Chapter 2 Existing Conditions of Power and Energy Sector in DIDP Area

Diversification of energy source is essential for the energy development in the Philippines. In line with this, the Philippine Energy Plan (PEP) was formulated by DOE, as seen in the previous section.

Diversification of energy source has been progressed also in the DIDP Area. Mini-hydropower plants were constructed, e.g., in the Sibulan river around the border of Santa Cruz in Davao del Sur and Davao City, and in Don Marcelino, Davao del Sur. Aside from these, DOST has promoted the development of briquetting and micro-hydropower.

Photovoltaic has been installed in remote areas or cultural communities in the DIDP Area also funded by foreign assistance. These activities are not so significant in terms of energy supply as a whole, but are very useful for the beneficiaries.

In view of regional development planning, electricity/power development is critical not only for industrial development, but also for enhancement of quality of life of people. Accordingly, power will be the focus of the Study.

2.1. Power Supply and Consumption

The Philippines has three independent power supply grids: Luzon, Visayas, and Mindanao covering the DIDP Area.

There is only one large power plant in the DIDP Area, a 100 MW power barge located in Maco, Compostela Valley. The National Power Corporation (NPC) generates and supplies power to one distribution company and three RECs in the DIDP Area.

The Davao Light and Power Company (DLPC) is located in Davao City, and distributes electricity to Davao City and parts of Davao del Norte (municipalities of Panabo, Carmen, and Santo Tomas). The three RECs are:

- The Davao del Norte Electric Cooperative, Inc. (DANECO) for Davao del Norte and Compostela Valley Provinces,
- The Davao del Sur Rural Electric Cooperative, Inc. (DASURECO) for Davao del Sur,
- The Davao Oriental Rural Electric Cooperative, Inc. (DORECO) for Davao Oriental.

NPC sells its generated electricity also directly to large consumers.

Electricity consumption in the DIDP Area or electricity sold by NPC amounted to 1,136 GWh in 1996 or 193 MW (converted into demand capacity), accounting for 23.9% of the Mindanao grid total as shown in Table 8.

Table 8 Electricity Sold by NPC to DIDP Area (1996)

	(1) DIDP		(2) Mindanao Total		(1) / (2)
Total ('000 Kwh)	**1,136,082**	**100.0%**	**4,745,403**	**100.0%**	**23.9%**
1. Utilities Total	**973,347**	**85.7%**	**3,243,171**	**68.3%**	**30.0%**
Davao del Norte Electric Cooperative (DANECO)	153,951	13.6%			
Davao Light and Power Company (DLPC)	703,915	62.0%			
Davao del Sur Rural Electric Cooperative (DASURECO)	80,874	7.1%			
Davao Oriental Rural Electric Cooperative (DORECO)	34,607	3.0%			
2. Industries	**162,695**	**14.3%**	**1,484,612**	**31.3%**	**11.0%**
3. Others	**40**	**0.0%**	**17,620**	**0.4%**	**0.2%**

Source: National Power Corporation (NPC)

Per capita consumption could be assumed to be 337 kWh per year in the DIDP Area, and 290 kWh per year in Mindanao as a whole. This higher figure could be attributable largely to the consumption in the metropolis of Davao City. NPC also sells electricity directly to a cement factory in Davao City, which consumed around 152 GWh or 93% of the direct sales total to industries (163 GWh) in 1996.

2.2. Electrification

Electrification ratio in the DIDP Area averaged at 56.5% in 1996 (connected household base) as shown in Table 9.

Table 9 Electrification Ratio in the DIDP Area (1996)

	Barangays		Electrification	Number of Households		Electrification
	Coverage	Connected	Ratios	Potential	Connected	Ratios
DIDP Total	1,160	730	62.9%	547,776	309,579	56.5%
Davao Province	460	312	67.8%	229,445	86,334	37.6%
Davao City	180	132	73.3%	159,976	141,638	88.5%
Davao del Sur	337	167	49.6%	112,000	48,583	43.4%
Davao Oriental	183	119	65.0%	46,355	33,024	71.2%
Reference:	Total number of households in 1995 (Census of Poulation)					
	• Davao Province: 232,366 (229,445 above in 1996)					
	• Davao City and Davao del Sur: 332,259 (do. 271,976)					
	• Davao Oriental: 78,533 (46,355). The electrification ratio: revised from 71.2% to 40%					

Source: Davao City and Davao Oriental (1996 Southern Mindanao Statistical Yearbook, NSO)

The ratio varies between the LGUs: 37.6% in Davao Province, 88.5% in Davao City, 43.4% in Davao del Sur, and 71.2% in Davao Oriental. It may be notable that the ratio was very low in Davao Province and high in Davao Oriental.

These ratios are based not on the total number of households, but on the number of households within the areas covered by the RECs and DLPC. Accordingly, actual electrification is likely to be lower than that of the coverage base, e.g., around 40.0% rather than 71.2% in Davao Oriental.

The above data on electrification are compiled by the RECs and DLPC, i.e., electricity distributors, and represent the extent/popularization of "electricity network." In other words, it does not always mean that non-networking barangays and households have no electricity. Some of them have self-generating systems, mini-hydropower plants, or photovoltaic systems, although they may not be so convenient, and sometimes relatively costly.

2.3. Power Prices

Power prices for industrial use in the DIDP Area are relatively low, e.g., ₱2.18 per kWh of DLPC that is around two-thirds of VECO-Cebu, ₱2.55 per kWh of DASURECO, and ₱2.65 per kWh of DANECO as of May 1997. These lower prices are an advantage of the DIDP Area in terms of industrial investment.

NPC sets its basic tariff per kWh on Mindanao's investor owned utilities (IOUs) in an inverse proportion to their demand base; ₱1.1972 on small utilities I, ₱0.9534 on small utilities II, and ₱0.8934 on large utilities. On the other hand, its basic tariff per kW (demand base) is higher to large utilities than smaller utilities. (They are effective as of February 28, 1997.)

Average power prices in the DIDP Area are shown in Table 10. The prices charged

on residential consumers are lowest in DLPC, lower in DANECO and DASURECO, and highest in DORECO.

Table 10 Average Power Prices on Residential Consumers in the DIDP Area

	Prices on Residential Consumers (P per kwWh)			Percent Shares	
	Total	NPC Sales Tariff	Distribution Cost	NPC Sales Tariff	Distribution Cost
Davao del Norte Electrc Cooperative (DANECO)	2.4667	1.3496	1.1171	55%	45%
Davao Light and Power Company (DLPC)	2.3173	1.3025	1.0148	56%	44%
Davao del Sur Rural Electric Cooperative (DASURECO)	2.4442	1.3357	1.1085	55%	45%
Davao Oriental Rural Electric Cooperative (DORECO)	2.7246	1.3299	1.3947	49%	51%

Source: ERB and NPC published rates in August 1997

The distribution charge on the average accounted for 44% to 51% of the total power prices to the consumers: highest in DORECO, and lowest in DLPC. As such, the distribution cost is higher in rural areas.

It may make sense to stipulate that a certain percentage of those add-ons (distribution charge) should be allocated for further rural electrification. With a stipulated percentage for rural electrification, transparency in RECs could be reached in the amount of subsidies and cost in achieving 100 % electrification in the DIDP Area.

Power prices are in general higher for industrial use than residential use in the DIDP Area as well as in the whole country. In order to invite investors in the DIDP Area, low power price is attractive. On the other hand, if the price is lower than the long run marginal cost (LRMC), especially the NPC's wholesale price to distributors, it may hinder the new investment in the power sector and cause power shortages in the long run. This might be a crucial point in line with privatization of NPC.

2.4. Energy Efficiency and DSM

Energy saving represents a sort of national security of the Philippines that heavily depends on imported energy. It is also a direct means for consumers to reduce the cost, and might be a "must" for suppliers and consumers to address to environmental problems. DOE has promoted an energy efficiency program consisting of information and education campaign (IEC), system loss reduction, room air conditioners labeling program, vehicle efficiency standards and testing program, and heat rate improvement of power plants.

Demand side management (DSM) has been promoted by DOE, practically put forward mainly by NPC, RECs, and manufacturers. It includes promoting high efficiency fluorescent lamp program, low-loss magnetic ballast, highly efficient window air conditioners (residential and commercial), and interruptible agreements. The agreements are the contract between power supply company and its consumers which allows the company to stop supplying power during the emergency power shortage, in turn, the customers get a discount in power price. According to the PEP, peak demand saving was estimated at 20 MW in 1996 and 789 MW in 2015 with expected accumulative savings of 78.9 MMBFOE worth ₱ 4.4 billion.

In the DIDP Area, e.g., DORECO in Davao Oriental has the following DSM:

- Load management program (peak clipping, energy efficient technologies, load shifting and interruptible/curtailable load management, and encouragement of

customers to use energy efficient technologies; and

- Compact fluorescent light program.

There is generally no peak and off-peak retail tariff in the DIDP Area, but DLPC applies the peak and off-peak price to large consumers with monthly consumption of 800 kWh or more. Each distribution has some kind of basic need tariff with slight difference. In Davao City, DLPC charges ₱2.00 for the first 15 kWh per month.

2.5. Utilization of Renewable Energy

(1) Overview

Renewable energy is the best in terms of its limitlessness as a resource and its effectiveness to environmental protection. The DIDP Area has abundant coconut residues, but not so much wind energy.

In 1996, the DIDP Area produced a total amount of 354,232 BFOE renewable energy including 354,018 BFOE biomass energy, mainly bagasse (57 % of the total), wood/wood wastes (20 %), and coconut shell (17 %) as shown in Table 11. Solar energy is estimated at 107 BFOE.

By province/City, Davao del Sur was the largest producer, contributing to 73% (259,398 BFOE) of the total thanks to its bagasse coming from a sugar refinery. The next was Davao City accounting for 27% (94,822BFOE), where solar and wind energy were utilized. Production of renewable energy was minimal in Davao Province and Davao Oriental.

Table 11 Renewable Energy Produced in the DIDP Area (1996)

	Barrels of Fuel-oil Equivalent (BFOE)					Percent Shares				
	DIDP Total	Davao Province	Davao City	Davao del Sur	Davao Oriental	DIDP Total	Davao Province	Davao City	Davao del Sur	Davao Oriental
Total	**354,232**	**7**	**94,822**	**259,398**	**5**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Biomass Sub-total	**354,018**		**94,616**	**259,397**	**5**	**99.9%**		**99.8%**	**100.0%**	**100.0%**
Rice Hull	10,105		10,065	36	4	2.9%		10.6%	0.0%	80.0%
Coconut Husk	1,066		1,066			0.3%		1.1%		
Coconut Shell	60,850		1,555	59,295		17.2%		1.6%	22.9%	
Bagasse	200,913		870	200,043		56.7%		0.9%	77.1%	
Wood/Wood Wastes	72,166		72,147	19		20.4%		76.1%	0.0%	
Charcoal	6,061		6,061			1.7%		6.4%		
Manure	2,857		2,852	4	1	0.8%		3.0%	0.0%	20.0%
Natural Energy Sub-toal	**214**	**7**	**206**	**1**		**0.1%**	**100.0%**	**0.2%**	**0.0%**	
Solar	107	7	99	1		0.0%	100.0%	0.1%	0.0%	
Wind	107		107	0.35		0.0%		0.1%	0.0%	

Source: DOE Mindanao Office as of January 17, 1996

According to the DOE Mindanao Office, renewable energy produced in the DIDP Area accounted for 4.3% of the Mindanao total, which is very small compared to its population share of 20%.

(2) Solar energy

Renewable energy, especially solar energy has been proven to be financially viable in remote hilly villages where the cost of recharging is at around 4 % of farmer's monthly income.

Use of solar energy has become active recently in the Philippines also coupled with

foreign assistance. Under the auspices of the Philippine-German Solar Energy Project (PGSEP) of the GTZ and the Department of Energy (DOE), solar home systems with 70 W have been installed. The reduced price of these systems is ₱16,000; ₱8,000 charged by the Special Energy Program (SEP) and ₱8,000 by the REC. The systems were designed to substitute for kerosene lamps. The customer has to pay ₱190 per month to the REC (the customer can avoid ₱50 per month kerosene cost). This kind of subsidies made the SPV systems affordable to the farmers.

In the DIDP Area, the PGSEP is implemented by the Business Center Davao (BCD), an NGO. Since 1994 up to September 1997, BCD has implemented a total project amounting to ₱7 million from the equipment loan extended by DOE in the amount of ₱9 million at 5 % per annum interest rate. The project intended to support health related activities, such as potable water supply, health care centers and hospitals, and household lighting. So far, BCD has undertaken 30-40 projects in Davao City, 10 in Davao Province, five in Davao del Sur, and three in Davao Oriental. BCD projects ₱1 million of SPV project per barangay. Projects in Davao Province are undertaken by DANECO with some Government grants.

In Calinan, a remote barangay in Davao City, around 65 households out of 200 are currently using solar. It is a central recharging station system. The panels were made by BP-Solar which carries a ten-year warranty, but is estimated to be able to last for 50 years. Each household pays about ₱45 per month for recharging. The SPV credit package with battery, lamps and wires costs ₱5,500 paid in five-year installment.

- Monthly Payment for solar package ₱92 per month
- Recharging fees ₱45 per month
- House net income: ₱1,250 per month
- Total cost to farmers as percentage of monthly income 10.96 %.

It is affordable but not inexpensive for farmers. The good news is that the most of the households in the barangay applied for SPV service, and BCD is only able to connect another 30 households this years. A local cooperative was also hired to manage the SPV system on a 30 % fee-collection commission. The problem is that the collection rate for the credit is unfortunately very low at 50-60 %.

Both BCD and the cooperative are now interested in developing solar-wind hybrid system and micro-hydro system. They hope that they could get some subsidized loan to expand this program.

A similar program is undertaken by NPC, which shows even better prospect. This system is very economical in that it only costs farmers ₱265 per month, including monthly installment payment. With this low cost, many households in the DIDP Area could access to electricity.

2.6. Energy Resource Potentials

There is a trend in power and energy development throughout the world, i.e., on-site use of power and energy. In this context, local energy resource potentials will be identified as follow.

There are coal reserves in the DIDP Area, but not much. The total mineable reserves are at around 125,000 tons as shown in Table 12.

Table 12 Coal Reserves ('000 MT)

Coal Region	Potential Reserves	Positive Reserves	Probable Reserves	Mineable Reserves
DAVAO	100,000	208		125
Total in MINDANAO	1,162,400	64,815	66,963	79,775

Source: DOE Mindanao Office

Hydropower contributed to 87 % of total power generation in the Mindanao grid. The total installed capacity in Mindanao is 983.7 MW in 1996. The DIDP Area has no large hydropower plant like the ones located around the Lake Lanao. There are a few mini-hydropower plants in Davao City and Don Marcelino, Davao del Sur. In addition to these, six sites have been identified with an aggregate 26.3 MW as shown in Table 13.

Table 13 Mini-hydropower Projects in the DIDP Area (already surveyed)

	Project Name	Location	Estimated Capacity	Proponent
DIDP Total			26,265 KW	
Davao Province	Benuling MHP	Samal Island	165 KW	DANECO
(Compostela Valley)	Tandik MHP	New Bataan	5,000 KW	DANECO
(Compostela Valley)	Camanlangan MHP	Nragsan	5,000 KW	None
	Cambagang MHP		5,000 KW	None
Davao City	Davao MHPC		6,600 KW	None
Davao Oriental	Aliwagwag	Cateel	4,500 KW	None

Source: DOE Mindanao Office

Presently, DANECO are proposing two mini-hydro projects. Davao Oriental has even hired an international consultant to carry out the survey for several hybrid generators using wood chips in Hulonta for self-consumption.

Wind energy potential is not very promising, but there is no survey being done.

There is one potential site for geothermal power in Davao del Norte/Davao Province, which is currently under investigation.

As for biomass energy, Davao del Sur has also a surplus of bagasse, from which power is generated. It is conceivable for such power to be sold to RECs.

2.7. Existing Power Development Plan

There are two ways of electrification: one is through connecting to networking, which is the predominant mode, the other is independent by on-site power generation. The former is connected with power plants of NPC through distributors. NPC formulated its power development plan up to the year 2010, which will be summarized as follows.

(1) Power development plan for Mindanao grid

Demand-supply forecast

The NPC Mindanao Office has forecasted the demand-supply of electricity in the Mindanao grid based on two scenarios. The high growth scenario has forecasted the electricity sales of 26,312 GWh in 2010, growing by 13% per annum during 1997-2010. In case of the low growth scenario, the sales will amount to 20,369 GWh in 2010, growing 11% per annum during the same period.

In the low growth scenario, NPC adopts almost the same growth rate as the national average, 11.2% set by the Philippines Energy Plan (PEP) of DOE. The Study will follow this low growth scenario consistent with the PEP, of which details are shown in Table 14.

Table 14 Demand-Supply Forecast for Mindanao Grid (low growth scenario)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
				(GWh)					(GWh)					(GWh)
Sales	5020	5475	6407	7465	8289	9193	10183	11270	12463	13760	15184	16750	18473	20369
	AAGR (1998-2000)			14.1%			(2001-2005)		10.8%			(2006-2010)		10.3%
Generation	5260	5739	6758	7874	8744	9697	10742	11888	13147	14515	16017	17669	19486	21486
(SF-Rserve)				14.4%					10.8%					10.3%
System Firm	7845	8472	8378	9203	10145	11499	11675	12844	14639	16050	18152	19554	20605	22707
(SF)				5.5%					9.7%					9.2%
Reserve	2585	2733	1620	1329	1401	1802	933	956	1492	1535	2135	1885	1119	1221
				(%)					(%)					(%)
Reserve/SF	33	32	16	14	14	16	8	7	10	10	12	10	5	5
Generation Mix				(%)					(%)					(%)
Hydro	74	63	58	48	41	44	41	44	45	48	43	39	36	32
Oil	21	30	32	44	52	69	40	38	41	38	44	49	53	58
Geotermal	5	7	10	8	7	7	6	6	5	4	4	4	4	3
Coal	0	0	0	0	0	10	13	12	9	10	9	8	7	7
Leyte Inter	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note 1: Some 200 MW imported power from Leyte-Mindanao INT is included as firm reserve only during deficit years (2006-2010).

Note 2: Demand from ferrous-alloy customers is not included.

Source: NPC Mindanao Office

Power generation (system firm minus reserve) will amount to 21,486 GWh in 2010 from 5,260 GWh in 1997 through 23,417 GWh in 2005. Reserve-system firm (gross power output) ratio also will decrease from 33% in 1997 to 5% in 2010. This 5% reserve ratio is very low, even though in Mindanao there is not much difference in power demand between seasons or day and night. Practically, Mindanao will face power shortage during 2006-2010. To address this, some 200 MW will be imported from Leyte-Mindanao inter-transmission (INT).

Power plant development plan

Table 15 summarizes the load demand forecast for the Mindanao grid in line with the two scenarios. These are bases for the Mindanao power plant development.

Table 15 NPC Load Demand Forecast for Mindanao Grid

	High Growth Scenario		Low Growth Scenario	
	Demand (MW)	Growth Rate (AAGR)	Demand (MW)	Growth Rate (AAGR)
1997-2000	926-1,510	16.2%	888-1,310	12.2%
2001-2005	1,693-2,638	11.8%	1,452-2,168	10.6%
2006-2010	2,939-4,517	11.4%	2,391-3,526	10.2%
1997-2010		12.9%		10.9%

In the low growth scenario, Mindanao's load demand is estimated at 1,310 MW in 2001, 2,168 MW in 2005, and 3,526 MW in 2010 increasing by more than 10% per annum, respectively.

Figure 2 illustrates the spatial distribution of power plants including the ones to be developed by the year 2010. Table 16 shows the details on the power plants.

According to Table 16, an aggregate capacity of power plants in Mindanao will be 4,204 MW in 2010, which may include power plant projects to address an expected power shortages during 2006-2010 already mentioned.

There were 20 power plants in 1997 with a total 1,690 MW, and the average capacity is around 84.5 MW. Additional 21 plants with a total 2,514 MW will be constructed during 1998-2010, and their averaged capacity is 120 MW. Thus, economies of scale for power plant will be enhanced.

Power generation mix (capacity base) will change. Hydropower will decrease its weight from 58.2% in 1997 to 38.5% in 2010. On the other hand, coal/oil excluding diesel fired and power barge will increase its weight to 42.8% in 2010. Such changes might reflect a lesson from "power crisis" in the early 1990s due to severe drought and dry-up of the main hydro source of the Lake Lanao. It may also take into account the environment protection of the lake areas. As a result, power prices may rise because of increasing dependence on oil and coal, depending on oil prices and coal prices.

(2) Power development plan for DIDP Area

Power plant development

The DIDP Area has a 100 MW power barge in Maco, which only meets around 50% of the total power demand in the DIDP Area, i.e., 193 MW in 1996.

By the year 2010, capacity of power generation in the DIDP Area will amount to 600 MW. Additional 500 MW will be shouldered by coal fired/combined cycle plants in Digos proposed by NPC: 200 MW in 2001 and 300 MW in 2007, respectively. The total 600 MW will account for 14% of the total Mindanao grid capacity (4,204 MW) forecasted by NPC.

