PART-II

MASTER PLAN STUDY

CHAPTER 1 STUDY AREA

1.1 Socio-Economy

1.1.1 Administrative Frame

GOI embarked on major decentralization initiatives in January 2001 that feature 1) decentralization (*desentralisasi*) rather than de-concentration (*dekonsentrasi)*, 2) the horizontal relationship between province and districts, where province is responsible for inter-district matters and overall coordination, and 3) the increasing role of the regional legislatures. A number of laws and regulations including the Law No.22/1999 on Regional Administration (amended by the Law No.32/2004) and the Law No.25/1999 on Fiscal Balance between the Center and the Regional Administration (amended by the Law No.33/2004) have been enacted to implement these and other aspects of decentralization.

The regional autonomy under the new arrangement covers a broad range of fields except for foreign policy, defense and security, judiciary, monetary and fiscal policy, religions, and "other matters"*[1] that are under the purview of the central government. The governor of province is a representative of the central government and is responsible for de-concentrated functions of the central government and for providing supervision and guidance to district/city. In addition, the provincial government has authority in the filed of administration which crosses district/city boundaries and the authority "in other specified fields of administration."*[2] However, as province is no longer superior to district/city and as the roles and responsibilities of province vis-à-vis those of district/city are not very clearly defined, the guidance and coordination functions of province have not been very effective in many cases.*[3]

Bali Province includes eight regencies (*Kabupaten*) and one city (*Kotamadia*), and each regency/city has three (3) to ten (10) districts (*Kecamatan*). See Table-II-1.1 and Figure-II-1.1.

Local governments are now given considerably larger fiscal resources to draw upon and greater authority over the use of the resources. By the end of 2002, local revenue and expenditure were more than three times of the pre-decentralization level. Total sub-national expenditure now makes up a little less than one-third of total government spending. But sub-national own-source revenue (*PAD*) is only about 7% of the total government revenue.*[4] The rest are funded by the central government as transfers. The transfer is comprised of revenue sharing fund (*DBH*), general allocation fund (*DAU*), and special allocation fund (*DAK*). Each fund relies on different sources of revenue. *DAU* is by far the largest allocation by the central government and is a fiscal pillar of the regional autonomy.

A local government budget is referred to as *APBD*, which is jointly approved by the regional administration and *DPRD*. The *APBD* of district/city has two components: *APBD I* (the transfer from the province) and *APBD II* (the own budget). The budget of the central government is *APBN*. It must be noted that *APBN* finances capital development projects implemented at provincial and district/city levels. As it will be explained later, a majority of civil servants of the regional governments, especially in the arena of public works, are engaged in these centrally funded projects.

*[1] "Other matters" are listed as "macro-planning, fiscal equalization, public administration, economic institutions, human resources development, natural resources utilization, strategic technologies, conservation, and national standardization" (Article 7 of the Law No.22/1999).

*[2] Article 9 of the Law No.22/1999

*[3] The Law No.32/2004 intends to strengthen the role of province and lists the responsibilities of province (Article 13) as well as those of district/city (Article 14), but the ambiguity in the original law is basically left intact. It is expected that case-by-case approaches based on the capacities of the respective levels of local government will be pursued in different regions and sectors until clearer arrangements emerge.

*[4] Blane D. Lewis, World Bank, "Indonesian Local Government Spending, Taxing and Saving: An Explanation of Pre and Post-Decentralization Fiscal Outcomes" (October 2004).

Table-II-1.1 Regency/City and District in Bali Province

Code	Name	Area (km^2)	Code	Name	Area (km^2)
5101	Jembrana	841.80	5105	Klungkung	315.00
5101010	Melaya	229.62	5105010	Nusapenida	208.70
5101020	Negara	184.76	5105020	Banjarangkan	39.07
5101030	Mendoyo	294.53	5105030	Klungkung	30.51
5101040	Pekutatan	132.89	5105040	Dawan	36.72
5102	Tabanan	839.33	5106	Bangli	520.81
5102010	Selemadeg	56.54	5106010	Susut	49.11
5102011	Selemadeg Barat	107.56	5106020	Bangli	59.03
5102012	Selemadeg Timur	64.32	5106030	Tembuku	48.24
5102020	Kerambitan	46.59	5106040	Kintamani	364.43
5102030	Tabanan	42.88	5107	Karangasem	839.54
5102040	Kediri	54.85	5107010	Rendang	109.93
5102050	Marga	43.33	5107020	Sidemen	43.30
5102060	Baturiti	106.43	5107030	Manggis	76.73
5102070	Penebel	141.14	5107040	Karangasem	92.72
5102080	Pupuan	175.68	5107050	Abang	134.05
5103	Badung	418.52	5107060	Bebandem	82.23
5103010	Kuta Selatan	106.10	5107070	Selat	71.61
5103020	Kuta	21.09	5107080	Kubu	228.97
5103030	Kuta Utara	37.16	5108	Buleleng	1,365.88
5103040	Mengwi	87.41	5108010	Gerokgak	418.18
5103050	Abiansemal	71.25	5108020	Seririt	161.81
5103060	Petang	95.52	5108030	Busungbiu	109.58
5104	Gianyar	368.00	5108040	Banjar	119.78
5104010	Sukawati	53.79	5108050	Sukasada	187.31
5104020	Blahbatuh	38.48	5108060	Buleleng	53.40
5104030	Gianyar	50.90	5108070	Sawan	91.33
5104040	Tampaksiring	38.54	5108080	Kubutambahan	123.85
5104050	Ubud	43.61	5108090	Tejakula	100.63
5104060	Tegallalang	68.25	5171	Denpasar	123.98
5104070	Payangan	74.43	5171010	Denpasar Selatan	44.88
			5171020	Denpasar Timur	34.29
			5171030	Denpasar Barat	44.81
			Total (Bali Province)		5,632.86

Source: 1) Area of Regency -Bali in Figures 2003, BPS of Bali Province 2) Area of District - Study Team

Figure-II-1.1 Administrative Division of Bali Province

1.1.2 Population

Latest population census was carried out in 2000, which shows 3.1 million people or 1.5% of national population lived in Bali Province. See Table-II-1.2. Population growth rate during the period over the last decade was 1.3%. Population density of Bali Province was 559 persons/km^2. Buleleng, Denpasar and Gianyar are the largest populated regencies.

Table-II-1.2 Actual Population and the Growth

Regions	Census Population (1,000 prs.)				% in Bali	Growth Rate		Density (prs./km^2)
	1971	1980	1990	2000		80-90	90-00	
Indonesia	119,208	147,490	179,379	206,265	-	2.0%	1.4%	109
Bali Province	2,119	2,470	2,777	3,147	100%	1.2%	1.3%	559
1. Jembrana	171	205	218	232	7%	0.6%	0.6%	275
2. Tabanan	329	343	350	376	12%	0.2%	0.7%	448
3. Badung	230	243	275	346	11%	1.2%	2.3%	826
4. Gianyar	272	306	337	393	12%	1.0%	1.6%	1,068
5. Klungkung	138	149	150	155	5%	0.1%	0.3%	493
6. Bangli	138	162	176	194	6%	0.9%	0.9%	372
7. Karangasem	267	314	343	361	11%	0.9%	0.5%	429
8. Buleleng	403	487	540	558	18%	1.0%	0.3%	409
9. Denpasar	171	261	388	532	17%	4.1%	3.2%	4,295

Source: 1) Web side of BPS of Indonesia, and 2) Bali in Figures 2003, BPS of Bali Province

1.1.3 Gross Regional Domestic Product (GRDP)

Gross Regional Domestic Product (GRDP) of Bali Province was Rp.28.9trillion in 2004 as shown in Table-II-1.3 that accounts for 1.3% of the national Gross Domestic Product (GDP). The GRDP growth rate of 2004 achieved stably at 4.6% in spite of the bomb incident occurred in late 2002. The largest contributor to GRDP was tertiary sector at 64% supported by the trade, hotel and restaurant activities. GRDP per capita of Bali Province was US$920 in 2004 that presents 80% of Indonesia as shown in Table-II-1.4.

