the MWSS formula, which made use of the level of production, growth rates (GVA for industry and services), inflation rates for water, and output and price elasticities (taken from 1992 MWSS study) to estimate the increase rate factors for the projection of water demand. This was done on a regional basis. FNA provided the industrial water demand data by region which were used as benchmark figures. Appendix Table 2 (page 209) presents the estimated industrial water demand by region. No information was available regarding the use of groundwater for agriculture.

TABLE 2. DOMESTIC DEMAND FROM GROUNDWATER, 1988-1994
(IN MILLION CUBIC METERS)

YEAR	1988	1989	1990	1991	1992	1993	1994
PHILS	1,839.16	1,882.62	1,926.32	1,970.18	2,014.29	2,058.18	2,102.12
NCR	208.64	214.35	220.03	225.66	231.24	236.73	242.16
I	127.94	130.28	132.66	135.04	137.57	139.79	142.28
II	88.88	91.07	93.26	95.45	97.67	99.94	102.16
III	192.60	197.16	201.76	206.36	210.99	215.63	220.22
IV	286.99	294.64	302.40	310.16	317.96	325.80	333.63
V	148.69	152.06	155.42	158.82	162.26	165.69	169.17
VI	179.51	183.37	187.20	191.06	194.89	198.72	202.48
VII	161.81	164.90	167.99	171.09	174.18	177.24	180.29
VIII	30.65	31.20	31.75	32.32	32.90	33.47	34.05
IX	39.34	40.20	41.06	41.92	42.79	43.67	44.54
X	112.41	115.28	118.19	121.17	124.14	127.15	130.16
XI	155.95	159.72	163.57	167.42	171.27	175.16	179.04
XII	105.75	108.39	111.03	113.71	116.43	119.19	121.94

Source of basic data: LWUA and NSCB

TABLE 3. DOMESTIC DEMAND FROM SURFACE WATER, 1988-1994
(IN MILLION CUBIC METERS)

YEAR	1988	1989	1990	1991	1992	1993	1994
PHILS	546.89	560.19	573.48	586.74	599.99	613.13	626.17
NCR	288.12	296.01	303.86	311.63	319.33	326.91	334.42
I	0	0	0	0	0	0	0
II	0	0	0	0	0	0	0
III	28.68	29.36	30.04	30.73	31.42	32.11	32.79
IV	3.31	3.4	3.49	3.58	3.67	3.76	3.85
V	9.74	9.96	10.18	10.41	10.63	10.86	11.09
VI	25.76	26.32	26.87	27.42	27.97	28.52	29.06
VII	5.99	6.1	6.22	6.33	6.45	6.56	6.67
VIII	91.75	93.39	95.06	96.75	98.48	100.21	101.93
IX	76.19	77.86	79.52	81.19	82.88	84.58	86.27
X	17.35	17.79	18.24	18.7	19.16	19.62	20.09
XI	0	0	0	0	0	0	0
XII	0	0	0	0	0	0	0

Source of basic data: LWUA and NSCB

This initial methodology provides good estimates of the demand for groundwater; however, a better methodology is being sought after to be able to treat its underestimation. At present, the possibility of using the regional per-capita water requirements for the domestic demand and the NSO's number of industrial and commercial establishments for the industrial demand is being considered.

c) Other Volume Changes – In terms of the potential capacity or actual volume of water that was foregone, the studies on the effect of natural disasters on groundwater resources are not available.

d) Closing Stock - The opening stock, less the changes in quantity plus the other accumulation and the other volume changes, yields the closing stock or the volume of water available at the end of the year. This figure will be entered as the opening stock in the next accounting period.

e) Change in Quality - Overextraction in some areas in the country has resulted in the intrusion of salt water. Affected by salt-water intrusion were the following 5 cities and 11 municipalities in the MWSS service areas, namely: Pasay City, Makati City (western part); Manila, Caloocan City (south); Las Piñas City, Parañaque, Valenzuela, Malabon, and Navotas in the National Capital Region (NCR); and Bacoor, Imus, Kawit, Noveleta, and Rosario in Cavite (northern part), (JICA-MWSS, 1992). The other critically affected provinces/cities identified are Capiz, Cebu City, and Obando in Bulacan (NEPC, 1987). A NEDA Handbook (1981) assumes that 50 percent of the inflow into the groundwater systems mixed with salt water.

E.2.1.2. Surface Water

Due to the constraints and bulkiness of the river data, only one principal river from each river basin, instead of accounting for all the 317 rivers, was obtained. This somehow gives a trend in the streamflow of rivers.

a) Opening Stock - The estimated runoff data from the FNA were used as the initial opening stock figures for the regions. Metro Manila's surface water supplies are polluted so no physical accounts for surface water in Metro Manila was estimated.

b) Change in Quantity and Other Accumulation

1. Recharge - The rainfall data from PAGASA and the streamflow data from the BRS of DPWH are used to estimate the basin recharge. As earlier stated, runoff figures for only one principal river in each water resources region were collected. Caution was applied in choosing the sample principal rivers. The hydrographs of these major rivers indicate that streamflow problems are encountered in Regions II and IX (see Appendix Figures 5 to 16, pages 221-224).

2) Withdrawals - The water volume diverted from the surface water resource is estimated by computing the demand requirements of the various sectors, namely: domestic, agricultural, industrial, and commercial (see Appendix Table 3, page 210).

The following charts compare the surface water demands for 1988 and 1994:

FIGURE 7. SURFACE WATER DEMAND, 1988 AND 1994

The major user of surface water is the agricultural sector, particularly for the provision of irrigation services. Agricultural needs fluctuate, responding to temperature and rainfall patterns over the seasons of the year and over longer cycles. Thus, reservoirs are constructed to smoothen out these fluctuations. The areas served by the National Irrigation Administration (NIA) vary between the dry and wet seasons. The water requirement for rice crops is 1.5 liters per second per hectare. Appendix Table 4 (page 211) shows the estimated water requirement for agricultural use.

For the other crops, the initial demand estimates from the FNA were used and then projections were done, using the growth rates of this sub-sector reported in the Philippine National Accounts Series (PNAS) of the NSCB.

Non-consumptive uses do not affect the water quantity but may affect the quality if accompanied by discharges of untreated wastes. Further study on this is still on-going.

c) Other Volume Changes - The 1990 earthquake and the 1991 volcanic eruption affected mainly Region III's water resources. The volume or potential capacity of the water resources affected by such disasters should enter this account and this should also be subtracted from the opening stock. The required data, however, are still not available during the conduct of this study.

d) Closing Stock **-** The opening stock, less the changes in quantity over the accounting period (year) and other volume changes, yields the closing stock or the volume of water available at the end of the year. This figure will serve as the opening stock in the next accounting period.

e) Change in Quality - The DENR classified the country's rivers and lakes according to their water use and also set water quality standards for each type of water (DENR Administrative Order No. 34). The Laguna Lake Development Authority (LLDA) is regularly monitoring only the Laguna de Bay; for the other rivers, one has to get the data from the DENR's regional offices. The estimates from case studies can be used for the siltation and sedimentation of reservoirs.

Most of the surface water resources in Metro Manila are contaminated. MWSS, therefore, had to get the water from river basins outside its service areas. The unabated pollution of Metro Manila's four major rivers, Pasig, San Juan, Tullajan-Tenejeros, and Parañaque-Zapote, has made these rivers fit only for limited navigation. Their biological oxygen demand (BOD) has become quite high; while the dissolved oxygen (DO) levels are below the standards for Class C rivers. They are also contaminated with heavy metals and pesticides. Likewise, there are indications of increasing contamination of Laguna de Bay from human, agricultural, and industrial development, and other non-point sources.

The surface water diverted from the Angat, Ipo, and Novaliches catchments is well-protected and meets the requirements of Class AA to A water. The raw water from the rivers and its catchments has good turbidity values, low mineral concentrations, sufficient natural alkalinity, and acceptable color values.

Due to lack of monitoring activities or inadequate database on the current quality of the rivers in the regions, no estimates were produced for the *change in quality* account.[1]

E.2.2. Monetary Asset Accounts

There are several approaches to resources valuation. The Net Price Method (NPM) is one way to determine the value of the change in the closing stock or the resource depletion. The net price is the difference between the revenues and the total cost associated with the use of water. The revenues from water are estimated by multiplying the selling price or the *average market value* per unit of the water (P_t) to the volume of water; while the total costs are estimated by multiplying this volume of water by the *unit cost* (C_t), incurred in the extraction or production of water. The *per-unit cost* is the marginal cost of extraction and development, including a normal return to capital. Thus, the net price can also be a gauge of the net benefits enjoyed by society from using the water resources. The value of the water resource, using the net price method, can be measured as follows:

net value of water = total benefits (or revenues) less total costs

$$V_t = (P_t \cdot R_t) - (C_t \cdot R_t)$$

$$V_t = (P_t - C_t) \cdot R_t$$

where V_t is the value of the water resource; $(P_t - C_t)$ is the net price; and R_t is the volume of the water resource.

This study made use of the *NPM* to estimate the value of the opening stock; the value of the changes in the stock due to (a) the depletion/repletion of water resources in the country and (b) degradation of the water resources (for groundwater only); and the value of the closing stock.

A benchmark estimate of water resource rent, using the 1994 CE was derived by subtracting from the net operating surplus the annualized opportunity cost of the money invested on fixed assets. This process is the same as that of the mineral resource rent estimation. With this calculation, the study derived a very minimal price of ₱1.43 per cubic meter of water. This as validated by some experts from UPSE, UP-NHRC, and NWRB, is somewhat low considering that the distribution of water in the country is highly subsidized by the government. The market price of water in the NCR ranges from an average of ₱7/cu.m. (charged by MWSS) to about ₱123/cu.m. (charged by water vendors or tankers). The latter price reflects the willingness of the water consumers to pay and of the households and firms to incur these costs just to have the necessary water. Each water district has its own water tariff schedule. Its average operating revenue per cubic

[1] The estimation of effluents and wastewater discharges and the abatement costs by selected economic activities are being done by the Technical Working Group (TWG) for Economic Activities. The EMB has data on some of the monitored rivers, but this information still needs to be processed.

meter of billed water in 1996 was about ₱9.07; and this could reflect the price of water in the other regions (LWUA, 1996). Moreover, the average operating expenditure of water districts in 1996 was ₱7.29 per cubic meter of billed water, as reported by LWUA.

Given that the computed resource rent based from the 1994 CE was low, the TWG decided to use the market price of water based on the revenues and quantity of water sold and distributed by water utilities. Table 4 presents the market price of water from 1987-1995. These market prices are temporarily used as the per unit cost of water, but it should be noted that they do not consider government subsidies and they still include the unit cost of extraction, treatment and distribution of water. Moreover, the unit price of groundwater should considerably be greater than the unit price of surface water, the former being scarce and the main source of water for domestic, commercial and industrial consumption.

TABLE 4. MARKET PRICE OF WATER AS CHARGED BY WATER UTILITIES, 1987-1995 (IN PESOS PER CUBIC METERS)

Region/Year	1987	1988	1989	1990	1991	1992	1993	1994	1995
Phils	1.9324	2.2015	2.4837	2.6204	3.1817	3.5692	3.7974	3.9214	3.9683
NCR	1.9438	2.2190	2.5235	2.6610	3.2269	3.6076	3.8228	3.9328	3.9729
CAR	1.8836	2.1129	2.3371	2.5202	3.0972	3.5793	3.8490	3.9442	4.0933
Ilocos	1.9195	2.2273	2.4421	2.6259	3.2746	3.7924	4.0177	4.1130	4.1620
Cagayan	1.9692	2.2947	2.5359	2.7253	3.3929	3.8696	4.0977	4.2608	4.2819
Central	1.9559	2.1589	2.3991	2.5390	3.0032	3.4353	3.7078	3.8557	3.8911
Southern	2.0112	2.2815	2.5094	2.6520	3.1964	3.6135	3.8816	4.0025	4.0763
Bicol	2.0629	2.3342	2.6094	2.7662	3.3212	3.7833	4.1394	4.3454	4.3803
Western Visayas	2.0661	2.3988	2.6685	2.8583	3.5244	4.0300	4.2609	4.4954	4.6266
Central Visayas	2.0143	2.2733	2.5068	2.6496	3.2310	3.6432	3.8990	4.0190	4.0670
Eastern Visayas	2.0050	2.2359	2.4933	2.6203	3.1900	3.5921	3.8554	4.0583	4.1402
Western Mindanao	2.1038	2.3354	2.5894	2.7188	3.5282	4.1000	4.2717	4.3722	4.4566
Northern Mindanao	2.0027	2.3096	2.5968	2.7159	3.3520	3.7551	4.0653	4.1865	4.1937
Southern Mindanao	2.0319	2.3679	2.6717	2.8123	3.3687	3.7235	3.9044	4.1020	4.1620
Central Mindanao	1.9669	2.2272	2.5173	2.6111	3.2043	3.4924	3.7768	3.8170	3.8668
ARMM	-	-	-	-	-	-	3.7687	4.0485	4.1620

Source of basic data : LWUA, MWSS, NWRB

The search for the true value of water is still on-going.

The revaluation item was computed as a residual value, by deducting from the value of the closing stock the opening stock, less depletion and degradation.

F. ANALYSIS, RESULTS AND DISCUSSION

Looking at the physical accounts, one will find that there is not much problem with the surface water supplies, especially at the national level. In the absence of storage (reservoirs) though, the country's surface water resources have not been fully utilized and the domestic and industrial users have to rely on groundwater. The intermittent supply from surface water makes the groundwater as the ideal regular or the *buffer* water supply source. The consequence, however, is the declining groundwater levels in some areas of the country and the extensive extraction resulted in additional cost of pumping and salt-water intrusion. However, siltation and pollution threatens the reliability of surface water as substitute source.

Comparison of the stock of groundwater and surface water availability is presented in Figure 8.

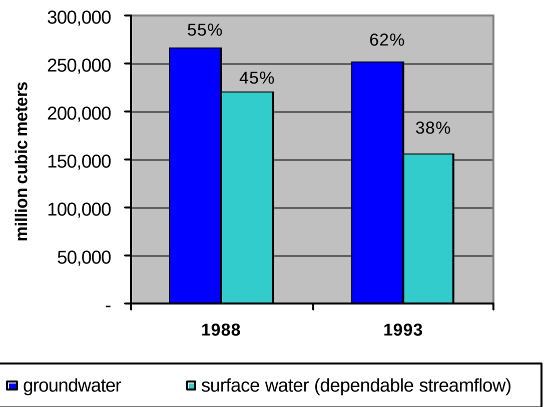


FIGURE 8. STOCK OF PHILIPPINE WATER, 1988 AND 1993

In 1989-1991, almost all of the regions in the country experienced lower rainfall rates; and this affected the recharge rates of both types of water resources. The physical and monetary accounts for groundwater by region are presented in Appendix Tables 5 and 6 (pages 211-212). For surface water, the preliminary physical and monetary accounts by region are presented in Appendix Tables 7 and 8 (pages 214-215).