Planned transmission network

Figure 3 illustrates the power development plan by NPC in the DIDP Area, including planned transmission lines. Don Marcelino, which has not been connected with power transmission line, will be electrified with on-going 69 kV line extension.

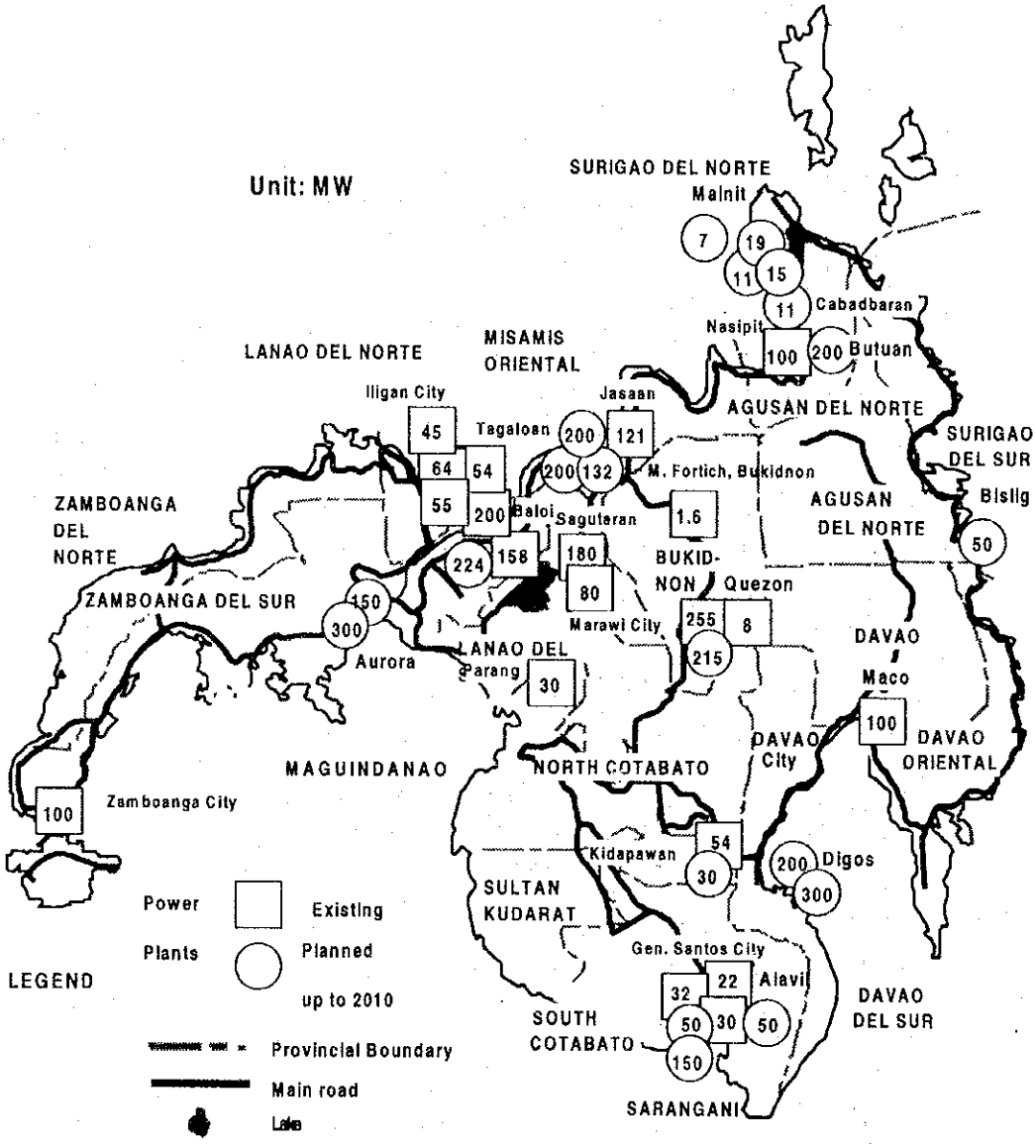
Extension of 69 kV line is also planned between Asuncion and Tagum, between Montevista and Monkayo in Compostela Valley, and between Lupon and Governor Generoso in Davao Oriental.

Installation of a transmission line of 138 kV has been carried out between Davao City (New Loon) and Digos, and between the Mt. Apo geothermal power plant (Mindanao Geothermal I) and Digos/Matanao stations.

Rural electrification

The Philippine Energy Plan (PEP) by DOE envisions the electrification of all 1,409 municipalities by 1996, all 35,213 barangays by 2010, and 100 % of potential 10.2 million households by 2018. Table 17 summarizes the targeted electrification ratio of household base.

Figure 2 Spatial Distribution of Power Plants including Ones Proposed by NPC



Source: NPC, Table 2.16

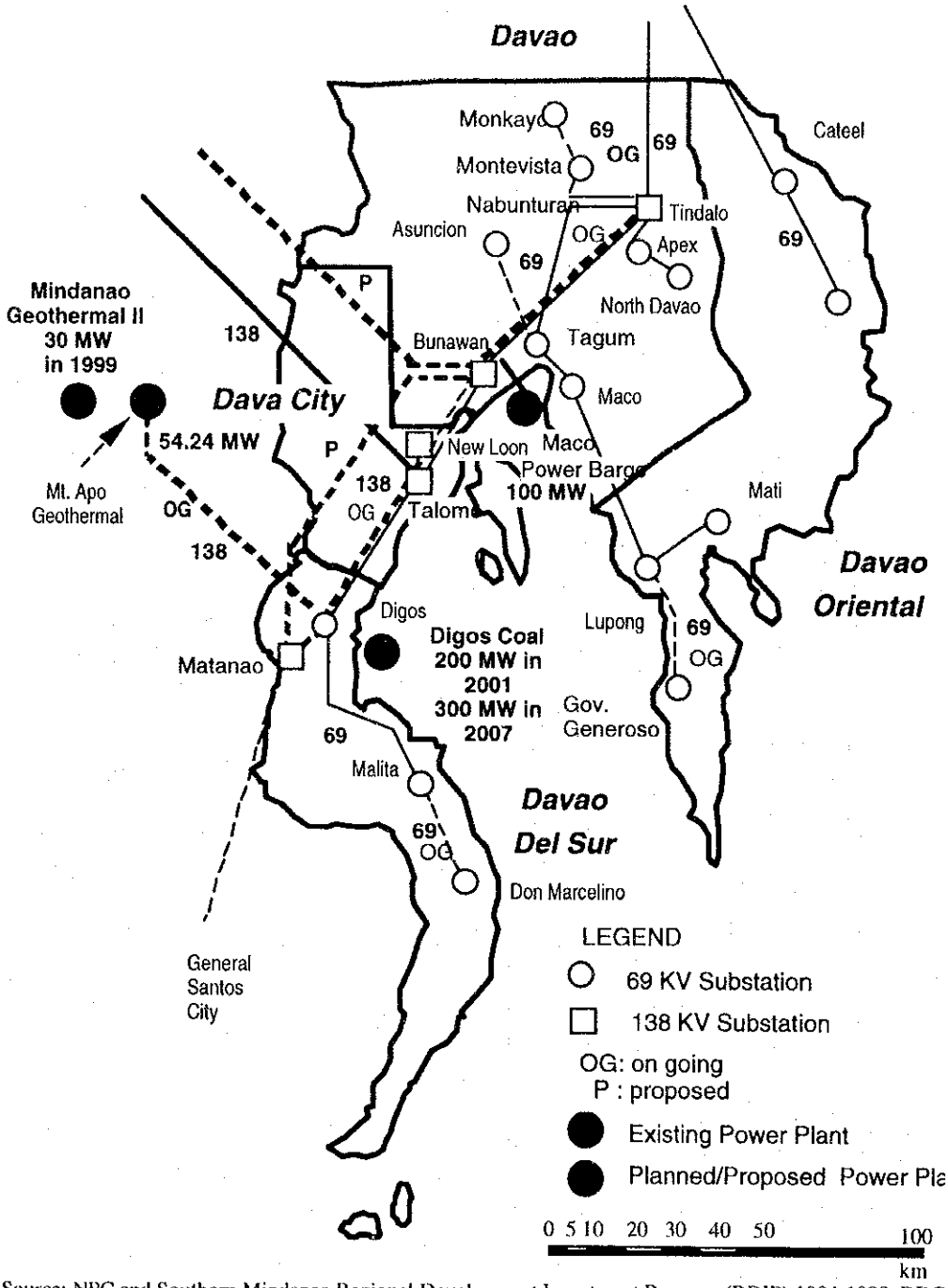
To achieve these targets, the sector will pursue the rehabilitation of 104,472 km of distribution lines, the expansion of 105,825 km of RECs' distribution lines, and the installation of an additional 3,185 MVA of RECs' substation capacity. Through the mandatory targets with phased expansion planning and subsidies, NEA, the agency in charge of rural electrification program, has been able to direct RECs to follow the national targets.

Table 16 Power Plant Development Forecast by the NPC up to the Year 2010

Year		Accum. Capacity (MW)	Hydro	Geo-Thermal/ Bagasse	Diesel	Power Barge	Coal/ Oil/ Others	Location
1953	Agus 6	200.0	200.0					Iligan City
1957	Agus	201.6	1.6					M. Fortich, Bukidnon
1977	Aplaya	322.8			121.2			Jasaan, Misamis Oriental
1979	Agus 2	502.8	180.0					Sagutaran, Lanao del Sur
1980	Gen. Santos	525.1			22.3			Gen. Santos City
1982	Agus 7	579.1	54.0					Iligan City
1985	Agus 4	737.2	158.1					Baloi, Lanao del Sur
	Agus 5	792.2	55.0					Iligan City
	Pulangi 4	1,047.2	255.0					Maramag, Bukidnon
1992	Agus 1	1,127.2	80.0					Marawi City
1993	NMPC-1	1,191.0			63.8			Iligan City
	NMPC-2	1,235.8			44.8			Iligan City
	PB 104	1,267.8				32.0		Gen. Santos City
	PB 202	1,297.8				30.0		Parang, Maguindanao
1994	PB 117	1,397.8				100.0		Nasipit, Agusan del Norte
	PB 118	1,497.8				100.0		Maco, Davao del Norte
1995	BUSCO	1,505.8		8.0				Quezon, Bukidnon
1996	PB 201	1,535.8				30.0		Gen. Santos City
1997	Zamboanga Diesel (BOO)	1,635.8			100.0			Sangali, Zamboanga City
	MIGPP (Mt. Apo)	1,690.0		54.2				Kidapawan, North Cotabato
1998	Gen. Santos City (BOO)	1,740.0			50.0			Alavil, Sarangani Province
1999	Mindanao Geothermal II (PPA)	1,770.0		30.0				Kidapawan, North Cotabato
2000	PUGU A HEP (BOT)	1,788.7	18.7					Mainit, Surigao del Norte
	PUGU B HEP (BOT)	1,803.8	15.1					Mainit, Surigao del Norte
	PUGU D HEP (BOT)	1,815.2	11.4					Mainit, Surigao del Norte
	PUGU E HEP (BOT)	1,822.0	6.8					Mainit, Surigao del Norte
	ASIGA HEP (BOT)	1,833.3	11.3					Cabadbaran, Ags. del Norte
	Mindanao Combined Cycle	2,033.3					200.0	Aplaya, Jasaan, Mis. Oriental
2001	Mindanao Coal/Cobined (BOT)	2,233.3					200.0	Digos, Davao del Sur
2002	Tagoloan (Coal)	2,433.3					200.0	Misamis Oriental
2003	Leyte-Mindana INT	2,433.3						Misamis Oriental
2004	B. Batang Hydro	2,565.3	132.0					Tagaloan, Misamis Oriental
	Gen. Santos	2,615.3					50.0	Gen. Santos
2005	Maramag	2,830.3	215.0					Bukidnon
	Gen. Santos	2,980.3					150.0	Gen. Santos
2006	224 Agus 11	3,204.3	224.0					Laona del Norte
2007	Digos	3,504.3					300.0	Digos, Davao del Sur
	Butuan (Coal)	3,704.3					200.0	Agusan del Norte
	Bislig	3,754.3					50.0	Surigao del Sur
2009	Aurora	3,904.3					150.0	Zamboanga del Sur
2010	Aurora	4,204.3					300.0	Zamboanga del Sur
	Exisiting Capacity in1997)	1,690.0	983.7	62.2	352.1	292.0		
	Capacity in 2000	2,033.3	1,047.0	92.2	402.1	292.0	200.0	
	Capacity in 2005	2,980.3	1,394.0	92.2	402.1	292.0	800.0	
	Capacity in 2010	4,204.3	1,618.0	92.2	402.1	292.0	1,800.0	
	Incremental (1998-2000)	343.3	63.3	30.0	50.0		200.0	
	Incremental (2001-2005)	947.0	347.0				600.0	
	Incremental (2006-2010)	1,224.0	224.0				1,000.0	
Percent Shares by Source: 1997		100.0%	58.2%	3.7%	20.8%	17.3%		
	2000	100.0%	51.5%	4.5%	19.8%	14.4%	9.8%	
	2005	100.0%	46.8%	3.1%	13.5%	9.8%	26.8%	
	2010	100.0%	38.5%	2.2%	9.6%	6.9%	42.8%	

Source: NPC

Figure 3 Development Plan of Power Plant and Transmission Line in the DIDP Area



Source: NPC and Southern Mindanao Regional Development Investment Program (RDIP) 1994-1998, RDC

Table 17 Targeted Electrification Ratio in the Philippines (household base)

	Electrification Ratio					Incrase in Eelectrification Ratio				
	1996	2000	2005	2010	2018	97-2018	97-2000	2000-05	2006-10	2010-18
Philippines Total	68.1%	75.1%	82.7%	90.5%	100%	31.9%	7.0%	7.7%	7.7%	9.6%
RECs Total	58.3%	67.3%	77.3%	87.2%	100%	41.7%	8.9%	10.1%	9.9%	12.8%
Region XI	50.9%	62.2%	73.4%	82.2%	100%	49.1%	11.3%	11.1%	8.8%	17.8%

Source: DOE-PEP 1996-2025

According to the PEP, the electrification ratio (ER) in Region XI is targeted to increase to 62.4% in 2000, to 73.4% in 2005, and to 82.2% in 2010. The DIDP Area, as part of Region XI, had only 56.5 % of the households connected in 1996. Based on the targeted incremental increase in ER of Region XI as shown in Table 17, the DIDP Area's ER will be at least 67.8% (56.5%+11.3%) in 2000, 78.9% (56.5%+11.3%+11.1%) in 2005, and 87.7% (56.5%+11.3%+11.1%+8.8%) in 2010.

Chapter 3 Prospects and Constraints to DIDP Power and Energy Development

This chapter presents bases to set up strategies for the DIDP power and energy development: prospects to be realized strategically, and constraints to be addressed by well organized strategies.

3.1. Prospects

There exist five aspects of prospect to the DIDP power and energy development as follows.

(1) Good potentials of local energy resources

There are indigenous/local energy resources to be tapped in the DIDP Area. An aggregate 26.3 MW of mini-hydropower, which corresponds to 13.6 % of the demand capacity of the Area, 193 MW in 1996. Also, Some power plant may be developed in line with irrigation facilities.

The DIDP Area also has a potential geothermal site in Davao del Norte and Sarangani, Davao del Sur. Solar energy is already utilized in remote areas of Davao City. In future, it is expected to be used not only in remote areas, but also in urban areas resulting to a comprehensive energy conservation. Davao del Sur has a bagasse potential to be utilized for power generation.

Municipal wastes will be utilized for power generation. Methane from the sludge after water treatment and residue derived fuel (RDF) made from municipal wastes will be used for power generation. Agricultural wastes represented by coconut residue are abundant in the DIDP Area. However presently, they are not utilized well, particularly in Davao Province and Davao Oriental. This is also a potential. In addition, charcoal made from bamboo is promising. Bamboo abounds in the DIDP Area, and is expected to come from banana plantations.

(2) Increasing power demand

This is related to power suppliers/distributors. Power demand in the DIDP Area will increase corresponding to economic growth of the DIDP Area, increase in income, and increase in middle class conducive to modernization of people's life style. Chapter 5 will forecast power demand in the DIDP Area as part of power and energy sector development plan.

(3) Two planned power plants

A total 500 MW power development planned in Digos, Davao del Sur will stabilize power supply in the DIDP Area to some extent. If the plan is successful, its development effects may extend to attracting petroleum refinery and other power-intensive industries, and thereby triggering additional investments in power plant.

(4) PAIC alliances

There are seven provincial agri-industrial centers (PAICs) in the DIDP Area. Among these, the four PAICs of Malalag, Nabuntran, Mati and Babanga organized an alliance of member municipalities: Malalag Bay, COMVAL, MAGUBALUSTA, and BACABOSCAM.

The Local Government Code of 1991 (LGC1991) has enhanced LGU's autonomy including management of "economic enterprises." Based on the LGC1991, the PAIC alliances can afford to efficiently develop infrastructure throughout the member municipalities. Under these alliances, the PAICs are putting forward a

cooperative development of infrastructure such as water supply and farm-to-market road.

Also for the power and energy development, such local initiative represented by the PAIC alliances is promising.

(5) People awareness of energy use

People in the DIDP Area are well aware of critical relationships between power/energy development and environment problems including global warming. Such mind and attitude are expected to lead an environment-friendly and economically efficient power and energy development in the DIDP Area.

3.2. Constraints

The four characteristics summarized from the analysis so far are closely related to constraints to the DIDP power and energy development:

1) Dependence but not deficiency (installed power plant capacity in the DIDP Area: 100 MW, power demand in the Area: 193 MW, respectively in 1996);
2) Low power generation cost in the Mindanao grid but high distribution cost in the DIDP Area;
3) Abundant renewable resources but not yet so much utilized; and
4) Currently sufficient in power generation within the Mindanao grid but deficient in power distribution/low electrification ratio.

Based on these, constraints to the DIDP power and energy development could be summarized as follows.

(1) Insufficient conditions to utilize local energy resources

In the DIDP Area, there are solar, biomass, and mini/micro-hydro potentials, which can contribute to the rural electrification programs in remote and isolated barangays. However, their exploitation is very limited.

No private company has invested in micro-hydro except that DANECO has proposed two. The slow pace in renewable energy development makes rural electrification more difficult and costly. Also, the low NPC power tariff to distributors may provide disincentives for them to purchase power directly generated from local renewable energy sources.

On the other hand, most renewable energy can be produced and consumed locally without incurring transmission loss. In this context, it is expected for conditions including financial supports to be prepared for further utilizing local energy resources.

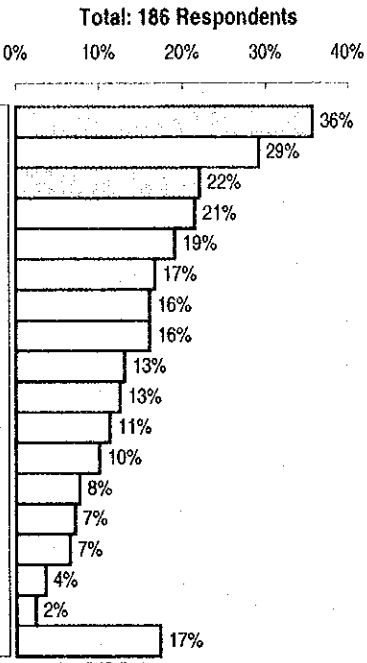
(2) Low efficiency of power distribution

Figure 4 shows infrastructure-related problems pointed out by the results of the Industrial Questionnaire Survey (IQS) conducted by the Study. Out of a total 186 gold processors (18) and manufacturers (168), some 36% (73) of them pointed out that the most critical problem is "high cost of electricity," which is the top one problem centering on respondents in Davao Province. Likewise, "poor electricity/brown out" ranks third pointed out by 22% of the respondents, centering on Davao Province and Davao Oriental. Such answers might reflect that electrification ratio in 1996 was lowest (37.6%) in Davao Province and lower (40%: all households base) in Davao Oriental.

Figure 4 Most Critical Infrastructure-related Problems by Province/City

Percent Shares by Province/City

Davao Province	Davao City	Davao del Sur	Davao Oriental	DIDP Total
51	73	39	23	(Answers within 5 items)
(74%)	32%	26%	4%	High Cost of Electricity
(60%)	8%	18%	(65%)	Poor Telecommunications
(69%)		18%	(26%)	Poor Electricity/Brown Out
11%	20%	18%	(48%)	Lack of Direct Liner etc.
14%	21%	15%	(26%)	Poor Road Conditions
3%	(32%)	10%		Other Procedures/Regulations
3%	13%	(31%)	(22%)	Traffic Congestion
9%	11%	8%	(57%)	Port Facilities/Operation
6%	8%	(23%)	(22%)	Lack/High Cost of Industrial Land
	(25%)	3%	9%	Poor Road Network
	3%	(31%)	(22%)	Lack of Farm to Market Road
6%	11%	5%	(22%)	Poor Airport Facilities etc.
9%	(13%)	3%		Lack of Flood Control etc.
6%	8%	8%	4%	Customs Clearance
6%	1%	8%	(22%)	Access to Bonded Warehouse
6%	4%		4%	Lack/High Cost of Industrial Water
	3%	3%	4%	Others
6%	24%	21%	9%	No Answer



Note 1: Respondents comprise 18 gold processors and 168 manufacturers in the DIDP Area.
Note 2: ( ) Responding rates = 4% points more than the average of all Industries except for "No Answer"
Source: Industrial Questionnaire Survey (IQS) by DIDP-PMO and JICA Study Team

High cost of electricity/power in the DIDP Area corresponds to the high distribution cost, contrasted with the fact that the delivery price from NPC is relatively low due to the dominance of hydropower in the Mindanao grid.