Table-II-1.3 GDP & GRDP at 2004 Constant Price

Unit: billion Rp.

Item		2001	2002	2003	2004	By Sector in 2004		
						Primary	Secondary	Tertiary
GDP and GRDP	Indonesia	2,001,252	2,088,818	2,190,664	2,303,031	24%	35%	41%
	Bali Prov.	25,917	26,750	27,704	28,984	21%	15%	64%
	% of Bali	1.3 %	1.3 %	1.3 %	1.3%	-	-	-
Growth Rate	Indonesia	3.5%	3.7%	4.1%	5.1%	0.5%	6.5%	7.0%
	Bali Prov.	3.4%	3.0%	3.6%	4.6%	3.7%	4.1%	5.1%

Note: Constant price is calculated by Study Team based on the data of statistical year book.
Source: 1) Indonesia; Statistical Year Book 2004, BPS of Indonesia, and 2) Bali; Bali in Figures 2004, BPS of Bali Province

Table-II-1.4 GDP & GRDP per Capita (Current Price)

Currency	Region	2001	2004	Annual Growth
Rupiah in million	Indonesia	8,080	10,641	9.6%
	Bali Province	6,369	8,531	10.2%
US$	Indonesia	780	1,150	13.8%
	Bali Province	610	920	14.5%
	% of Bali	79%	80 %	-

Source: 1) Statistical Year Book 2004, BPS of Indonesia, and 2) Bali in Figures 2004, BPS of Bali Province

1.1.4 Economic Sector Profile

(1) Agriculture

Agriculture is an important economic sector in Bali Province in terms of employment absorption (forty percent of labor force engage in agriculture sector). The features of agriculture products by regency are presented in Table-II-1.5.

Table-II-1.5 Agriculture Products by Regency in Bali

Items		Wetland Paddy	Maize	Cabbage	Tomato	Orange	Banana	Arabica Coffee
Year 1999 (ton)		850,350	108,572	55,750	42,504	46,964	51,812	5,394
Year 2003 (ton)		791,573	85,951	51,189	43,788	71,391	102,158	4,411
Share (%) in Bali Prov.	Jembrana	6%	2%	-	-	0.3%	24%	-
	Tabanan	26%	2%	68%	88%	1%	7%	3%
	Badung	15%	2%	1%	1%	25%	3%	6%
	Gianyar	21%	1%	0.2%	0.4%	0.5%	6%	4%
	Klungkung	4%	19%	-	1%	0.02%	2%	42%
	Bangli	3%	9%	24%	9%	65%	39%	6%
	Karangasem	7%	23%	-	1%	0.1%	0.1%	39%
	Buleleng	13%	43%	8%	0.1%	8%	18%	-
	9. Denpasar	4%	0.1%	-	-	0.02%	2%	-

Source: Bali in Figures 2003, BPS of Bali Province

(2) Manufacturing Industry

The leading manufacturing industries in Bali Province are characterized by 1) food and beverage, 2) textiles and leather, and 3) wood related as shown in Table-II-1.6. And most of the industries gather in Denpasar, Badung, Karangasem and Tabanan as shown in Table-II-1.7.

Table-II-1.6 Number of Establishments and Employees of Manufacturing Industry

Classification of Manufacturing Industry	1999		2003		Output in Year 2002 (million Rp.)	
	Establish-ment	Employee	Establish-ment	Employee	Total	/Employee
1. Food & Beverage	52	4,902	48	4,785	857,267	179.2
2. Textile & Leather	196	14,664	128	9,527	385,294	40.4
3. Wood & Furniture, Others	151	9,167	84	5,991	185,415	30.9
4. Publish & Printing	15	884	12	906	50,996	56.3
5. Rubber & Plastic	3	265	1	62	1,238	20.0
6. Other Non-Metallic	35	1,196	49	1,581	24,451	15.5
7. Fabricated Metal	15	1,574	11	827	14,139	17.1
Total	467	32,652	333	23,679	1,518,800	64.1

Source: Bali in Figures 2003, BPS of Bali Province

Table-II-1.7 Number of Establishments by Regency

Classification of Manufacturing Industry	Regency/City								
	JEM	TAB	BAD	GIA	KLU	BAN	KAR	BUL	DEN
1. Food & Beverage	9	6	3	3	1	0	4	1	21
2. Textile & Leather	2	11	34	14	10	0	4	0	53
3. Wood & Furniture, Others	3	10	10	42	0	4	3	0	12
4. Publish & Printing	0	0	1	0	0	0	0	1	10
5. Rubber & Plastic	1	0	0	0	0	0	0	0	0
6. Other Non-Metallic	2	3	1	1	1	0	37	3	1
7. Fabricated Metal	0	8	0	1	0	0	0	0	2
Total	17	38	49	61	12	4	48	5	99

Source: Bali in Figures 2003, BPS of Bali Province

(3) Tourism

Tourism is an important economic sector in Bali Province that largely depends on foreign tourists. Number of tourist arriving directly to Bali sharply dropped in 2003 due to the bomb incident occurred in late 2002. Although it is completely recovered in 2004 almost reaching 1.5 million and furthermore broke the record of 2000, the tourists decreased from October 2005 caused by bomb incident again as shown in Table-II-1.8.

Table-II-1.8 Foreign Visitors direct to Bali Province (1,000 persons)

Month	1999	2000	2001	2002	2003	2004	2005	Monthly Share
January	102	93	109	87	61	104	102	7%
February	105	104	99	96	67	84	101	7%
March	117	111	116	114	72	100	117	8%
April	104	110	117	105	54	111	116	8%
May	105	104	111	119	48	117	117	8%
June	120	122	129	131	81	132	136	9%
July	144	143	138	147	112	148	158	11%
August	146	144	145	161	116	156	157	11%
September	135	140	134	151	107	142	162	10%
October	104	130	97	81	97	128	81	8%
November	88	110	73	31	84	111	63	6%
December	86	102	89	63	94	125	n/a	7%
Total	1,356	1,413	1,357	1,286	993	**1,458**	1,310	100%

Source: Information of Bali Provincial Tourism Office

Number of hotels and rooms in Bali Province gather mostly in the two areas of Badung and Denpasar as shown in Table-II-1.9.

Table-II-1.9 Number of Hotels and Rooms in Bali Province

Classification of Hotel	2000		2004	
	No. of Hotel	No. of Room	No. of Hotel	No. of Room
Classified Hotel	117	17,933	143	19,812
Non-classified Hotel and other accommodations	920	14,011	1,146	16,420
Total	1,037	31,944	1,289	36,232

Source: Bali in Figures 2003, BPS of Bali Province

(4) External Trade

Foreign trade of Bali Province shows constant surplus being supported by export of fish and fruit related products. Meanwhile, domestic (inter-provincial) trade of Bali Province results in negative balance every year. See Table-II-1.10.

Table-II-1.10 Foreign Trade/Domestic Trade of Bali Province

Unit: million US$

Trade		2000	2001	2002	2003	2004
Foreign Trade	Export	278	250	242	228	237
	Import	28	23	35	51	29
	Balance	250	227	207	177	208
Inter-provincial Trade	From Bali	265	283	372	428	446
	To Bali	357	371	449	530	500
	Balance	-92	-89	-77	-102	-54

Source: Source: Bali in Figures 2003, BPS of Bali Province

(5) Inflation and Foreign Exchange Rate

Inflation rate of Denpasar is presented in Table-II-1.11. Although the inflation became stable in 2003 & 2004 for the first time after economic crises in 1997, it soared in 2005 caused by worldwide high energy prices.

