WATER RESOURCES, QUALITY, AND AVAILABILITY

The Philippines, an archipelago of 7,107 islands, is comprised of three major island groups: Luzon, Visayas, and Mindanao. Luzon occupies nearly 50 percent of the land area of the country, with close to 80 percent of the country's manufacturing establishments and nearly 60 percent of all its households. Luzon has the most number of regions, with seven of the 16 regions, as compared to the Visayas, which has only three regions, and Mindanao, which has six regions. Table 1 shows the region's comparative distribution of land area, households, gross regional domestic product (GRDP), manufacturing establishments, and gross value added (GVA) for manufacturing and agriculture.

WATER RESOURCES

The country is endowed with rich natural resources, including water, which are essential for the country's economic development and in meeting its Millennium Development Goals (MDGs). Water resources of the Philippines include inland freshwater (rivers, lakes, and groundwater), and marine (bay, coastal, and oceanic waters). Overall, there is sufficient water but not enough in highly populated areas, especially during dry season.

Rivers and Lakes occupy 1,830 square kilometers (0.61 percent of total area). The Philippines has 421 principal river basins in 119 proclaimed watersheds. Of these, 19 are considered major river basins and were included in the Water Quantity Scorecard (see Annex 1). The longest river is the Cagayan in Region II. Other important rivers in Luzon include the Agno and Pampanga, crossing the plains of

Table 1 Regional Demography and Economic Activities, 1999

Region	Land Area (in km²)	No. of Households	GRDP	No. of Mfg. Establishments	GVA Mfg	Agriculture Land Area (in km²)	GVA Agriculture
NCR-Metro Manila	636	2,132,989	279,045	7,774	87,487	-	-
CAR-Cordillera Autonomous Region	13,714	263,816	22,301	88	7,410	190,235	3,348
I - Ilocos	12,840	831,549	28,639	344	1,598	415,434	11,996
II - Cagayan Valley	26,838	554,004	21,337	146	718	709,964	11,474
III - Central Luzon	18,067	1,632,047	83,940	1,840	26,652	653,607	19,174
IV - Southern Tagalog	46,844	2,410,972	142,075	3,806	44,726	1,410,315	33,696
V - Bicol	17,633	891,541	25,811	234	381	1,004,425	8,541
VI - Western Visayas	20,011	1,211,647	65,439	580	10,223	889,549	19,661
VII - Central Visayas	14,952	1,129,317	62,952	1,432	12,863	665,446	8,183
VIII -Eastern Visayas	21,432	715,025	22,171	169	4,653	957,329	6,764
IX - Western Mindanao	15,586	595,728	25,641	238	2,239	763,796	12,862
X - Northern Mindanao	14,033	542,075	39,592	311	9,205	828,515	12,632
XI - Southern Mindanao	27,141	1,066,199	51,061	727	7,561	1,103,297	16,171
XII - Central Mindanao	14,571	501,915	24,983	186	7,118	706,472	8,762
ARMM - Autonomous Region in Muslim Mindanao	18,847	393,269	9,080	13	365	-	5,203
CARAGA	11,410	393,362	13,314	144	1,468	-	4,940

Source: Philippines Statistical Yearbook, 2000.

Central Luzon; the Pasig, a commercially important artery flowing through the center of Metro Manila, providing the main drainage outlet for most of the waterways; and the Bicol, the primary river of Region V. The principal river of Mindanao is the Rio Grande de Mindanao, which receives the waters of the Pulangi and the Agusan.

There is no updated inventory of lakes at present, but a recent study has placed the number of lakes at 72.[1] The largest lake is the Laguna de Bay, which encompasses two regions: Metro Manila and Region IV with an area of 922 km^2 (Box 1).

Lake Taal, 56 km south of Manila, occupies a huge volcanic crater and contains an island that is itself a volcano, with its own crater lake. The largest lake in Mindanao is Lake Lanao, which is a major source of hydropower.

Bays and Coastal Waters cover an area of 266,000 km^2, while oceanic waters cover 1,934,000 km^2. The total length of the coastline is 36,289 km. The Philippine coastline is irregular, with numerous bays, gulfs, and islets. Manila Bay, a sheltered harbor, is the country's busiest commercial hub. About 60 percent of Philippine municipalities and cities are coastal, with 10 of the largest cities located along the coast. These coastal cities and municipalities are inhabited by about 60 percent of the total population[2].