The 1976 FNA states that the regions that would experience long-run surface water problems are III, VI, and VII; however, in this account, they turned out to be regions II, VIII, and IX. The 1976 FNA further revealed that groundwater could have a great stock; but the study shows it is incapable of replenishing its previous amount of stock.

F.1. Physical Asset Accounts

F.1.1. Groundwater

For the period 1988 to 1994 the stock of groundwater has been decreasing at an annual rate of 1.4 percent, equivalent to an average of 3,500 million cubic meters per year (see Figure 9). The increasing abstraction of groundwater coupled with diminishing recharge led to the shrinkage of the overall supply of groundwater. Depletion of groundwater as shown in Figure 10, increased from 2.4 billion cubic meters in 1988 to 4.4 billion cubic meters, registering an annual growth of 10.2 percent. Table 5 presents in summary the physical accounts of groundwater for the period 1988 to 1994.

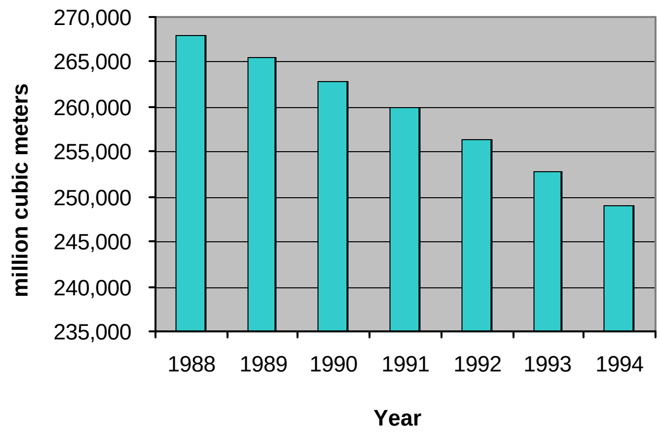


FIGURE 9. STOCK OF GROUNDWATER, 1988-1994

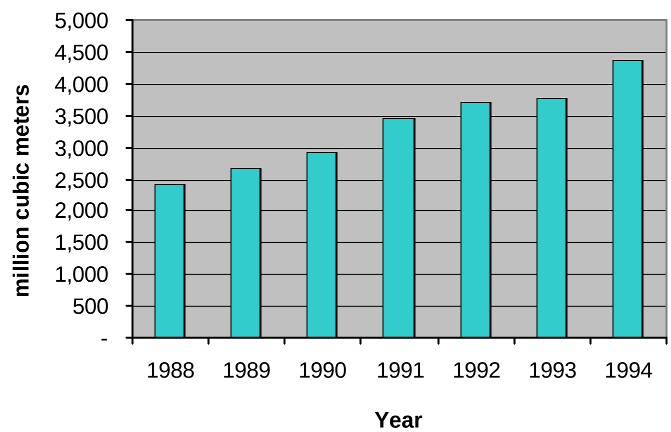


FIGURE 10. DEPLETION OF GROUNDWATER, 1988-1994

In terms of the regional outlook, Regions IV, VI, VII, XII, and the NCR are critical areas. Only Regions II and VIII do not show any problem. The over extraction or continuous excessive pumping above the natural recharge rates resulted in declining water tables in the NCR even during the wet or rainy season. The volume of withdrawals exceeded the volume of recharge by an average of 400.7 mcm for the period 1988-1994 (see Appendix Table 5).

TABLE 5. PHYSICAL ACCOUNTS OF GROUNDWATER IN THE PHILIPPINES, 1988-1994
(IN MILLION CUBIC METERS)

PHILIPPINES	1988	1989	1990	1991	1992	1993	1994
Opening Stock	267,960.14	265,523.08	262,856.76	259,924.72	256,456.58	252,745.25	248,980.83
Changes in Quantity							
Withdrawal	(4,298.17)	(4,522.00)	(4,826.11)	(4,974.61)	(5,134.45)	(5,391.81)	(5,856.39)
Other Accumulation							
Net recharge	1,861.11	1,855.68	1,894.07	1,506.46	1,423.13	1,627.38	1,480.87
Closing Stock	265,523.08	262,856.76	259,924.72	256,456.58	252,745.25	248,980.83	244,605.30
Changes in Quality							
Salt-water intrusion	1,758.03	1,767.00	1,776.33	1,417.63	1,330.76	1,529.22	1,374.67

F.1.2. Surface Water

From the national outlook, the physical accounts show that the stock of surface water is diminishing at an annual average of 13,700 million cubic meters. This is due to the fact that between 1988 and 1991, recharge was always lower than the abstraction of surface water. From 1992 to 1993, however, recharge was higher than abstraction, slightly improving the stock of surface water. Table 6 presents the physical accounts of surface water and Figure 10 shows the stock of surface water.

On a regional basis, the critical problem in the NCR is the poor quality of its surface water, further widening the gap between increasing demand and declining supply. For the lakes, rivers, and reservoirs, the change in quality may be attributed not only to pollution but also due to increasing siltation and sedimentation, as a result of deforestation and land use changes.

TABLE 6. PHYSICAL ACCOUNTS OF SURFACE WATER IN THE PHILIPPINES, 1988-1993
(IN MILLION CUBIC METERS)

PHILIPPINES	1988	1989	1990	1991	1992	1993
Opening Stock	220,400.00	198,402.39	189,172.35	152,373.05	144,709.73	156,919.22
Change in Quantity						
Withdrawal	(35,468.97)	(37,600.12)	(38,446.31)	(40,229.76)	(40,159.77)	(41,223.27)
Other Accumulation						
Additions	13,471.36	28,370.08	1,647.01	32,566.44	52,369.26	42,800.58
Closing Stock	198,402.39	189,172.35	152,373.05	144,709.73	156,919.22	158,496.53

As shown in Figure 11, withdrawal of surface water grew from 35.4 in 1988 to 41.2 billion cubic meters in 1993. This is equivalent to an annual increase of 1.2 billion cubic meters.

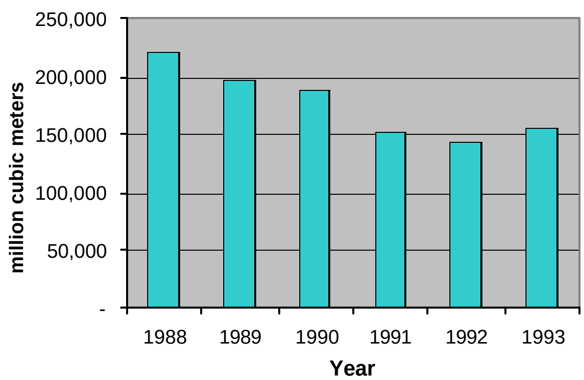


FIGURE 11. STOCK OF SURFACE WATER, 1988-1993

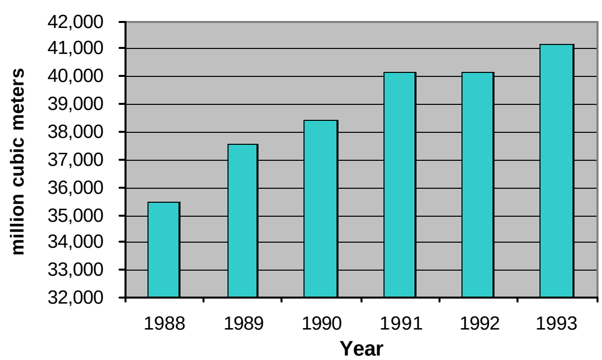


FIGURE 12. SURFACE WATER WITHDRAWAL, 1988-1993

F.2. <u>Monetary Asset Accounts</u>

F.2.1. Groundwater

Despite the decreasing volume of stock of water resources, the value of groundwater is on the rise. From 473.4 billion pesos in 1988, it almost doubled to 764.6 billion pesos in 1994. Depletion, which is due to higher abstraction than recharge, swelled in 1994 to more than three times its original value in 1988. Degradation of groundwater, which was caused by salt water intrusion due to abstraction of water, annually grew by 7.2 percent. Nevertheless, the reversal of negative revaluation in 1988 to a positive ₱29.3 billion pesos in 1994 more than compensated the reduction caused by depletion and degradation. Table 7 presents the monetary accounts of groundwater.

TABLE 7. MONETARY ACCOUNTS: GROUNDWATER IN THE PHILIPPINES, 1988-1994 (IN MILLION PESOS)

PHILIPPINES	1988	1989	1990	1991	1992	1993	1994
Opening Stock	537,883.68	473,425.78	521,560.71	542,180.20	648,645.30	718,859.59	756,822.95
Depletion	(5,545.56)	(6,724.39)	(7,816.42)	(11,205.20)	(13,515.37)	(14,678.28)	(17,608.29)
Degradation	(2,592.48)	(3,095.30)	(3,372.33)	(3,364.95)	(3,422.33)	(3,970.76)	(3,939.48)
Revaluation	(56,319.86)	57,954.62	31,808.24	121,035.25	87,151.99	56,612.40	29,337.72
Closing Stock	473,425.78	521,560.71	542,180.20	648,645.30	718,859.59	756,822.95	764,612.90

F.2.1. Surface Water

The same holds true for surface water; its value from 1988 to 1993 increased by 36 percent from 455.7 in 1988 to 621.9 billion pesos in 1993. Except for 1990, recharge continued to swell during the period. As a result, no depletion was recorded for the years 1992 and 1993. Table 8 shows the monetary accounts of surface water.

TABLE 8. MONETARY ACCOUNTS: SURFACE WATER IN THE PHILIPPINES, 1988-1993 (IN MILLION PESOS)

PHILIPPINES	1988	1989	1990	1991	1992	1993
Opening Stock	442,697.48	455,732.87	480,780.11	408,247.49	474,587.45	576,924.39
Depletion	(48,901.08)	(26,213.38)	(100,495.90)	(25,847.07)	-	-
Revaluation	61,936.46	51,260.63	27,963.29	92,187.02	102,336.94	44,974.40
Closing Stock	455,732.87	480,780.11	408,247.49	474,587.45	576,924.39	621,898.79

G. LIMITATIONS AND RECOMMENDATIONS

G.1. Information Base

Adequacy of Data

The usefulness of water resources is influenced by both the composition and state of freshwater sources (surface and groundwater) and the total demand for these resources (see Figure 1, page 180). Because these resources are essential to life and development, they should be efficiently managed; and as such, the availability of adequate and timely information is necessary. Measurement problems, however, are often encountered. Data about hydrological and climatological conditions are usually intermittent, and data on the water resource base and demand are based upon the extrapolation of a limited number of observations. For example, the assessment of water resources in the country was done in the mid-1970s and projections were made for the year 2000. These projections, however, may no longer be that reliable considering the rapid urbanization and economic development in recent years.

While streamflow data for rivers are measured in about 300 stations in the country, there is hardly any systematic national/regional groundwater monitoring program for a resource that supplies the majority of domestic and industrial consumers. Not all aquifer systems in the country have been identified. Regular annual observations are also not available since studies are usually conducted only when there are foreign-assisted projects. Likewise, data on the quality of water bodies and other water-related data are not available in the format needed in resource accounting.

Refinements

The degree of accuracy of demand projections has to be upgraded. The estimated volume of groundwater withdrawals is just the *minimum water requirements* and the actual extraction may actually be above these figures. For domestic use, the average per-capita water requirement (103.4 liters per day) set by LWUA needs to be updated since each water district has a measure of the per-capita requirement in its respective jurisdiction. The estimated water demand for industrial use can also be modified by using the classification of existing establishments according to scale, and applying the average water requirement for each type of industry. Moreover, changes in population growth and the rate of economic progress have major effects on the water demand and should be considered in approximating the demand figures. The problem of eventual depletion must now be dealt with to prevent it from actually occurring and the actual demand and extraction rates will indicate how long such a policy of relying on groundwater can be sustained.

Another area where refinements are needed is in the estimation of the stock and recharge rates of both surface and groundwater resources. Since there were no subsequent studies as comprehensive as the FNA done in the 1970s, the streamflow data collected by BRS-DPWH have to be processed before one can get a picture of current surface water supply outlook at the national and regional levels. But these streamflow data are not continuous for a number of rivers. For groundwater, a number of studies have been done for the NCR and Cebu City; these can be utilized as benchmark figures for resource accounting purposes, but no extensive studies have been conducted in the other regions.

The price of water delivered by the public water utilities (e.g., MWSS and the water districts under LWUA) is very low and, therefore, does not provide the true value of the benefits (or revenues) from using the resource. The water tariff that these utilities charge covers only a mark-up over their operating costs and exchange rate adjustments *(cost-recovery approach)*. Thus, there is a need to conduct more studies on the water's actual value (and price).

Ideally, the total cost of groundwater usage consists of the direct costs (investment or capital cost and the operating and maintenance costs) and other scarcity and external costs. For groundwater, the initial investment cost consists of the installation of the well, pumps, pipes, and storage tanks. The operating and maintenance costs are estimated by relating the depth of the water table to pumping costs. The declining water tables result from pumping levels exceeding recharge rates. Figures 4 and 5 (page 189) show the case of Metro Manila where water levels are declining at a rate of 5-8 m annually. As the water table declines, pumping costs increase. Moreover, over-extraction of groundwater results in possibly irreversible developments, such as salt-water intrusion, land subsidence, and eventual depletion, all of which are externalities that are not reflected in the market price.

The per-unit cost of water in SEEA is measured in terms of the marginal costs of extraction and development, including the normal return to capital. A study on the marginal opportunity cost-pricing of the water resource has been done for Metro Manila only (Munasinghe, 1990; Ebarvia, 1997). From 1988-1994, the average incremental cost of water supplied by MWSS is about ₱ 51 per cubic meter. For the other regions, no studies have been done.

Collection and Monitoring of Water Data

The personnel in all agencies concerned must be properly informed of the importance of monitoring and data collection for policy formulation and efficient management of the water resources.

G.2. Water Management

Water Supply Facilities

Due to lack of storage facilities (reservoirs), the domestic and industrial sectors have relied on groundwater to meet their water-demand requirements. Even the majority of the water districts derive their water from the underground source, and aquifers in some areas of the country are showing signs of overexploitation. Only MWSS gets 97 percent of its water supply from surface water (from Angat River, located in Bulacan); but the reservoir is multipurpose and the allocation is divided among agricultural, hydroelectric power, and water supply for the NCR. The allocation given to MWSS is not enough to meet the demand in the NCR and other areas under the jurisdiction of MWSS. Thus, groundwater resources -- which have been relied on – show increasing rates of extraction and the water-balance computations indicate that groundwater in the NCR is being mined.