Table-II-1.11 Inflation and Foreign Exchange Rate

Items	Area	2000	2001	2002	2003	2004	2005
Inflation	Indonesia (1)	9.35	12.55	10.03	5.06	6.40	17.11
	Denpasar	9.81	11.52	12.49	4.56	5.97	14.88(2)
Exchange Rate (3)	Rps./US$	9,595	10,400	8,940	8,465	9,290	9,830

Note: (1) Average rate of 43 cities, (2) yearly rate until October 2005, (3) Middle rate at the end of Year
Source: 1) Statistical Yearbook of Indonesia 2004, BPS of Indonesia, 2) Bali in Figures 2004, BPS of Bali Province, and 3) Web side of BPS Indonesia and Bali, and Central Bank

1.1.5 Infrastructure

(1) Electricity

At present, the operation of the electricity system in Bali Province is managed by the following five unit enterprises under National Electricity Limited Company (*PT. Perusahaan Listrik Negara/PLN*) that are: 1) PT. PLN-Distribusi Bali, 2) PT. PLN-P3B, 3) PT. Indonesia Power, 4) Rural Electricity Project, and 5) PT. PLN-Proyek Induk Jawa Bali Nusra. Five main electricity sources in Bali and the potential power generated by those sources and peak load demand in Bali are shown in Table-II-1.12.

The electricity consumption in 2003 was 1,672 GWh. The largest electricity consumption was households sector, followed by commercial, public, and industrial sectors. Basic tariff of the electricity in Bali is Rp.620.84/kWh.

Demand and supply capacity of electric power in Bali in the next 15 years are shown in Table-II-1.13. Crisis on the electricity supply in Bali is forecasted in 2006 looking at the total demand against the supply capacity.

Table-II-1.12 Present Electricity Sources and Supply Potential in Bali

Description	Unit	Production Capacity	Supply Potential
Total Potential Power	MW	-	516
a. Inside Bali	MW	452	316
- PLTD Gilimanuk (Diesel)	MW	50	(70% of Production)
- PLTG Gilimanuk (Gas)	MW	100	
- PLTD Pesanggrahan (Diesel)	MW	78	
- PLTG Pesanggrahan (Gas)	MW	128	
- PLTG Pemaron (Gas)	MW	96	
b. From Jawa	MW	-	200
- JAMALI Interconnected System	MW	-	200
Peak Load Demand	MW	450	

Source: 1) Revised Spatial Plan of Bali Province 2003 - 2010 (Revisi Rencana Tata Ruang Wilayah Propinsi Bali 2003 – 2010), and 2) Information from Indonesia Power at Denpasar

Table-II-1.13 Demand and Supply Capacity of Electric Power in Bali in 2004-2018

Unit: MW

Description	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Peak Load	369	414	461	511	564	619	678	739	796	855	916	979	1,046	1,115	1,188
Reserved Margin (30% of the above)	111	124	138	153	169	186	203	222	239	256	275	294	314	335	356
Total Demand (A)	480	538	600	665	733	805	881	961	1,035	1,111	1,190	1,273	1,360	1,450	1,544
Total Installed Capacity	636	676	686	786	941	996	1,051	1,051	1,201	1,351	1,351	1,501	1,501	1,651	1,801
Supply Capacity (B) (85% of the above)	541	575	583	668	800	847	893	893	1,021	1,148	1,148	1,276	1,276	1,403	1,531
New Installed Capacity in Total	80	40	10	100	155	55	55	0	150	150	0	150	0	150	150
- Bedugul Geothermal Plant	-	-	10	-	55	55	55	-	-	-	-	-	-	-	-
- Pemaron Gas Plant	80	40	-	-	-	-	-	-	-	-	-	-	-	-	-
- New Generator Plant	-	-	-	100	100	-	-	-	150	150	-	150	-	150	150
Surplus of Power (B-A)	61	37	-17	3	67	42	12	-68	-14	37	-42	3	-84	-47	-13

Source: General Planning on Regional Electricity in Bali, 2004 (Rencana Umum Ketenagalistrikan Daerah/RUKD, BAPPEDA-Propinsi Bali, 2004)

(2) Road

Total length of the roads in Bali Province reaches 6,600 km as shown in Table-II-1.14. A new artery road named “sunrise road” is now under the construction at the east coastal region that will be connected the road to Pedang Bali of Karangasem. On the other hand, a new collector road named “sunset set road” is also under the construction at the west coastal region.

Table-II-1.14 Length of Road by Status

Region	National Road	Provincial Road	Regency Road	Total	Share
Bali Province	406 km	847 km	5,391 km	6,644 km	100.0%
1. Jembrana	76	26	846	948	14.3%
2. Tabanan	67	119	860	1,047	15.7%
3. Badung	43	69	604	716	10.8%
4. Gianyar	27	104	558	689	10.4%
5. Klungkung	17	16	342	375	5.6%
6. Bangli	-	139	479	618	9.3%
7. Karangasem	6	208	410	624	9.4%
8. Buleleng	111	151	878	1,140	17.2%
9. Denpasar	59	14	414	487	7.3%

Source: Public Work Office of Bali Province

1.1.6 Labor Force and Minimum Wage

The labor force of Bali Province is shown in Table-II-1.15, which shows 40% of workers engaged in primary sector and tertiary sector. Unemployment rate of 2003 was 7.6% that shows a significant increase compared with 1.7% of 1999.

Table-II-1.15 Labor Force of Bali Province

Year	Regency	>age 10 years	Labor Force	Working	By Economic Sector (%)			Unemployment	
		1000 persons			Primary	Secondary	Tertiary	1000 persons	Rate (%)
1999	Total	2,517	1,766	1,703	(1) 32.9	(1) 22.8	(1) 44.3	63	1.7%
2003	1. Jembrana	204	136	122	38.8	19.7	41.5	15	10.9%
	2. Tabanan	340	243	225	47.0	21.6	31.4	17	7.1%
	3. Badung	336	225	206	26.6	21.8	51.6	20	8.9%
	4. Gianyar	352	236	217	25.1	39.9	35.0	19	8.0%
	5. Klungkung	142	102	97	53.8	12.1	34.1	5	4.9%
	6. Bangli	172	128	124	58.9	18.4	22.7	3	2.7%
	7. Karangasem	324	238	218	59.1	18.2	22.7	20	8.3%
	8. Buleleng	509	336	310	50.1	30.0	19.9	26	7.7%
	9. Denpasar	395	266	246	3.8	16.6	79.6	20	7.4%
	Total	2,774	1,910	1,765	38.7	20.3	41.0	145	7.6%

Note: (1) a ratio of the year 2000

Source: Bali in Figures 2000 and 2003, BPS of Bali Province

The minimum wage of Bali Province is currently categorized into 6 grades. Badung ranks the highest grade in Bali Province. The level of Bali Province is counted as 70% (Badung) to 60% (Others) of Jakarta. See Table-II-1.16.

Table-II-1.16 Minimum Wage

Region		2003	2004	2005	Increase
Jakarta		631,000	671,500	711,840	6.0%
Bali Province	1. Badung	430,000	469,000	506,500	8.0%
	2. Denpasar	427,500	465,000	500,000	7.5%
	3. Gianyar	423,000	446,265	475,000	6.4%
	4. Jembrana	417,500	432,650	455,300	5.2%
	5. Bangli	410,000	425,000	450,000	5.9%
	6. Others	410,000	425,000	447,500	5.3%

Source: Labor Office of Bali Province

1.1.7 Poverty Line

The percentage of the population below the poverty line of Bali Province was 6.9% in 2004, which is smaller than 16.7% of Indonesia as shown in Table-II-1.17.