Box 1 - Laguna Lake, Pasig River and Manila Bay

Laguna de Bay or Laguna Lake receives water from 21 river systems that flow through five provinces (including Manila), 10 cities, and 51 municipalities. The watershed covers about 292,200 hectares and is home to a high concentration of industries (1600 estimated by Laguna Lake Development Authority - LLDA). As a result of land-use changes (deforestation, quarry activities, urban expansion), about 4 million tons of suspended solids enter the lake annually, leading to an average net accretion of 0.5 cm/ yr. The present average depth of the lake is 2.5 m. The lake's only outlet is to the Pasig River.

The Pasig River which passes through the center of Metro Manila and serves as its major waterway, has become seriously polluted over time. The Pasig river discharges into the Manila Bay. Manila Bay is an important economic resource with competing uses. The surrounding catchment area covers about 17,000 km^2 and is home to an estimated 16 million people. The largest harbor in the country is located in Manila Bay with primary port services catering to both national and international maritime traffic. Increasing urbanization has damaged the coastal habitats and estuaries, which serve as spawning grounds of many economically important fishes.

Sources: DENR-EMB and LLDA, 2002.

Groundwater is replenished or recharged by rain and seepage from rivers. As noted in Table 2, the recharge or extraction potential is estimated at 20,200 MCM per year. Groundwater contributes 14 percent of the total water resource potential of the Philippines. Region X has the lowest potential source of groundwater compared to its surface water potential, while Regions I and VII have the highest potential.

Groundwater is used for drinking by about 50 percent of the people in the country. Based on the water rights granted by the National Water Resources Board (NWRB) since 2002, 49 percent of groundwater is consumed by the domestic sector, and the remaining shared by agriculture (32 percent), industry (15 percent), and other sectors (4 percent). About 60 percent of the groundwater extraction is without water- right permits, resulting in indiscriminate withdrawal[3]. A high percentage (86 percent) of piped-water supply systems uses groundwater as a source.

In terms of sectoral demand, agriculture has a high demand of 85 percent, while industry and domestic have a combined demand of only 15 percent (see Table 3).

Table 2 Groundwater Availability (in MCM)

Water Resources Region	Groundwater Potential	Surface Water Potential	Total Water Resources Potential	Percent Ground Water to Total Potential
X Northern Mindanao	2,116	29,000	31,116	6.8
VI Western Visayas	1,144	14,200	15,344	7.45
IX Western Mindanao	1,082	12,100	13,182	8.21
XII Southern Mindanao	1,758	18,700	20,458	8.59
XI Southeastern Mindanao	2,375	11,300	13,675	17.37
III Central Luzón	1,721	7,890	9,611	17.91
IV Southern Tagalog	1,410	6,370	7,780	18.12
VIII Eastern Visayas	2,557	9,350	11,907	21.47
II Cagayan Valley	2,825	8,510	11,335	24.92
V Bicol	1,085	3,060	4,145	26.18
I Ilocos	1,248	3,250	4,498	27.75
VII Central Visayas	879	2,060	2,939	29.91
Total	**20,200**	**125,790**	**145,990**	**13.84**

Source: NWRB, 2003.

Table 3 Water Demand in the Philippines (in MCM/year)

Water Demand	1996	2025		% of Total
		Low	High	(1996)
Municipalities	2,178	7,430	8,573	7.27
Industrial	2,233	3,310	4,997	7.46
Agriculture	25,533	51,920	72,973	85.27
Irrigation	18,527	38,769	53,546	61.87
Livestock	107	224	309	0.36
Fishery	6,899	14,437	19,939	23.04
Total Demand	**29,944**	**62,660**	**86,543**	**100.00**
Groundwater (GW) Recharge	20,200	20,200	20,200	
% GW Potential / Total Demand	67.46	32.24	32.24	

Sources: NWRB, 2003 and JICA, Master Plan Study on Water Resources Management in the Republic of the Philippines, 1998.

[1] SEAFDEC-PCAMRD-DA / BFAR Conversation and Ecological management of Philippine Lakes in relation to Fisheries and Aquaculture, 2001.

[2] Local Government Development Foundation (LOGODEP) and Konrad Adenaur Siftung (KAS). Instructive Guide in the Replication of the Tubigon-LOGODEP-KAS Mariculture Project (Manila, September 2001).