Groundwater mining is being allowed as a temporary measure to solve the current availability limitations from surface water even if there is a critical threat from salt-water intrusion and, possibly, land subsidence wherein the detrimental effects could be irreversible.

Variability is also important on the water demand side, as on the supply side. Agricultural needs do fluctuate, in response to the temperature and rainfall patterns over the seasons of the year and over longer cycles. The areas served by the NIA vary between the dry and wet seasons. Residential and industrial water uses also vary, depending on daily, weekly, and seasonal considerations. Thus, both storage and distribution systems and management institutions must be prepared to satisfy *peak loads* in high demand periods.

Coordination among all Water-related Agencies

In government services, each type of water use is managed by a separate agency. However, there is a lack of coordination among the 32 agencies involved in water-related activities. For example, irrigation, municipal water supply, power, and transportation are managed by different agencies, each with its own interests. This set-up is not wrong; but an overlying framework and a well-developed institutional system that will formulate policies and provide the necessary water resources management must be put in place. This fragmentation has resulted in the failure to consider cross-sectoral effects of water activities and has led to waste and misallocation. Moreover, this has created confusion among constituents who do not know which agency to approach regarding some local water-related problems.

Conservation and Pricing Policies

There is a need to come up with a comprehensive plan on the pricing policies of the water utilities. The price of water must reflect its scarcity value and not just for the cost recovery of the utilities or water districts but also for conservation purposes. Pricing water below its economic value often results in inefficient use for policy and decision-making.

Water Pollution

In view of the pollution issue, the provision of sanitary sewerage systems should, likewise, be given as much importance as that of increasing the water supply. The low priority given to the management of sewage collection and disposal has resulted in the increasing amount of untreated wastewater in the waterways. This condition has further aggravated the available quantity of water for human use. The lack of water supply, as well as poor water quality due to pollution, has adversely affected health, as indicated by the increasing number of morbidity and mortality cases of waterborne diseases. The pollution of water bodies has also affected the fishery production, as in the case of Laguna de Bay. Siltation and sedimentation have impacts on irrigation canals, which affect rice production, and on the large reservoirs, which affect both the hydroelectric power generating capacity and irrigation services. Aesthetics and other non-economic benefits have also been foregone, due to the degradation of many water bodies in the country.

ACRONYMS

AO	Administrative Order
ASE	Annual Survey of Establishments
BOD	Biochemical Oxygen Demand
BRS	Bureau of Research and Standards
CE	Census of Establishments
DENR	Department of Environment and Natural Resources
DO	Dissolved Oxygen
DPWH	Department of Public Works and Highways
EMB	Environmental Management Bureau
ENRA	Environmental and Natural Resources Accounting
GDP	Gross Domestic Product
FNA	First National Assessment
GVA	Gross Value Added
IPIN	Implicit Price Index
IDRC	International Development Research Centre
IEMSD	Integrated Environmental Management for Sustainable Development
JICA	Japan International Cooperation Agency
LLDA	Laguna Lake Development Authority
LWUA	Local Water Utilities Administration
MCM	Million Cubic Meter
MTPDP	Medium-Term Philippine Development Plan
MWSS	Metropolitan Waterworks and Sewerage System
NCR	National Capital Region
NEDA	National Economic Development Authority
NEPC	National Environmental Protection Council
NIA	National Irrigation Administration
NPC	National Power Corporation
NPM	Net Price Method
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
NWRB	National Water Resources Board
NWRC	National Water Resources Council
PAGASA	Philippine Atmospheric, Geophysical, and Astronomical Services Administration
PNAS	Philippine National Accounts Series
SEEA	System of Integrated Environmental and Economic Accounting
SNIA	System of National Income Accounts
SS	Suspended Solids
TWG	Technical Working Group
UNDP	United Nations Development Program
UP-NHRC	University of the Philippines-National Hydraulics Research Center
WRMM	Water Resources Management Model

DEFINITION OF TERMS

Aquifer	a water-bearing, geologic formations, usually soil which contains groundwater and which readily yields it to wells and springs.
Consumptive Use	that part of water which is withdrawn through evaporation, transpiration, incorporation into products or crops consumed by humans or livestock or otherwise removed from the immediate water environment; hence, it cannot be re-used. Also referred to as water consumed.
Evapotranspiration	a collective term that includes water discharged to the atmosphere, as a result of evaporation from the soil and surface water bodies and of plant transpiration.
Freshwater	water that contains less than 1,000 milligrams per liter (mg/l) of dissolved solids, biologically and chemically not contaminated.
In-stream Use	water that is used, but not withdrawn, from a ground- or surface-water source, for such purposes as hydroelectric power-generation, navigation, water-quality improvement, fish propagation, and recreation, sometimes called non-withdrawal use or in-channel use.
Off-stream Use	water withdrawn or diverted from a ground- or surface-water source for public water supply, industry, irrigation, livestock, thermoelectric power generation, and other uses, sometimes referred to as consumptive use.
Per-capita Use	the average amount of water used per person during a standard period of time, generally per day or per year.
Precipitation	the amount of liquid or solid products brought about by the condensation of water vapor falling from clouds or deposited from air on the ground, generally rainfall and snowfall.
Reservoir	a place where water is collected and kept, usually a body of water, either natural or artificial, in sufficient quality for use when wanted.
Runoff	1) that part of precipitation that flows towards a stream on the ground surface (surface run-off) or within the soil (sub-surface run-off or inter-flow); 2) synonymous to flow - the total volume of water that flows during a year, usually referred to the outflow of the drainage area or river basin.
Stream Flow	the amount of water flowing in a stream channel.
Surface Water	an open body of water, such as a stream or lake characterized as a mixture of surface runoff and groundwater.
Water Resources	the supply of water in a given area or basin interpreted in terms of availability of surface and groundwater.

APPENDIX TABLES

APPENDIX TABLE 1. WATER DEMAND REQUIREMENTS FROM GROUNDWATER, BY SECTOR AND BY REGION, IN MILLION CUBIC METERS, 1988-1994

SECTOR	REGION	1988	1989	1990	1991	1992	1993	1994
Domestic	**NCR**	208.64	214.35	220.03	225.66	231.24	236.73	242.16
	I	127.94	130.28	132.66	135.04	137.57	139.79	142.28
	II	88.88	91.07	93.26	95.45	97.67	99.94	102.16
	III	192.60	197.16	201.76	206.36	210.99	215.63	220.22
	IV	286.99	294.64	302.40	310.16	317.96	325.80	333.63
	V	148.69	152.06	155.42	158.82	162.26	165.69	169.17
	VI	179.51	183.37	187.20	191.06	194.89	198.72	202.48
	VII	161.81	164.90	167.99	171.09	174.18	177.24	180.29
	VIII	30.65	31.20	31.75	32.32	32.90	33.47	34.05
	IX	39.34	40.20	41.06	41.92	42.79	43.67	44.54
	X	112.41	115.28	118.19	121.17	124.14	127.15	130.16
	XI	155.95	159.72	163.57	167.42	171.27	175.16	179.04
	XII	105.75	108.39	111.03	113.71	116.43	119.19	121.94
Sub-total		1,839.16	1,882.62	1,926.32	1,970.18	2,014.29	2,058.18	2,102.12
Industrial	**NCR**	300.38	324.09	348.00	370.39	376.63	387.74	409.58
	I	123.35	136.99	164.35	152.36	112.12	107.94	132.50
	II	2.52	1.88	1.89	1.69	0.98	0.54	0.36
	III	68.78	66.26	67.28	63.65	67.01	70.19	74.23
	IV	1,014.65	1,098.36	1,230.93	1,308.85	1,435.15	1,627.75	1,924.98
	V	94.08	95.52	101.59	101.98	107.66	114.82	126.57
	VI	117.51	105.32	94.59	74.04	63.48	55.54	51.05
	VII	439.85	493.16	557.03	592.57	613.60	605.99	629.81
	VIII	18.22	22.45	27.71	33.89	38.97	45.08	55.24
	IX	27.56	30.49	35.70	39.77	43.40	51.35	65.04
	X	31.10	27.43	23.93	20.49	17.19	14.32	13.05
	XI	51.82	50.47	48.42	45.26	39.93	36.22	34.21
	XII	158.67	175.68	185.68	185.51	188.85	199.52	218.69
Sub-total		2,448.48	2,628.11	2,887.09	2,990.44	3,104.99	3,317.01	3,735.32
Commercial	**NCR**	10.53	11.28	12.69	13.99	15.18	16.62	18.95
Sub-total		10.53	11.28	12.69	13.99	15.18	16.62	18.95
ALL USES	**NCR**	519.54	549.71	580.73	610.04	623.05	641.08	670.69
	I	251.29	267.27	297.01	287.40	249.69	247.73	274.78
	II	91.40	92.95	95.15	97.14	98.65	100.48	102.52
	III	261.38	263.42	269.04	270.01	278.00	285.82	294.45
	IV	1,301.64	1,393.00	1,533.33	1,619.01	1,753.11	1,953.55	2,258.61
	V	242.77	247.58	257.01	260.80	269.92	280.51	295.74
	VI	297.02	288.69	281.79	265.10	258.37	254.26	253.53
	VII	601.66	658.06	725.02	763.66	787.78	783.23	810.10
	VIII	48.87	53.65	59.46	66.21	71.87	78.55	89.29
	IX	66.90	70.69	76.76	81.69	86.19	95.02	109.58
	X	143.51	142.71	142.12	141.66	141.33	141.47	143.21
	XI	207.77	210.19	211.99	212.68	211.20	211.38	213.25
	XII	264.42	284.07	296.71	299.22	305.28	318.71	340.63
T O T A L		**4,298.17**	**4,522.00**	**4,826.11**	**4,974.61**	**5,134.45**	**5,391.81**	**5,856.39**

Source of basic data: LWUA, MWSS and NSCB

APPENDIX TABLE 2. INDUSTRIAL WATER DEMAND BY REGION, 1988-1994
IN MILLION CUBIC METERS

REGION	1988	1989	1990	1991	1992	1993	1994
NCR							
Total	375.47	405.11	435.00	462.99	470.79	484.67	511.97
Using groundwater	300.38	324.09	348.00	370.39	376.63	387.74	409.58
Using surface water	75.09	81.02	87.00	92.60	94.16	96.93	102.39
REGION I							
Total	123.35	136.99	164.35	152.36	112.12	107.94	132.50
Using groundwater	123.35	136.99	164.35	152.36	112.12	107.94	132.50
Using surface water	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REGION II							
Total	2.52	1.88	1.89	1.69	0.98	0.54	0.36
Using groundwater	2.52	1.88	1.89	1.69	0.98	0.54	0.36
Using surface water	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REGION III							
Total	79.02	76.13	77.29	73.13	76.99	80.65	85.28
Using groundwater	68.78	66.26	67.28	63.65	67.01	70.19	74.23
Using surface water	10.24	9.87	10.02	9.48	9.98	10.45	11.05
REGION IV							
Total	1,026.35	1,111.02	1,245.12	1,323.94	1,451.70	1,646.52	1,947.17
Using groundwater	1,014.65	1,098.36	1,230.93	1,308.85	1,435.15	1,627.75	1,924.98
Using surface water	11.70	12.67	14.19	15.09	16.55	18.77	22.20
REGION V							
Total	100.25	101.78	108.24	108.67	114.72	122.35	134.86
Using groundwater	94.08	95.52	101.59	101.98	107.66	114.82	126.57
Using surface water	6.17	6.26	6.66	6.68	7.06	7.52	8.29
REGION VI							
Total	134.37	120.43	108.16	84.67	72.60	63.51	58.38
Using groundwater	117.51	105.32	94.59	74.04	63.48	55.54	51.05
Using surface water	16.86	15.11	13.57	10.63	9.11	7.97	7.33
REGION VII							
Total	456.14	511.42	577.65	614.51	636.32	628.43	653.13
Using groundwater	439.85	493.16	557.03	592.57	613.60	605.99	629.81
Using surface water	16.28	18.26	20.62	21.94	22.72	22.43	23.32
REGION VIII							
Total	72.75	89.65	110.68	135.32	155.64	180.04	220.62
Using groundwater	18.22	22.45	27.71	33.89	38.97	45.08	55.24
Using surface water	54.54	67.20	82.96	101.44	116.67	134.96	165.38
REGION IX							
Total	80.93	89.55	104.83	116.79	127.47	150.81	191.03
Using groundwater	27.56	30.49	35.70	39.77	43.40	51.35	65.04
Using surface water	53.38	59.06	69.14	77.02	84.06	99.46	125.98
REGION X							
Total	35.90	31.67	27.62	23.65	19.84	16.53	15.06
Using groundwater	31.10	27.43	23.93	20.49	17.19	14.32	13.05
Using surface water	4.80	4.23	3.69	3.16	2.65	2.21	2.01
REGION XI							
Total	51.82	50.47	48.42	45.26	39.93	36.22	34.21
Using groundwater	51.82	50.47	48.42	45.26	39.93	36.22	34.21
Using surface water	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REGION XII							
Total	158.67	175.68	185.68	185.51	188.85	199.52	218.69
Using groundwater	158.67	175.68	185.68	185.51	188.85	199.52	218.69
Using surface water	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source of basic data: MWSS

APPENDIX TABLE 3. WATER DEMAND REQUIREMENTS FROM SURFACE WATER, BY SECTOR AND BY REGION, 1988 - 1994, IN MILLION CUBIC METERS