Table-II-1.17 Population below the Poverty Line

Region	Poverty Line (Rp.)			% of Population below the Poverty Line		
	2002	2003	2004	2002	2003	2004
Indonesia	-	-	-	18.2%	17.4%	16.7%
Urban	130,499	138,803	143,455	14.5%	13.6%	12.1%
Rural	96,512	105,888	108,725	21.1%	20.2%	20.1%
Bali Province	-	-	-	6.9%	7.3%	6.9%
Urban	145,650	158,415	158,639	5.7%	6.1%	5.1%
Rural	118,463	130,668	136,166	8.3%	8.5%	8.7%

Source: 1) Statistical Yearbook of Indonesia 2003 and 2004, BPS of Indonesia

On the other hand, according to the information of BPS of Bali Province, number of households below the poverty line accounts for 15.5% of total households in Bali Province as shown in Table-II-1.18. Regional features are summarized as follows; 1) slightly below 5% in southern areas of Bali Province, 2) just beyond 10% in western areas, and 3) absolutely high level in northern areas - 35% in Karangasem and 24% in Buleleng.

Table-II-1.18 Number of Households below the Poverty Line

Item	JEM	TAB	BAD	GIA	BAN	KLU	KAR	BUL	DEN
Households below Poverty Line [1)]	7,069	11,369	4,001	6,473	10,449	6,948	32,328	36,171	3,639
% in the regency [2)]	10.6%	11.3%	4.8%	7.8%	20.8%	19.4%	34.6%	24.3%	3.6%

Source: 1) Information from BPS Bali, and 2) Study Team by utilizing number of total household of respective regency that is presented in Bali in Figures 2005.

1.2 Balinese Society and Subak System

The Balinese society and agriculture are characterized by *subaks*, socio-religious agriculture communities dealing with water management and crop production, which have been in existence for centuries. Physical conditions in Bali as well as the perspective of the Hindu religion are said to have contributed to the development of the intricate system of irrigation on steep mountain slopes and valleys. A number of studies have already been conducted on the s*ubak* system by Indonesian and international researchers and this section provides a gist of observations and analyses made in some major literatures as well as interviews conducted during the study period.

1.2.1 Tradition of Subak

According to the information in the *Subak* Museum*[5] the origin of the irrigation system in Bali dates back to the ninth century. Historical records use such terminology as wet rice fields, dry fields, dikes, water diversion, tunnels, and a measurement of water distribution. The shallow valleys and the geological conditions characterized by soft, non-collapsable, and unsaturated rocks made it easier for early irrigators, who possessed only simple technology, to dig tunnels that were essential for channeling irrigation water. The rainfall patterns in Bali, determined by the mountains, are that the number of dry month with rainfall less than 100mm is more than six months in the northern area and the southern peninsula. The dry season necessitated irrigation and influenced the way people think about their work, cooperation, and structuring their society.*[6]

Subaks organize and maintain intricate systems for taking and distributing irrigation water to final unit fields through site-specific adjustments. The intensive water management is supported by both techniques and spirituality, which is closely related to Hinduism. The Hindu value system and water

*[5] Located in Tabanan, Tabanan Regency, Bali Province.

*[6] KAYANE Isamu, SHIMMI Osamu, and Putu Djapa WINAYA, "Physical and Religious Background of Subak in Bali."

administration in Bali is discussed in detail in an article by Wohlwend*[7]. Hinduism centers around the doctrine of the supreme knowledge, of which all that is perceptible, materially or otherwise, constitutes a part. Individuality, therefore, represents nothing in absolute terms, but forms an essential constitutive element of the universe. A human being is regarded as an integral part of the community, communities as constitutive elements of humanity, and humanity together with minerals, plants, and animals make up the world, which is a microcosm of the universe. As a consequence, in the Hindu cosmology nothing is left apart nor remains individuality isolated from its environment, and the Hindu is aware of his/her effective participation in universal harmony.

This value system is reflected in the basic philosophy of *subak*, which is crystallized in the expression "*Tri Hita Karana*", meaning "three reasons to reach the prosperity". The three "reasons" refer to three types of relations: human beings and the god; human beings and their society; and human beings and the nature.

It must also be mentioned that water, in Hinduism, is regarded not only as a natural element but as the prototype of the universal substance and mother of existence because of its fluid and plastic nature. Water is symbolically equated with life, the sustainer of plant, animal and human life, and, spiritually, the support of divine influences. Rainwater collected in streams and discharging into the ocean is the manifestation of the divine influences. This symbolism leads to the image of *subak* as a human body, in which water of its irrigation networks is blood.*[8]

1.2.2 Organization of Subak

The grouping of a *subak* is based on the same water source. All farmers possessing land within a reasonable distance from a stream worked together to construct a diversion weir and a network of canals and feeders to bring the water to their fields. And all the participants in the process automatically became members of the *subak*. The area of a *subak* on average is 100 hectares, the largest being around 800 hectares and the smallest about 10 hectares. Large *subaks* are sub-divided into smaller units called *tempek*. According to the list prepared by each regency in 1993, there are a total of 1,600 *subaks* in Bali.*[9]

Subaks exist in parallel with traditional villages called *banjar**[10] as well as administrative villages or *desa**[11]. Members of a *banjar* are often members of two ore more *subaks*, and the functions of *banjars* and *subaks* are completely separate. While *banjars* are communal organizations, *subaks* are dedicated to cooperative use of irrigation water.

The institution of *subak* is characterized by three elements: *awig-awig* or the customary law, the staff or the "management", and meetings for decision-making. *Awig-awig* is written as well as unwritten regulations governing the internal affairs of a *subak* and sets out rules on water distribution, membership, staff, meetings, collection and use of funds, breaches and fines, and other matters. The management of a *subak* consists of a leader called *kelian subak* or *pekaseh*, *pangliman* or *kasinoman* (secretary), and *juru arah* or *saya* (expert). Other staff members of the management vary but often include *juru raksa* (treasurer) and *wakil* (assistant). In addition each *subak* usually has *pemangku* (priest), who is responsible for religious aspects of water allocation and distribution. The management is democratically elected by *subak* members. Generally the period of the assignment is five years and re-election is possible. The meeting is a supreme vehicle for operating the *subak* and is held monthly or seasonally. All main decisions must be approved by the meeting. The matters decided in the meeting include work activities, cropping patterns and schedules, religious ceremonies, and all aspects of *subak* activities and problems. An amendment to *awig-awig* require a decision of the meeting as well. The resources of subak are monetary or in-kind contributions from members,

*[7] Bernard J. Wohlwend, "Hindu Water Law and Administration in Bali" (note dated).

*[8] Bernard J. Wohlwend, ibid.

*[9] *Bupati* of each Regency issued a decree in 1993 listing all the existing *Subaks* and their areas. This was done in response to a request from ADB prior to the commencement of a *subak* strengthening project.

*[10] *Banjar* is a traditional Balinese unit of social organization based on the territory and/or genealogy. It is a unit of communal activities and mutual aid. Each married man within a particular area is expected to become a member. Two or more Banjars comprise a traditional village called *Desa Adat*, which is also independent of government administration.

*[11] *Desa* was introduced across Indonesia by the Law No.5/1979 on Village Administration.

which are used for operation and maintenance, construction, staff compensations, and loans to members, as well as collective work of members (*gotong-royong*).*[12]

Physical changes in the irrigation systems brought by the Bali Irrigation Project that started in 1979 promoted development of federations of *subaks*. With the objective of increasing economies of scale, the project integrated many irrigation systems with their own intakes into single systems sharing a new common permanent weir, usually with a total command area of at least 150 hectares. As the new system created situations favorable to upstream *subaks*, there was a need to negotiate water allocation among the related *subaks* within the irrigation system. With the support of external facilitators led by Udayana University of Bali and later on with the own initiatives of *subaks*, federations called *subak-gede* were created. There are a total of 41 *subak-gedes* across Bali, many of them being located in Tabanan, Klungkung, Buleleng, and Gianyar. The table below shows distribution of *subaks* and *subak-gedes* in each Regency/City.