The distribution cost of power accounts for about 44%-51% of the total consumer price: 45% in Davao Province (DANECO) and 51% in Davao Oriental (DORECO). It may rise since NPC can now sell power directly to large consumers, leaving the distribution companies with small consumers.

The high distribution cost is a complicated constraint caused by factors as follows:

- Over dependence of power supply of the DIDP Area, i.e., 100 MW installed capacity to 193 MW demand in 1996, resulting in high transmission and distribution cost;
- Lack of critical mass of the electricity user/demand due to less developed economy in most part of the DIDP Area;
- Scattered distribution of settlements and low household density in rural areas;
- Low and non-differentiated NPC power tariff that tends to limit RECs and DLPC to improve management and power supply services; and
- Low collection efficiency of electricity bills and large system losses in distribution, which combined are both a result of low investment in rehabilitation and maintenance and a hindrance to further investment.

The DIDP Area is not facing power shortages, but 50 % of the households can not enjoy the benefits of electricity due mainly to costly transmission extension in rural areas where the households have scattered. RECs are now in the transition from membership cooperatives to stock cooperatives, which means they will focus more on cost reduction and dividend increase to their stock-holders. This may not be a

good news for those residents who are not currently the members or stockholders but reside in the franchised boundaries of the cooperatives. In terms of technical loss, it has been standardized by NEA to be within 10-15 %.

(3) Difficult public acceptance for power development

Rising land prices and compensation are one of the constraints to building power plants, transmission stations/lines and the like. Power distributors in the DIDP Area have been facing difficulties in acquiring the right-of-way for transmission line. Coconut trees are sometimes a hindrance, but the real cause is not the tree but less public acceptance/cooperation.

It is likely for the planned power plants to bring about some social and environmental problems. There are also difficulties in assuring public acceptance for the implementation. Accordingly, a well planned and coordinated power development plan is essential to address such constraints.

(4) Unstable energy security

This is a critical constraint to the DIDP Area development as a whole. Poor electricity/brown out is the critical problem, particularly in Davao Province and Davao Oriental. Voltage fluctuation often occurred during the peak time, disrupting industrial activities including industries dependent on computers. Power reliability is very important, and critical particularly for high tech industries engaging in precise processing and automated production.

In terms of regional aspect of energy supply, the DIDP Area will continue to depend on power generation in other regions. The DIDP people attach more importance to food security than energy supply reliability. Such attitude may constrain the power and energy development in the DIDP Area.

Chapter 4 Strategy for DIDP Power and Energy Development

Development strategy is a set of considerations to effectively guide and mobilize various efforts toward a successful development of the power and energy sector in the DIDP Area or its development goal/vision.

4.1. Development Goal/Vision and Basic Strategy

A DIDP development goal/vision for the power and energy sector extends over the year 2016, the target year of the DIDP Master Plan. Goal is the principle to guide the DIDP power and energy development. Vision is the fundamental roles that the sector will be assigned in the context of the DIDP regional development as a whole. The basic strategy will be set up to support the vision directly.

4.1.1. Goal

Development goal of the power and energy sector in the DIDP Area could be set corresponding to the three aspects of regional development in general; economic, social, and environmental aspects. In other words, the goal should intensively incorporate the three aspects while addressing to constraints to the DIDP power and energy development.

Accordingly, energy best mix could be the goal that the DIDP power and energy development should reach. The energy best mix will pursue an energy mix economically efficient and reliable, socially acceptable and integrated with the development of communities in the DIDP Area having quite different with each other in terms of cultures, infrastructure and development stage, and an environment-friendly energy mix.

4.1.2. Vision and basic strategy

Power and energy development is an infrastructure development to support people's life and economic activities.

Accordingly, its development vision should serve to achieve the DIDP regional development vision/goal, which is represented by the DIDP development paradigm. The paradigm comprises basically the DAVAO concepts already defined in the Master Plan Report: 1) diversification, 2) agri-industrialization, 3) value development, 4) amenity creation, and 5) outward-orientation.

On the other hand, the basic strategy is a set of strategies to directly support the DIDP development vision of the power and energy sector, while well incorporating prospects to the sector development.

The five aspects of prospect are already clarified: 1) good potentials of local energy resources, 2) increasing power demand, 3) two planned power plants, 4) PAIC alliances, and 5) people awareness of energy and environment.

Thus, the vision and basic strategy for the development of DIDP power and energy sector could be established as follows.

1) The first vision is that the power and energy sector will be a catalyst for ***diversification*** of industrial structure necessary for further growth of the DIDP economy. To this end, **enhancing the security and quality of power and energy supply** could be strategized to attract industries including high tech industries.

2) The second vision is that the power and energy sector will be a promoter of the ***agri-industrialization*** in the DIDP Area. To this end, **accelerating rural**

electrification could be strategized.

3) The third vision is that the power and energy sector will be a supporter to the ***value development*** conducive to the people's new ways of life also addressing to the global warming. To this end, **strengthening energy conservation** could be strategized.

4) The forth vision is that the power and energy sector will be a leader of ***amenity creation***. Toward this end, **promoting an integrated development** could be strategized in response to the forthcoming recycle-oriented and environment-friendly society.

5) The fifth vision is that the power and energy sector will be a contributor to ***outward-orientation*** of the DIDP Area. To this end, **institutionalizing an open system** could be strategized to provide the private sector/foreign investors with opportunities for power and energy business.

4.2. Specific Strategies

Specific strategies could be derived from the basic strategy, and organized to establish specific policy measures and projects/programs for the DIDP power and energy development.

These specific strategies will be mobilized with different emphasis by the DIDP development phase (phase 1-3) or the DIDP regional development strategy, which comprises Internal Integration, Globalization Drive, and High Tech-High Services.

The Internal Integration strategy pursues resource-based and domestic market-oriented development toward agri-industrialization. The basic concept is to localize value added and utilize indigenous resources by and for the benefit of local people. This strategy will be effective through the three phases up to the year 2016 but meaningful particularly during Phase 1 (1999-2004).

The Globalization Drive is outward-oriented strategy of the DIDP Area likely conducive to its higher growth through increase in export to and various exchange with foreign countries. This strategy will be effective, particularly during Phase 2 (2005-2010) and onward.

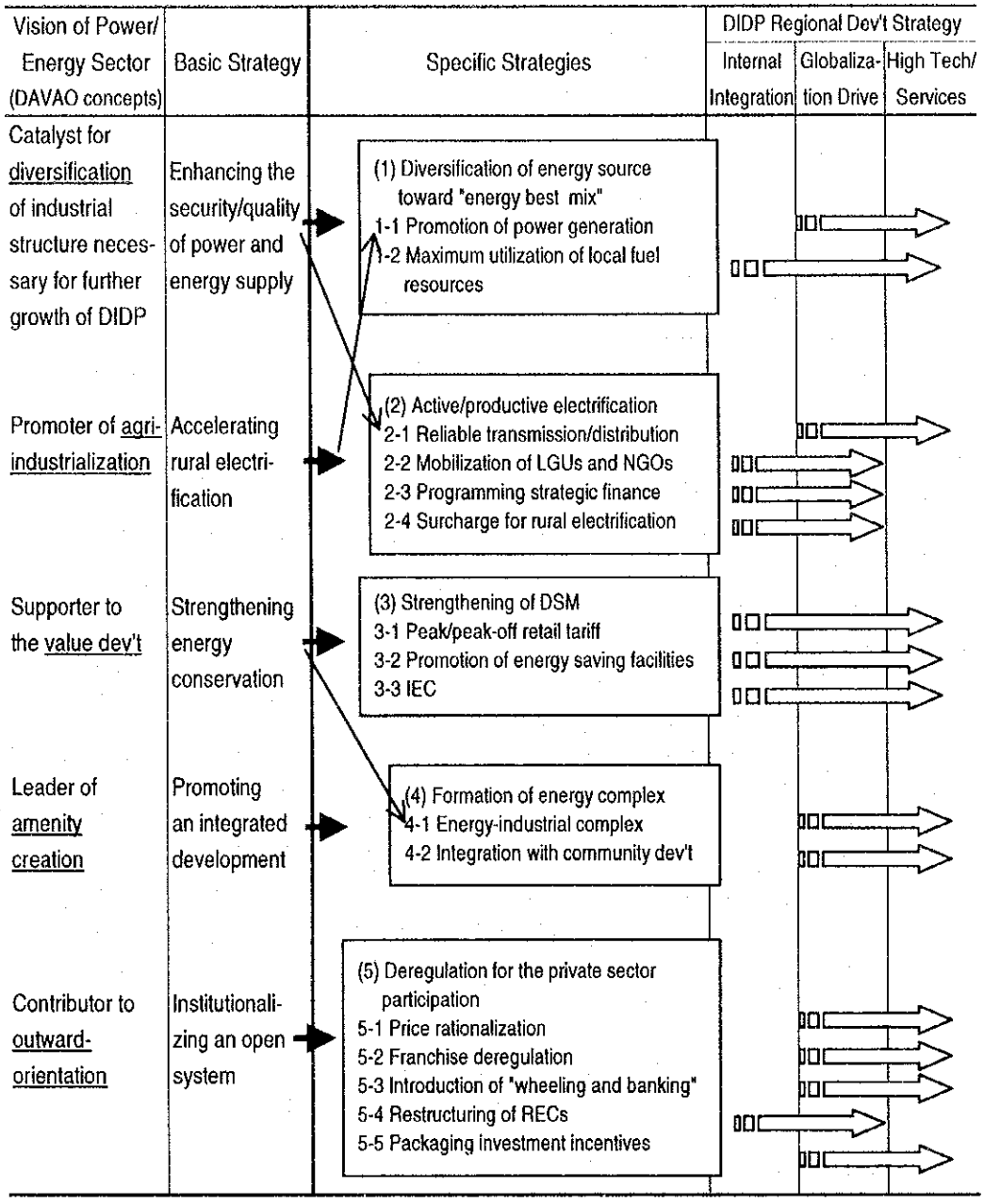
The High Tech-High Services strategy pursues external resources/market driven development. Industries to be introduced under the strategy would not be confined to resource-based and labor-intensive ones. More footloose type industries would be introduced including various high tech industries. This strategy is effective already in Davao City but , particularly during Phase 3 (2011-2016) for the DIDP Area as a whole.

Table 18 shows relationships between the specific strategies and the three DIDP regional development strategies.

(1) Diversification of energy source toward energy best mix

This strategy will serve mainly for enhancing security and quality of power and energy supply in the DIDP Area through the following measures toward the energy best mix that is the goal of the DIDP power and energy development.

Table 18 Vision and Strategy for DIDP Power and Energy Development



Source: JICA Study Team

1) Promotion of power generation

In addition to two planned power plants in Digos, power generation should be promoted to meet an expected increasing power demand under the Globalization Drive strategy in view of energy security. Based on an existing power plant (100MW) and the planned ones (500 MW), the DIDP Area in 2016 will be supplied the remaining 606 MW from power plants located in other regions (refer to Chapter 5). Otherwise, additional power plant development is considered. In line with this, the successful development of two power plants in Digos might trigger investments to meet additional power demand, also depending on power plant development in other regions including the ones at Mt. Apo.

Various local resources also will be utilized depending on the expected demand and quality of power to accelerate rural electrification toward energy best mix as follows:

- Natural energy resources to be strongly encouraged for power generation, such as solar, wind, and tidal wave as well as biomass including dendro-power in rural/remote areas;
- Municipal wastes that will be promising in the long run for power generation in Davao City;
- Geothermal energy in Davao del Norte and Sarangani, Davao del Sur to be validated as early as possible; and
- Mini-hydropower to be materialized by identifying proper proponents.

2) Maximum utilization of local fuel resources

There are sizable amounts of energy demand other than electricity. The following should be put forward in consideration of already depleted firewood resource and addressing to environmental protection, while transferring high technology from advance countries:

- Briquetting and charcoal from bamboo; and
- Residue derived fuel (RDF) and residue derived charcoal (RDC) to substitute for firewood and coconut shell.

(2) Active/productive electrification

This strategy is targeted mainly to accelerate rural electrification, which is essential for the internal integration of the DIDP Area toward agri-industrialization.

There are constraints to the power and energy development as already clarified. Low efficiency of power distribution is one of them, also resulting to RECs' reluctance to extend distribution lines in less profitable rural/remote areas in the DIDP Area.

To address such situations, active/productive electrification should be put forward with the following.

1) Reliable transmission and distribution

Brown out and voltage fluctuation is still not rare. Quality of electricity is essential for industrialization, particularly for high tech industrialization. To address these, it is costly for investors to install self-generators and voltage stabilizers. Accordingly, power supply reliability should be improved. Also, system losses regarding power distribution should be decreased.

2) Mobilization of LGUs and NGOs

LGUs now can enter into power and energy business, which could be one of the economic enterprises prescribed in the Local Government Code of 1991. The PAIC alliances may be useful for rural/remote electrification. Apart from RECs, also some NGO has been active in rural/remote electrification.

Accordingly, LGUs and NGOs are expected to be active more extensively involved in power and energy development as follows:

- Survey and exploration by DOE/EDC, LGUs, NGOs and RECs for new energy sources including geothermal, tidal wave, hydropower and wind energy

potentials, particularly in Davao City for power generation coupled with municipal wastes treatment;

- Mobilization of LGUs alliances and NGOs in power and energy development to realize energy best mix and self-reliant/energy-conserving societies; and
- LGUs support for right-of-way acquisition and coconut tree cutting for transmission and distribution lines.

3) Programming strategic finance

The Davao Business Center, an affiliate of the Davao Cooperatives Bank, has been successful in rural electrification in Davao City as mentioned before.

Solar photovoltaic (PV) is an ideal option for providing small amounts of energy reliably and in a versatile form in sparsely populated rural areas, which is fit for the DIDP Area. It can also be used for telecommunications facilities, small-scale rural enterprises, and other rural community projects such as health clinic and evening education centers. As a tropical area, the isolation level in Mindanao is high and the PV-systems are an option for remote barangays where it is uneconomical to build transmission lines. Households in these areas can be supplied either by a central PV-plant or with decentralized SPV-systems for each single household. The key issue of the PV-systems is the high price.

There are business associations and cooperatives willing to undertake solar energy and other renewable energy projects. The issue is a lack of an affordable credit. To help achieve the 100 % electrification program, a credit program should be formulated based on the cooperative model prevalent in the Philippines where villagers could jointly guarantee a loan for purchase of solar equipment. The availability of electricity will improve the education, health, and productivity in the covered rural areas.

To address increasing entities that want to enter into power and energy business, a strategic finance for energization is expected to be programmed, coupled with rural or indigenous people development based on the comprehensive development plan.

4) Surcharge for rural electrification

High distribution costs of RECs, ranging in 44-51% of power prices, have been sometimes controversial in terms of transparency. RECs' explanation is that the costs include cost for extension of distribution lines. However, consumers have not always known how and when such cost is used for the extension. In this regard, the cost for extension of distribution lines will be an independent account separated from power prices as the surcharge exclusively used for it.

(3) Strengthening of DSM

Demand side management (DSM) is effective for energy conservation, and should be put forward more extensively as follows.

1) Peak/peak-off retail tariff

Peak/peak-off retail tariff will be conducive to efficiency in power generation with smaller capacity of power generation for peak-time. It is partly adopted by DLPC, and expected for wider adoption by RECs for narrowing a demand gap between peak time and off-peak time. The peak-hour tariff structure would also create a price level that supports renewable energy generation.

2) Promotion of energy saving facilities

This is to encourage using energy saving device, constructing energy saving buildings, installing energy saving lighting materials, modifying motors etc. Solar heater for hot water is also useful for accommodations like hotels. It is desirable for this strategy to guide development and growth of new industries engaging in manufacturing such devices and facilities in the DIDP Area.

3) IEC

Information and education campaign (IEC) for energy conservation and lifestyle will be conducive to the formation of self-reliant society with an optimum energy mix. The IEC will be conducted coupled with environmental protection and development of energy saving facilities, which might open up new market/demand for such facilities.

(4) Formation of energy complex

This strategy will serve to amenity creation through organizing an energy-industrial complex comprising a power plant and energy-intensive industries, while contributing to energy conservation.

In addition, the energy-industrial complex could be integrated with community development, and thereby will contribute to quality improvement of people's life through providing hot water and air-conditioning generated from waste heat.

(5) Deregulation for private sector participation

Insufficient conditions to utilize local energy resources are one of the constraints to the DIIDP power and energy development. This strategy is addressed to institutionalizing an open system for the private sector participation in the DIDP power and energy sector development as follows.

1) Price rationalization

- Adequate tariff levels to ensure new investments in the DIDP power sector;
- Tariff arrangements with power distributors to allow private renewable generators to sell directly to consumers; and
- Introduction of interruptable agreements between distribution companies and consumers.

2) Franchise deregulation

This is based on economies of scale so that neighboring RECs can merge or expand into unserved areas. To this end, ERB is expected to re-evaluate existing franchise territories, also in response to new power suppliers that will enter the business.

3) Introduction of "wheeling and banking"

To attract newcomers to power and business, an open system is essential. The newcomers expect their generated power to be sold to RECs not only for its distribution, but also for their economically feasible operation. Under this agreement, a power producer can directly sign a contract with its customers, and agree with the grid to "wheel" the power to them at a transmission fee. In a "banking" arrangement, the power producer-user such as sugar factories and rice mills can supply the power to the grid during the season and get free power back during the off-season. Thus, the wheeling and banking of existing transmission/distribution lines is effective for the private newcomers to manage

their business.

4) Restructuring of RECs

RECs are now in the transition from membership cooperatives to stock cooperatives, which means they will focus more on cost reduction and dividend increase to their stock-holders. This is a sort of restructuring of RECs. Through the transition process, management of RECs should be reviewed in terms of transparency. In addition to aforementioned surcharge for rural electrification, new RECs are expected to expand their business not only for power distribution, but also for power generation including use of local renewable energy.

5) Packaging investment incentives

Although there are potentials in renewable energy sources including solar, mini-hydro, biomass etc., the private sector's participation in renewable energy development is non-existence.

To address such a situation, a concerted government incentive package should be made available to encourage the participation of the private sector in exploring, developing, and selling energy to the grid. NPC or REC's purchase price from the renewable energy source should be somewhere between their purchase price from hydropower and thermal power by IPPs.

Chapter 5 DIDP Power and Energy Development Plan

The development plan of the power and energy sector is composed of development framework, development projects/programs to be implemented by the year 2016, and policy recommendation on the sector development.

5.1. Development Framework

(1) Power demand in DIDP Area

Table 19 shows the results of power demand in the DIDP Area up to the year 2016. The power demand is forecasted to grow by 7.9% per annum during 1997-2004 (Phase 1), 14.0% during 2005-2010 (Phase 2), and 7.6% during 2011-2016 (Phase 3). This growth rates are based on the demand elasticity (DC) to GRDP growth estimated by the Department of Energy (DOE). Thus, power demand in the DIDP Area as a whole will amount to 2,083 GWh in 2004, 4,576 GWh in 2010, and 7,100 GWh in 2016. These account for 18.5% in 2004 and 22.5% in 2010 of the Mindanao total forecasted by NPC, respectively. Such decrease in the DIDP's shares might be attributable to different growth rates of GRDP between the DIDP Area and Mindanao as a whole.

Table 19 Forecast of Power Demand in the DIDP Area

1) GRDP in DIDP Area Estimated by Master Plan Report				
RDP (₱ million in 1995 constant price:	1995	2004	2010	2016
Total	**87,967**	**135,225**	**223,202**	**338,347**
Agriculture/Fishery/Forestry	31,103	37,711	46,759	56,695
Industry	22,306	41,084	77,018	123,875
Services	34,557	56,430	99,425	157,777
2) DIDP GRDP Annual Average Growth Rate (AAGR)				
	1996-2016	1996-2004	2005-2010	2011-2016
GRDP Total	**6.6%**	**4.9%**	**8.7%**	**7.2%**
Agriculture/Fishery/Forestry	2.9%	2.2%	3.6%	3.3%
Industry	8.5%	7.0%	11.0%	8.2%
Services	7.5%	5.6%	9.9%	8.0%
3) DOE's Assumption for Electricity Demand Elasticity				
		1996-2004	2005-2010	2011-2016
Economic Growth		6.90%	6.90%	6.90%
Electricity Growth		11.10%	11.10%	7.30%
Demand Elasticity **(DE)**		1.61	1.61	1.06
4) DIDP Power Growth Rates per Annum				
	1997-2016	1997-2004	2005-2010	2011-2016
(GRDP Total Growth Rates * DE)	**9.6%**	**7.9%**	**14.0%**	**7.6%**
5) Power Demand in DIDP Area (Demand in 1996 X 4) DIDP Power Growth Rate)				
	1996	2004	2010	2016
DIDP Demand for Capacity (MW)	193	354	777	1,206
DIDP Demand for Energy (GWh)	1,136.1	2,083.2	4,576.5	7,100.6
(Mindanao Grid forecasted by NPC)	(4,745.4)	(11,270.0)	(20,369.0)	
(DIDP' Shares of Mindanao Grid)	(23.9%)	(18.5%)	(22.5%)	

Source: GRDP, JICA Study Team; National Load Forecast, PEP 1996-2025

Demand on capacity base will increase from 193 MW in 1996 to 353 MW in 2004, 777 MW in 2010, and 12,06 MW in 2016. On the other hand, power generation capacity in the DIDP Area will be 300 MW in 2004 and 600 MW in 2010 according to the NPC proposed plan. Thus, power/electricity self-sufficiency will be improved to 77% in 2010 (600 MW / 777 MW). If there is no large and additional power plant operation in the DIDP Area during 2011-2016, the power/electricity self-sufficiency will go down to 50% (600 MW / 1,206 MW) in 2016.