SECTOR	REGION	1988	1989	1990	1991	1992	1993	1994
Domestic	NCR	288.12	296.01	303.86	311.63	319.33	326.91	334.42
	I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	II	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	III	28.68	29.36	30.04	30.73	31.42	32.11	32.79
	IV	3.31	3.40	3.49	3.58	3.67	3.76	3.85
	V	9.74	9.96	10.18	10.41	10.63	10.86	11.09
	VI	25.76	26.32	26.87	27.42	27.97	28.52	29.06
	VII	5.99	6.10	6.22	6.33	6.45	6.56	6.67
	VIII	91.75	93.39	95.06	96.75	98.48	100.21	101.93
	IX	76.19	77.86	79.52	81.19	82.88	84.58	86.27
	X	17.35	17.79	18.24	18.70	19.16	19.62	20.09
	XI	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	XII	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sub-total		546.89	560.19	573.48	586.74	599.99	613.13	626.17
Agricultural	I	1,527.71	1,764.60	1,761.46	1,607.99	1,363.75	1,580.41	1,631.44
	II	5,173.61	5,555.27	5,817.31	5,893.22	6,074.66	6,174.52	6,173.37
	III	5,245.68	5,560.37	5,597.45	5,629.94	5,455.48	5,456.07	5,603.92
	IV	5,468.83	5,779.62	5,824.54	6,095.48	6,032.01	6,244.94	6,321.51
	V	637.47	585.04	735.00	737.80	777.48	796.91	707.05
	VI	7,081.15	7,476.73	7,134.77	7,829.31	8,251.46	8,213.19	8,403.82
	VII	5,968.21	6,482.43	6,694.23	7,038.54	6,815.04	7,153.66	7,296.84
	VIII	261.90	282.74	293.71	278.50	244.52	275.96	285.65
	IX	2,496.00	2,546.27	2,676.29	2,669.45	2,709.29	2,795.55	2,828.89
	X	621.96	702.41	731.26	882.68	867.35	943.86	868.99
	XI	1,399.09	1,367.45	1,603.18	1,951.71	1,943.46	1,867.25	1,877.02
	XII	1,118.19	1,267.08	1,298.92	1,347.21	1,188.83	1,270.12	1,411.22
	MRIIS	3,321.05	3,372.87	3,425.21	3,417.53	3,383.87	3,359.46	3,577.24
	UPRIIS	2,933.39	3,595.69	3,836.71	3,814.34	3,890.73	3,758.47	3,866.44
	CAR	0.00	0.00	0.00	0.00	0.00	0.00	429.26
Sub-total		43,254.23	46,338.58	47,430.06	49,193.69	48,997.92	49,890.37	51,282.65
Industrial	NCR	75.09	81.02	87.00	92.60	94.16	96.93	102.39
	I	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	II	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	III	10.24	9.87	10.02	9.48	9.98	10.45	11.05
	IV	11.70	12.67	14.19	15.09	16.55	18.77	22.20
	V	6.17	6.26	6.66	6.68	7.06	7.52	8.29
	VI	16.86	15.11	13.57	10.63	9.11	7.97	7.33
	VII	16.28	18.26	20.62	21.94	22.72	22.43	23.32
	VIII	54.54	67.20	82.96	101.44	116.67	134.96	165.38
	IX	53.38	59.06	69.14	77.02	84.06	99.46	125.98
	X	4.80	4.23	3.69	3.16	2.65	2.21	2.01
	XI	-	-	-	-	-	-	-
	XII	-	-	-	-	-	-	-
Sub-total		249.06	273.67	307.86	338.04	362.95	400.71	467.96
Commercial	NCR	131.60	140.95	158.65	174.82	189.74	207.73	236.90
Sub-total		131.60	140.95	158.65	174.82	189.74	207.73	236.90
ALL USES	NCR	494.81	517.98	549.51	579.05	603.23	631.57	673.71
	I	1,527.71	1,764.60	1,761.46	1,607.99	1,363.75	1,580.41	1,846.07
	II	8,494.66	8,928.14	9,242.52	9,310.75	9,458.53	9,533.98	9,965.24
	III	8,217.99	9,195.29	9,474.22	9,484.49	9,387.61	9,257.10	9,514.21
	IV	5,483.84	5,795.68	5,842.23	6,114.16	6,052.23	6,267.47	6,347.56
	V	653.37	601.26	751.84	754.89	795.17	815.30	726.43
	VI	7,123.77	7,518.17	7,175.22	7,867.36	8,288.54	8,249.68	8,440.21
	VII	5,990.48	6,506.79	6,721.08	7,066.81	6,844.21	7,182.65	7,326.82
	VIII	408.18	443.33	471.74	476.69	459.66	511.13	552.96
	IX	2,625.56	2,683.19	2,824.94	2,827.66	2,876.23	2,979.58	3,041.15
	X	644.11	724.44	753.19	904.54	889.16	965.69	891.09
	XI	1,399.09	1,367.45	1,603.18	1,951.71	1,943.46	1,867.25	1,877.02
	XII	1,118.19	1,267.08	1,298.92	1,347.21	1,188.83	1,270.12	1,411.22
T O T A L		**44,181.78**	**47,313.39**	**48,470.04**	**50,293.30**	**50,150.60**	**51,111.94**	**52,613.68**

Source of basic data: LWUA, MWSS, NIA and NSCB

APPENDIX TABLE 4. AGRICULTURAL WATER USES BY REGION, 1988-1994
IN MILLION CUBIC METERS

SECTOR	REGION	1988	1989	1990	1991	1992	1993	1994
NIA (rice crop)	I	1,050.33	1,263.16	1,236.40	1,077.63	841.61	1,054.20	1,083.02
	II	1,278.65	1,351.83	1,488.19	1,400.46	1,403.09	1,392.70	982.22
	III	2,165.61	2,196.32	1,911.46	1,854.01	1,677.66	1,610.63	1,545.06
	IV	1,443.27	1,551.97	1,537.71	1,600.74	1,481.08	1,604.81	1,595.54
	V	623.33	570.58	720.63	723.04	763.13	782.41	692.20
	VI	1,698.26	1,786.48	1,573.12	1,974.56	1,952.33	1,736.43	1,794.93
	VII	251.74	272.06	283.27	267.92	234.00	265.28	274.83
	VIII	251.74	272.06	283.27	267.92	233.95	265.28	274.83
	IX	523.71	511.86	524.69	545.39	510.89	514.27	522.75
	X	606.03	685.32	714.17	865.04	849.42	925.03	849.82
	XI	1,388.34	1,356.90	1,592.56	1,940.81	1,932.88	1,856.38	1,865.86
	XII	1,106.52	1,255.12	1,286.96	1,334.94	1,176.93	1,257.84	1,398.49
	MRIIS	3,321.05	3,372.87	3,425.21	3,417.53	3,383.87	3,359.46	3,577.24
	UPRIIS	2,933.39	3,595.69	3,836.71	3,814.34	3,890.73	3,758.47	3,866.44
	CAR							429.26
Sub-total		18,641.97	20,042.22	20,414.35	21,084.33	20,331.57	20,383.19	20,752.49
Sugarcane & Livestock	I	477.38	501.44	525.06	530.36	522.14	526.21	548.42
	II	3,894.96	4,203.44	4,329.12	4,492.76	4,671.57	4,781.82	5,191.15
	III	3,080.07	3,364.05	3,685.99	3,775.93	3,777.82	3,845.44	4,058.86
	IV	4,025.56	4,227.65	4,286.83	4,494.74	4,550.93	4,640.13	4,725.97
	V	14.14	14.46	14.37	14.76	14.35	14.50	14.85
	VI	5,382.89	5,690.25	5,561.65	5,854.75	6,299.13	6,476.76	6,608.89
	VII	5,716.47	6,210.37	6,410.96	6,770.62	6,581.04	6,888.38	7,022.01
	VIII	10.16	10.68	10.44	10.58	10.57	10.68	10.82
	IX	1,972.29	2,034.41	2,151.60	2,124.06	2,198.40	2,281.28	2,306.14
	X	15.93	17.09	17.09	17.64	17.93	18.83	19.17
	XI	10.75	10.55	10.62	10.90	10.58	10.87	11.16
	XII	11.67	11.96	11.96	12.27	11.90	12.28	12.73
Sub-total		24,612.26	26,296.36	27,015.71	28,109.36	28,666.35	29,507.18	30,530.17
ALL USES	I	1,527.71	1,764.60	1,761.46	1,607.99	1,363.75	1,580.41	1,631.44
	II	5,173.61	5,555.27	5,817.31	5,893.22	6,074.66	6,174.52	6,173.37
	III	5,245.68	5,560.37	5,597.45	5,629.94	5,455.48	5,456.07	5,603.92
	IV	5,468.83	5,779.62	5,824.54	6,095.48	6,032.01	6,244.94	6,321.51
	V	637.47	585.04	735.00	737.80	777.48	796.91	707.05
	VI	7,081.15	7,476.73	7,134.77	7,829.31	8,251.46	8,213.19	8,403.82
	VII	5,968.21	6,482.43	6,694.23	7,038.54	6,815.04	7,153.66	7,296.84
	VIII	261.90	282.74	293.71	278.50	244.52	275.96	285.65
	IX	2,496.00	2,546.27	2,676.29	2,669.45	2,709.29	2,795.55	2,828.89
	X	621.96	702.41	731.26	882.68	867.35	943.86	868.99
	XI	1,399.09	1,367.45	1,603.18	1,951.71	1,943.46	1,867.25	1,877.02
	XII	1,118.19	1,267.08	1,298.92	1,347.21	1,188.83	1,270.12	1,411.22
	MRIIS	3,321.05	3,372.87	3,425.21	3,417.53	3,383.87	3,359.46	3,577.24
	UPRIIS	2,933.39	3,595.69	3,836.71	3,814.34	3,890.73	3,758.47	3,866.44
	CAR	-	-	-	-	-	-	429.26
TOTAL		**43,254.23**	**46,338.58**	**47,430.06**	**49,193.69**	**48,997.92**	**49,890.37**	**51,282.65**

Source of basic data: NIA and NWRB

APPENDIX TABLE 5. PHYSICAL ACCOUNTS OF GROUNDWATER, BY REGION, 1988-1994
IN MILLION CUBIC METERS

ACCOUNT	1988	1989	1990	1991	1992	1993	1994
NCR							
Opening Stock	6,185.14	5,871.76	5,499.42	5,154.17	4,721.80	4,283.50	3,838.74
Changes in Quantity (Withdrawal)	(519.54)	(549.71)	(580.73)	(610.04)	(623.05)	(641.08)	(670.69)
Other Accumulation (Recharge)	206.16	177.37	235.48	177.67	184.75	196.32	212.41
Closing Stock	5,871.76	5,499.42	5,154.17	4,721.80	4,283.50	3,838.74	3,380.46
Changes in Quality	103.08	88.69	117.74	88.84	92.38	98.16	106.21
REGION I							
Opening Stock	4,620.00	4,472.31	4,377.64	4,242.93	4,096.09	4,003.73	3,869.82
Changes in Quantity (Withdrawal)	(251.29)	(267.27)	(297.01)	(287.40)	(249.69)	(247.73)	(274.78)
Other Accumulation (Recharge)	103.60	172.60	162.30	140.56	157.33	113.82	103.97
Closing Stock	4,472.31	4,377.64	4,242.93	4,096.09	4,003.73	3,869.82	3,699.01
Changes in Quality	103.60	172.60	162.30	140.56	157.33	113.82	103.97
REGION II							
Opening Stock	11,850.00	11,938.25	12,035.31	12,215.36	12,340.87	12,430.74	12,482.76
Changes in Quantity (Withdrawal)	(91.40)	(92.95)	(95.15)	(97.14)	(98.65)	(100.48)	(102.52)
Other Accumulation (Recharge)	179.65	190.01	275.21	222.65	188.51	152.51	139.94
Closing Stock	11,938.25	12,035.31	12,215.36	12,340.87	12,430.74	12,482.76	12,520.19
Changes in Quality	179.65	190.01	275.21	222.65	188.51	152.51	139.94
REGION III							
Opening Stock	54,700.00	54,618.27	54,499.92	54,421.20	54,280.08	54,157.35	54,061.46
Changes in Quantity (Withdrawal)	(261.38)	(263.42)	(269.04)	(270.01)	(278.00)	(285.82)	(294.45)
Other Accumulation (Recharge)	179.65	145.07	190.32	128.89	155.27	189.93	125.84
Closing Stock	54,618.27	54,499.92	54,421.20	54,280.08	54,157.35	54,061.46	53,892.85
Changes in Quality	179.65	145.07	190.32	128.89	155.27	189.93	125.84
REGION IV							
Opening Stock	37,000.00	35,901.79	34,723.95	33,426.30	32,008.17	30,418.75	28,684.27
Changes in Quantity (Withdrawal)	(1,301.64)	(1,393.00)	(1,533.33)	(1,619.01)	(1,753.11)	(1,953.55)	(2,258.61)
Other Accumulation (Recharge)	203.43	215.16	235.68	200.88	163.69	219.07	170.94
Closing Stock	35,901.79	34,723.95	33,426.30	32,008.17	30,418.75	28,684.27	26,596.61
Changes in Quality	203.43	215.16	235.68	200.88	163.69	219.07	170.94
REGION V							
Opening Stock	8,625.00	8,485.48	8,368.65	8,220.26	8,043.35	7,852.41	7,688.63
Changes in Quantity (Withdrawal)	(242.77)	(247.58)	(257.01)	(260.80)	(269.92)	(280.51)	(295.74)
Other Accumulation (Recharge)	103.25	130.75	108.62	83.90	78.98	116.73	98.42
Closing Stock	8,485.48	8,368.65	8,220.26	8,043.35	7,852.41	7,688.63	7,491.31
Changes in Quality	103.25	130.75	108.62	83.90	78.98	116.73	98.42
REGION VI							
Opening Stock	55,242.00	55,071.23	54,885.16	54,687.34	54,493.72	54,306.79	54,150.83
Changes in Quantity (Withdrawal)	(297.02)	(288.69)	(281.79)	(265.10)	(258.37)	(254.26)	(253.53)
Other Accumulation (Recharge)	126.25	102.61	83.97	71.49	71.44	98.30	72.65
Closing Stock	55,071.23	54,885.16	54,687.34	54,493.72	54,306.79	54,150.83	53,969.95
Changes in Quality	126.25	102.61	83.97	71.49	71.44	98.30	72.65
REGION VII							
Opening Stock	2,053.00	1,507.22	900.68	219.00	(511.56)	(1,264.82)	(2,000.82)
Changes in Quantity (Withdrawal)	(601.66)	(658.06)	(725.02)	(763.66)	(787.78)	(783.23)	(810.10)
Other Accumulation (Recharge)	55.88	51.53	43.34	33.09	34.53	47.23	43.54
Closing Stock	1,507.22	900.68	219.00	(511.56)	(1,264.82)	(2,000.82)	(2,767.38)
Changes in Quality	55.88	51.53	43.34	33.09	34.53	47.23	43.54
REGION VIII							
Opening Stock	8,400.00	8,493.93	8,579.41	8,600.90	8,614.88	8,606.46	8,615.95
Changes in Quantity (Withdrawal)	(48.87)	(53.65)	(59.46)	(66.21)	(71.87)	(78.55)	(89.29)
Other Accumulation (Recharge)	142.80	139.12	80.96	80.18	63.45	88.05	91.28
Closing Stock	8,493.93	8,579.41	8,600.90	8,614.88	8,606.46	8,615.95	8,617.94
Changes in Quality	142.80	139.12	80.96	80.18	63.45	88.05	91.28
REGION IX							
Opening Stock	14,700.00	14,723.23	14,727.49	14,705.75	14,673.18	14,641.83	14,615.83
Changes in Quantity (Withdrawal)	(66.90)	(70.69)	(76.76)	(81.69)	(86.19)	(95.02)	(109.58)
Other Accumulation (Recharge)	90.13	74.95	55.01	49.12	54.84	69.02	59.84
Closing Stock	14,723.23	14,727.49	14,705.75	14,673.18	14,641.83	14,615.83	14,566.08
Changes in Quality	90.13	74.95	55.01	49.12	54.84	69.02	59.84
REGION X							
Opening Stock	15,950.00	15,951.62	15,978.32	15,997.94	15,966.48	15,939.84	15,925.59
Changes in Quantity (Withdrawal)	(143.51)	(142.71)	(142.12)	(141.66)	(141.33)	(141.47)	(143.21)
Other Accumulation (Recharge)	145.13	169.42	161.73	110.20	114.68	127.22	146.97
Closing Stock	15,951.62	15,978.32	15,997.94	15,966.48	15,939.84	15,925.59	15,929.35
Changes in Quality	145.13	169.42	161.73	110.20	114.68	127.22	146.97
REGION XI							
Opening Stock	12,635.00	12,590.36	12,524.19	12,443.36	12,334.94	12,215.30	12,148.15
Changes in Quantity (Withdrawal)	(207.77)	(210.19)	(211.99)	(212.68)	(211.20)	(211.38)	(213.25)
Other Accumulation (Recharge)	163.13	144.02	131.16	104.26	91.56	144.24	148.30
Closing Stock	12,590.36	12,524.19	12,443.36	12,334.94	12,215.30	12,148.15	12,083.20
Changes in Quality	163.13	144.02	131.16	104.26	91.56	144.24	148.30
REGION XII							
Opening Stock	36,000.00	35,897.63	35,756.63	35,590.21	35,394.57	35,153.39	34,899.62
Changes in Quantity (Withdrawal)	(264.42)	(284.07)	(296.71)	(299.22)	(305.28)	(318.71)	(340.63)
Other Accumulation (Recharge)	162.05	143.07	130.29	103.57	64.10	64.94	66.77
Closing Stock	35,897.63	35,756.63	35,590.21	35,394.57	35,153.39	34,899.62	34,625.76
Changes in Quality	162.05	143.07	130.29	103.57	64.10	64.94	66.77