Table-II-1.19 Distribution of Subaks and Subak-gedes

District/City	No. of *Subak-gedes*	No. of *Subaks* belonging to *Subak-gedes*	Total No. of *Subaks*
Tabanan	9	95	348
Bangli	2	30	51
Klungkung	10	39	46
Jembrana	5	56	95
Buleleng	7	64	296
Badung	2	21	113
Gianyar	6	79	465
Karangasem	0	0	140
Denpasar	0	0	46
Total	41	384	1,600

Sources: JICA Study Team

In addition, a larger federation called *subak-agun* was organized in two places, Tabanan and Buleleng.*[13] The management structure of *subak-gede* and *subak-agun* is similar to the one for a *subak*: heads of member *subaks* elect the members of the management including a chairperson, a vice-chairperson, a secretary, and a treasurer.

1.2.3 Water Allocation and Distribution by Subak

The water shares of individual members of the *subak* are measured in "*tektek*", which is a volume of water flowing through an inlet of a specified depth and width on a wooden flow diversion structure. The size of rice field receiving one *tektek* varies among *subaks* and within *subak*, ranging from 0.20-0.80 hectares. For *subak* members, water is equitably allocated if one or more of the factors listed below has been considered and agreed upon by all *subak* members:

- Initial investment of labor and other contributions such as money and materials provided by the farmer for construction of the irrigation system;
- Soil conditions, with land of higher porosity usually entitled to receive an extra share of water;
- The distance of the plot from the intake, to compensate for the loss of water along the irrigation canals and ditches due to seepage, percolation, and evaporation;
- Tthe position and role of the farmer in the subak, i.e. the subak head or officials may receive an extra share of water; and

*[12] Bali Provincial Public Service Department, "*Subak* in Bali", August 1997. N. Sutawan, M. Swara, W. Windia, W. Suteja, N. Arya and W. Tjatera, "Community Based Irrigation System in Bali, Indonesia" in W. Gooneratne and S. Hirashima, ed., "Irrigation and Water Management in Asia" (Sterling Publishers Private Ltd. year?)

*[13] The negation processes that led to the formation of *Subak-gede* and *Subak-agun* are elaborated in Nyoman Sutawan, "Negotiation of Water Allocation among Irrigators' Associations in Bali, Indonesia" in Bryan Randolph Bruns and Ruth S. Meinzen-Dick, ed., "Negotiating Water Rights" (IFPRI, 2000), and in more detail in "Negotiation of Water Allocation amongst Irrigators' Associations: A Note from Bali, Indonesia," a paper presented by the same author for the Water Rights Panel IASCP 96 on 5-8 June 1996 in Berkeley, California.

- Transaction of water rights that may increase or decrease a farmer's water share in a given period of time.

Subak members are expected to perform duties and responsibilities corresponding to the share of water they receive. However, the *subak* head and officials are exempt from the duties. Also, the additional water received as compensation for soil porosity, seepage, percolation, and evaporation is not taken account of in the water-duty equation.*[14]

During the dry season, if available water is not sufficient for irrigating the entire area of the *subak*, two alternatives are usually implemented:

- Each subak member receives an amount of irrigation water reduced proportionally to the reduction in the available water, and as a result, each member reduces his own farming area accordingly; or
- The areas to be irrigated are decided based on crop rotations.

Also, the practice of staggering takes place in a *subak* during the period of land preparation, when available water is not sufficient for carrying out the land preparation in all the *subak* rice fields. Rotational and staggering practices are implemented by using logs or wooden planks to close or reduce the openings at the water division and off-take structures.*[15] When either of these arrangements is carried out, the group of farmers receiving the water first is called "*ngulu*" (head), the group after it is "*mawongin*" (neck), and the last group is "*ngesep*" (leg), which evokes the image of a *subak* as a human body.

1.2.4 Subak and the Government

The *subak* hydraulic system of conveying and distributing the irrigation water is based on the delicate equilibrium between physical and non-physical aspects and has been independent from government administration. This is in contrast to the situations in Java, where the irrigation system was brought under the central government's regulation in 1936 and the village (*desa*) administration became fully in charge of irrigation water management. Water distribution at *desa* was to follow the requirements of the cultivation plan formulated by the district irrigation commission. Since 1950s, a realization of the needs to organize water users independently from *desa* administration led to the formation and strengthening of water users' associations (WUAs), and the process continues till today.

There are basically three offices involved in the government's interface with subaks: public works (water resources), agriculture, and revenue. Public works is responsible for the irrigation systems that are under the government's responsibility.*[16] Agriculture provides technical guidance and extension services to subak farmers. Revenue is responsible for collecting land taxes from the farmers. Until recently, there was a position of *sedahan agung* (chief tax officer) in accordance with the institution introduced during the Dutch administration and enjoyed authority and respect among *subak* members. *Sedahan agung* was responsible not only for tax collection but supporting various subak activities (including religious and social activities). When problems arose, including water allocation issues, the first government contact point for *subaks* was *sedahan agung*. In the absence of *sedahan agung*, tax officers (called *sedahan*) are responsible for tax collection as well as providing some managerial support to subaks. But some *subaks* wish to have the system of *sedahan agung* restored (perhaps for the purpose of having "one stop shop" in the government for *subak* affairs).

The government in recent years has been supporting strengthening of *subaks* through provision of training on irrigation, agriculture production, and socio-economic-cultural aspects. Provincial Dinas PU, through the Bali Potential Irrigation Project, established *Subak* Training Center, (Located in the

*[14] Ibid.
*[15] Bali Provincial Public Service Department, "*Subak* in Bali," ibid.
*[16] The new Water Resources Law (No.7/2004) stipulates that primary and secondary irrigation systems are under the government's responsibility and tertiary systems under the responsibility of water users' associations. Due to unique topographic situations of Bali, it is often difficult to identify which systems fall under which. In addition, subaks are often requested by the government to provide gotong royong contributions for the maintenance of main systems, even though they fall under the responsibility of the government. Small Scale Irrigation Management Project (SSIMP), under its sub-project in Bali, is facilitating discussions and deliberations between government officials and subaks to determine the responsibilities in four districts: Buleleng, Jembrana, Karangasem, and Klungkung.

compound of *Subak* Museum in Tabanan.) where university professors, private sector specialists, and government officials are invited to organize training sessions. The relationship between *subaks* and the government is generally cordial and cooperative. As can be seen in the development of *subak-gedes* and *subak-aguns*, *subaks* today continue to demonstrate its excellent organizational capacity to cope with changing situations and make adjustments within the *subak* arrangement. Increasing tensions between *subaks* and non-*subak* entities (such as PDAM) in recent years, however, indicate that the government may have to play more proactive roles in structuring water allocation and facilitating dispute resolution.

1.3 Topography, Geology and Land Use

1.3.1 Topography

Bali Island is topographically divided into two areas; northern and southern parts being separated by mountain ranges of 1,500m to 3,000m in altitude running in an east-west direction. The northern area has steep topography, while the southern part has relatively gentle slopes particularly below 500 m above the sea, though the upper area is a little steeper. See Figure-II-1.2.

Rivers on the northern slopes sharply descend their altitude from highland to the coastal area and drain into the Bali Sea. Some alluvial fans are formed near the river mouths of the relatively large rivers such as Panarakan River and Saba River etc.

On the other hand, rivers on the southern slopes, including Ayung River, Oos River and Unda River etc., descend from highland on a steep gradient in the upper and middle reaches, being confined in deep V-shaped valley where both banks form steep topography of more than 40 degrees, which is referred to the red-colored thin lines extending southward in Figure-II-1.2. The rivers flow from north to south with many bends reflecting the geological condition of the area, and finally drain into the Badung Strait or the Bali Strait.