(2) Power demand by province/City

Power demand by province/City in the future could be indicated based on the power demand in the DIDP Area forecasted above and the following considerations.

- Incremental power demand from 1996 to 2016 could be divided into those corresponding to 1) population growth, 2) progress of electrification (increase in electrification ratio, and 3) incremental GRDP.

1) Population growth is conducive to increase in power demand for people energized already by 1996. Population by province/City is forecasted to grow around by around 2% per annum up to the year 2016 in Master Plan and Spatial/Infrastructure Sector Report (refer to the Appendix).

2) Progress of electrification will result to increase in households/population energized in the future. The National Electrification Administration (NEA) under DOE sets 100% electrification by the year 2018 (refer to Table 17). Based on this, electrification ratio by province/City could be estimated.

3) Incremental GRDP's shares by province/City is useful to allocate incremental power demand other than those corresponding to the above (population growth and electrification). However, to adopt this method, there is a condition that there is not much difference between power consumption parameter, i.e., power (kWh) per GVA (₱ million) by industry and by province/City. It is here assumed that the difference would not be so much. GRDP by province/City is estimated according to the considerations as shown in Table 20. For example, the GRDP in 2016 will amount to ₱96.3 billion in Davao Province, ₱142.0 billion in Davao City, ₱67.3 billion in Davao del Sur, and ₱32.7 billion in Davao Oriental. Detail procedures for that estimation by sector is referred to Part 2, Part 4 and Part 5 of Economic Sector Report.

4) There is also another problem that the coverage of the Davao Light and Company (DLPC) includes the three municipalities in Davao Province: Carmen, Panabo, and Santo Tomas. In relation to this, some adjustments are necessary. Population of the three municipalities should be counted into DLPC/Davao City. Likewise, incremental GRDP should be adjusted, adding to Davao City (less from Davao Province) the amounts corresponding to increase in population. Accordingly, population and GRDP in Davao City and Davao Province shown in Table 20 become different from those below.

	Socioeconomic Framework (Table 20)				For power demand allocation			
Population ('000)	**1996**	**2004**	**2010**	**2016**	**1996**	**2004**	**2010**	**2016**
Davao Province	1,221,4	1,430.8	1,612.0	1,799.0	952.6	1,090.1	1,208.8	1,329.4
Davao City	1,035,9	1,268.0	1,406.0	1,534.9	1,304.7	1,608.7	1,809.2	2,004.5
GRDP (P million)	**1995**	**2004**	**2010**	**2016**	**1995**	**2004**	**2010**	**2016**
Davao Province	25,393	37,608	60,357	96,258	19,743	28,653	45,227	71,131
Davao City	41,047	63,992	99,484	142,017	46,697	72,947	114,614	167,144

Table 20 Procedural Considerations on and Result of GRDP Forecast

• Factor for GRDP Growth Estimation by Phase

- Agriculture	1) Demand 2) Expansion of High-value Crop and Livestock Production 3) Progress of Irrigation	(referable to Economic Sector Report Parrt 2)
- Mining	1) Demand (3% per annum up to 2016)	(referable to Economic Sector Report Parr 4)
- Manufacturing	1) Agri-industrialization 2) Export 3) High Tech (referable to Economic Sector Report Parrt 5)	
- Utilities	1) Growth Elasticity to Agriculture plus Manufacturing	
- Construction	1) Growth Elasticity to Agriculture plus Manufacturing	
- Services	1) Growth Elasticity to Agriculture plus Manufacturing	

GRDP Estimation by Phase

• Results on GRDP (₱ million in 1995 constant prices) by Phase (AAGR)

	1995	2004	2010	2016	1996-2016	1996-2004	2005-2010	2011-2016
GRDP Total	**87,967**	**135,225**	**223,203**	**338,347**	**6.6%**	**4.9%**	**8.7%**	**7.2%**
Agriculture etc.	31,103	37,711	46,759	56,695	2.9%	2.2%	3.6%	3.3%
Industry	22,306	41,084	77,018	123,875	8.5%	7.0%	11.0%	8.2%
Manufacturing	15,316	29,342	55,762	88,183	8.7%	7.5%	11.3%	7.9%
Services	34,557	56,430	99,425	157,777	7.5%	5.6%	9.9%	8.0%

• Factor for GVA Allocation by Province/City

- Agriculture	1) Land Use Capability/Agronomy 2) Market
- Mining	1) Existing Agglomeration
- Manufacturing	1) Existing Agglomeration 2) Market/Labor/Land/Water Potentials 3) Pinpoint Location of Specific Industry 4) Spillover from the City
- Utilities	1) Power Plant Location (Davao del Sur) 2) Population Growth
- Construction	1) Shares of Incremental Population to allocate incremental GVA
- Services	1) Multiplier Parameter (Services GVA / [Agriculture GVA + Industry GVA]) 2) Shares of Incremental Population to allocate the remaining GVA

GVA Allocation by Province/City

• Results of GRDP (₱ million in 1995 constant prices) Allocation by Province/CITy and by Phase (AAGR)

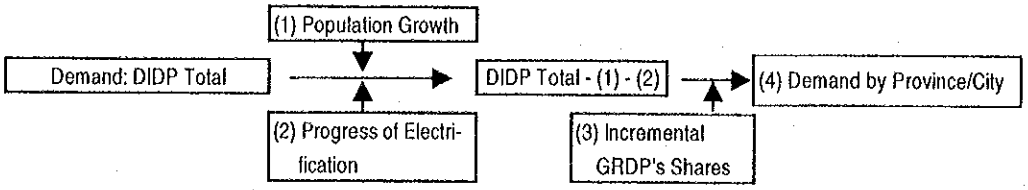
	1995	2004	2010	2016	1996-2016	1996-2004	2005-2010	2011-2016
DIDP Total	**87,967**	**135,225**	**223,203**	**338,347**	**6.6%**	**4.9%**	**8.7%**	**7.2%**
Davao Province	25,393	37,608	60,357	96,258	6.6%	4.5%	8.2%	8.1%
Davao City	41,047	63,992	99,484	142,017	6.1%	5.1%	7.6%	6.1%
Davao del Sur	13,302	21,151	42,356	67,333	8.0%	5.3%	12.3%	8.0%
Davao Oriental	8,224	12,475	21,006	32,739	6.8%	4.7%	9.1%	7.7%

Source: JICA Study Team

Table 21 shows the indicative power demand by province/City and by phase, estimated based on the considerations described above. Power demand will increase rapidly in low electrification provinces, particularly in Davao Oriental of which demand will amount to 602 GWh in 2016 grown by 15.3% per annum from 1996. On the other hand, the demand increase will be relatively slow in Davao City with the highest electrification ratio of 88.5% in 1996, where power demand will be 3,645 GWh grown by 7.4% per annum during the same period.

Per capita power demand per year reflects electrification ratio, GRDP, population income, and industrial structure, among others. The highest in 1996 is 664 kWh of Davao City, which would keep the top, 1,818 kWh in 2016, though difference from the DIDP provinces will become smaller. Davao Oriental, of which per capita power demand is the lowest, 82 kWh in 1996, would increase its level rapidly that the per capita power demand will be 894 kWh in 2016. This is due mainly to progress of electrification as well as of agri-industrialization.

Table 21 Indicative Power Demand by Province/City in the DIDP Area



(1) Demand Increase by Population Growth	Power Demand (GWh)				Population ('000): Estimated			
	1996	2004	2010	2016	1996	2004	2010	2016
DIDP Total	1,136.1	1,382.8	1,554.1	1,723.0	3,370.5	4,034.0	4,538.0	5,044.9
DANECO/Davao Province	154.0	176.2	195.4	214.8	952.6	1,090.1	1,208.8	1,329.4
DLPC/Davao City	866.7	1,068.6	1,201.7	1,331.5	1,304.7	1,608.7	1,809.2	2,004.5
DASURECO/Davao del Sur	80.9	95.6	108.3	121.7	689.7	815.7	924.0	1,038.0
DORECO/Davao Oriental	34.6	42.5	48.7	55.0	423.5	519.5	596.0	673.0

(2) Demand Increase by Population growth and Progress of Electrification	Power Demand (GWh)				Electrification Ratio			
	1996	2004	2010	2016	1996	2004	2010	2016
DIDP Total	1,136.1	1,604.9	1,970.7	2,408.9				
DANECO/Davao Province	154.0	281.1	389.7	514.3	37.6%	60.0%	75.0%	90.0%
DLPC/Davao City	866.7	1,116.9	1,290.0	1,504.5	88.5%	92.5%	95.0%	100.0%
DASURECO/Davao del Sur	80.9	143.2	199.7	266.4	43.4%	65.0%	80.0%	95.0%
DORECO/Davao Oriental	34.6	63.7	91.3	123.7	40.0%	60.0%	75.0%	90.0%

(3) Demand Increase by Incremental GRDP's Shares	Power Demand (GWh)			Incremental GRDP		
	2004	2010	2016	1996-2004	2005-2010	2011-2016
Additional Total (AT)	478	2,493	2,524	(₱ million in 1995 constant prices)		
Allocation: AT - (2)	478	2,605	4,691	47,258	87,978	115,144
DANECO/Davao Province	90	491	1,055	8,910	16,574	25,905
DLPC/Davao City	266	1,234	2,140	26,250	41,667	52,529
DASURECO/Davao del Sur	79	628	1,018	7,849	21,205	24,977
DORECO/Davao Oriental	43	253	478	4,251	8,531	11,733

(4) Power Demand (Final Output)	Power Demand (GWh)				Annual Average Growth Rates			
	1996	2004	2010	2016	1997-2016	1997-2004	2005-2010	2011-2016
DIDP Total	1,136.1	2,083.0	4,576.0	7,100.0	9.6%	7.9%	14.0%	7.6%
DANECO/Davao Province	154.0	371.3	880.5	1,569.6	12.3%	11.6%	15.5%	10.1%
DLPC/Davao City	866.7	1,382.4	2,523.9	3,644.6	7.4%	6.0%	10.6%	6.3%
DASURECO/Davao del Sur	80.9	222.7	827.7	1,284.0	14.8%	13.5%	24.5%	7.6%
DORECO/Davao Oriental	34.6	106.7	344.0	601.8	15.3%	15.1%	21.5%	9.8%

Per Capita Power Demand (reference)	Population ('000): Estimated				Per Capita Power Demand (KWh)			
	1996	2004	2010	2016	1996	2004	2010	2016
DIDP Total	3,370.5	4,034.0	4,538.0	5,044.9	337	516	1,008	1,407
DANECO/Davao Province	952.6	1,090.1	1,208.8	1,329.4	162	341	728	1,181
DLPC/Davao City	1,304.7	1,608.7	1,809.2	2,004.5	664	859	1,395	1,818
DASURECO/Davao del Sur	689.7	815.7	924.0	1,038.0	117	273	896	1,237
DORECO/Davao Oriental	423.5	519.5	596.0	673.0	82	205	577	894

Note: 1/ DLPC covers Carmen, Panabo, and Santo Tomas in Davao del Norte (This is relative to population).

2/ Electricity for investor-owned utilities and others is included in DLPC.

3/ Population is estimated in Spatial/Infrastructure Report of this Study (1996 population is also estimated based on growth rates from 1995 to 2000) and Master Plan Report

4/ GRDP in Davao Province is distributed to Davao City corresponding to transfer of population.

Source: JICA Study Team

RECs are expected to put forward rural electrification. Both DLPC and DORECO predict an increase in power and capacity demand at 9 % per annum in the next ten years. DLPC's prediction is almost the same as the growth rate of indicative power demand, 8.9% during 1997-2010. The DORECO's growth rate, 9% is quite lower than the forecasted indicative growth rate, 17.8% during the same period. It is strongly expected that RECs including DORECO will tackle with rural electrification much more than they did so far. Improvement or new construction of roads will support the RECS' efforts to expand the transmission/distribution line.

5.2. Development Projects and Programs

The DIDP power and energy development will be put forward by the projects/programs which incorporate and integrate the specific strategies to achieve the development goal and vision effectively. They comprise two projects and one program as shown in Table 22, and details on them are compiled in the project profiles contained in Project Report.

(1) Rural Electrification and Renewal Energy Development Program (REREDP)

This program has two main objectives. One is to achieve an optimum energy mix as a whole based on local conditions of energy supply and resources toward fully energized DIDP Area. Another is to strengthen capability of the University of Southeastern Philippines (USEP) in terms of providing technical assistance, training, field survey, and R&D relating to renewable energy.

In addition to extension of reliable transmission/distribution lines, the program will promote exploration and use of various forms of renewable energy through the formulation of a DIDP renewable energy council for coordination of activities by concerned agencies including LGUs and NGOs.

The program initially has three component projects: Solar Energy Development Project, Bio-Gas Pilot Project, and Sarangani Renewable Energy Island Project.

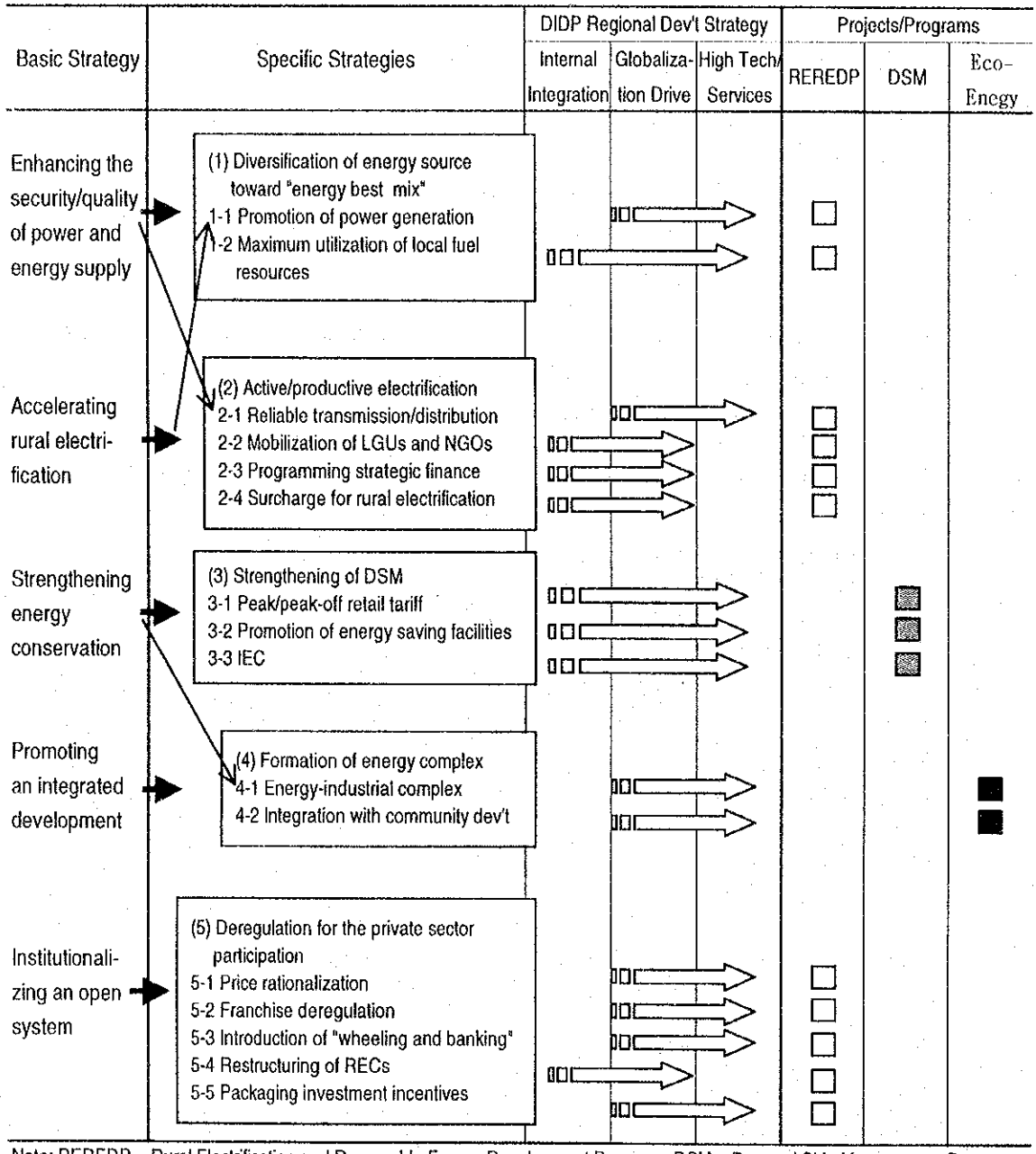
The Solar Energy Development Project (SEDP) will be implemented in rural/remote areas throughout the DIDP Area during Phase 1 (1999-2004). A solar central battery charging system (SCBCS) will be installed to substitute for kerosene lamp. This system is competitive and economical to cost farmers ₱265 per month for three lights running three to four hours a day. The beneficiaries could save ₱167 per month. Also, a separate solar household system with more power supply capacity than that of SCBCS will be installed in part of the DIDP Area where the villages/users are 2 km away from the grid and the population density is below 22 households per km^2. In addition, a solar water pumping system is viable in island and isolated areas for portable water and irrigation use.

The Bio-Gas Pilot Project will be implemented during Phase 1 to produce hot water in place of fuel by building a new digester at the Davao Slaughter House and by rehabilitating an existing one at a chicken farm.

The Sarangani Renewable Energy Island Project aims to experiment on alternative renewable energy sources for rural electrification toward wider application in the DIDP Area and create additional man-made attraction for tourism on the Sarangani island. A solar system may be installed relatively easily for immediate use, e.g., at hospital/health clinic with refrigerators for vaccine. Solar pumps and wind pumps will be considered for portable water supply and rural irrigation. In addition, the project is to establish a center for research and application of renewable energy. Toward the implementation, a period during Phase 1 will be served to a conceptual design of the renewable island and planning for geothermal exploration and

installation of solar system. During Phase 2 (2005-2010), planning and implementation of other renewable energy development will be materialized.

Table 22 Relationships between Specific Strategies and Development Projects/Programs



Note: REREDP = Rural Electrification and Renewable Energy Development Program DSM = Demand Side Management Program
Eco-Energy = Eco-Energy Park Project
Source: JICA Study Team

(2) Demand Side Management Program (DSMP)

This DSMP aims to realize an energy-conserving society in the DIDP Area. The program has three components: (1) IEC on energy conservation especially at schools, (2) encouragement of new business to produce energy saving device, buildings and products, and (3) introduction of interruptable agreements between

power distribution companies and consumers. The program will be implemented Phase 1 through Phase 3 (2011-2016).

(3) Eco-Energy Park Project (EEPC)

The Park is to establish a site to accommodate major power plants and energy-intensive industries for both efficient energy use and effective pollution control as follows.

- Location of petroleum refinery: The two planned power plants in Digos are proposed by NPC as oil/coal combined cycle system by BOT. Sizable amounts of oil will be used for the plants. Such demand might be helpful for the creation of a critical mass for oil industry coupled with oil demand increase for general use. Thus, the plants might be conducive to the materialization of Mindanao petroleum refinery also promoted by BOI.
- Location of power-intensive industries: A combined location of power plant and power-intensive industries is popular in some advanced countries. It is economically efficient due mainly to direct power supply or the supply through very short transmission lines to neighboring locators. Such supply is good for power plant to avoid voltage fluctuation caused by power intensive industries like electric-furnace steel mills. The combined location will also be environmentally protective, if a common service facility such as tall fume is installed jointly by locators.

Another important component is an energy-use complex utilizing waste heat discharged from the energy-intensive industries in neighboring areas for domestic, public and other uses. The Park also will interact with a solar system that provides solar peak power as complement to the whole system.