[3] Presentation by Engr. Jorge Estioko, Chief, Monitoring and Enforcement Division, National Water Resources Board during an NGO Consultative Workshop in 2003 at Miriam College, Philippines.

WATER QUALITY

Water pollution affects fresh, marine, and groundwater resources of the country. Details on water quality for surface water (rivers, lakes, bays) and groundwater are found in Annex 1. Surface water quality can be assessed by using Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) as parameters[4]. The environmental and public health dimensions of the water quality situation are as follows:

- 36 percent of the river sampling points have been classified as public water supply sources (Table 4 and Figure 1);
- about 60 percent of the country's population live along coastal areas and contribute to discharge of untreated domestic and industrial wastewater from inland[5];
- preliminary data indicate that up to 58 percent of groundwater intended for drinking water supplies are contaminated with total Coliform and would need treatment[6]; and
- 31 percent of illnesses for a five-year period was from water-related diseases (Figure 2) [7].

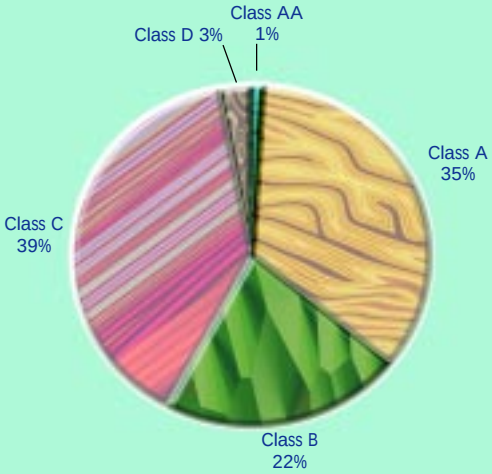
Water classification, based on "beneficial use," is outlined in Table 4. Water classifications are arranged in the order of the degree of protection required, with Classes AA and SA having generally the most stringent requirements, while Class D and SD have the least stringent water quality.

Table 4 Water Classification by Beneficial Use

Classification	Beneficial Use
For Fresh Surface Waters *(rivers, lakes, reservoirs, etc.)*	
Class AA: Public Water Supply	Waters that require disinfections to meet the National Standards for Drinking Water (NSDW)
Class A: Public Water Supply	Waters that require complete treatment to meet the NSDW
Class B: Recreational Water	Waters for primary contact recreation (e.g. bathing, swimming, skin diving, etc.)
Class C:	• Water for the fishery production • Recreational Water Class II (boating, etc.) • Industrial Water Supply Class I
Class D:	• For agriculture, irrigation, livestock watering • Industrial Water Supply Class II • Other inland waters
For Coastal and Marine Waters *(as amended by DAO 97-23)*	
Class SA	• Waters suitable for the fishery production • National marine parks and marine reserves • Coral reefs parks and reserves
Class SB	• Tourist zones and marine reserves • Recreational Water Class 1 • Fishery Water Class 1 for milk fish
Class SC	• Recreational Water Class II (e.g. boating) • Fishery Water Class II (commercial) • Marshy and/or mangrove areas declared as fish and wildlife sanctuaries
Class SD	• Industrial Water Supply Class II • Other coastal and marine waters

Sources: DENR Administrative Order No. 34 and No. 97-23.

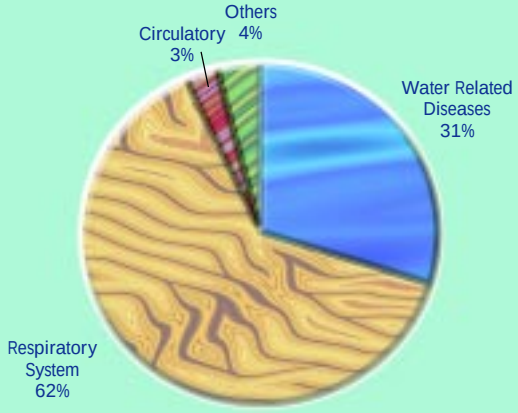
Figure 1 River Water Classification as of 2001



Total Sampling Points in Year 2001 = 445

Source: DENR-EMB, 2003.

Figure 2 Sources of Illnesses for 1996-2000



Total Number of Illnessess = 16,703,148

Source: National Epidemiology Center data, Department of Health.