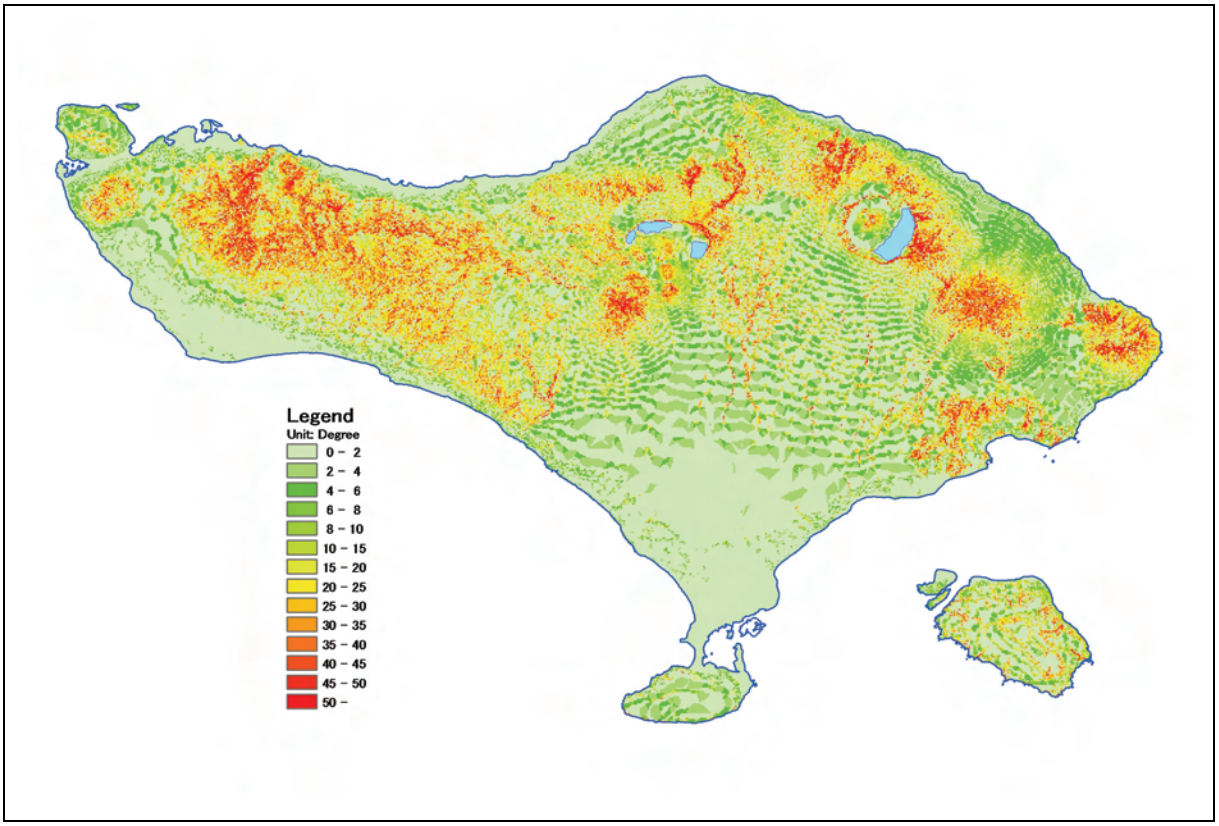


Figure-II-1.2 Slope Map of Bali Island

1.3.2 Regional Geology

Bali island consists of Miocene to Pliocene volcanic products and marine sediment as basement rock, overlain by a thick pyroclastic flow, volcanic products and volcanic mudflow originated from intensive volcanic activities in Pleistocene to Holocene of Quaternary period. See Figure-II-1.3.

The exposure of basement rocks observed are the Ulakan Formation (volcanic breccia, lavas and tuff) of the oldest strata distributed in an area covering from the coast to mountain slopes up to EL. 500 m in the southeast, the Sorga Formation (sandstone) seen in limited areas from northwestern to northern coast, the Selatan Formation (limestone) forming Bukit Peninsula and Nusa Penida, the Parapatagung Formation (limestone, calcareous sandstone and marlstone) distributed in Prapatagung of west end of Bali, Palaki volacanics (lavas, volcanic breccia) and the Ash Formation (lavas, volcanic breccia and tuffs). Almost all of these strata of Tertiary age are covered by the Quaternary volcanic rocks.

1.3.3 Land Use

"Bali in Figures 2003 (BPS Statistics of Bali Province)" specifies the area of land use based on the result of agricultural survey thorough questionnaire in 2003, while the JICA Study Team conducted the land use estimate based on Landsat 7 of 2003. Both data are summarized in 6 categories as shown in Table-II-1.20 and Figure-II-1.4. Figures between two data sources are quite different because of the way to count the land use, particularly dry land, plantation and forest that are in reality a mixture of several types of land use. Thus, it is not possible to judge which data reflect the actual conditions but the assessment of land use can be conducted by comparison of two data. The difference in the total provincial area is due to sand area along the coast. In this Study, 5,632.86 km^2 is adopted as the total provincial area.

The agriculture land in Bali consists of the wetland paddy field, dry land and plantation, and occupies approximately 60 % of the provincial land. Data of both sources are consistent in terms of the agricultural land. Forest coverage is considered ranging within 20 % - 25 % of the provincial area.