APPENDIX TABLE 6. MONETARY ACCOUNTS OF GROUNDWATER, BY REGION, 1988-1994
IN MILLION PESOS

ACCOUNT	1988	1989	1990	1991	1992	1993	1994
NCR							
Opening Stock	12,022.68	13,029.44	13,877.78	13,715.25	15,236.78	15,453.16	14,674.73
Depletion	(695.40)	(939.61)	(918.70)	(1,395.22)	(1,581.21)	(1,700.24)	(1,802.34)
Degradation	(228.73)	(223.81)	(313.31)	(286.68)	(333.27)	(375.25)	(417.70)
Revaluation	1,930.89	2,011.76	1,069.48	3,203.43	2,130.86	1,297.06	839.97
Closing Stock	13,029.44	13,877.78	13,715.25	15,236.78	15,453.16	14,674.73	13,294.66
REGION I							
Opening Stock	8,868.09	9,961.17	10,690.64	11,141.50	13,413.05	15,183.74	15,547.79
Depletion	(328.96)	(231.18)	(353.75)	(480.83)	(350.26)	(538.00)	(702.56)
Degradation	(230.75)	(421.51)	(426.18)	(460.28)	(596.66)	(457.29)	(427.63)
Revaluation	1,652.79	1,382.16	1,230.79	3,212.66	2,717.61	1,359.34	796.42
Closing Stock	9,961.17	10,690.64	11,141.50	13,413.05	15,183.74	15,547.79	15,214.02
REGION II							
Opening Stock	23,335.02	27,394.70	30,520.33	33,290.52	41,871.34	48,101.97	51,150.61
Depletion	202.51	246.12	490.70	425.85	347.74	213.19	159.45
Degradation	(412.24)	(481.85)	(750.03)	(755.43)	(729.46)	(624.94)	(596.26)
Revaluation	4,269.41	3,361.36	3,029.52	8,910.40	6,612.35	3,460.39	2,632.21
Closing Stock	27,394.70	30,520.33	33,290.52	41,871.34	48,101.97	51,150.61	53,346.01
REGION III							
Opening Stock	106,987.73	117,915.38	130,750.75	138,175.43	163,013.94	186,046.75	200,449.07
Depletion	(176.45)	(283.94)	(199.86)	(423.81)	(421.62)	(355.56)	(650.11)
Degradation	387.85	348.04	483.22	387.08	533.40	704.22	485.20
Revaluation	10,716.25	12,771.27	7,141.32	24,875.24	22,921.03	14,053.66	7,510.49
Closing Stock	117,915.38	130,750.75	138,175.43	163,013.94	186,046.75	200,449.07	207,794.65
REGION IV							
Opening Stock	74,414.40	81,909.94	87,136.29	88,646.55	102,310.93	109,918.17	111,340.88
Depletion	(2,505.56)	(2,955.67)	(3,441.37)	(4,532.90)	(5,743.37)	(6,732.55)	(8,355.88)
Degradation	(464.13)	(539.92)	(625.02)	(642.09)	(591.49)	(850.34)	(684.19)
Revaluation	10,465.23	8,721.94	5,576.65	18,839.37	13,942.10	9,005.60	4,152.12
Closing Stock	81,909.94	87,136.29	88,646.55	102,310.93	109,918.17	111,340.88	106,452.93
REGION V							
Opening Stock	17,792.51	19,806.80	21,837.14	22,738.88	26,713.59	29,708.02	31,826.30
Depletion	(325.67)	(304.86)	(410.47)	(587.53)	(722.40)	(677.97)	(857.44)
Degradation	(241.01)	(341.17)	(300.45)	(278.66)	(298.82)	(483.17)	(427.65)
Revaluation	2,580.97	2,676.37	1,612.66	4,840.90	4,015.65	3,279.42	2,011.51
Closing Stock	19,806.80	21,837.14	22,738.88	26,713.59	29,708.02	31,826.30	32,552.72
REGION VI							
Opening Stock	114,135.50	132,104.88	146,461.04	156,312.82	192,057.68	218,856.36	230,731.28
Depletion	(409.63)	(496.55)	(565.42)	(682.37)	(753.35)	(664.51)	(813.15)
Degradation	(302.85)	(273.81)	(240.01)	(251.96)	(287.90)	(418.85)	(326.59)
Revaluation	18,681.86	15,126.52	10,657.21	36,679.19	27,839.93	12,958.28	13,024.97
Closing Stock	132,104.88	146,461.04	156,312.82	192,057.68	218,856.36	230,731.28	242,616.51
REGION VII							
Opening Stock	4,135.36	3,426.35	2,257.83	580.27	(1,652.86)	(4,607.98)	(7,801.21)
Depletion	(1,240.73)	(1,520.46)	(1,806.18)	(2,360.46)	(2,744.25)	(2,869.68)	(3,080.81)
Degradation	(127.03)	(129.18)	(114.83)	(106.91)	(125.80)	(184.15)	(174.99)
Revaluation	658.75	481.12	243.45	234.24	(85.07)	(139.40)	(65.10)
Closing Stock	3,426.35	2,257.83	580.27	(1,652.86)	(4,607.98)	(7,801.21)	(11,122.11)
REGION VIII							
Opening Stock	16,842.00	18,991.58	21,391.03	22,536.94	27,481.46	30,915.25	33,217.95
Depletion	210.02	213.11	56.33	44.58	(30.25)	36.62	8.06
Degradation	319.29	346.87	212.14	255.77	227.92	339.47	370.44
Revaluation	1,620.27	1,839.47	877.44	4,644.17	3,236.12	1,926.61	1,377.73
Closing Stock	18,991.58	21,391.03	22,536.94	27,481.46	30,915.25	33,217.95	34,974.18
REGION IX							
Opening Stock	30,925.86	34,384.64	38,135.37	39,981.98	51,769.91	60,031.49	62,434.42
Depletion	54.26	11.03	(59.12)	(114.91)	(128.55)	(111.06)	(217.49)
Degradation	(210.49)	(194.08)	(149.56)	(173.31)	(224.84)	(294.83)	(261.63)
Revaluation	3,615.01	3,933.78	2,055.29	12,076.15	8,614.97	2,808.82	1,730.52
Closing Stock	34,384.64	38,135.37	39,981.98	51,769.91	60,031.49	62,434.42	63,685.82
REGION X							
Opening Stock	31,943.07	36,841.86	41,492.51	43,448.80	53,519.65	59,855.68	64,742.29
Depletion	3.74	69.35	53.27	(105.44)	(100.06)	(57.93)	15.74
Degradation	(335.19)	(439.95)	(439.24)	(369.39)	(430.63)	(517.19)	(615.29)
Revaluation	5,230.24	5,021.25	2,342.26	10,545.68	6,866.72	5,461.73	2,545.47
Closing Stock	36,841.86	41,492.51	43,448.80	53,519.65	59,855.68	64,742.29	66,688.21
REGION XI							
Opening Stock	25,673.06	29,812.72	33,460.88	34,994.47	41,552.71	45,483.65	47,431.24
Depletion	(105.69)	(176.79)	(227.32)	(365.24)	(445.50)	(262.16)	(266.43)
Degradation	(386.28)	(384.78)	(368.86)	(351.22)	(340.92)	(563.17)	(608.33)
Revaluation	4,631.63	4,209.73	2,129.77	7,274.70	4,717.36	2,772.92	3,008.81
Closing Stock	29,812.72	33,460.88	34,994.47	41,552.71	45,483.65	47,431.24	49,565.29
REGION XII							
Opening Stock	70,808.40	79,951.20	90,010.16	92,929.61	113,414.80	122,769.69	131,808.88
Depletion	(228.00)	(354.94)	(434.53)	(626.92)	(842.29)	(958.43)	(1,045.33)
Degradation	(360.92)	(360.15)	(340.20)	(331.87)	(223.86)	(245.27)	(254.86)
Revaluation	9,731.72	10,774.05	3,694.18	21,443.98	10,421.04	10,242.89	1,657.83
Closing Stock	79,951.20	90,010.16	92,929.61	113,414.80	122,769.69	131,808.88	132,166.52

APPENDIX TABLE 7. PHYSICAL ACCOUNTS OF SURFACE WATER, 1988-1994
IN MILLION CUBIC METERS

ACCOUNT	1988	1989	1990	1991	1992	1993	1994
REGION I							
Opening Stock (Dep. Streamflow)	12,100.00	9,853.03	24,192.14	13,707.27	15,343.38	11,100.20	10,139.06
Change in Quantity	(1,527.71)	(1,764.60)	(1,761.46)	(1,607.99)	(1,363.75)	(1,580.41)	(1,846.07)
Other Accumulation	(719.26)	16,103.71	(8,723.42)	3,244.10	(2,879.43)	619.27	
Closing Stock (Dep. Streamflow)	9,853.03	24,192.14	13,707.27	15,343.38	11,100.20	10,139.06	
REGION II							
Opening Stock (Dep. Streamflow)	39,300.00	34,109.52	33,147.07	21,714.99	19,186.66	15,522.67	14,243.64
Change in Quantity	(8,494.66)	(8,928.14)	(9,242.52)	(9,310.75)	(9,458.53)	(9,533.98)	(9,965.24)
Additions / Other vol. changes	3,304.18	7,965.69	(2,189.55)	6,782.42	5,794.54	8,254.95	
Closing Stock (Dep. Streamflow)	34,109.52	33,147.07	21,714.99	19,186.66	15,522.67	14,243.64	
REGION III[a]							
REGION IV							
Opening Stock (Dep. Streamflow)	39,900.00	28,798.65	24,278.32	34,916.17	34,587.42	29,054.80	22,670.58
Change in Quantity	(5,483.84)	(5,795.68)	(5,842.23)	(6,114.16)	(6,052.23)	(6,267.47)	(6,347.56)
Other Accumulation	(5,617.50)	1,275.35	16,480.09	5,785.41	519.61	(116.76)	
Closing Stock (Dep. Streamflow)	28,798.65	24,278.32	34,916.17	34,587.42	29,054.80	22,670.58	
REGION V							
Opening Stock (Dep. Streamflow)	14,700.00	13,689.08	14,088.25	10,559.50	9,940.41	14,690.41	12,386.01
Change in Quantity	(653.37)	(601.26)	(751.84)	(754.89)	(795.17)	(815.30)	(726.43)
Other Accumulation	(357.54)	1,000.43	(2,776.92)	135.81	5,545.17	(1,489.10)	
Closing Stock (Dep. Streamflow)	13,689.08	14,088.25	10,559.50	9,940.41	14,690.41	12,386.01	
REGION VI							
Opening Stock (Dep. Streamflow)	11,600.00	15,272.46	5,483.51	4,654.34	4,060.76	6,297.17	4,653.74
Change in Quantity	(7,123.77)	(7,518.17)	(7,175.22)	(7,867.36)	(8,288.54)	(8,249.68)	(8,440.21)
Other Accumulation	10,796.23	(2,270.78)	6,346.04	7,273.79	10,524.95	6,606.26	
Closing Stock (Dep. Streamflow)	15,272.46	5,483.51	4,654.34	4,060.76	6,297.17	4,653.74	
REGION VII							
Opening Stock (Dep. Streamflow)	8,700.00	12,139.00	4,638.78	6,353.00	6,835.94	14,160.08	13,054.57
Change in Quantity	(5,990.48)	(6,506.79)	(6,721.08)	(7,066.81)	(6,844.21)	(7,182.65)	(7,326.82)
Other Accumulation	9,429.48	(993.43)	8,435.29	7,549.76	14,168.34	6,077.14	
Closing Stock (Dep. Streamflow)	12,139.00	4,638.78	6,353.00	6,835.94	14,160.08	13,054.57	
REGION VIII							
Opening Stock (Dep. Streamflow)	33,900.00	24,830.21	18,475.83	16,810.62	10,757.82	17,006.10	17,629.36
Change in Quantity	(408.18)	(443.33)	(471.74)	(476.69)	(459.66)	(511.13)	(552.96)
Other Accumulation	(8,661.61)	(5,911.05)	(1,193.47)	(5,576.11)	6,707.94	1,134.39	
Closing Stock (Dep. Streamflow)	24,830.21	18,475.83	16,810.62	10,757.82	17,006.10	17,629.36	
REGION IX							
Opening Stock (Dep. Streamflow)	17,100.00	11,759.38	8,412.93	8,955.72	3,600.19	2,673.33	2,317.80
Change in Quantity	(2,625.56)	(2,683.19)	(2,824.94)	(2,827.66)	(2,876.23)	(2,979.58)	(3,041.15)
Other Accumulation	(2,715.05)	(663.26)	3,367.73	(2,527.87)	1,949.37	2,624.05	
Closing Stock (Dep. Streamflow)	11,759.38	8,412.93	8,955.72	3,600.19	2,673.33	2,317.80	
REGION X							
Opening Stock (Dep. Streamflow)	2,400.00	2,801.74	2,674.68	1,822.46	1,896.58	2,103.83	2,430.52
Change in Quantity	(644.11)	(724.44)	(753.19)	(904.54)	(889.16)	(965.69)	(891.09)
Other Accumulation	1,045.85	597.38	(99.03)	978.66	1,096.42	1,292.38	
Closing Stock (Dep. Streamflow)	2,801.74	2,674.68	1,822.46	1,896.58	2,103.83	2,430.52	
REGION XI							
Opening Stock (Dep. Streamflow)	18,700.00	25,725.46	22,780.78	9,604.08	15,409.16	10,944.68	18,234.08
Change in Quantity	(1,399.09)	(1,367.45)	(1,603.18)	(1,951.71)	(1,943.46)	(1,867.25)	(1,877.02)
Other Accumulation	8,424.55	(1,577.22)	(11,573.52)	7,756.79	(2,521.02)	9,156.66	
Closing Stock (Dep. Streamflow)	25,725.46	22,780.78	9,604.08	15,409.16	10,944.68	18,234.08	
REGION XII							
Opening Stock (Dep. Streamflow)	22,000.00	19,423.87	31,000.05	23,274.90	23,091.40	33,365.95	40,737.17
Change in Quantity	(1,118.19)	(1,267.08)	(1,298.92)	(1,347.21)	(1,188.83)	(1,270.12)	(1,411.22)
Other Accumulation	(1,457.94)	12,843.27	(6,426.23)	1,163.71	11,463.37	8,641.35	
Closing Stock (Dep. Streamflow)	19,423.87	31,000.05	23,274.90	23,091.40	33,365.95	40,737.17	