[4] National standards for DO vary from 2 to 5 mg/l and for BOD from 1 to 15 mg/l based on beneficial water usage and classification.
[5] Local Government Development Foundation (LOGODEF) and Konrad Adenauer Stiftung (KAS). Instructive Guide in the Replication of the Tubigon-LOGODEF-KAS Mariculture Project. (Manila, September 2001).
[6] Compiled data from various Feasibility Studies of LWUA, 1990-1997.
[7] National Epidemiology Center data, Department of Health.

Rivers and Lakes. Between 1996-2001, the Environmental Management Bureau (EMB) monitored 141 rivers. About 41 rivers (or 29 percent) had minimum DO values of less than 5 mg/l, which affects fish; 92 rivers (or 64 percent) had maximum values of BOD that exceeded the criterion for Class A waters. These high percentages indicate organic pollution. Figure 1 illustrates the percentages for river water classification levels for 2001. Further, between 1996-2001, DO and BOD levels for Laguna de Bay, Taal Lake, and Lake Danao in Leyte meet the Class A criteria. Naujan Lake in Oriental Mindoro has DO and BOD levels that do not meet its Class B criteria.

Bays and Coastal Waters. EMB monitored a total of 39 bays and coasts in the Philippines for a long time and regularly since 1996. Manila Bay has its own monitoring program. Except for Puerto Galera Bay, which is a protected seascape, the data indicated that 64 percent had DO levels below 5 mg/l, the minimum criterion set for waters suitable as a tourist zone, fishery spawning area, and contact recreation or swimming area. In the coasts of Mandaue to Minglanilla in Cebu (Central Visayas), DO levels varied from 0 to 14 mg/l, which indicate that the ecosystem is already undergoing "stress" during certain periods.

Except in Cawacawa (Zamboanga City), the maximum values of BOD were all within the criterion set for Class SB waters of 5 mg/l. Manila Bay has BOD levels that are generally within fishery water quality criterion (Figure 3). However, seasonal high organic loadings from rivers draining into the bays and in particular, Manila Bay, also result in harmful algal blooms (HABs) that pose a continuing threat to marine resources and public health (see Box 2).

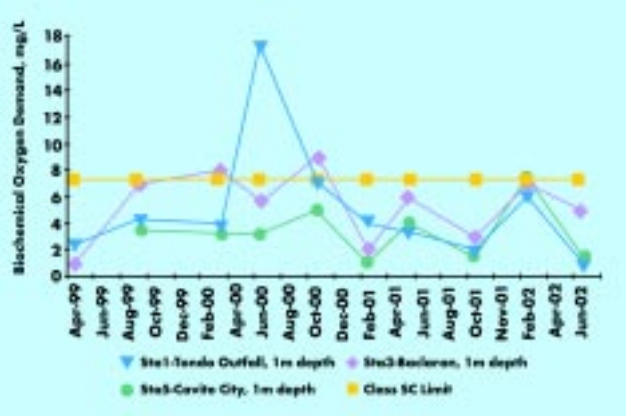
Groundwater. Pollution of groundwater may come from domestic wastewater, agricultural runoffs, and industrial effluents. This occurs when contaminants reach the aquifer or water table in the form of leachate.

Domestic wastewater is the main contributor of bacterial contamination to the groundwater supplies. The presence of coliform bacteria in drinking water supplies can cause water-borne diseases such as diarrhea, cholera, dysentery, hepatitis A, and others. Limited data on the bacteriological content of groundwater from 129 wells indicated a high level of positive coliform bacteria in 75 wells (58 percent)[8].

Another problem is saline water intrusion, which is caused by over-exploitation or excessive withdrawal of groundwater. This reduces water availability for domestic usage, including drinking and agricultural usage (See Water Quality Scorecard for groundwater).

[8] Compiled data from various Feasibility Studies of Water Districts, LWUA, 1990-1997 and NWRB-NWIN Project. Positive means the presence of total coliform bacteria in the water sample. Negative means total coliform must not be detectable in any 100 ml sample. Because of the small number of samples, the statistical reliability of this data needs to be improved.

Figure 3 Biochemical Oxygen Demand Observations for Manila Bay Area, April 1999 - June 2002



Source: DENR-EMB.

Box 2 Persistent Red Tide: A Threat to Marine Resources and Public Health

The extent of water pollution in Philippine bays can be gleaned from the frequent occurrence of red tide since it first came to the attention in 1983. Red tide usually occurs when high organic loading from rivers drain into bays resulting in harmful algal blooms (HABs).