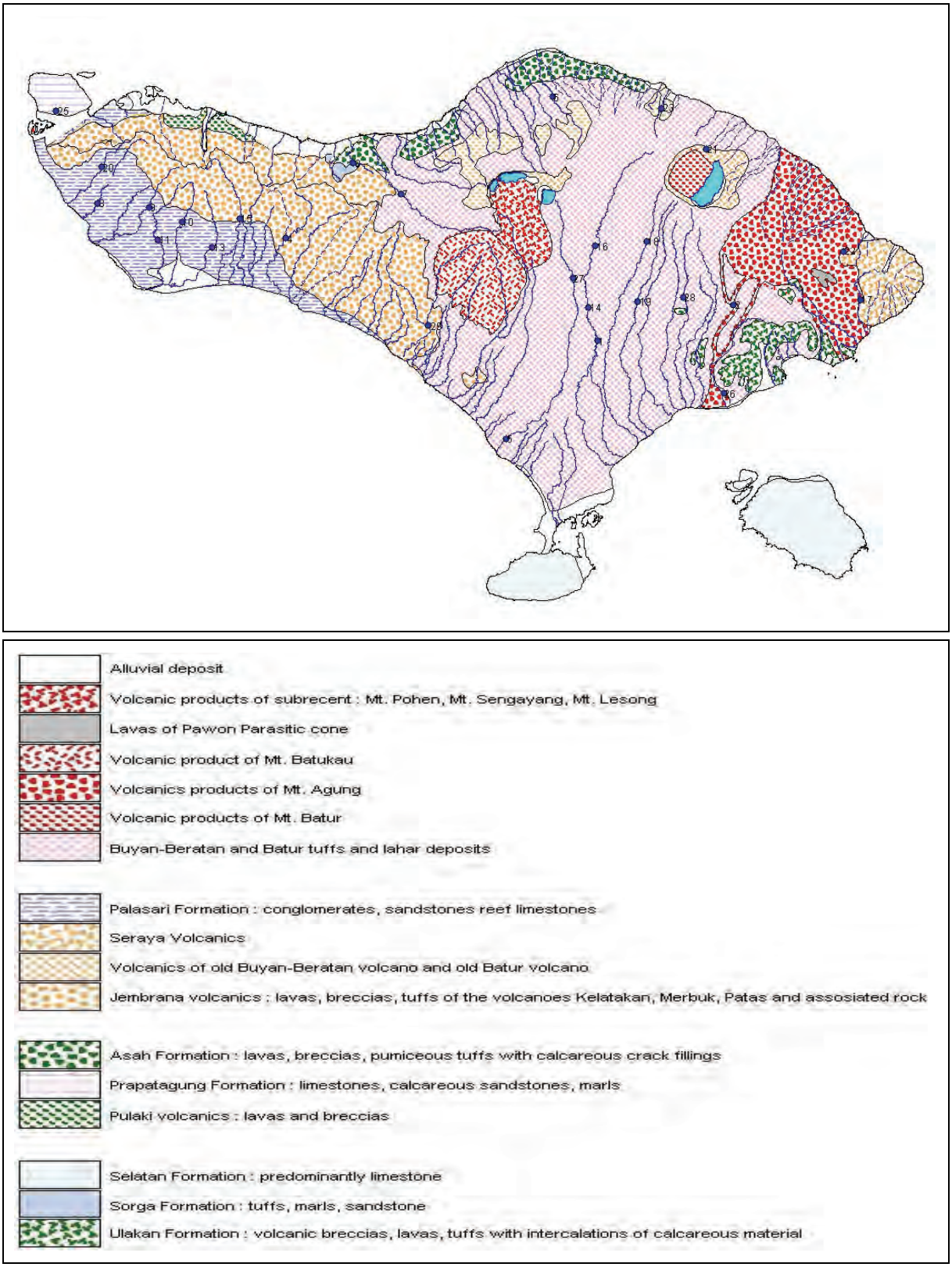
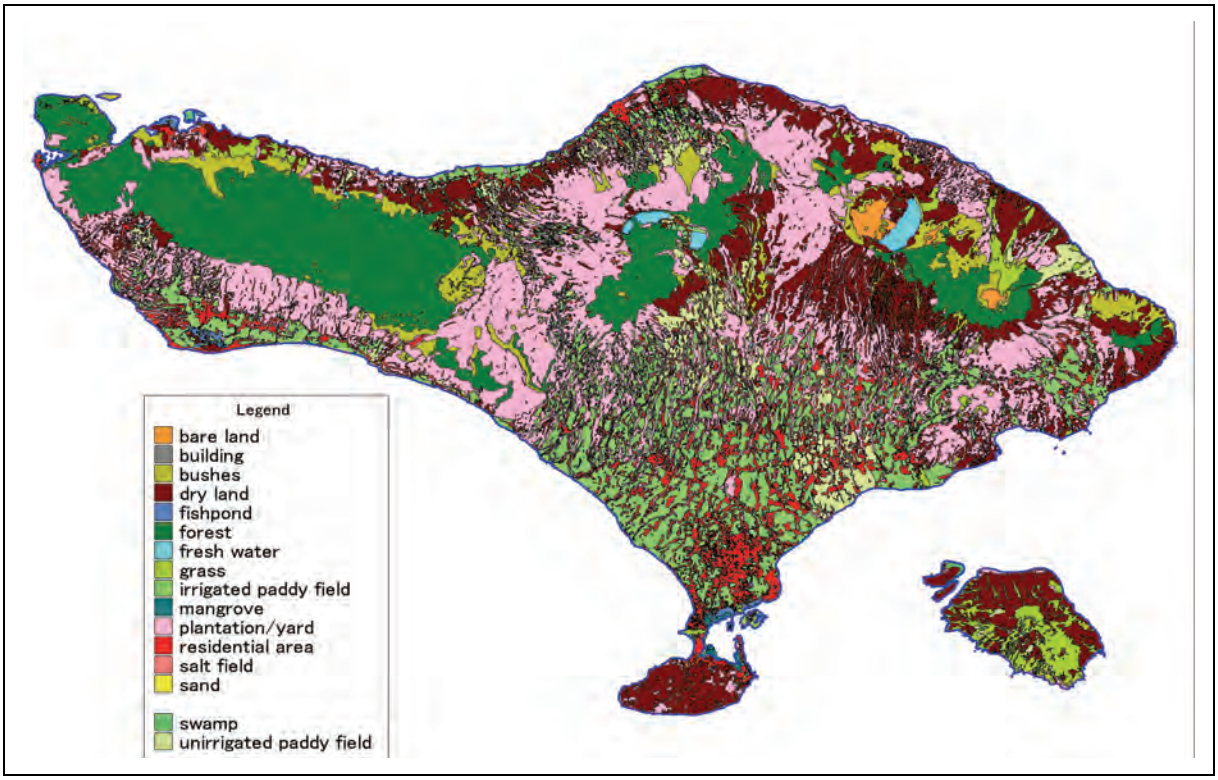


Figure-II-1.3 Geological Map of Bali Province

Table-II-1.20 Land Use in Bali

Category of Landuse	JICA Study		BPS	
	Area (km^2)	Ratios (%)	Area (km^2)	Ratios (%)
Yard and Housing	555.65	9.9	451.10	8.0
Wetland Paddy Field	782.45	13.9	826.44	14.7
Dry Land	1,047.63	18.6	1,294.86	23.0
Plantation	1,738.73	30.8	1,272.07	22.6
Forest	1,076.85	19.1	1,387.09	24.5
Others (swamp, pond, sand etc)	431.54	7.7	405.10	7.2
Total Provincial Area	5,632.86	100.0	5,636.66	100.0

Source: Bali in Figures 2003, BPS Statistics of Bali Province, Result of Satellite Imaginary Analysis for Landsat 7 of 2003



Source: Satellite Imaginary Analysis by the JICA Study Team based on Landsat 7 of 2003

Figure-II-1.4 Land Use Map of Bali

1.4 Climate and Hydrology

1.4.1 General Climate

Bali Island occupies an area of 5,632.86 km^2, situated adjacent to Java Island to the west. Because of the geographic condition, the climate of Bali Island is similar to that of East Java with two distinct seasons, dry and wet seasons. Usually, the wet season lasts for the period from November/December to March/April, varying according to start time of rainfall and its duration in the year.

From the topographic viewpoint, Bali is characterized by a ridge of volcanoes which run from east to west in the central part of the island. The major rivers in Bali Island originate from the central mountainous areas, flowing down in the northern and southern directions. The annual rainfall amount and climate in Bali Island is dependent on the altitude and also affected by the topographic condition as well as annual movement of the Inter Tropical Convergence Zone (ITCZ). In general, the annual rainfall in Bali increases with altitude. This tendency is common to most of other regions of the country. Meteorological Features are shown in Table-II-1.21.

Table-II-1.21 Meteorological Features in Bali Province

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Mean/Total
Annual Mean monthly Air Temperature (Unit: °C)													
Denpasar (1996-2003)	27.4	28.5	27.5	27.5	27.2	26.6	25.9	25.8	26.6	27.5	27.8	27.5	27.1°C
Singaraja (1993-2003)	27.3	28.0	27.9	28.2	28.1	27.8	27.5	27.2	27.7	28.0	28.1	28.1	27.8°C
Bedugul (1998-2003)	21.5	22.4	21.8	21.7	21.7	21.5	21.4	20.8	20.6	20.7	20.6	20.6	21.3°C
Annual Mean Monthly Relative Humidity (Unit: %)													
Denpasar (1995-2003)	80.9	81.5	80.3	79.6	78.8	78.1	78.4	76.7	77.1	77.8	79.8	79.2	79.0%
Singaraja (1993-2003)	75.8	77.4	76.3	79.6	74.4	70.9	72.1	74.3	71.1	72.6	68.1	77.9	73.5%
Bedugul (1998-2003)	95.3	91.3	94.1	94.1	94.0	92.8	94.9	95.4	95.0	93.2	93.6	95.4	94.1%
Annual Mean Monthly Pan-A Evaporation (mm/day)													
Denpasar (1995-2003)	4.5	4.6	4.7	4.7	4.5	4.2	4.2	4.8	5.1	5.5	5.2	4.9	1,722 mm/y
Ngurah Rai (1995-2003)	5.0	5.3	5.3	5.4	5.3	5.3	5.4	6.2	6.5	6.4	5.7	5.4	2,048 mm/y
Negara (1998-2003)	4.7	4.4	4.9	4.3	4.2	4.0	4.1	4.8	5.1	5.3	4.8	4.6	1,695 mm/y
Karangasem (1995-2003)	3.0	2.5	3.5	4.2	4.7	4.4	4.5	4.8	5.6	5.4	4.4	3.2	1,479 mm/y