5.3. Policy Recommendation

The DIDP power and energy sector development will progress focusing on rural electrification coupled with extensive use of renewable energy, promoting energy conservation, and integrating with community and amenity development as seen above. This will be realized supported by a concerted development efforts of DLPC, RECs, LGUs, NGOs, and the Government agencies such as DOE, EDC and NEA. DOST and USEP will support R&D on the use of renewable energy and energy conservation. In addition, DIDP PMO, which is likely to be transformed into an autonomous entity, i.e., the Davao Development Authority (DDA: a tentative name, hereinafter the same) might be a coordinator to organize a proposed renewable energy development council for the Rural Electrification and Renewable Energy Development Program.

Among the considerations conceived in the specific strategies, the ones regarding improvement or creation of better power and energy business environments are strongly recommended to be realized as fast as possible, since they are preconditions for extensive use of renewable energy.

It is recommended that the power generated from renewable energy be sold to the grid at a price level that allows the investors some profit. The Government should provide guidelines for the wheeling and banking of electricity from renewable sources. It is expected that a matching fund should be provided.

Likewise, It is recommended that the private sector be brought in to build, operate, and own a length of distribution line to a community and allow it to charge a transmission fee through its network. ERB should reevaluate the franchise territory

and allow neighboring RECs/other entities to merge or expand into the unserved territory, since most unserved barangays are in the bordering areas.

In some case, a mandatory transmission component/surcharge in distribution price (e.g.., ₱10) should be specified and the surcharge will go into a revolving fund for investment in transmission and distribution expansion program.

It is also recommended that DIDP PMO, NPC, EDC DOST and USEP should continue to carry out survey and exploration for geothermal, tidal wave, hydro and wind energy potentials in the DIDP Area toward the implementation of Rural Electrification and Renewable Energy Development Program.

It is finally recommended that concerted efforts to develop energy saving and DSM programs be carried out by LGUs in cooperation with DOE and relevant industries as well as NGOs.

SPATIAL/INFRASTRUCTURE SECTOR REPORT

Part 5: Water Resources

Chapter 1 Water Related Policies and Institutions

In this study, the water sector covers: i) water resources development and management, ii) flood control, iii) water supply for domestic and industrial use, and iv) sewerage including domestic wastewater, industrial wastewater and urban drainage. Irrigation and hydropower are covered under agriculture and power and energy, respectively.

1.1. Water Policies

(1) National policies and strategy

According to the "Water Resources Policies of the Philippines" formulated by the National Water Resources Board (NWRB), all development activities of the Government in respect of water and its relevant land resources are pursued in accordance with the Philippine Development Plan and the pertinent provisions of the Water Code. The current Philippine Development Plan (1993 -1998) outlines policies and strategies to support the long-term goals of poverty alleviation and improved income and wealth distribution. It emphasizes the necessity of continuing efforts to provide for basic needs of the majority of the population.

The water resources sector has direct bearings on some of basic needs and serves for economic development and social well-beings of the people. The following are addressed in the Plan as policies and strategies in the water sector:

1) To adopt an integrated planning and development strategy for an area-wide development scheme for the purpose of combining irrigation, power, flood control, and domestic and industrial water supply to realize optimum benefits,
2) To implement cost recovery in the process of planning and selection of piped water supply projects,
3) To improve the efficiency in the collection of irrigation and water supply service fees and the water tariff system,
4) To implement cost-efficient water resources development projects for increased productivity and employment opportunities, and
5) To develop more small and medium-scale projects which yield quicker results and can be developed and maintained through the active participation of the rural populace.

The Updated Philippine Development Plan (1996-98) reflects increasing concerns on decentralization, people's participation and environmental quality. Increased policy emphasis of the plan representing these concerns may be placed in the pursuance of decentralized, coordinated and efficient management of water resources and cost effective water resources and sanitation development based on demand and local initiatives through:

1) Giving due consideration to environmental protection,
2) Integrating quality and quantity concerns, and
3) Encouraging participation of LGUs, NGOs and private groups.

Another emphasis reflecting recent changes is to develop a computer-based comprehensive information system for water resources and sanitation sector.

For respective sub-sectors, the following specific objectives for the nationwide development are laid down.

Flood control and drainage

1) To give priority to major river basins which encompass large tracks of fertile lands,
2) To implement non-structural measures such as flood plain management, zoning regulations, flood forecasting and warning as well as reforestation works,
3) To provide appropriate flood control and drainage mechanisms in Metro Manila and other highly urbanized centers, and
4) To carry out river improvement/revival program.

Water supply and sewerage

1) To continue provision of safe and adequate water supply and sanitation services,
2) To pursue proper O & M of facilities for sustainable water supply in identified industrial centers and in both urban and rural areas,
3) To undertake gradual construction and installation of sewerage facilities, and
4) To develop the capabilities of LGUs to implement water supply, sewerage and sanitation programs with the national government providing assistance in the areas of community participation, sub-sector planning, program management, regulation of development, selection of technologies, financial management, construction supervision, monitoring and reporting.

(2) Regional objectives and strategy

The Southern Mindanao Region Development Plan (1993-98) defines water resources development objectives and strategy by sub-sector. They may be summarized as follows.

Water supply: To provide potable water supply to unserved households with priorities on areas of greater population size and density, while continuing to develop traditional wells and spring facilities.

Irrigation: To support the thrust of the agricultural sector to attain self-sufficiency in basic food crops and increase production of high value crops through:

1) Organizing irrigation associations,
2) Prioritizing the completion of on-going projects,
3) Maintaining/rehabilitating existing facilities,
4) Developing small-scale irrigation projects, particularly communal schemes, and
5) Formulating major multi-purpose projects.

Sewerage and sanitation: To support the objective of the health sector to reduce the incidence of water-borne diseases by establishing sewerage and sanitation facilities in a step-wise manner based on a study for major cities and capital towns.

Flood control and drainage: To support socioeconomic development by reducing adverse effects of floods and poor drainage with priorities on those areas most

extensively affected, providing critical transportation links, and producing essential food supplies.

The Updated Southern Mindanao Region Development Plan (1996-98) has set specific targets for infrastructure development. Related to water resources, the following are spelled out:

1) To raise the level of the population served with potable water from 77% in 1991 to 98% in 1998, and

2) To irrigate 98% or 101,379 ha of the Region's total irrigable area.

1.2. Institutional Framework

At the central level, there are three line departments (DILG, DPWH and DOH) and two government owned and controlled corporations (LWUA and MWSS), responsible for planning and implementation in the water sector. Other departments are partly concerned with macro-planning, national resource allocation decisions, and exercise of regulatory powers for tariff setting, and environmental protection and management issues.

In the Philippines, institutional scheme of the water supply and sanitation sub-sector today is in a transition stage. In 1991, the Local Government Code (LGC) has essentially re-defined the role, relationship and linkages of central, provincial, municipal and barangay institutions in the provision of basic services, including water and sanitation. The current direction mandates LGUs to play a larger role in planning and implementing water supply and sanitation projects.

(1) National level institutions

Department of Pubic Works and Highways (DPWH): is responsible for the development of flood control, other water resources development and water supply system, mainly but not exclusively for the development of Level I water supply system in line with national plans and policies. It performs engineering and construction functions such as flood protection structures, drilling of wells and development of springs. DPWH is also responsible for providing technical assistance and exercising government budget allocation for construction and major repair and rehabilitation of water works.

National Water Resources Board (NWRB): attached to DPWH, is a high level body responsible for coordinating and integrating all the activities related to water resources development and management. It formulates policies, evaluates and coordinates water resources programs, regulates and controls the utilization, exploitation, development and conservation of the Country's water resources and the regulation of the water utilities operation.

Department of Interior and Local Government (DILG): has the mandate of strengthening local capacity for delivery of basic services, including water and sanitation. It is responsible for providing general administration and institution-building support to LGUs including assistance in the formation and training of Barangay Waterworks and Sanitation Association (BWSAs). Ultimately, DILG is geared to provide a range of support activities to develop the capability of LGUs. On a transitory basis, interagency provincial and municipal water task forces have been established in some provinces.

Local Water Utilities Administration (LWUA): is a specialized lending institution mandated to promote and oversee the development of provincial water utilities based on financial viability of projects. LWUA responsibilities were expanded to include assistance to Level II Rural Waterworks and Sanitation Association (RWSAs). The provision of Level II and III services and of wastewater disposal systems in communities outside of Metropolitan Manila are largely coordinated through LWUA. LWUA has developed a wide array of support services for WDs (Water District) and RWSAs development such as institutional arrangements, financial services and technical services as well as consulting with LGUs on the formation of WDs and RWSAs.

Department of Health (DOH): is the primary health policy-making and implementing agency. Its main function is to develop and implement sanitation programs nationwide and administer health education aimed at reducing morbidity due among others to waterborne and sanitation related diseases specifically diarrhea. Its role in the water supply program is in the promotion of safe water supplies through water quality surveillance.

(2) **Regional level institution**

Regional Development Council (RDC): In Region-XI, RDC is entitled to: (i) approval of the regional development plan, the multi-year regional development investment program and the regional annual investment program, (ii) reviewing and endorsing to the national government the regional budget proposals of government agencies, and (iii) ensuring the consistency of local development plans with regional plan and priorities.

(3) **Provincial level institutions**

Provincial Development Council (PDC): The main function of PDC is to formulate a long-term, medium-term and annual socioeconomic development plan and policies as well as investment program of the province.

Provincial Planning and Development Office (PPDO): is the nerve center of all provincial planning activities in LGUs. It conducts research and studies necessary to support plan formulation. PPDO likewise integrates and coordinates sectoral plans and studies done by different groups or agencies and monitors and evaluates the implementation of development programs and projects. PPDO also maintains a Special Project Division which performs analysis on plans and programs as well as the implications and resource requirements of development plans and project before implementation process.

Provincial Engineer's Office (PEO): primarily takes charge of the construction, maintenance, improvement and repair of water supply system of Level I and Level II system. It provides engineering services like investigation and survey, engineering design, feasibility study, and project management.

Provincial Waterworks Office (PWO): assumes responsibility for the operation and maintenance of the water system which covers some municipalities. Moreover, PWO renders advisory and technical assistance in the preparation of programs of work and cost estimates for the construction of shallow wells, spring development programs and other sources. It also supervises the installation of water supply, drainage and toilet facilities in buildings constructed by the provincial government.

(4) Municipal level institutions

Municipal Planning and Development Office (MPDO): In the Philippines, the municipalities are responsible for solid waste disposal or environmental management system, general hygiene and sanitation and infrastructure facilities intended primarily to service the residents of the municipality. MPDO is mandated to take charge of the planning and development and formulate an integrated economic, social, physical, and development plans and policies for consideration of the local development council.

Municipal Engineer's Office (MEO): provides engineering services to the local government unit concerned, including investigation and survey, engineering design, feasibility study and project management. It also administers, coordinates, supervises and controls the construction, maintenance, improvement and repair of public works projects.

(5) Other relevant units

Water Districts (WDs): are local government corporations formed pursuant to Presidential Decree No. 198, organized for the purpose of serving the water supply requirements of the residents within its franchise area. Technical and financial assistance (loan) are provided by LWUA to WDs. WDs, to be self-sufficient, are operated in a business-like manner to generate enough revenues from their water sales. In general, WDs provide Level III system water services.

Rural Waterworks and Sanitation Associations (RWSAs): are organized by beneficiaries to facilitate participation in the planning, construction, operations, maintenance and management of water supply projects. RWSAs operates and maintains the community water supply system. The members of RWSAs contribute a part of the project cost as local equity and pay a monthly service fee sufficient to operate, maintain and amortize the project. Most of RWSAs provide Level I or II service.

Barangay Waterworks and Sanitation Association (BWSAs): are non-stock cooperative with their own water supply facilities constructed through their own resources or with external capital development assistance. They are mandated: (i) to operate, manage and own the water supply facilities; and (ii) to mobilize the members' resources (financial contribution to the cooperative fund) for the construction, operation and maintenance of the system.

Private sector: has been involved in water supply development in the form of investments, technical studies and construction of water supply and sanitation facilities. Non-government organizations (NGOs) have also demonstrated capability to undertake project development and implementation with community participation.

1.3. Financial Aspects

Financial sources

In the past, the development of the water resource sector in the province was mainly achieved by line agencies such as DPWH, LWUA, DILG and DOH. Since 1992, local programs and projects for the water supply sub-sector have been devolved from central government agencies to LGUs according to the Local Government Code of 1991 and NEDA Board Resolution No.4 (1994). In the water supply sector, accordingly, Internal

Revenue Allotment (IRA) and grants or loans provided by external agencies are main financial sources.

For the water resources development and flood control sub-sectors, DPWH has spent 7 - 20% of its total budget every year.

Cost recovery

In the water supply sub-sector, the capital cost for Level I systems is free to the community, while operation and maintenance are the responsibility of the associations or barangays. As for Level II systems, capital cost is shouldered by RWSA through a loan or grants. Water charges collected by each association cover cost of operation and maintenance, and loan amortization. For Level III system, the provincial waterworks bears the capital cost by loans. The cost of amortizing the loan and operation and maintenance of the system is recovered through monthly water bills. The water rate system for Davao City Water District (DCWD) is given in Table 1.

External financial supports

As for multilateral agencies' aides, the World Bank (WD) provided significant capital funds for the water resources sector in the Philippines, especially in the water supply sub-sector, for development projects of rural water supply nationwide. In addition, it is preparing two loans for LWUA implementation in the field of urban water supply and urban sewerage and sanitation. The Asian Development Bank (ADB) supported institution building activities of LWUA and WDs.

The United Nations Development Programme (UNDP), through its Danish Trust Fund facilities, has actively supported the preparation of provincial master plans for the water resources sector. The United Nations Children's Fund (UNICEF) supports the sector through the Philippines Plan of Action for Children. UNICEF assists NEDA in updating of the national master plan.

Table 1 Water Rates in Davao City Water District

Not Beyond 10 m^3 of Water Consumption		Beyond 10 m^3 of Water Consumption	
Connection Pipe Size	Rates (Peso)	Water Consumption (m^3)	Charge (Peso/m^3)
3/8 inches	20.0	11 – 20	5.25
1/2 inches	50.0	21 – 30	6.80
3/4 inches	80.0	31 – 40	9.00
1 inches	160	Beyond 41	15.0
11/2 inches	400		
2 inches	1,000		

Notes : 1) 17 Peso per cu-m is applied for bulk sale. 2) As of December, 1996
Source : Davao City Water District

With respect to bilateral agencies' aides, the Japan International Cooperation Agency (JICA) extends technical cooperation nationwide in the basic design study for the water resources sector including water resources development, flood control and water supply, for the latest example, the Provincial Water Supply and Sanitation Planning in Central Luzon. The Overseas Economic Cooperation Fund (OECF) is providing a loan for the water resources sector. The Australian International Development Assistance Bureau (AIDAB) is also supporting the water supply sub-sector.

1.4. Major Legislation and Regulations

Major legislation and regulations affecting the development, planning, project implementation, construction, O & M, etc. in the water resources sector are outlined as follows.

The Local Government Code of 1991 (RA 7160): provides for a more responsive and accountable local government structure. LGUs now exercise more authority and responsibilities and provide resources to accelerate the provision of basic services and facilities, including water supply, sanitation and sewerage. Under this Code, the Implementing Rules and Regulations (IRR) to effect the devolution of water and sanitation responsibilities are active.

The Water Code of the Philippines (PD 1067): consolidates legislation relating to the ownership, development, utilization, exploitation and conservation of water resources. The Code established the principles and frameworks on the appropriation, control and conservation of water resources to achieve their optimum economic efficiency and rational development. In addition, PD 424, declares that NWRB shall be responsible for coordinating and integrating all activities related to water resources. PD 1067 also pertains to the grant of water right privileges (water permits) to appropriate and use water. Water permit applications are reviewed and granted by NWRB.

The Provincial Water Act of 1973 (PD 198): authorizes the formation of local water districts in the provincial areas outside the Metropolitan Manila area, and provides for their administration and operation. It also created LWUA as a specialized lending institution for the promotion, development and financing of local water districts.

The Philippine Environmental Policy (PD 1151): requires all public and private entities to undertake an environmental impact assessment of all projects which significantly affect the quality of the environment. The Philippine Environmental Code (PD 1152) establishes standards for air and water quality, and guidelines for land use management, natural resource management and conservation, utilization of surface and groundwater, and waste management.

The Sanitation Code (1975): was promulgated to deal with water supply, excreta disposal, sewerage and drainage issues. The Sanitation Code and the National Building Code (1977) require that new buildings be connected to a waterborne sewerage system. Where such systems do not exist, sewage must be disposed of by imhoff tanks or septic tanks with a subsurface absorption field. In addition, the facilities are required to conform with the 1959 National Plumbing Code.

The 1981 Rules and Regulations for Domestic Wastewater Disposal: require all subdivisions and condominiums, etc. to have adequate sewage collection, conveyance, treatment and disposal facilities. A permit must be obtained prior to commissioning a new system.

Chapter 2 Existing Conditions

2.1. Water Resources and Hydrological Conditions

(1) Water regions and climatic types

Usually, the land of the Philippines is subdivided in accordance with the two different categories: water resources region (WRR) and administrative region. The Country is divided into 12 WRRs largely coinciding with the administrative division. The WRR XI where most part of the DIDP Area is located, however, does not coincide with the administrative Region XI. In the DIDP Area, a part of Davao Province, constituting the upper Agusan river basin, is covered by the WWRX.

The climate in the Philippines is greatly influenced by semi-permanent cyclones, the systems of air streams and ocean currents responsible for patterns and intensity of rainfalls. According to the climatic classification in the Philippines, the DIDP Area belongs to Type II and Type IV as follows.

Type II: Characterized by no dry season with a very pronounced maximum rainfall from November to January affecting Davao Oriental and the eastern part of Davao Province, and

Type IV: Characterized by more or less evenly distributed rainfall throughout the year. Included are Davao del Sur, the western part of Davao Province and Davao City.

The annual rainfall in the DIDP Area ranges broadly from 1500 mm to 3500 mm. The rainfall data were collected from three observatories operational in Davao City, Davao Province and Davao Oriental. Figure 1 shows representative rainfall patterns with relatively even monthly rainfall. While the shortage of observed data would not allow precise estimation of rainfall patterns, an isohyet map in the DIDP Area, as shown in Figure 2 was formulated to assess the water resources potential, referring to the interim results of the on-going "Master Plan Study on Water Resources Management in the Philippines" being undertaken by JICA.

(2) River systems

According to the river basin classification in the Philippines, the river basin with more than 400 km^2 area is designated as the major river basin and the one with the area between 40 km^2 basin as the principal river basin. There are 31 different watersheds in the DIDP Area including 28 principal river basins and three major river basins (Table 2 and Figure 3). The major river basins in the DIDP Area are described.

Davao river basin: This is a narrow basin covering a total area of 1,300 km^2, with its major portion lying within the territory of Davao City. The basin has a generally mountainous terrain in the upper reaches. Relatively flat agricultural areas mostly in the lower reaches are limited and are presently dominated by banana and coconut. The Davao river, which is the main drainage way of the basin, originates from the foot of Mt. Malambo and flows generally in a southerly direction, turning east near Lacson and resumes southerly flow through Davao City. It discharges into the Davao Gulf with an estimated some 7,000 million m^3 of annual run-off. The built-up area in the urban center of Davao City is located in the estuary of the Davao river.

Tagum-Libuganon river basin: The basin encompasses the western side of Davao Province and small portions of Agusan del Sur Province. The Libuganon river, originating from the foot of Mt. Pantado discharges towards the Davao Gulf through generally flat land, which is one of major agricultural areas in the DIDP Area. Tagum, the provincial capital, is located at the side of the Libuganon river around the estuary. It has a total area of about some 3,600 km^2 with an average annual run-off of some 6,790 million m^3.

Table 2 Characteristics of Major/Principal River Basins in the DIDP Area

Provine /Municipalities	Watershed	Code	Class	Watershed Area (km^2)	Annual Rainfall (mm)	Approximate Annual Run-off (MCM)/1	Present Land Use Situation	
							Agriculture (%)	Non-Agriculture (%)
Davao Oriental								
Mati	Sumlog	8	Principal	1,372	1,250	1,715	21.4	62.9
	Baguan	17	Principal	176	1,500	264	14.2	71.0
Tarragona	Quinaman	18	Principal	221	1,500	332	9.1	80.0
Gov. Generoso	Baguian	31	Principal	766	2,250	1,754	7.2	47.5
Manay	Casauman	16	Principal	403	1,500	605	4.7	70.4
	Manay	19	Principal	139	2,250	313	122.0	76.3
Caraga	Caraga	21	Principal	613	2,500	1,352	8.5	70.3
	Lanunayao	15	Principal	330	2,875	949	7.0	61.2
Baganga	Baganga	14	Principal	420	2,875	1,208	19.5	68.8
	Dapnan	29	Principal	168	2,875	483	38.1	61.9
Cateel	Cateel	13	Principal	868	3,000	2,604	13.0	87.0
Total of Davao Oriental				5,476		11,577		
Davao Province								
	Upper Agusan		Major	1,600	3,900	6,240	-	-
	Tagum-Libuganon	6	Major	2,587	2,625	6,791	18.1	82.0
Panabo	Lasang	10	Principal	447	2,750	1,229	32.7	41.2
Pantukan	Kingking	30	Principal	566	2,250	1,274	30.2	37.5
Total of Davao del Norte				3,600		9,294		
Davao City								
	Davao River	9	Principal	2,625	2,750	7,527	20.0	8.0
Toril	Lim-Dan	7	Principal	195	2,250	439	77.4	20.0
Talomo	Talomo	32	Principal	362	2,250	815	76.2	11.3
Bunawan	Tagonol	33	Principal	237	1,750	415	76.7	5.6
Total of Davao City				3,419		9,195		
Davao del Sur								
	Padada	6	Major	1,813	1,500	2,720	51.3	48.7
J. A. Santos	Margus	23	Principal	493	1,125	555	3.5	17.3
	Tabayon	24	Principal	229	2,000	458	10.0	40.2
	Murabatuan	25	Principal	126	2,000	252	15.1	23.0
	Culaman	26	Principal	138	2,000	276	5.1	57.3
Don Marcelino	Calian	27	Principal	1,032	2,000	2,064	39.7	6.5
Maitum	Sibulan	28	Principal	314	2,000	707	43.6	33.8
Total of Davao del Sur				1,813		7,032		
Total of DIDP Area				14,308		37,097		

Note: /1 : The annual run-off in the table were calculated simply by annual rainfall, based on assuming of run-off coefficient 1.0.