[a] not accounted due to incomplete data

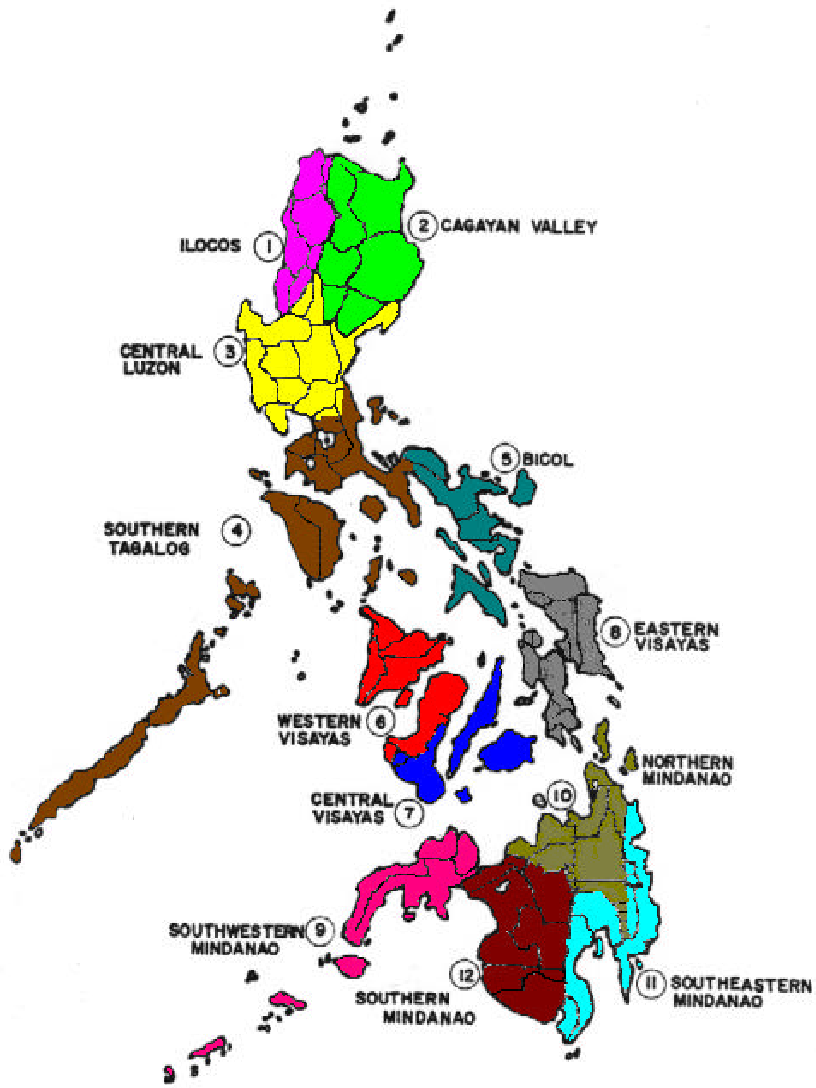
APPENDIX TABLE 8. MONETARY ACCOUNTS OF SURFACE WATER, 1988-1994
IN MILLION PESOS

ACCOUNT	1988	1989	1990	1991	1992	1993	1994
REGION I							
Opening Stock (Dep. Streamflow)	23,225.95	21,945.65	59,079.64	35,993.92	50,243.42	42,096.39	40,735.69
Depletion	(5,004.68)	35,017.55	(27,532.23)	5,357.60	(16,091.83)	(3,861.58)	
Revaluation	3,724.38	2,116.43	4,446.52	8,891.91	7,944.80	2,500.87	
Closing Stock (Dep. Streamflow)	21,945.65	59,079.64	35,993.92	50,243.42	42,096.39	40,735.69	
REGION II							
Opening Stock (Dep. Streamflow)	77,389.56	78,271.11	84,057.64	59,179.87	65,098.42	60,066.52	58,366.16
Depletion	(11,910.60)	(2,440.68)	(31,155.83)	(8,578.38)	(14,178.17)	(5,241.08)	
Revaluation	12,792.15	8,227.22	6,278.05	14,496.93	9,146.28	3,540.72	
Closing Stock (Dep. Streamflow)	78,271.11	84,057.64	59,179.87	65,098.42	60,066.52	58,366.16	
REGION III[a]							
REGION IV							
Opening Stock (Dep. Streamflow)	80,246.88	65,704.12	60,924.00	92,597.69	110,555.23	104,989.53	87,998.11
Depletion	(25,327.73)	(11,343.33)	28,211.60	(1,050.82)	(19,992.11)	(24,781.02)	
Revaluation	10,784.97	6,563.21	3,462.09	19,008.36	14,426.41	7,789.59	
Closing Stock (Dep. Streamflow)	65,704.12	60,924.00	92,597.69	110,555.23	104,989.53	87,998.11	
REGION V							
Opening Stock (Dep. Streamflow)	30,324.63	31,953.06	36,761.88	29,209.68	33,014.10	55,578.22	51,270.66
Depletion	(2,359.68)	1,041.59	(9,761.24)	(2,056.10)	17,970.66	(9,538.82)	
Revaluation	3,988.11	3,767.24	2,209.04	5,860.52	4,593.46	5,231.25	
Closing Stock (Dep. Streamflow)	31,953.06	36,761.88	29,209.68	33,014.10	55,578.22	51,270.66	
REGION VI							
Opening Stock (Dep. Streamflow)	23,966.76	36,635.57	14,632.75	13,303.49	14,311.76	25,377.60	19,829.14
Depletion	8,809.49	(26,121.81)	(2,370.03)	(2,091.98)	9,012.72	(7,002.48)	
Revaluation	3,859.32	4,118.98	1,040.77	3,100.25	2,053.12	1,454.02	
Closing Stock (Dep. Streamflow)	36,635.57	14,632.75	13,303.49	14,311.76	25,377.60	19,829.14	
REGION VII							
Opening Stock (Dep. Streamflow)	17,524.41	27,595.58	11,628.50	16,832.90	22,086.94	51,587.99	50,899.76
Depletion	7,817.87	(18,801.53)	4,541.98	1,560.41	26,683.28	(4,310.37)	
Revaluation	2,253.30	2,834.46	662.42	3,693.63	2,817.78	3,622.15	
Closing Stock (Dep. Streamflow)	27,595.58	11,628.50	16,832.90	22,086.94	51,587.99	50,899.76	
REGION VIII							
Opening Stock (Dep. Streamflow)	67,969.50	55,517.86	46,065.79	44,048.88	34,317.46	61,087.61	67,968.23
Depletion	(20,279.15)	(15,843.37)	(4,363.35)	(19,308.43)	22,444.43	2,402.92	
Revaluation	7,827.51	6,391.30	2,346.43	9,577.01	4,325.72	4,477.71	
Closing Stock (Dep. Streamflow)	55,517.86	46,065.79	44,048.88	34,317.46	61,087.61	67,968.23	
REGION IX							
Opening Stock (Dep. Streamflow)	35,974.98	27,462.87	21,784.45	24,348.82	12,702.20	10,960.67	9,900.93
Depletion	(6,340.73)	(1,717.45)	9,156.20	(8,918.83)	7,992.44	11,209.14	
Revaluation	3,960.36	2,986.88	1,088.63	7,248.76	2,058.59	459.01	
Closing Stock (Dep. Streamflow)	27,462.87	21,784.45	24,348.82	12,702.20	10,960.67	9,900.93	
REGION X							
Opening Stock (Dep. Streamflow)	4,806.48	6,470.90	6,945.60	4,949.62	6,357.34	7,900.11	9,880.79
Depletion	927.86	(329.95)	(2,314.53)	248.45	778.26	1,328.07	
Revaluation	736.56	804.66	318.55	1,159.27	764.51	652.61	
Closing Stock (Dep. Streamflow)	6,470.90	6,945.60	4,949.62	6,357.34	7,900.11	9,880.79	
REGION XI							
Opening Stock (Dep. Streamflow)	37,996.53	60,915.31	60,863.42	27,009.54	51,908.83	40,752.50	71,193.16
Depletion	16,635.58	(7,867.28)	(37,056.85)	19,555.57	(16,623.49)	28,460.76	
Revaluation	6,283.20	7,815.39	3,202.98	5,343.71	5,467.17	1,979.89	
Closing Stock (Dep. Streamflow)	60,915.31	60,863.42	27,009.54	51,908.83	40,752.50	71,193.16	
REGION XII							
Opening Stock (Dep. Streamflow)	43,271.80	43,260.84	78,036.44	60,773.09	73,991.77	116,527.24	153,856.16
Depletion	(5,737.56)	29,140.73	(20,171.15)	(587.99)	35,882.83	27,839.65	
Revaluation	5,726.60	5,634.86	2,907.81	13,806.67	6,652.63	9,489.28	
Closing Stock (Dep. Streamflow)	43,260.84	78,036.44	60,773.09	73,991.77	116,527.24	153,856.16	