From 1983 to 2001, a total of 42 toxic outbreaks have resulted in a total of 2,107 paralytic shellfish poisoning cases with 117 deaths. Earlier, only a few coastal areas of the country were affected in scattered locations, but today, this has grown to a total of 20 coastal areas.

For Manila Bay, during the 1992 *Pyrodinium* red tide outbreak, around 38,500 fisherfolks were displaced from their livelihood due to the red tide scare. Estimated economic losses for displaced fisherfolks was PhP 3.4 billion (in 2002 prices).

The Government has created the National Red Tide Task Force. A major activity of the Task Force is the regular issuance of Red Tide Updates.

Sources: BFAR-JICA, Guide on Paralytic Shellfish Poisoning Monitoring in the Philippines, 2002 and F.A.Bajarias, Red Tide Monitoring Program in the Philippines.

At present, the large cities and coastal areas that have serious problems of saltwater intrusion are: Metro Manila (from Malabon, Navotas, Manila, Paranaque), Cavite (from Noveleta, Rosario, Tanza, Naic), along Laguna de Bay (from Muntinlupa to Binangonan), and Cebu, Iloilo, Zamboanga, Laoag, and Dagupan[9]. One solution to arrest saltwater intrusion is groundwater recharge (see Box 3).

WATER AVAILABILITY

The amount of water availability and demand by river basin is presented in Figure 4. Water is distributed unevenly among the regions, with some areas containing more while others have limited supplies. For the low economic growth scenario[10], it is projected that by the year 2025, water availability deficit would take place in Pasig-Laguna (WRR IV), Pampanga and Agno (WRR III), Bicol (WRR V), Cagayan (WRR II), all regions in Luzon and Jalaur and Ilog-Hilabangan (WRR VI), and the island of Cebu (WRR VII) in Visayas. Cebu Island was included in the analysis due to its significant economic role, which is second to Metro Manila.

All major cities, except Angeles and Iloilo, show a water supply deficit until 2025 (Table 5). This tabulation also shows the limitations of groundwater potential and extraction in highly urbanized areas, which has to be balanced with surface water. Metro Manila is currently experiencing water deficits. Although for some cities like Baguio, which have no shortfall considering current demand, it is known that major water shortages do occur during the summer. In general, water deficits are time and site specific. Meanwhile, the basins of Agusan and Cagayan de Oro (WRR X) in Mindanao enjoy the highest surplus.

Further details on water quantity issues for major basins are found in the Water Quantity Scorecard in Annex 1.

Box 3 Groundwater Recharge … A Possible Solution to a Dwindling Resource?

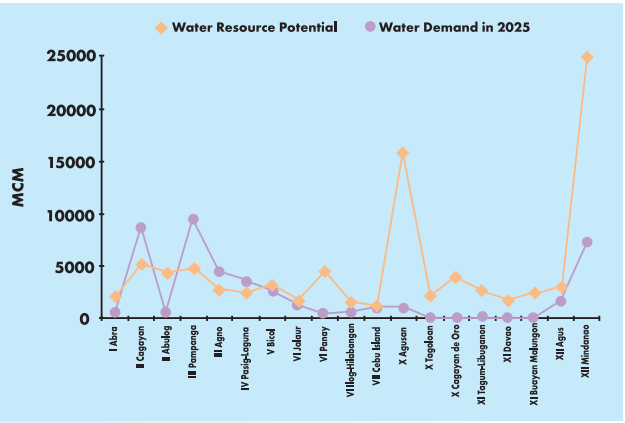
Many major coastal cities in the Philippines, like Cebu, Iloilo, Dagupan, and coastal areas of Metro Manila and Cavite, are encountering saltwater intrusion problems in their groundwater resources due to over extraction of fresh water. This phenomenon is a consequence of:

- Over utilization of groundwater by water service providers e.g., LGU, WD, Private-run, RWSA / BWSA, among others;
- Exploitation of groundwater in inland municipalities resulting in conflicts on water rights and allocation of water usage, and lack of an inter-municipal integrated water supply concept in coastal cities.

Countermeasures

Groundwater recharge in inland areas and usage of surface water are the most reliable countermeasures to limit the saltwater intrusion. Surface water requires water treatment facilities and assurance of steady water intake throughout the year. In addition, available surface water near coastal cities is usually limited. Groundwater recharge, on the other hand, helps ensure a constant supply of fresh water to coastal cities. This low-cost option needs exploration for the Philippines.