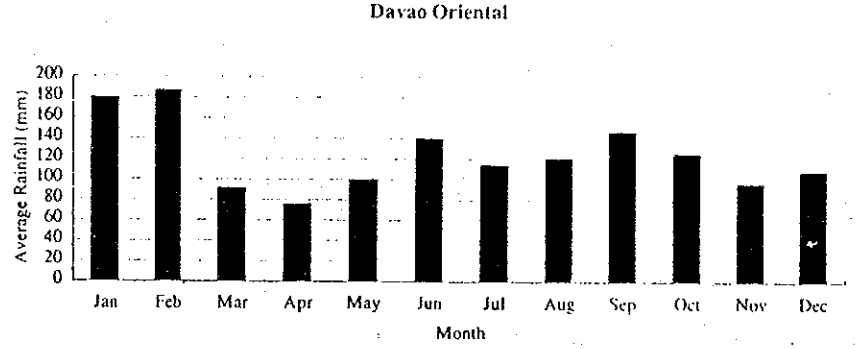
Source: "Land Use Assessment for Region XI", Bureau of Soil and Water Management, 1989

Figure 1 Rainfall in the DIDP Area

Monthly Rainfall at Davao Oriental

Location: Menzi Farmers Cooperative, Mati (Unit :mm)

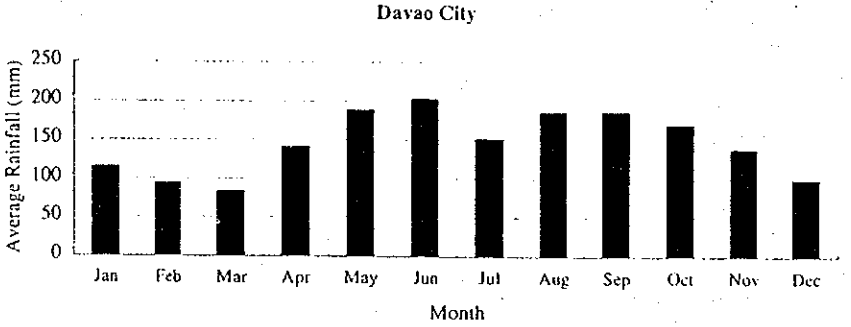
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annualy
Ave	178	186	91	75	99	139	114	121	146	125	96	108	1,451
Max	442	810	281	255	260	289	276	331	1,318	263	241	323	3,258
Min	1	0	0	0	8	1	1	1	27	26	26	17	777



Monthly Rainfall at Davao City

Location :Lat 07 07' N, Long 125 39E (Unit :mm)

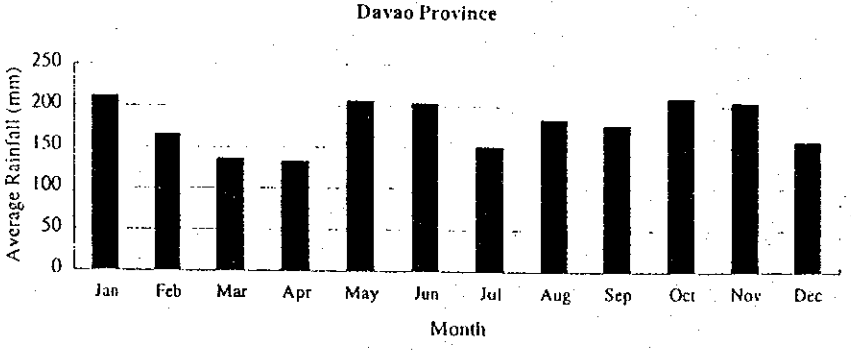
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annualy
Ave	114	93	82	140	188	202	150	185	186	169	138	99	1,743
Max	303	259	354	326	462	509	387	384	391	457	247	232	2,251
Min	4	1	4	5	47	21	34	38	39	59	40	8	1,128



Monthly Rainfall at Davao Province

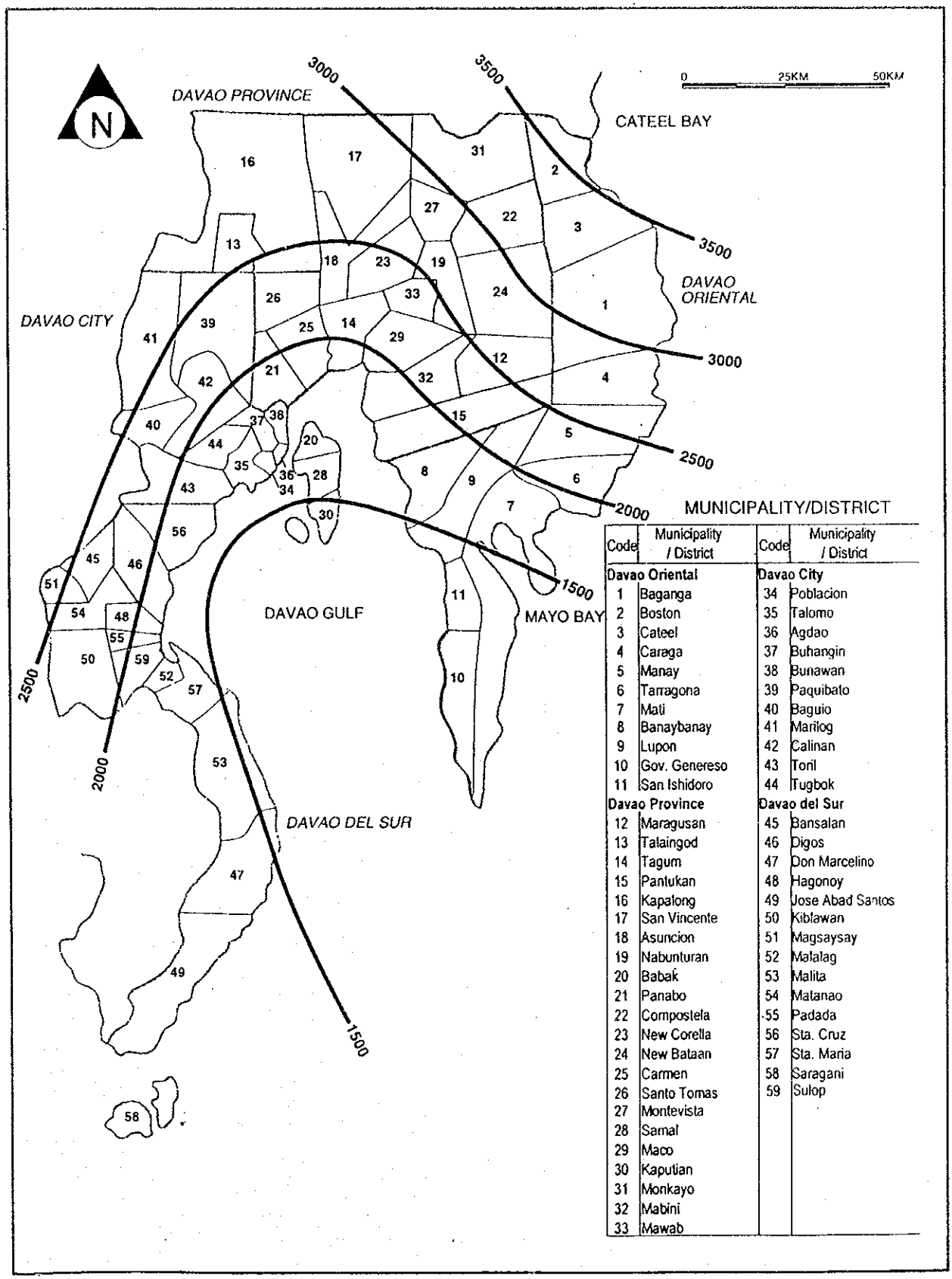
Location :Tagum (Unit :mm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annualy
Ave	210	164	135	131	205	203	151	183	176	209	204	157	2,127
Max	486	510	350	268	530	434	313	408	321	581	317	407	4,925
Min	31	12	12	6	52	54	58	33	52	76	94	29	508



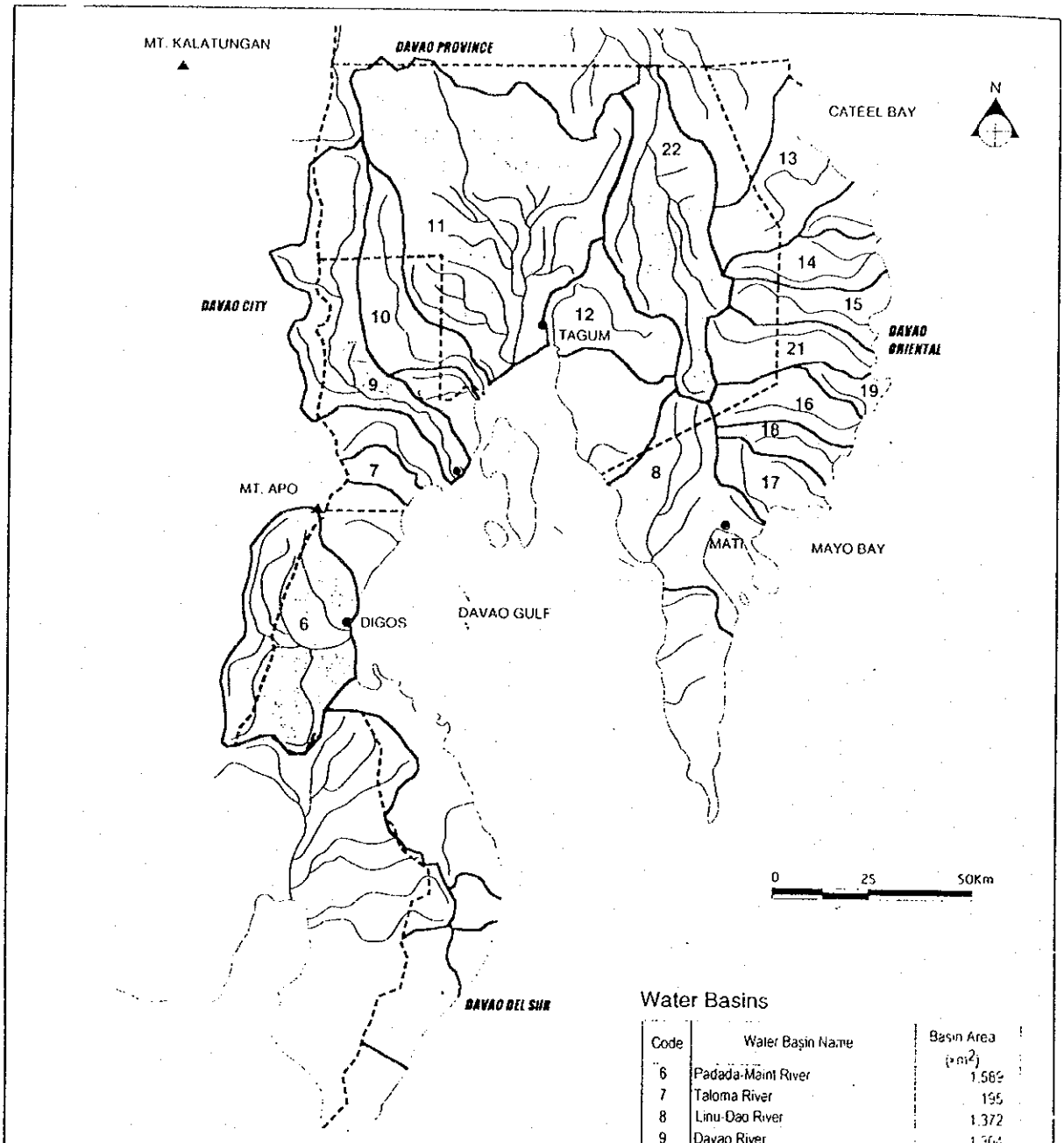
Source : PAGASA and Agriculture Cooprative.

Figure 2 Isohyet Map in the DIDP Area



Code	Municipality / District	Code	Municipality / District
Davao Oriental		**Davao City**	
1	Baganga	34	Poblacion
2	Boston	35	Talomo
3	Cateel	36	Agdao
4	Caraga	37	Buhangin
5	Manay	38	Bunawan
6	Tarragona	39	Paquibato
7	Mati	40	Baguio
8	Banaybanay	41	Marilog
9	Lupon	42	Calinan
10	Gov. Genereso	43	Toril
11	San Ishidoro	44	Tugbok
Davao Province		**Davao del Sur**	
12	Maragusan	45	Bansalan
13	Talaingod	46	Digos
14	Tagum	47	Don Marcelino
15	Pantukan	48	Hagonoy
16	Kapalong	49	Jose Abad Santos
17	San Vincente	50	Kiblawan
18	Asuncion	51	Magsaysay
19	Nabunturan	52	Malalag
20	Babak	53	Malita
21	Panabo	54	Matanao
22	Compostela	55	Padada
23	New Corella	56	Sta. Cruz
24	New Bataan	57	Sta. Maria
25	Carmen	58	Saragani
26	Santo Tomas	59	Sulop
27	Montevista		
28	Samal		
29	Maco		
30	Kaputian		
31	Monkayo		
32	Mabini		
33	Mawab		

Figure 3 Major River Basins in the DIDP Area



Water Basins

Code	Water Basin Name	Basin Area (km^2)
6	Padada-Maint River	1,569
7	Taloma River	195
8	Linu-Dao River	1,372
9	Davao River	1,364
10	Lasang River	447
11	Tagum-Libuganon River	3,590
12	Hijo River	696
13	Cateel River	868
14	Baganga-Mahandor River	429
15	Magungao River	420
16	Casauman River	330
17	Bagoan River	176
18	Quiraman River	221
19	Manay River	139
21	Caraga River	613
22	Upper Agusan River	2,277

Source : Based on the map formulated by NIA.

Padada river basin: The Padada river, with the annual run-off of 2,720 million m^3 and the catchment area of 1,600 km^2, originates from northwestern part of Davao del Sur, the foot of Mt. Apo. It is accompanied by many tributaries such as the Mal river and the Miral river, and finally discharges to the Davao Gulf. The Padada river is characterized by steep slopes along the upper reaches, slightly sloping towards its mouth.

Upper Agusan river basin: With a total drainage area of 11,500 km^2, it runs and drains the area from Davao Province to Agusan del Norte. It occupies an area of 2,300 km^2 within Davao Province. The river, with a total length of 120 km, originates from the mountains, and runs through the Compostela Valley, enters the narrow gorge and empties into the Bunawan marsh. It eventually discharges into the Datuan Bay through the central Agusan basin and the lower Agusan basin. The climate around the basin is characterized by no dry season with very pronounced maximum rainfalls from December to February.

Generally, main features of rivers in the DIDP Area are relatively short length with steep slope, with the tendency of easy and frequent occurrence of flash floods. Discharges and related hydrological data of major rivers in the DIDP Area are shown in Table 3.

(3) Groundwater

The primary source of water supply for domestic use in the DIDP Area is groundwater from springs and through deep and shallow wells, at present. The Water Resources Maps, based on "Rapid Assessment of Water Supply Sources, 1982" conducted by NWRB, present the aerial distribution of groundwater availability as shown in Figure 4, and data on wells through the assessment summarized in Table 5. The maps depict the status of a specific area into either one or a combination of two or more of the following groundwater categories: shallow well areas, deep well areas and difficult areas. Table 4 shows their shares in the DIDP Area.

Table 4 Aerial Extent of Groundwater Classifications

Province/City	Deep Well Area		Shallow Well Area		Difficult Area	
	Area (km^2)	Ratio (%)	Area (km^2)	Ratio (%)	Area (km^2)	Ratio (%)
Davao Oriental	2,580	50	520	10	2,064	40
Davao Province	5,280	65	1,200	15	1,650	20
Davao City & Davao del Sur	3,700	58	765	12	1,913	30
DIDP Total	11,560	59	2,485	13	5,627	29

Source : "Rapid Assessment of Water Supply Sources", National Water Resources Council, 1982.

For general planning purposes, the DIDP Area is divided into the following groundwater categories:

Shallow well areas: where wells with depths not greater than 20 m are recommended and static water levels are generally within 6 m below ground surface (mbgs);

Deep well areas: where wells with depths greater than 20 m are recommended and static water levels usually exceed 6 mbgs; and

Difficult areas: where groundwater depths vary considerably and about 25 percent of such areas may yield non-productive boreholes.

Table 3 Discharge Data of Major Rivers in the DIDP Area

Tagum River

Location : Pagsabangan, Tagum, Davao Province
Drainage Area : 2326 km^2
Period : Sep 1949 - Dec 1970
Gauging Elev : 0.94 m Above Sea Level

Annual Characteristics

Peak Discharge (m^3/sec)	Max Water Level (m)	Max Daily Discharge (m^3/sec)	Mean Daily Discharge (m^3/sec)	Min Daily Discharge (m^3/sec)	Min Water Level (m)	Mean Annual Runoff (MCM)
837		801	135	9.2		1,046

Monthly Discharge

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	165.4	124.3	85.7	69.1	123.0	136.4	130.3	101.6	136.6	118.5	101.2	129.2
Max	384.0	236.4	196.1	187.7	350.0	309.0	165.9	150.5	198.1	213.5	171.6	261.7
Min	61.8	58.7	31.1	23.6	52.5	67.7	101.7	55.7	51.8	68.2	53.5	42.7

Matina(Davao) River

Location : Matina, Pangi, Davao City
Drainage Area : 48 km^2
Period : Sep 1959 - May 1978
Gauging Elev : 5.891 m

Annual Characteristics

Peak Discharge (m^3/sec)	Max Water Level (m)	Max Daily Discharge (m^3/sec)	Mean Daily Discharge (m^3/sec)	Min Daily Discharge (m^3/sec)	Min Water Level (m)	Mean Annual Runoff (MCM)
21.20	1.80	21.20	0.56	0.20	0.10	368

Monthly Discharge

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	0.56	0.62	0.55	0.53	0.63	1.07	0.68	0.56	0.65	0.58	0.73	0.63
Max	0.92	1.18	1.04	0.74	1.05	2.39	1.18	0.74	1.02	0.71	0.96	0.94
Min	0.44	0.35	0.21	0.38	0.44	0.47	0.49	0.38	0.38	0.49	0.51	0.34

Padada River

Location : Lapulabao, Hagonoy, Davao del Sur
Drainage Area : 821 km^2
Period : Sep 1959 - May 1978
Gauging Elev : 21.608 m

Annual Characteristics

Peak Discharge (m^3/sec)	Max Water Level (m)	Max Daily Discharge (m^3/sec)	Mean Daily Discharge (m^3/sec)	Min Daily Discharge (m^3/sec)	Min Water Level (m)	Mean Annual Runoff (MCM)
88.30	2.60	77.31	17.82	1.95	0.11	2,252

Monthly Discharge

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	17.4	16.9	15.3	16.0	18.7	21.8	22.2	24.2	26.7	21.7	21.5	19.8
Max	27.4	38.4	26.1	24.3	29.3	38.4	35.0	36.2	34.3	35.5	38.9	28.1
Min	5.1	3.1	2.9	4.9	6.2	11.0	12.7	12.4	20.2	14.5	10.2	9.3

Monkayo(Upper Agusan) River

Location : Kalaw Brodge, Monkayo, Davao Prov.
Drainage Area : 1313 km^2
Period : 1958 - 1971
Gauging Elev

Annual Characteristics

Peak Discharge (m^3/sec)	Max Water Level (m)	Max Daily Discharge (m^3/sec)	Mean Daily Discharge (m^3/sec)	Min Daily Discharge (m^3/sec)	Min Water Level (m)	Mean Annual Runoff (MCM)
N.A	N.A	N.A	N.A	N.A	N.A	581

Monthly Discharge

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean	206.5	239.3	97.3	48.9	47.5	56.3	56.3	51.1	47.5	53.4	54.4	50.2
Max	477.5	546.7	176.1	83.5	64.0	67.8	67.8	65.6	62.0	111.7	97.3	72.4
Min	59.7	44.4	33.7	16.9	29.7	38.8	38.8	33.9	34.5	27.6	28.7	37.3