[a] not accounted due to incomplete data

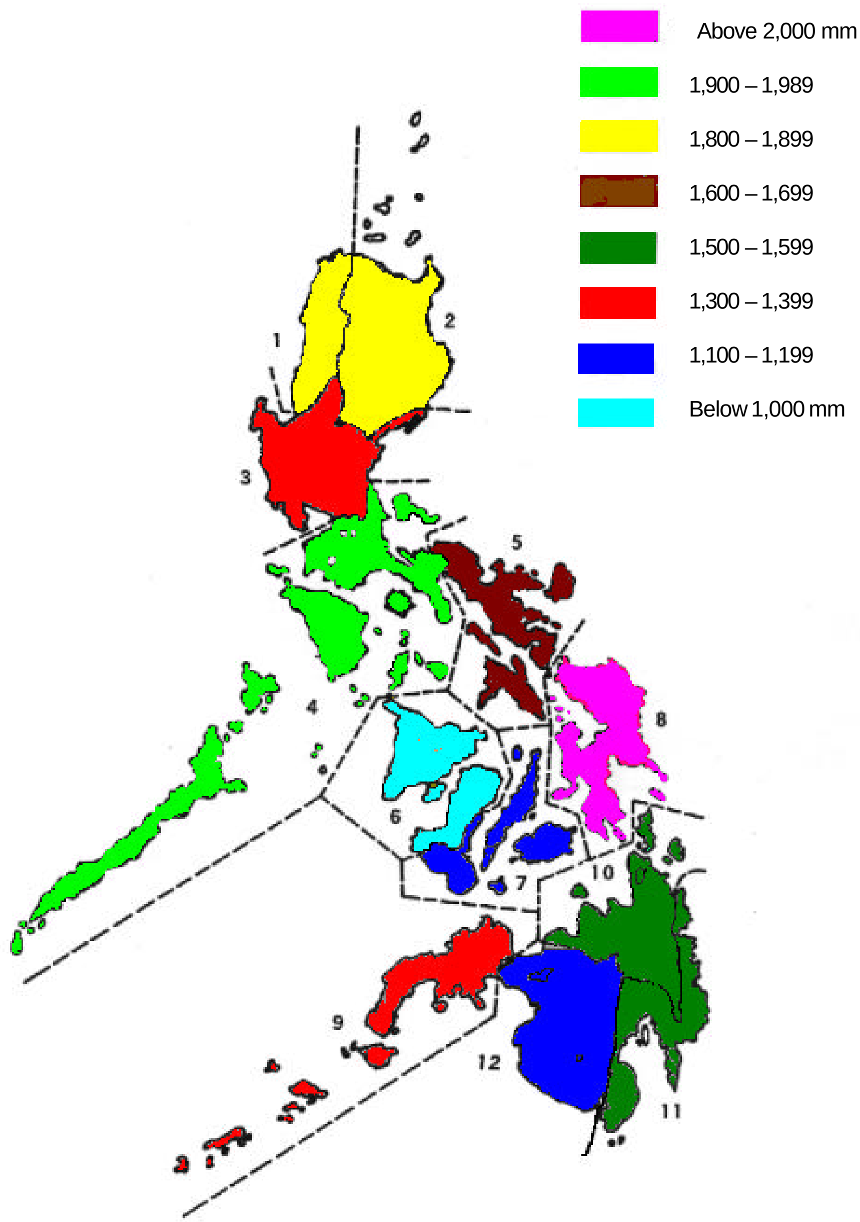
APPENDIX FIGURES

APPENDIX FIGURE 1. PHILIPPINE WATER RESOURCES REGIONS



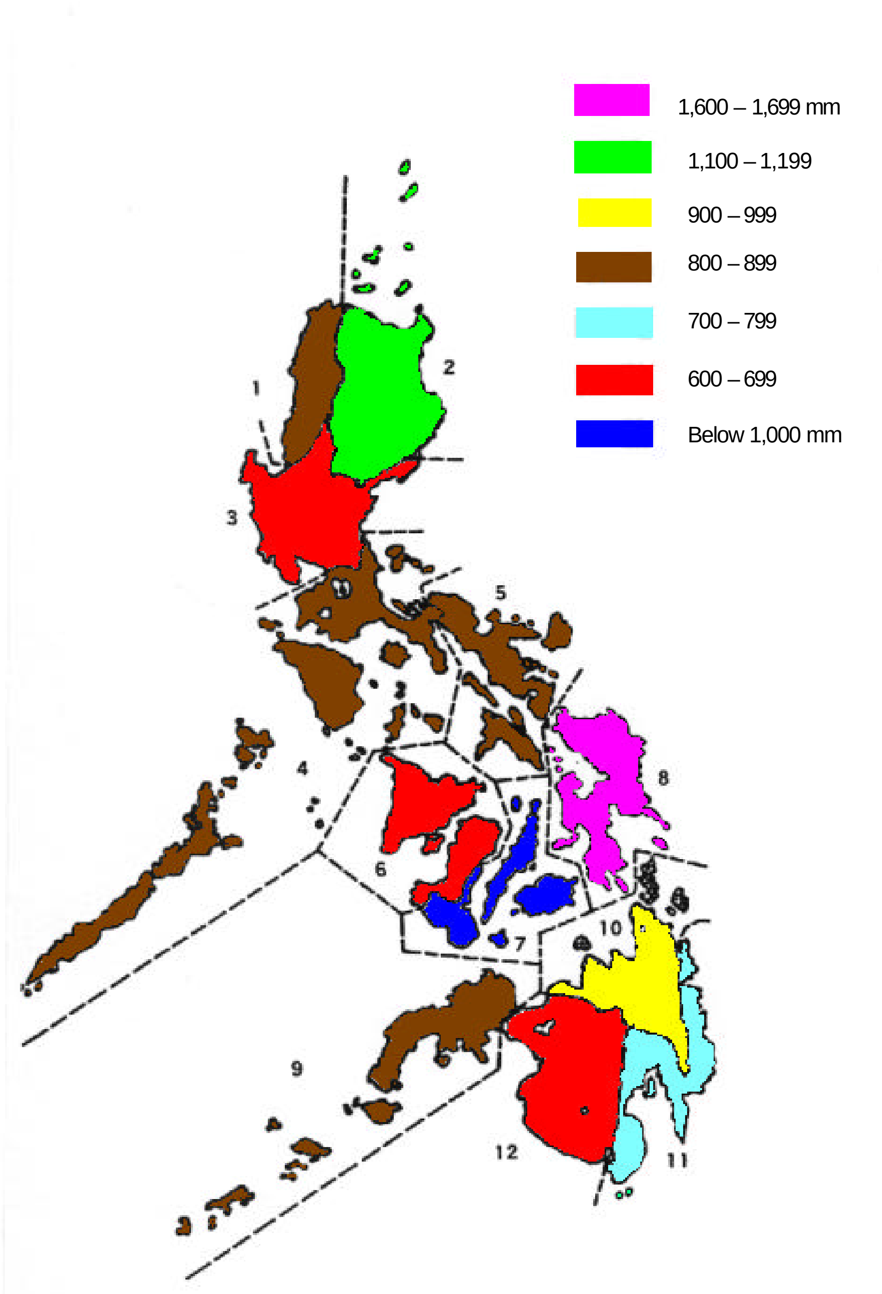
Source: 1972 National Economic Atlas

APPENDIX FIGURE 2. REGIONAL AVERAGE ANNUAL RUNOFF (50% AVAILABILITY)



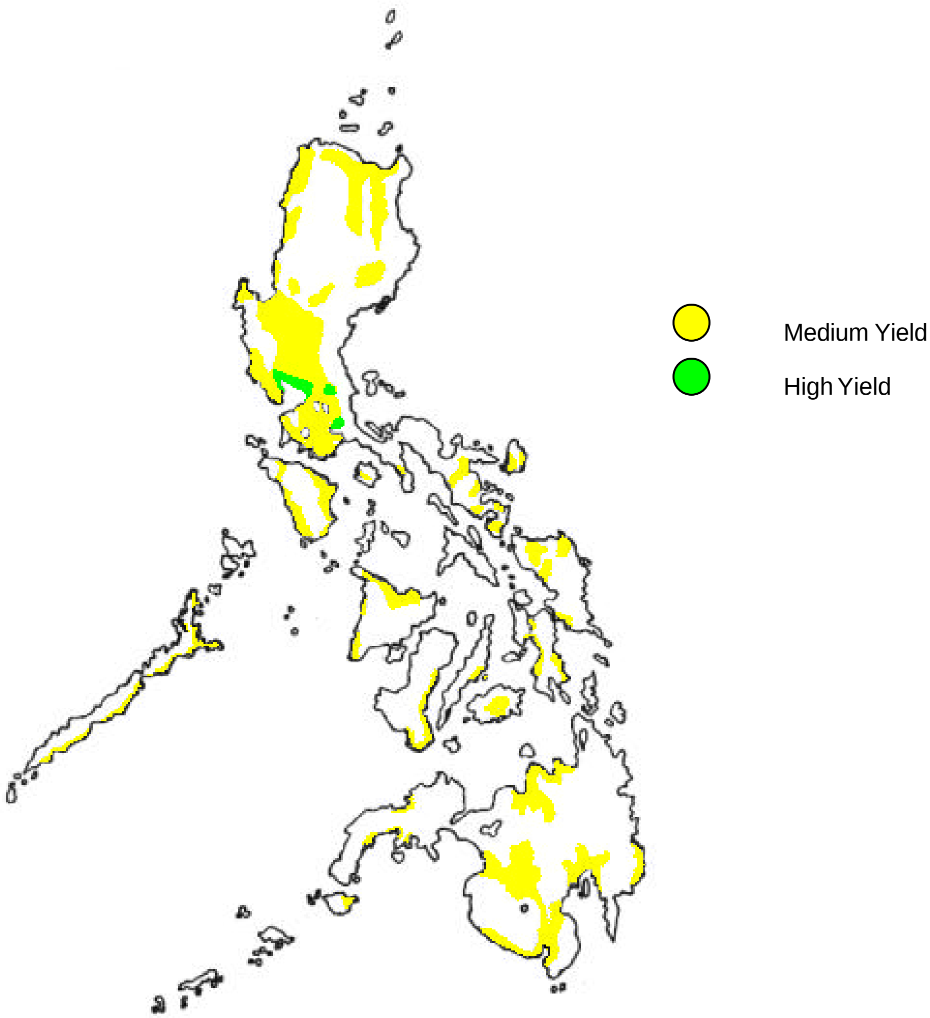
Source: 1972 National Economic Atlas

APPENDIX FIGURE 3. REGIONAL AVERAGE ANNUAL RUN-OFF (90% AVAILABILITY)



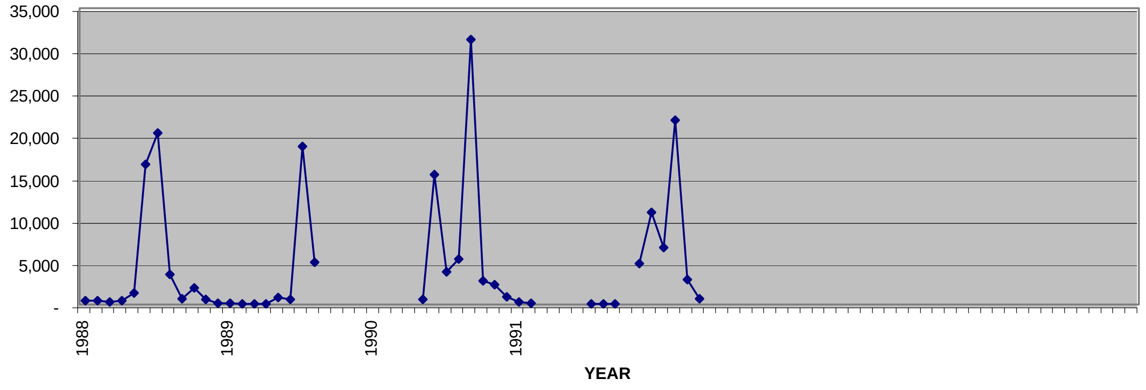
Source: 1972 National Economic Atlas

APPENDIX FIGURE 4. GROUNDWATER RESOURCES MAP

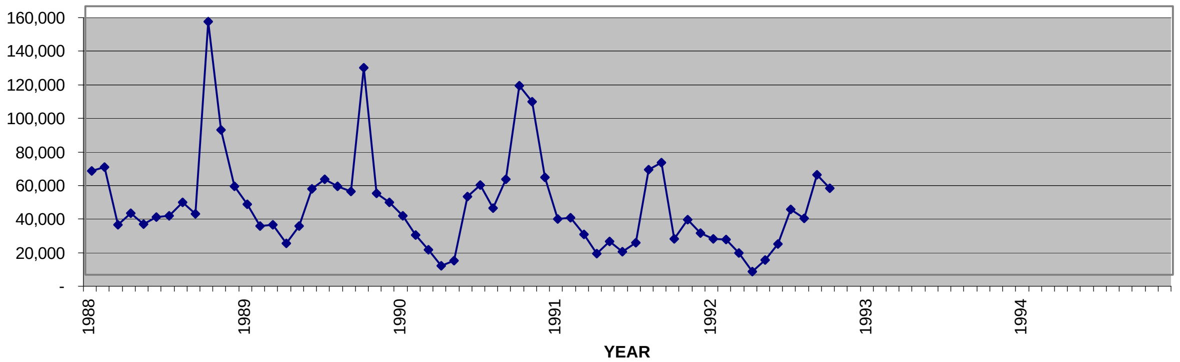


Source: 1972 National Economic Atlas

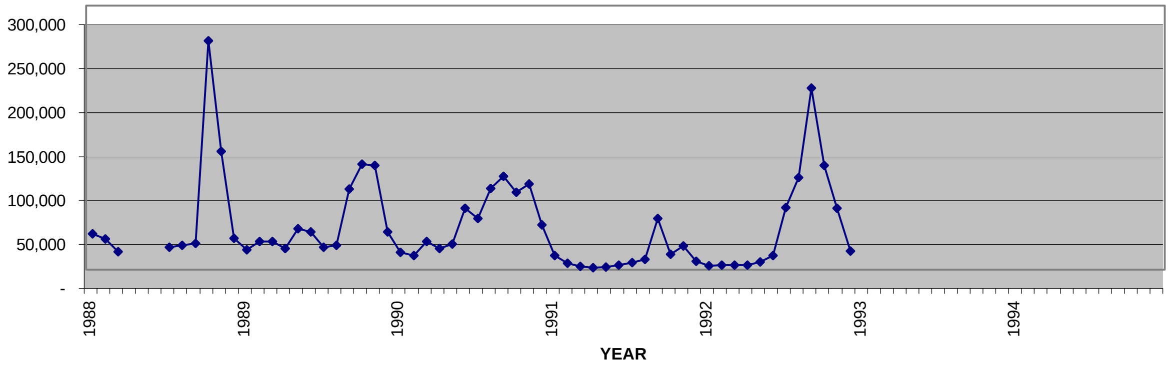
APPENDIX FIGURE 5. HYDROGRAPH: RIVER MARAGAYAP (LA UNION) IN WATER REGION I, IN SECOND-LITERS



APPENDIX FIGURE 6. HYDROGRAPH: RIVER GANANO (CAGAYAN) IN WATER REGION II, IN SECOND-LITERS

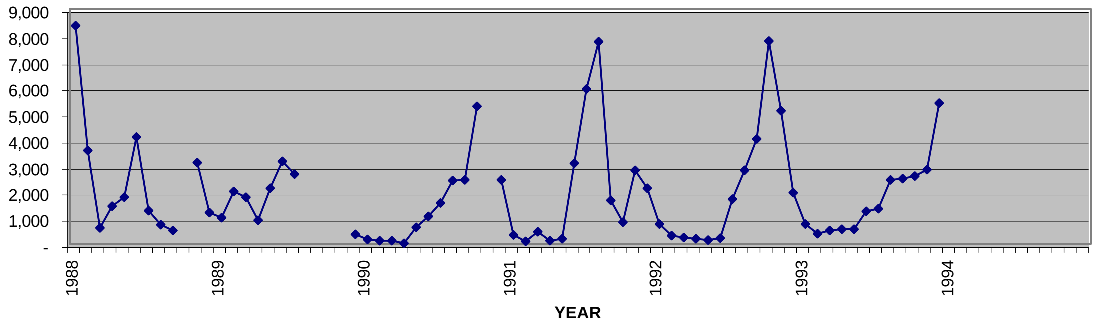


APPENDIX FIGURE 7. HYDROGRAPH: RIVER CORONEL IN WATER REGION III, IN SECOND-LITERS

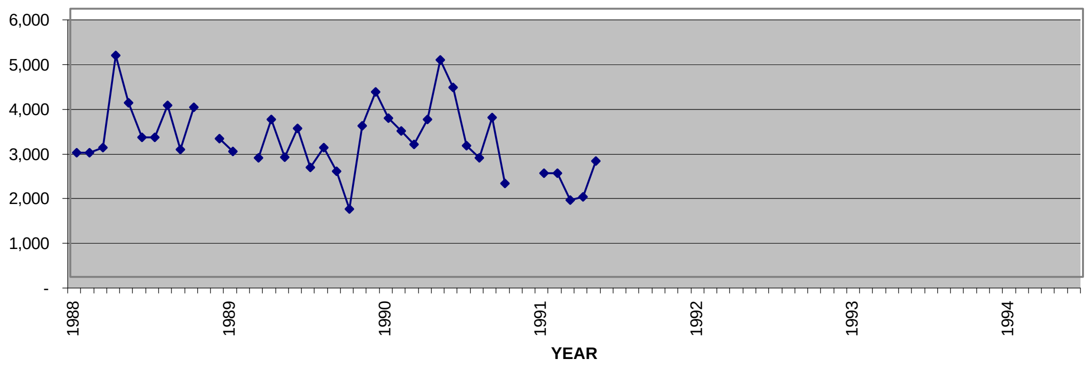


Source of basic data : BRS

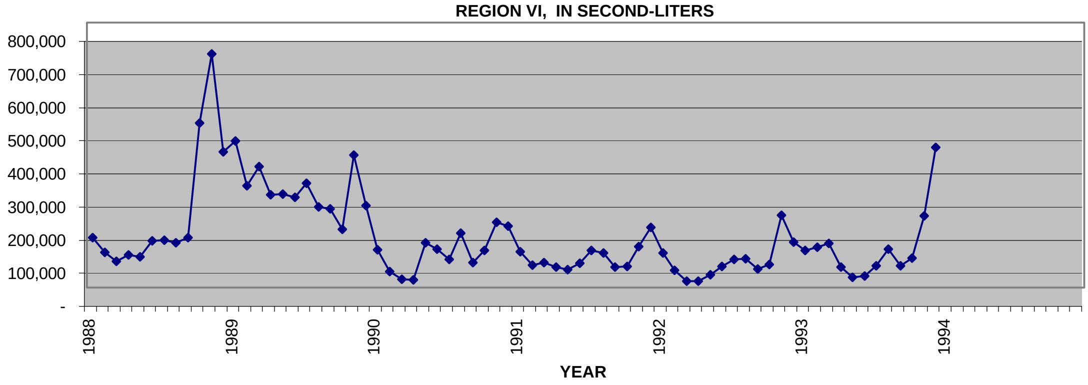
APPENDIX FIGURE 8. HYDROGRAPH: MAYOR RIVER AT FAMY (LAGUNA) IN WATER REGION IV, IN SECOND-LITERS



APPENDIX FIGURE 9. HYDROGRAPH: RIVER CAGAYCAY(BICOL) IN WATER REGION V, IN SECOND-LITERS.