Figure 4 Water Potential and Demand by River Basin



Source: JICA Master Plan Study on Water Resources Management in the Philippines (1998). Low economic growth scenario, 80 percent surface water availability.

[9] JICA-NWRB Master Plan Study on Water Resources Management in the Republic of the Philippines, 1998.
[10] Low growth scenario 1998 JICA-NWRB Master Plan Study.

Table 5 Water Demand of Major Cities in the Philippines in MCM/year

	YEAR	TOTAL	Metro Manila	Metro Cebu	Davao	Baguio	Angeles	Bacolod	Iloilo	Cagayan de Oro	Zamboanga
Demand	1995	1,303	1,068	59	50	12	11	37	9	29	28
Demand	2025	3,955	2,883	342	153	87	31	111	47	98	203
Groundwater Availability Average		759	191	60	84	15	137	103	80	34	54
Surplus/Deficit	1995		-877	1	34	3	126	66	71	5	26
Surplus/Deficit	2025		2,692	-282	-69	-73	106	-8	33	-64	-149
Surplus/Deficit	1995		-82%	2%	69%	21%	1148%	179%	788%	18%	92%
Surplus/Deficit	2025		-93%	-82%	-45%	-83%	343%	-7%	70%	-65%	-73%

Source: JICA Master Plan on Water Resources Management in the Philippines, 1998.

Water Availability Per Capita

Among Southeast Asian countries, the Philippines ranks second from the lowest in terms of per capita water availability per year with only 1,907 cubic meters as reflected in Table 6. This is much lower than Asian and world averages[11].

Areas where the per capita water supply drops below 1,700 m^3/year experience water stress while areas with per capita water supply below 1,000 m^3/year are already experiencing water scarcity[12]. There are four river basins that belong to the latter category: Pampanga, Agno, Pasig-Laguna, and the island of Cebu (Table 7).

WATERSHED MANAGEMENT

Watersheds supply water according to the requirements of various domestic and industrial water and irrigation systems, as well as hydroelectric dams. One of the most formidable environmental challenges the Philippines faces today is its diminishing forest cover. Of the country's total forestland area of 15.88 M hectares, only 5.4 M ha are covered with forests and fewer than a million hectares of these are left with old growth forests. Over-exploitation of the forest resources and inappropriate land use practices have disrupted the hydrological condition of watersheds, resulting in accelerated soil erosion, siltation of rivers and valuable reservoirs, increased incidence and severity of flooding, and decreasing supply of potable water.

Table 6 Annual Renewable Water Resources

Country	Total Resources (km^3)	2000 (m^3/person)
World	42,655.0	7,045
Asia	13,508.0	3,668
United States of America	2,460.0	8,838
Japan	460.0	3,393
Lao People's Dem Rep	190.4	35,049
Malaysia	580.0	26,074
Myanmar	880.6	19,306
Indonesia	2,838.0	13,380
Cambodia	120.6	10,795
Vietnam	366.5	4,591
Philippines	146.0[1/]	1,907[1/]
Thailand	110.0[2/]	1,854[2/]

Source: World Resources Institute 2000-2001.
1/ JICA Master Plan on Water Resources Management in the Philippines, 1998.
2/ World Bank Thailand Environment Monitor, 2001.

Table 7 Water Availability for All Uses Per Capita by Water Resource Region

Major River Basin WRR	Total Water Resources Potential [1/] (in MCM)	Water Availability per Capita (m^3/person)
IV Pasig-Laguna	1,816	124
VII Cebu Island	708	218
III Pampanga	4,688	888
III Agno	2,275	972
V Bicol	2,138	1,533
VI Jalaur	1,150	1,657
VI Ilog-Hilabangan	1,351	1,843
II Cagayan	5,496	2,143
XI Davao	1,449	2,368
XI Tagum-Libuganon	2,504	3,449
X Tagoloan	1,476	3,646
I Abra	2,200	4,954
XII Agus	2,479	5,070
XI Buayan Malungon	1,827	5,656
VI Panay	4,340	6,782
XII Mindanao	24,854	7,027
X Cagayan de Oro	3,672	9,321
X Agusan	15,984	13,732
II Abulog	4,326	19,228
TOTAL	**84,734**	

1/ Includes groundwater and surface water at 80 percent dependability.

[11] World Resources Institute 2000-2001.
[12] Ibid