Data : National Water Resources Board (NWRB)

Table 5 Well Data Summary in the DIDP Area

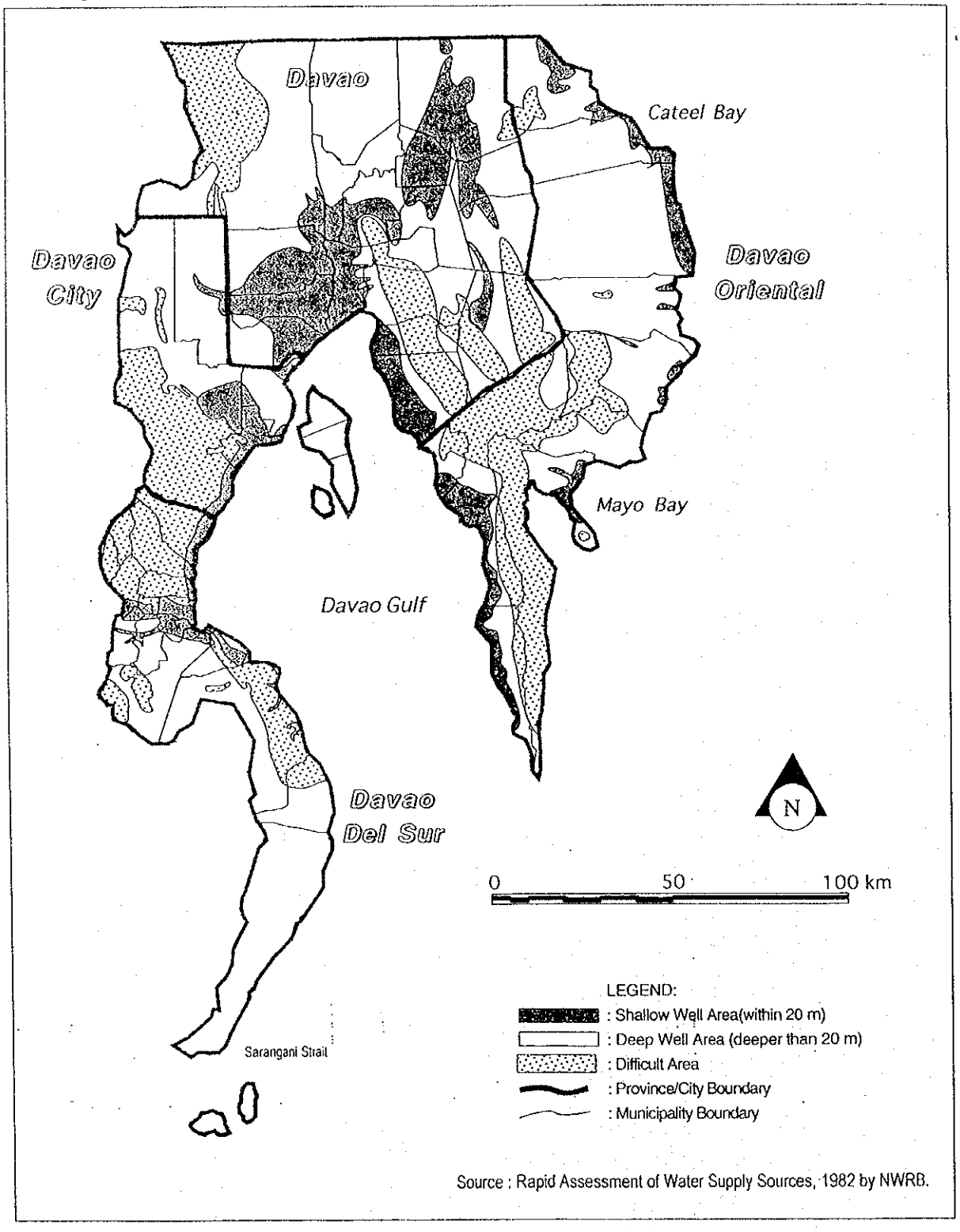
Province/Municipality	Number of Well	Average Specific Capacity (lit/sec.m)	Average Well Depth (m)	Average Static Water Level (mbgs)
1. Davao Oriental				
Baganga	10	1.4	10.2	5.6
Caraga	9	0.6	23.9	6.7
Cateel	4	1.2	9.6	3.4
Gov. Generoso	17	0.5	12.3	1.9
Lupon	21	0.6	42.0	3.3
Manay	7	1.1	21.5	10.6
Mati	15	0.8	18.7	10.1
Mampising	2	1.7	95.0	11.3
2. Davao Province				
Asuncion	2	1.3	43.5	17.4
Babak	29	0.7	42.5	29.0
Bunawan	1		41.1	41.2
Compostela	8	0.5	17.8	3.9
Kapalong	9	0.5	25.9	9.6
Mabini	9	0.9	18.8	3.5
Maco	2	0.1	15.6	1.8
Monkayo	12	0.5	15.0	4.7
Nabunturan	6	0.4	18.3	2.2
New Corella	1	0.0	25.6	0.9
Panabo	35	0.6	17.3	4.1
Pantukan	39	0.8	21.0	3.3
Samal	32	0.7	55.9	37.7
Sto. Tomas	3	0.8	47.9	1.6
Tagum	21	0.9	33.7	3.0
Saug	11	0.3	24.2	2.6
Doña Alicia	1	0.0	79.6	0.6
3. Davao City	189	1.0	49.7	24.7
4. Davao del Sur				
Bansalan	29	1.1	35.5	21.9
Digos	16	0.7	46.3	29.3
Hagonoy	14	1.4	24.0	9.0
Jose Abad Santos	12	1.3	15.2	6.9
Malita	59	0.9	19.2	9.1
Malalag	35	0.7	21.5	5.7
Matanao	9	1.0	40.9	27.6
Padada	15	2.2	32.4	3.7
Sta. Cruz	14	1.8	26.6	13.2
Sulop	8	0.7	32.1	16.0

Note : Mbgs: Meter below ground surface
Source: Compiled based on "Rapid Assessment of Water Supply Sources" by National Water Resources Council, 1982

Shallow well areas generally consist of recent formations with slopes ranging from 0 to 3%. Most of these areas are located at elevation within 50 m above the mean sea level, like alluvial and coastal plains and river valleys. Since shallow wells areas may also have deep water aquifers, the development of shallow wells, particularly for Level I and

Level II services, generally deserves higher priority for economic reasons. Although shallow wells can easily be made safe from bacteriological contamination, they may not be resistant to the effects of fertilizers and pesticides, particularly those that are constructed near rice fields.

Figure 4 Groundwater Map in the DIDP Area



Deep well areas are generally sedimentary formations, 90% volume of which are water carriers. These are usually located in slopes reaching up to 10%, typically at elevations of more than 50 m above the mean sea level. Construction of wells with depths greater than 20 m is generally characteristic of deep well areas. The chances of shallow wells are slim since the aquifers or water-bearing formations are generally found deeper than 20 m.

Sedimentary rocks of diverse geologic ages are included under this category. The water from deep wells are, in general, of good quality. Care must be exercised, however, in limestone formations where calcium carbonates are the major constituents. These aquifers are generally susceptible to pollution caused by human activities and other natural factors.

Difficult areas have varying slopes, elevations and water depths. The water supply sources are mainly replenished by way of sheared rocks, i.e. through fissures, cracks and crevices. The basic grains of the geologic formations in this category are so arranged and sized that only a negligible amount of water can move, meaning their primary permeability are near zero or they are practically impermeable. This also accounts for the high probability of non-productive boreholes. In difficult areas, the probability of occurrence are 50% for deep wells, 25% for shallow wells and 25% for non-productive boreholes.

Springs are generally found in the difficult areas. Although the yields from springs are minimal, they may be the only viable source in the difficult areas.

(4) Water quality and sediments

Table 6 shows the results of chemical analysis for surface water samples at representative locations, indicating that water in the DIDP Area is generally suitable for both agricultural use and domestic use. Relatively high values of TSS (total suspended solids) implicates that the basin areas are always suffering from severe soil erosion, causing heavy silting. Lower concentration of ionic components as shown in the table may be one of the causes for severe soil erosion.

It is reported in the DIDP Area that, in general, locations of 6 km or more away from the river mouth are classified safe in water quality for agricultural use, while salinity intrusions into surface water are detected even in the areas 15 km away from the river estuary. For example, the Bingcungan and Tungay rivers in Davao Province have exhibited higher salinity concentration even at a distance of 10 to 15 km away from the river mouth.

As for the pollution in surface and groundwater by domestic wastes, industrial wastes and pesticides used in agriculture, sufficient reliable monitoring data have been not available yet. A specific pollution problem by leachate from dumping site for groundwater, however, has already been identified in Davao Province.

Table 6 Chemical Analysis of Representative Surface Water

Province/City River/Location	pH	TSS (mg/l)	Cation (mg/l) Na+	K+	Ca++	Mg++	Anion (mg/l) CO_3^-	HCO_3^-	SO_4^-	Cl^-
1. Davao City										
Davao (Calinan)	7.0	273	12	11	4.0	16		101	98	18
Lasang (Paquibato)	7.6	500	4.0	4.0	6.0	38	42	113	30	10
Talomo (Talomo)	7.6	240	4.0	4.0	2.0	10	24	82	2.4	6.7
Suwawan Spring (Baquio)	7.6	1,000	42	42	9.0	40	20	356	38	12
Bicayan Spring (Marilog)	7.5	1,100	10	10	28	4.0		403	139	9.2
2. Davao Province										
Lasang (Lasang)	7.7	505	0.8	0.1	0.6	2.3	0.6	12	0.4	0.4
Tuganay (Sto. Tomas)	7.7	350	0.2	2.0	0.7	0.1	2.2	1.2	0.2	0.3
Libuganon (Kapalong)	7.6	270	0.7	0.0	0.2	3.0	0.3	1.3	0.1	0.2
Agusan (Monkayo)	7.4	435	1.0	0.1	1.3	1.6	0.6	0.8	0.6	0.7
Tagum (Carmen)	7.0	353	0.7	0.1	0.3	1.5	0.7	1.8		0.3
Hijo (Tagum)	7.6	810	1.3	0.2	1.8	0.8	1.0	2.0	3.8	1.1
3. Davao Oriental										
Sumlog (Lebesty, Tampakan)	6.8	203	10.2	1.5	4.5	8.4	7.5	75	2.3	8.9
Cateel (Cateel)	6.3	203	2.8		23	2.5	9.1	81	1.4	7.1
Mani (Kakubi, Marbel)	6.4	186	4.3		10	3.2	9.0	75	1.4	7.1

Source : "Land Use Assessment for Potential Agri-Environmental Development and Investment for Region XI", Department of Agriculture, 1989.

2.2. Water Use and Facilities

(1) Existing water utilization

In the Philippines, water utilization, whether either groundwater or surface water, mandate to be registered by the National Water Resources Board (NWRB), before utilization of water. NWRB has set up the standard criteria of water usage as the condition of grant as summarized in Table 7.

The water utilization is categorized into domestic, commercial, industrial, irrigation, power generation, livestock, recreation and fisheries. Present water consumption in the DIDP Area was surveyed based on the registration record of water grants by NWRB. The total water use at present has been estimated at some 4,700 million m^3 annually including hydropower generation use, as shown in Table 8.

Table 7 Standard Criteria of Water Right Grant

Type of Water Usage	Standard Criteria for Water Right Grant
Domestic	0.0029 lit/sec per planned population served (capita)
Commercial	based on the application; lit/sec to be approved by WD
Industrial	based on the application; lit/sec to be approved by DENR
Irrigation	1.5 lit /sec planned irrigation area (ha)
Livestock	0.00024 lit/sec per planned head
Recreation	0.6 lit/sec per planned area (ha); golf course
Fishery	0.9259 lit/sec per planned water surface (ha)
Hydropower	based on the application; lit/sec to be approved by NPC
Source : NWRB	

Of the total annual water resources potential of 30,000 million m^3 (both surface water and groundwater) estimated in the subsequent section, approximately 8% is utilized for various human activities in the DIDP Area, excluding uses for hydropower generation. Among water use purposes, irrigation water is the largest user accounting for 90%. The types of water sources are categorized into "surface water" and "groundwater". As a

water source of respective water utilization, major part of irrigation system and domestic system are relying on surface water and groundwater, respectively.

(2) Water resources and flood control

In the Philippines, the aim of flood control works at first was to protect agricultural lands from floods. It has been reported through surveys conducted by DPWH that additional construction for mitigation measures are called for and a majority of the existing drainage systems, riparian works, dikes and protection works require intensive restoration or improvement. The DIDP Area is characterized as a flood-prone area with the occurrence of habitual flood-related calamities, as shown in Table 9.

Generally, a sharp land slope, heavy silting of river beds and enlargement of run-offs caused by deforestation contribute to the outbreak of flash floods in case of heavy rains in the DIDP Area. The flood-prone areas are distributed widely in the entire DIDP Area as shown in Figure 5.

Davao Oriental: has four large rivers in District I, namely, the Casauman river in Manay, the Manurigo river in Cararago, the Cabasagan river in Boston and the Cateel river which were installed with revetment in the selected portions where erosion is likely to occur. Also, the Bitaugan river in San Isidro was re-channeled for an easy flow of water during flash floods. The rest of these rivers are still remaining under natural waterway, causing habitual floods almost every year.

Davao Province: occupies the flood plain of the Libuganon river. Its 13,000 ha basin has been widely flooded every year, particularly during the period from December to February.

While a dike of 20 km in length was constructed as a component of the irrigation project, no other major flood control works had been furnished. Thus, the targeted improvement on agricultural production is still not attained due to frequent flooding in the area.

In the upper Agusan river basin of Davao Province, the Compostela Valley, with an estimated maximum flood-prone area of 20,000 ha has been affected by serious floods every year. The river channels of the upper Agusan basin heavily silted due to excessive sediment run-off are further degraded by the gold mining activities in the watershed of the Compostela Valley. The latest was the flood during January, 1997 that affected 21,000 people in 64 barangays forced to be isolated for several days due to traffic interruption.

Davao City: covers an area of 2,400 km^2 but the urban area is limited only in the narrow coastal plain along the Davao Gulf. The City is now undergoing a rapid urban development and its population has increased at high rates. The urban development in the low-lying coastal plains have generated flood problems. Therefore, most of existing flood control facilities are located along the banks of major river systems of Davao City such as the Davao, Talomo, Matina and Lasang rivers.

Table 8 Present Water Right Registration

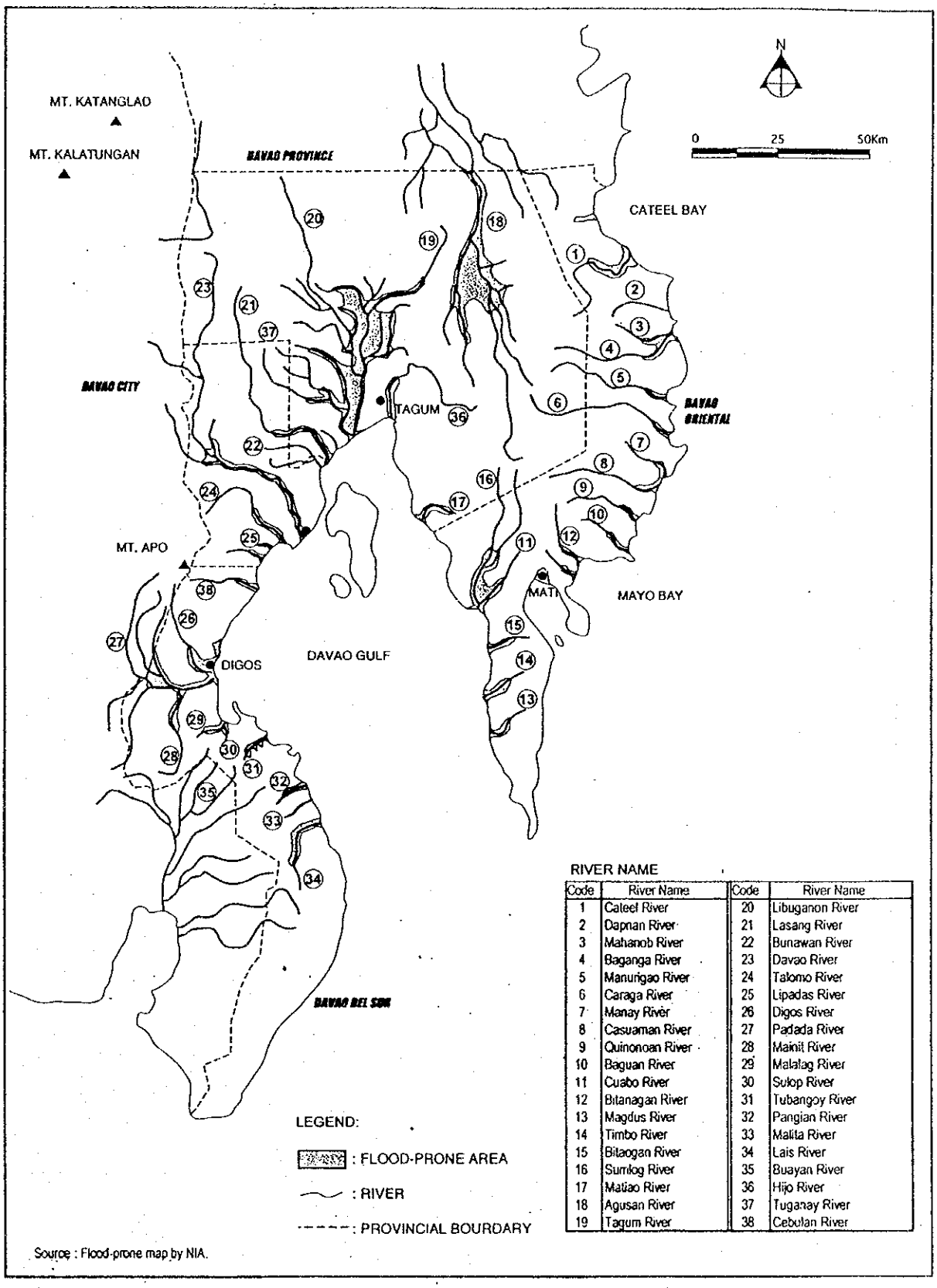
(Unit : million m³/year)

Province / Purpose	Grant number	Surface Water (MCM)	Ground Water (MCM)	Total (MCM)
Davao Oriental				
Irrigation	27	242.5	2.1	244.5
Domestic	2	0	0.40	0.40
Industry	2	0.11	0	0.11
Fishery	0	0	0	-
Livestock	0	0	0	-
Hydropower	0	0	0	-
Total	31	242.6	2.5	245.0
Davao Province				
Irrigation	167	1,482.3	5.5	1,487.9
Domestic	31	24.2	9.3	33.5
Industry	10	69.9	0.26	70.1
Fishery	4	0.74	0	0.74
Livestock	0	0.0	0	-
Hydropower	5	1,577.1	0	1,577.1
Total	217	3,154.2	15.1	3,169.3
Davao City				
Irrigation	14	23.5	0.25	23.8
Domestic	58	12.6	46.9	59.5
Industry	3	0	0.59	0.6
Fishery	4	3.93	0.08	4.0
Livestock	11	0	0.15	0.15
Hydropower	4	599.2	0	599.2
Total	94	639.2	48.0	687.2
Davao del Sur				
Irrigation	92	569.1	4.74	573.8
Domestic	9	0.01	2.63	2.64
Industry	7	0	5.17	5.17
Fishery	11	18.2	7.17	25.3
Livestock	0	0	0	0
Hydropower	1	0.25	0	0.25
Total	120	587.5	19.7	607.2
DIDP Total				
Irrigation	300	2,317.4	12.6	2,329.9
Domestic	100	36.8	59.3	96.0
Industry	22	70.0	6.02	76.0
Fishery	19	22.8	7.25	30.1
Livestock	11	0.0	0.15	0.15
Hydropower	10	2,176.5	0	2,176.5
Total	462	4,623.5	85.3	4,708.7

Source : The table was compiled based on the water right registration by National Water Resources Board (NWRB) as of 1997.

The flood in January, 1997 lasted for nearly a month affecting 6,100 people, of which about 3,000 evacuated their homes. It is expected that the flood problem will aggravate in the future, as it keeps pace with the progress of urban development. Given that changes in river course causes new erosion areas along the river system, the existing extent of shore protection is still far from ideal in Davao City. Some dikes have been erected along seashores facing the Davao Gulf to protect from flood and monsoon waves. Some of these areas are the Magsaysay Park, Bucana settlement and some parts of Daliao, Toril.