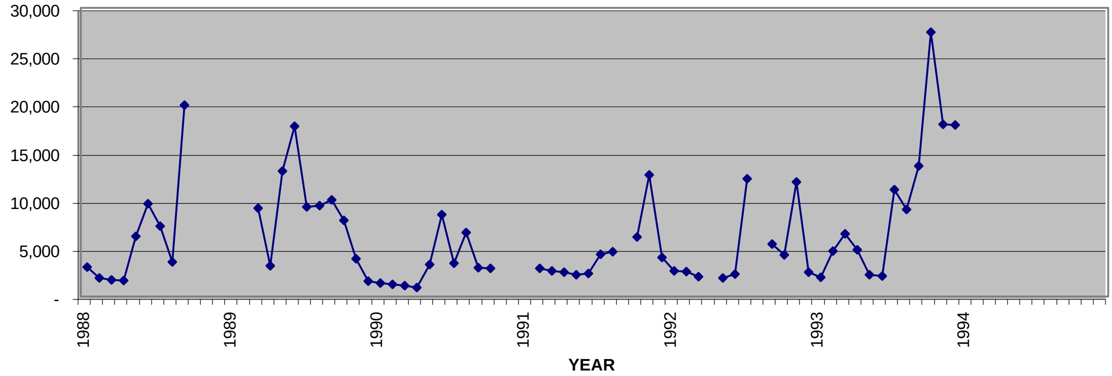


APPENDIX FIGURE 10. HYDROGRAPH: RIVER AKLAN (AKLAN) IN WATER REGION VI, IN SECOND-LITERS

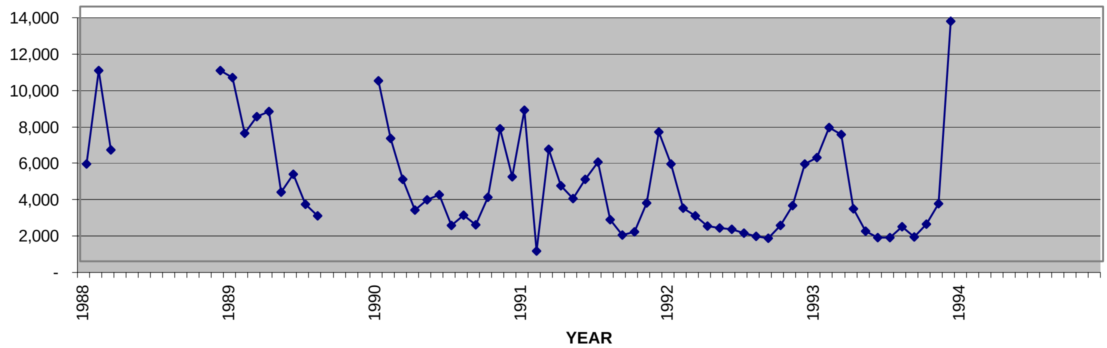


Source of basic data : BRS

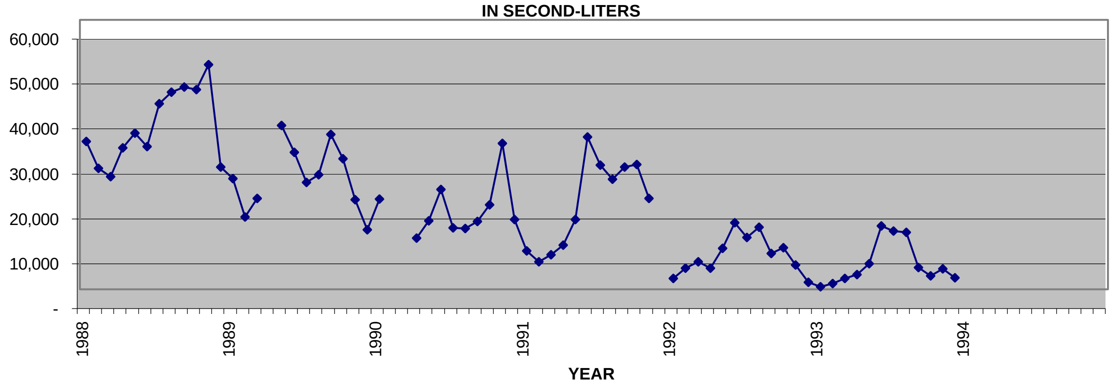
APPENDIX FIGURE 11. HYDROGRAPH: RIVER LA LIBERTAD IN WATER REGION VII, IN SECOND-LITERS.



APPENDIX FIGURE 12. HYDROGRAPH: RIVER DAS-AY (SOUTHERN LEYTE) IN WATER REGION VIII, IN SECOND-LITERS

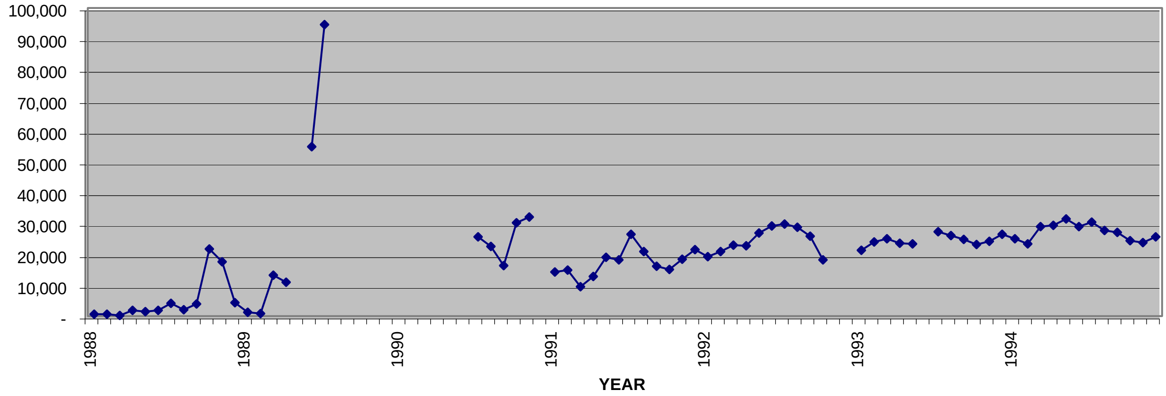


APPENDIX FIGURE 13. HYDROGRAPH: RIVER INGIN IN WATER REGION IX, IN SECOND-LITERS

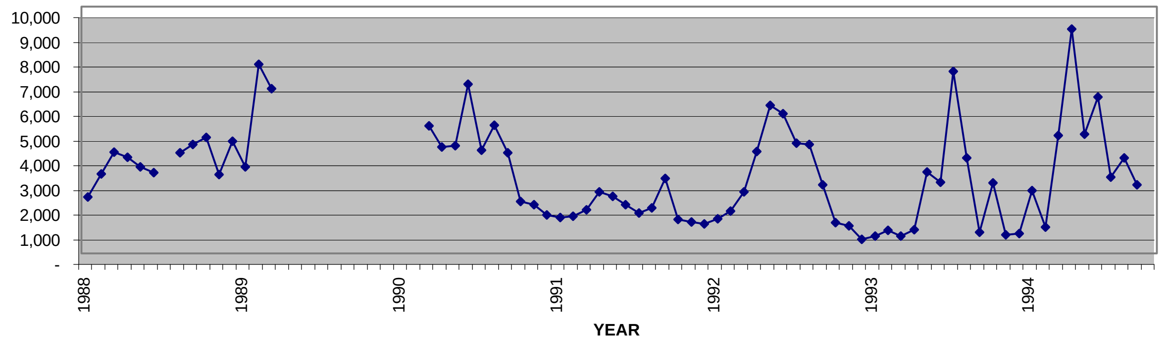


Source of basic data : BRS

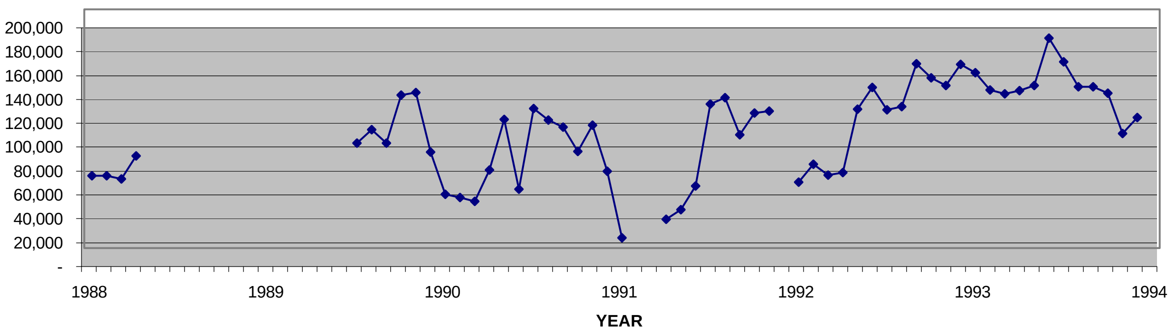
APPENDIX FIGURE 14. HYDROGRAPH: RIVER MULETA (BUKIDNON) IN WATER REGION X, IN SECOND-LITERS



APPENDIX FIGURE 15. HYDROGRAPH: RIVER BUAYAN (SOUTH COTABATO) IN WATER REGION XI, IN SECOND-LITERS



APPENDIX FIGURE 16. HYDROGRAPH: RIVER MAGANOY (MAGUINDANAO) IN WATER REGION XII, IN SECOND-LITERS



Source of basic data: BRS

LITERATURE CITED

Arnell, N. et al. 1990. *Human Influences on Hydrological Behaviour: An International Literature Survey*. Paris: UNESCO .

Bureau of Research and Standards. 1993. *Philippines Water Data 1980-1983*. Surface Water Records , No. 22.

Bureau of Research and Standards. 1991. *Philippine Water Resources Summary Data*. Vol. II. Streamflow and Lake or River Stage. Report No. 1.

Cuaderes, Mike S. 1995. *An Introduction to Geology*. Unpublished report.

Ebarvia, M.C. *The Economics of Water Resources* . A Paper Presented for the Training-Workshop on Valuation Methods of Economic Activities and Other Resources on February 8-10, 1996, at City of Springs, Los Baños, Laguna.

Ebarvia, M.C. 1997. *Pricing of Groundwater Use by Industries in Metro Manila*. Economy and Environment Programme for Southeast Asia. Draft Report.

Gisser, M. 1983. *Groundwater: Focusing on the Real Issue*. Journal of Political Economy, Vol. 91, No. 6.

Howe, Charles. 1979. *Natural Resource Economics: Issues, Analysis, and Policies*. New York: John Wiley and Sons.

International Development Research Centre - University of the Philippines – National Hydraulics Research Center. 1993. *Water Resources Management Model for Metro Manila*.

Linsley, Ray and Joseph B. Franzini. 1979. *Water Resources Engineering*. New York: McGraw-Hill, Inc.

Local Water Utilities Administration (LWUA). 1996. ______________________.

L'vovitch, M. I. and G. F. White. 1990. *Use and Transformation of Terrestrial Water Systems* in B. L. Turner *et al*. (eds.). The Earth as Transformed by Human Action. Cambridge: Cambridge University Press.

Metropolitan Waterworks and Sewerage System. 1992. *Study for the Groundwater Development in Metro Manila*. Vol. II (Main Report, draft). Japan International Cooperation Agency.

Munasinghe, Mohan. 1993. *Environmental Economics and Sustainable Development*. World Bank Environment Paper, *No. 3* . Washington D.C.: World Bank.

Munasinghe, Mohan. 1990. *Managing Water Resources to Avoid Environmental Degradation: Policy Analysis and Application.* Environment Working Paper, No. 41. Washington, D.C.: World Bank.

National Economic and Development Authority. 1981. *National Handbook on Land and Other Physical Resources*. Manila.

National Environmental Protection Council. 1987. *Philippine Groundwater Salinity Intrusion Control Study: A Digest.* Unpublished report.

National Irrigation Agency. *Annual Reports*. 1988 – 1994.

National Water Resources Board. 1991. *Philippine Water Code and the Implementing Rules and Regulations*.

National Water Resources Council. 1976. *Philippine Water Resources: First National Assessment.* Report No. 19.

National Water Resources Council. 1976. *Principal River Basins of the Philippines*. Report No. 4.

National Water Resources Council. 1977. *Water Availability in the Philippines*.

National Water Resources Council. 1980. *Groundwater of the Philippines*. Report No. 34-1.

Newson, Malcolm. 1994. *Hydrology and the River Environment.* Oxford: Oxford University Press.

PAGASA. *Monthly Total and Annual Climatic Data.* Rainfall Amount, 1961 - 1994.

Rogers, Peter. 1993. *America's Water: Federal Roles and Responsibilities*. Cambridge: Twentieth Century Fund - MIT Press.

Villenas, L.R. *Water Resources Management in the Philippines.* A Paper Presented for the Training-Workshop on Valuation Methods of Economic Activities and Other Resources on February 8-10, 1996 at City of Springs, Los Baños, Laguna.

Young, Robert A. 1992. *Water Economics.* in L. Mays (ed.). Handbook of Water Resources. New York: McGraw-Hill, Inc.

Young, Robert A. 1992. *Managing Aquifer Overexploitation: Economics and Policies.* Selected Papers on Aquifer Overexploitation.

United Nations. 1993. Integrated Environmental and Economic Accounting (Interim Version). Series F, No. 61 (Sales No. E 93.XVII.12).

United Nations. 1993. *System of National Accounts* (Sales No. E94. XVII.4).