Figure 5 Flood-Prone Areas in the DIDP Area



RIVER NAME

Code	River Name	Code	River Name
1	Cateel River	20	Libuganon River
2	Dapnan River	21	Lasang River
3	Mahanob River	22	Bunawan River
4	Baganga River	23	Davao River
5	Manurigao River	24	Talomo River
6	Caraga River	25	Lipadas River
7	Manay River	26	Digos River
8	Casuaman River	27	Padada River
9	Quinonoan River	28	Mainit River
10	Baguan River	29	Malalag River
11	Cuabo River	30	Sulop River
12	Bitanagan River	31	Tubangoy River
13	Magdus River	32	Pangian River
14	Timbo River	33	Malita River
15	Bitaogan River	34	Lais River
16	Sumlog River	35	Buayan River
17	Matiao River	36	Hijo River
18	Agusan River	37	Tuganay River
19	Tagum River	38	Cebotan River

Table 9 Flood Damage Records in the DIDP Area (1/2)

No.	Period		Affected Area	Number of Affected			Casualty	Damaged House Number		Damage Cost(1000P)			Remark
	Year	Date		Barangay	Family	Dependent	Dead	Totally	Partially	Infrastructure	Agriculture	Private Property	
1	1995	Jan 16 - 22	Davao Province: Kapalong, Tagum, Sto. Tomas, Asuncion, Carmen, Monkayo, Montevista, Nabunturan, Mawab, Maco, New Corella, Panabo, Talaingod, Laak, New Bataan	142	15,726	61,898	4	13		11,055	44,140		
2	1995	Jan 16 - 22	Davao Oriental: Baganga, Cateel, Gov. Generoso, Manay, Tarragona, Boston, San Isidro, Caraga, Banaybanay		1,060	5,894	1	6		62,736	6,114	50	
3	1995	Feb 7 - 8	Davao Province: Tagum, Asuncion, Kapalong, Maco, Compostela, New Bataan, Monkayo, Nabunturan, Montevista, Sto. Tomas, Panabo, Pantukan, Laak, New Corella	156	16,960	67,153	4	13	2	45,680	44,250		
4	1995	Feb 7 - 8	Davao Oriental: San Isidro, Caraga, Boston, Banaybanay, Manay, Tarragona, Gov. Genroso, Baganga, Cateel		1,777	10,272		9	12	27,454	5,544	278	
5	1995	Mar 16 - 18	Davao Province: Tagum, Monkayo, Montevista, Nabunturan, Compostela, Asuncion, Carmen	35	1,830	9,187	1						
6	1995	Mar 16 - 18	Davao Oriental: Tarragona, Caraga	20	120		1			160			
7	1995	Mar 19	Davao Province: Monkayo, Montevista, Nabunturan, Carmen, Asuncion, Tagum	41	4,800	19,200				6,850			
8	1995	Jun 25	Davao Province: New Corella										El Unido river overflowed
9	1995	Jul 9	Davao City:	4	317								
10	1995	Jul 15	Davao City:				5						
11	1995	Jul 16	Davao Oriental: San Isidro	5	231					695			
12	1995	Jul 29	Davao Oriental:							1,320			
13	1995	Oct 31	Davao Province:				3						Cabidianan river overflowed
14	1996	Jan 1 - 11	Davao Oriental: Carmen, Caraga		203	1,212			2		1,579		
15	1996	Jan 18	Davao Oriental: Cateel,	1									
16	1996	Jan 23	Davao Province: Carmen	4	1,594	5,564							
17	1996	Jan 15-Feb 26	Davao Oriental: Cateel, Manay, Tarragona	22	1,589	9,416	1	82	46		8,399		

Table 9 Flood Damage Records in the DIDP Area (2/2)

No.	Period		Affected Area	Number of Affected			Casualty Dead	Damaged House Number		Damage Cost(1000P)			Remark
	Year	Date		Barangay	Family	Dependent		Totally	Partially	Infrastructure	Agriculture	Private Property	
18	1996	Feb 6	Davao Province: Montevista, Nabunturan, Carmen	16	2,634	14,540							
19	1996	Apr 25	Davao City:	15	1,200			2	6		100		Overflowe at
20	1996	Apr 25	Davao Province: Carmen, Panabo, Sto. Tomas	7	7,799	29,787				2,825	11,437		Lasang bridge
21	1996	Apr 25	Davao Oriental: San Isidro	14	540								
22	1996	Apr 28	Davao Province: Tagum, Sto Tomas, Asuncion										Libganon river overflowed
23	1996	June	Davao Oriental: Gov. Generoso	1	51				1	79,450			
24	1996	Aug 18	Davao Oriental: Pantukan		8				9				
25	1996	Oct 23	Dava del Sur:										
26	1997	Jan 12 - 16 Jan 30 - 31	Davao Province: Monkayo, Montevista, Nabunturan, Compostela, New Bataan, Carmen, Kapalong, Asuncion, Sto. Tomas, Mawab, Tagum, Maco, New Corella, Panabo, Maragusan	142	21,527	85,825	6	22	8	26,332	27,827		
27	1997	Jan 12 - 18 Jan 28 - Feb 6	Davao Oriental: Baganga, Cateel, Caraga, Boston, San Isidro, Tarragona, Manay	71	6,310	37,864	1			36,580	8,892		
28	1997	Jan 28 -30	Davao City:	19	1,533	6,133	1			4,213	2,388		
29	1997	Mar 6 - 7	Davao Province: Sto. Tomas, New Corella, Asuncion, Nabunturan	7	2,010	8,040	3						
30	1997	Apr 24	Davao City: Talomo, Pirok, San Vicente, San Isidro, Alzate, Tahimik Avenue, Balusong, NHA Village Matina Pangi Matina Aplaya		500			33	42				
31	1997	Apr 24	Davao Province:							500			Tuganay river
32	1997	May 2	Davao Oriental: Gov. Generoso, San Isidro	16	1,896	11,376	3	16	36	10,538	6,219		
33	1997	July 9	Davao Del Sur: Jose Abad Santos	9	766	3,705							Flash flood
34	1997	Sept 20	Davao Oriental: Mati		13					50			
35	1997	Oct 28	Davao Province: Panabo		917	3,876							The dike of Tuganay river was collapsed.
36	1997	Oct 30	Davao Province: Sto. Tomas		482	2,400				1,833			

Source : Disaster Coordinating Council

Davao del Sur: has seven major river control works, three of which are constructed in the municipalities of Digos. These include the Digos-Aplaya River Control, the Tres de Mayo River Control and the Jumao-as River Control. Others are the Langan River Control in Coronon, Sta. Cruz, Bansalan River Control in Marbel, Bansalan, etc. The Digos river generates flash floods at times of successive rainy days and brings serious damage to the poblacion area of Digos and the national highway. The Padada, Cebulan and Sta. Cruz rivers also cause frequent flash floods during heavy downpours. Denudation of the forest in the upstream highland is regarded as a major cause for flash floods of these rivers.

(3) Water supply

In the Philippines, water supply systems are defined as the following three categories, depending on the service level and system components as shown in Table 10.

Table 10 Components of Water Supply System in the Philippines

Description	Level I (Point Source Facilities)	Level II (Communal Faucet System)	Level III (Individual House Connection)
1. Water Source	Drilled/driven shallow well Drilled/driven deep well Dug well Spring Rain collector	Drilled shallow/deep well Spring Infiltration gallery	Drilled deep well Spring Infiltration gallery Surface water intake
2. Water Treatment	Generally none. Disinfection of wells is conducted periodically by local health authorities. Iron removal facilities are provided in problem areas.	Generally none. Disinfection facilities are sometimes provided.	Disinfection is practiced. System with a surface water source have a series of water treatment facilities.
3. Distribution	None.	Piped system provided with reservoir(s).	Piped system provided with reservoir(s) and pumping facilities.
4. Delivery and Service Level	At point (within 250 m radius)	Communal faucet (within 25 m radius)	Individual house connection / household tap
5. Consumption Rate (adequately served)	at least 20 lpcd	at least 60 lpcd	at least 100 lpcd

Level I system: Level I facilities (point source) are common in rural barangays, majority of which are owned privately. DILG and DPWH also have Level I systems which cover not only parts of rural areas but also the urban areas not being serviced by Level III systems. Major facilities are different types of wells equipped with handpumps or developed springs with transmission line and one communal faucet. A rain collector is also used in some area.

Moreover, Department of Health (DOH) has classified Level I system, depending on the water source, as safe (reliable water source) or unsafe sources/facilities under drinking water quality standard as follows:

Safe source: Protected deep well, protected shallow well, improved/covered dug well and developed spring, and

Unsafe source: Unprotected deep well, unprotected shallow well, open dug well, undeveloped/unprotected spring and rain collector.

Water sources other than the above, such as untreated surface water of rivers, lakes and ponds are among unsafe sources. Level II and Level III water supply systems are, on the other hand, regarded to have safe/reliable sources in a provision of adequate treatment.

Level II system: Level II (communal faucet) systems are designed to cater for barangay level water supply with limited service coverage and supply capacity. These systems have been implemented by different agencies (DPWH, LWUA, DILG, DENR and LGUs) encouraging the use of spring sources and are operated by LGUs, RWSAs or NGOs.

Level III system: Level III (individual house connection) system at municipal level are usually established and operated by WD under technical and financial assistance of LWUA. Some LGUs also implement and operate Level III systems, commonly at barangay level.

In the DIDP Area, as shown in Table 11, nearly 61% of people are provided with safe water services and the remaining some 39% of people forced to unreliable water not protected from contamination by using: unprotected wells and springs, rainwater pond and stream, etc. Of population serviced by safe water, only 43% people are equipped with Level III system and the remaining 57% of people are still depending on Level I or Level II system. Service coverage by city/province varies widely from some 90% in Davao City to some 37% in Davao Oriental as shown in Figure 6.

Almost all of water systems are relying on groundwater including spring water as water sources at present, but the WD in Davao City is examining surface water use in order to cope with the water demand growth and the likely groundwater shortage in the future.

The current unit consumption rate is still remaining at 100 lit/capita day at the highest. The water loss in Level III system from distribution pipes, taking Davao City Water Districts for example, is reportedly as high as 30 - 40%, likely being caused by insufficient maintenance of the system.

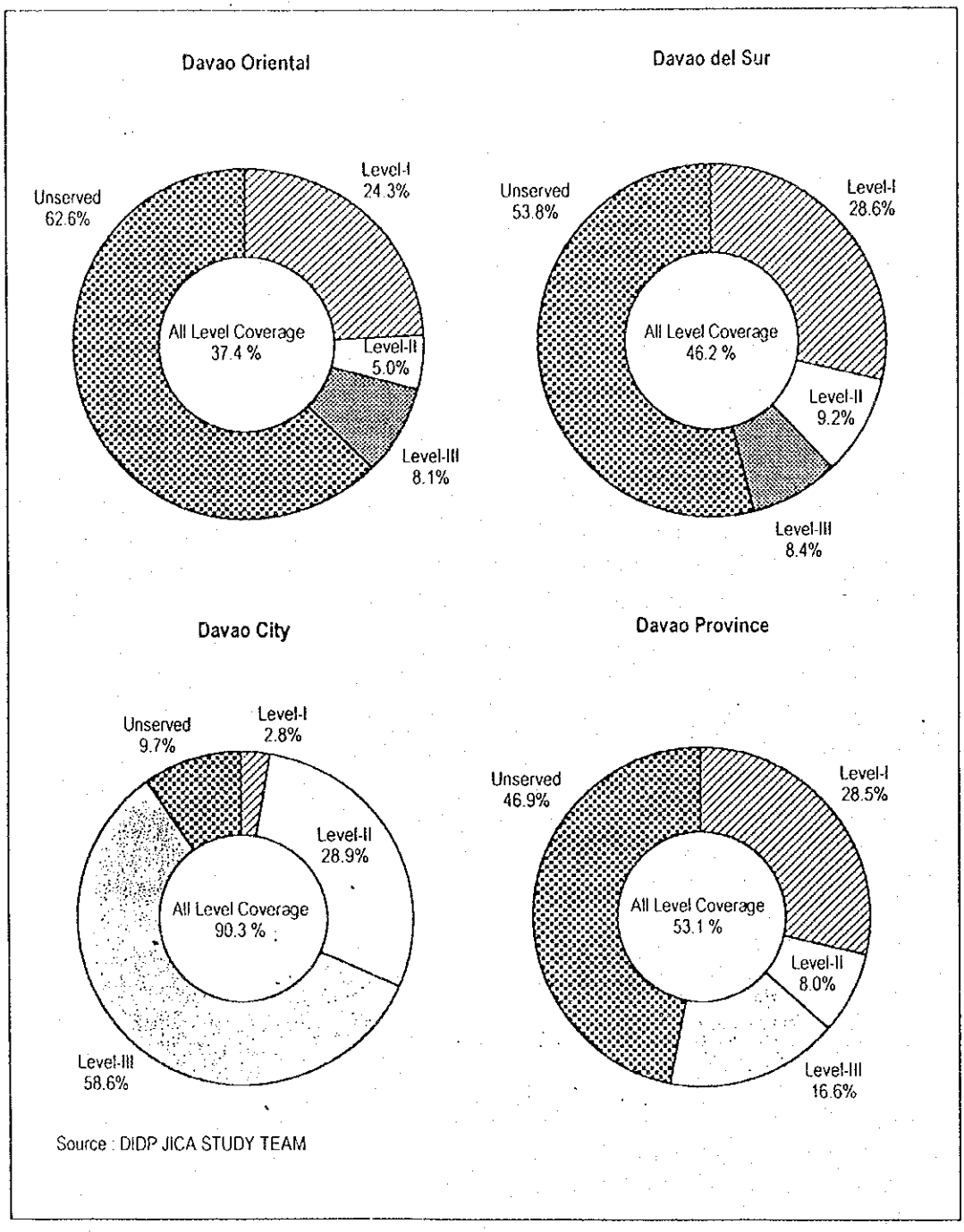
(4) Sewerage

Sewerage facilities are defined as facilities that collect human wastes and sullage from residences and establishments and convey wastewater in structures for eventual treatment and safe disposal. Thus, sewerage includes a collection system (street laterals), conveyance system (trunk sewers and pump stations), and a treatment plant/disposal.

At present, there exist no sewerage facilities with a treatment plant in the DIDP Area. Existing ones are quite limited extent of pipes or open ditches for storm water drainage. Accordingly, domestic wastewater goes to septic tanks or directly to storm drains, canals, rivers and other natural disposal areas without treatment. Households in the DIDP Area are relying on a variety type of on-site excreta disposal such as septic tanks, closed pits, and other depositories. At present, there is no available information to assess water quality. Urban areas, particularly densely populated zones in Davao City are feared that the surface water and groundwater pollution be likely caused by the direct outflow of wastewater to water courses and underground.

Apart from the sewerage system, the development of sanitary toilets for human excreta disposal is being enforced as a measure for sanitation improvement in both urban and rural areas of the DIDP Area.

Figure 6 Existing Safe Water Service Coverage by City/Province



Source : DIDP JICA STUDY TEAM

Table 11 Existing Water Supply Coverage by Municipality

Province Municipality/District	Surveyed Population	Served Population Number (capita)			Served Population Share (%)				Unserved Population
		Level-I	Level-II	Level-III	Level-I	Level-II	Level-III	All Levels	Share (%)
Davao Oriental									
Baganga	39,750	7,115	994	6,837	17.9	2.5	17.2	37.6	62.4
Boston	3,389	870	500	-	25.7	14.8	0.0	40.4	59.6
Cateel	27,211	5,279	1,197	2,803	19.4	4.4	10.3	34.1	65.9
Caraga	31,617	4,327	1,428	3,430	13.7	4.5	10.8	29.1	70.9
Manay	31,836	3,559	393	-	11.2	1.2	0.0	12.4	87.6
Tarragona	19,779	8,955	560	46	45.3	2.8	0.2	48.3	51.7
Mati	44,552	1,566	2,011	7,711	3.5	4.5	17.3	25.3	74.7
Banaybanay	36,171	22,511	3,734	1,085	62.2	10.3	3.0	75.6	24.4
Lupon	33,800	7,769	401	926	23.0	1.2	2.7	26.9	73.1
Gov. Generoso	27,053	10,926	3,598	779	40.4	13.3	2.9	56.6	43.4
San Isidro	17,849	3,212	847	1,759	18.0	4.7	9.9	32.6	67.4
Total	313,007	76,089	15,662	25,377	24.3	5.0	8.1	37.4	62.6
Davao Province									
Maragusan	31,728	7,256	8,056	2,664	22.9	25.4	8.4	56.7	43.3
Talaingod	10,796	4,144	2,642	308	38.4	24.5	2.9	65.7	34.3
Tagum	78,960	15,892	805	17,521	20.1	1.0	22.2	43.3	56.7
Pantukan	60,422	16,311	13,851	1,213	27.0	22.9	2.0	51.9	48.1
Kapalong	62,827	14,490	1,462	1,938	23.1	2.3	3.1	28.5	71.5
San Vicente	55,642	6,522	7,169	455	11.7	12.9	0.8	25.4	74.6
Asuncion	64,093	25,716	688	-	40.1	1.1	0.0	41.2	58.8
Nabunturan	22,962	9,602	849	8,651	41.8	3.7	37.7	83.2	16.8
Babak	28,014	15,308	3,201	523	54.6	11.4	1.9	67.9	32.1
Panabo	35,733	7,693	150	1,209	21.5	0.4	3.4	25.3	74.7
Compostela	58,639	38,639	1,843	557	65.9	3.1	1.0	70.0	30.0
New Corella	5,301	4,998	290	13	94.3	5.5	0.2	100.0	0.0
New Bataan	44,505	11,617	6,625	10,340	26.1	14.9	23.2	64.2	35.8
Carmen	52,796	10,532	1,725	1,102	19.9	3.3	2.1	25.3	74.7
Santo Tomas	72,802	26,452	3,410	12,192	36.3	4.7	16.7	57.8	42.2
Montevista	36,815	4,848	9,521	2,339	13.2	25.9	6.4	45.4	54.6
Samal	9,723	2,720	1,052	1,457	28.0	10.8	15.0	53.8	46.2
Maco	55,761	24,603	8,620	13,733	44.1	15.5	24.6	84.2	15.8
Kaputian	27,747	4,345	7,093	994	15.7	25.6	3.6	44.8	55.2
Monkayo	87,568	11,959	4,485	22	13.7	5.1	0.0	18.8	81.2
Mabini	30,340	11,830	4,673	3,553	39.0	15.4	11.7	66.1	33.9
Mawab	28,767	11,133	12,945	3,912	38.7	45.0	13.6	97.3	2.7
Total	961,941	275,476	88,210	80,785	28.6	9.2	8.4	46.2	53.8
Davao City									
Poblacion	79,015	-	-	70,267	0.0	0.0	88.9	88.9	11.1
Talomo	248,517	3,281	17,071	211,027	1.3	6.9	84.9	93.1	6.9
Agdao	93,723	-	-	89,210	0.0	0.0	95.2	95.2	4.8
Buhangin	172,582	11,299	47,529	99,858	6.5	27.5	57.9	91.9	8.1
Bunawan	84,550	144	43,944	22,318	0.2	52.0	26.4	78.5	21.5
Paquibato	33,851	2,165	29,989	-	6.4	88.6	0.0	95.0	5.0
Baguio	22,061	992	19,613	1,372	4.5	88.9	6.2	99.6	0.4
Marilog*	*	*	*	*	*	*	*	*	*
Calinan*	*	*	*	*	*	*	*	*	*
Toril	98,188	2,482	67,669	13,566	2.5	68.9	13.8	85.3	14.7
Tugbok	57,780	4,191	31,663	14,504	7.3	54.8	25.1	87.2	12.8
Total	890,267	24,555	257,477	522,122	2.8	28.9	58.6	90.3	9.7
Davao del Sur									
Bansalan	34,236	5,277	3,132	11,573	15.4	9.1	33.8	58.4	41.6
Digos	106,565	24,297	15,345	37,937	22.8	14.4	35.6	72.8	27.2
Don Marcelino	31,515	8,134	56	188	25.8	0.2	0.6	26.6	73.4
Hagonoy*	41,752	1,002	1,253	30,228	2.4	3.0	72.4	77.8	22.2
Jose Abad Santos	50,071	9,581	1,034	-	19.1	2.1	0.0	21.2	78.8
Kiblawan	38,494	22,946	1,522	-	59.6	4.0	0.0	63.6	36.4
Magsaysay	43,542	9,139	2,128	1,481	21.0	4.9	3.4	29.3	70.7
Malalag	32,139	14,058	1,545	1,766	43.7	4.8	5.5	54.0	46.0
Malita	84,630	27,968	10,294	7,747	33.0	12.2	9.2	54.4	45.6
Matanao	44,489	21,217	1,199	2,520	47.7	2.7	5.7	56.0	44.0
Padada	22,384	2,059	940	11,931	9.2	4.2	53.3	66.7	33.3
Sta. Cruz	61,838	17,945	11,048	2,394	29.0	17.9	3.9	50.8	49.2
Sta. Maria	43,023	22,350	568	-	51.9	1.3	0.0	53.3	46.7
Sarangani	16,648	-	4,012	3,812	0	24.1	22.9	47.0	53.0
Sulop	26,695	7,093	-	1,195	26.6	0.0	4.5	31.0	69.0
Total	678,021	193,066	54,075	112,774	28.5	8.0	16.6	53.1	46.9
DIDP Total	**2,843,236**	**569,186**	**415,424**	**741,057**	**20.0**	**14.6**	**26.1**	**60.7**	**39.3**

Source : Compiled based on National Economic and Development Authority, November 1997, with some modification.
Note : The lines marked by "*" stand for no available data.