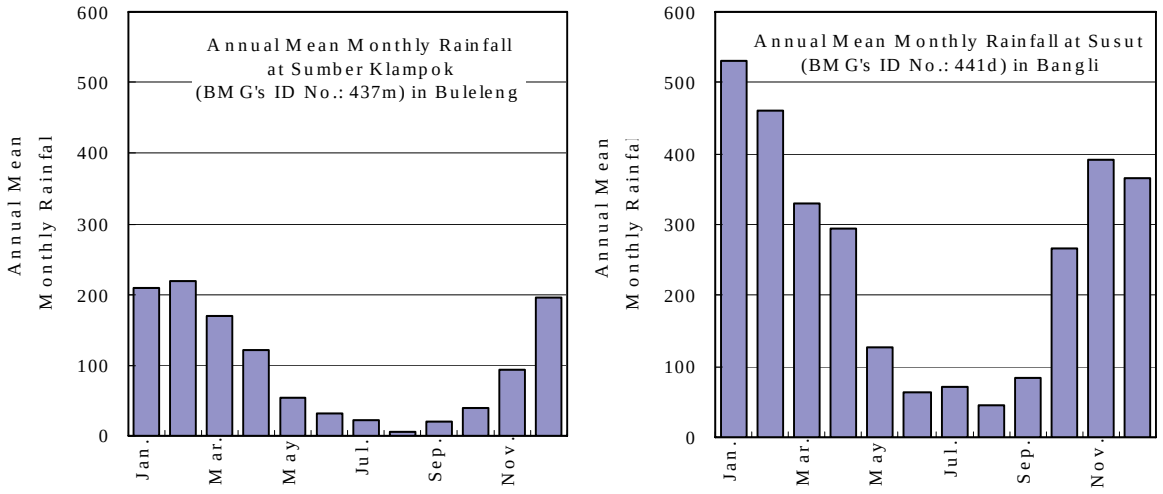
1.4.2 Availability of Rainfall Data

In Bali Island, the BMG is operating the largest number of rainfall stations out of the three (3) agencies, namely BMG, PU Hydrology Office and BPDAS Office in Denpasar under the Ministry of Forest. The number of rainfall stations operated by each of the three (3) agencies is shown below:

- BMG: 90 stations
- PU Hydrology Office: 36 stations
- BPDAS Office: 2 stations
- Total: 128 stations

(1) Monthly Rainfall

To clarify the difference between monthly rainfall patterns in coastal area and mountainous area, the annual average monthly rainfall patterns are analyzed, and those at the Sumber Klampok station in Buleleng in the coastal area and at the Susut station in Bangli in the mountainous area are shown in Figure-II-1.5



(Coastal Area) (Mountainous Area)

Figure-II-1.5 Monthly Rainfall Patterns

Table-II-1.22 shows the ratio of rainfall in the dry season to annual rainfall at the coastal and mountainous rainfall stations, herein assuming the dry season to be the period of May to October. In the mountainous area, rainfall in the dry season increases with the increase of annual rainfall. Thus, the mountainous area contributes to yields of the dry season flow to a considerable extent.

Table-II-1.22 Annual Average Rainfall in Regency (Kabupaten) in Bali Island

Classification	Name of Rainfall Station	Regency (Kabupaten)	Annual Rainfall (mm)	Ratio of the Dry Season* Rainfall to Annual One (%)
Coastal Area	Sumber Klampok	Buleleng	1,167	15
	Rambutsiwi	Jembrana	1,859	27
	Celuk	Gianyar	1,610	17
	Klungkung	Klungkung	1,589	27
	Kubu	Karangasem	1,390	11
	Bukti	Buleleng	1,446	7
Mountainous Area	Tegarasih	Buleleng	2,618	22
	Petang	Badung	2,960	21
	Susut	Bangli	2,998	22
	Pempatan	Karangasem	2,679	19

Note: * The period of May to October is taken as the dry season.

(2) Annual Rainfall

BMG's 64 rainfall stations at which the comparatively continuous rainfall records are available for the period from 1992 to 2003 are selected as the key rainfall stations. An isohyetal map of annual average rainfall for Bali is prepared based on the mean annual rainfalls at the said key rainfall stations. Refer to Table-II-1.23. The isohyetal map updated in this M/P is depicted in Figure-II-1.6 with the key rainfall stations. As seen in the figure, the annual rainfall in Bali ranges from below 1,500 mm in the coastal areas to over 3,000 mm in the central mountainous areas. From the isohyetal map, the mean annual rainfall in Bali Island is estimated to be 2,003 mm for the period from 1992 to 2003.

Table-II-1.23 Annual Average Rainfall between 1992 and 2003

No.	Name of Regency	Area (km^2)	Annual Rainfall (mm)
5101	JEMBRANA	858.26	1,970
5102	TABANAN	855.40	2,549
5103	BADUNG	398.29	2,078
5104	GIANYAR	367.96	2,323
5105	KLUNGKUNG	106.77	1,763
5106	BANGLI	531.30	2,092
5107	KARANGASEM	846.32	1,810
5108	BULELENG	1,333.59	1,834
5110	NUSA PENIDA (KLUNGKUNG)	209.61	1,079
5171	DENPASAR	125.36	1,790
Total/Average in Bali Province		5632.86	2,003

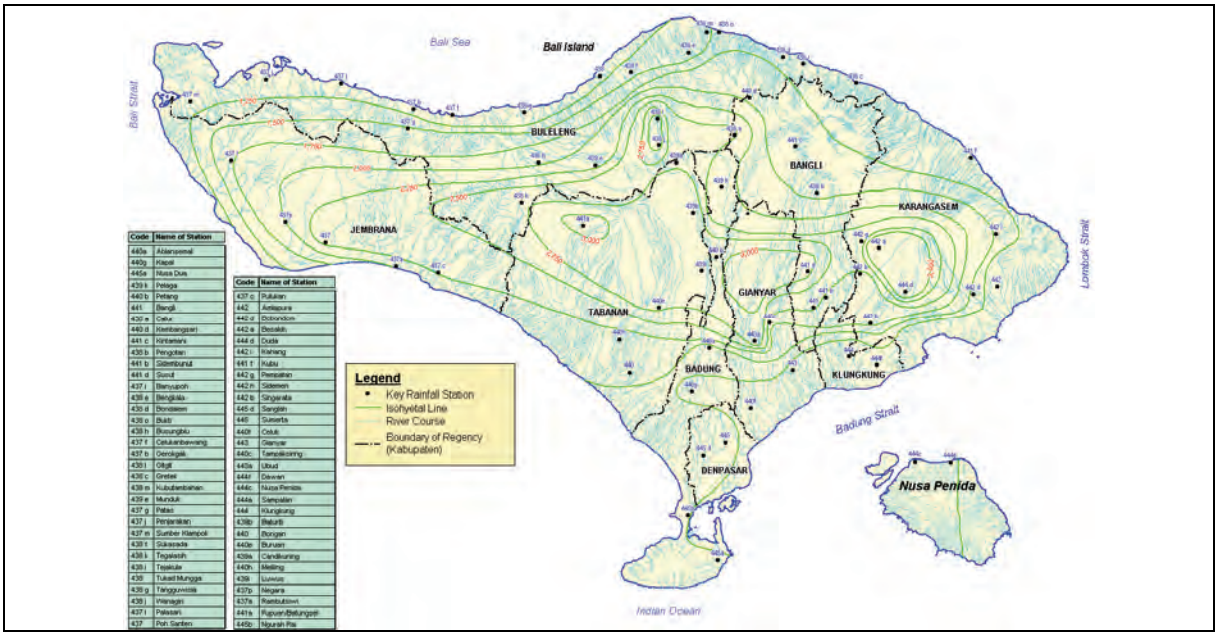
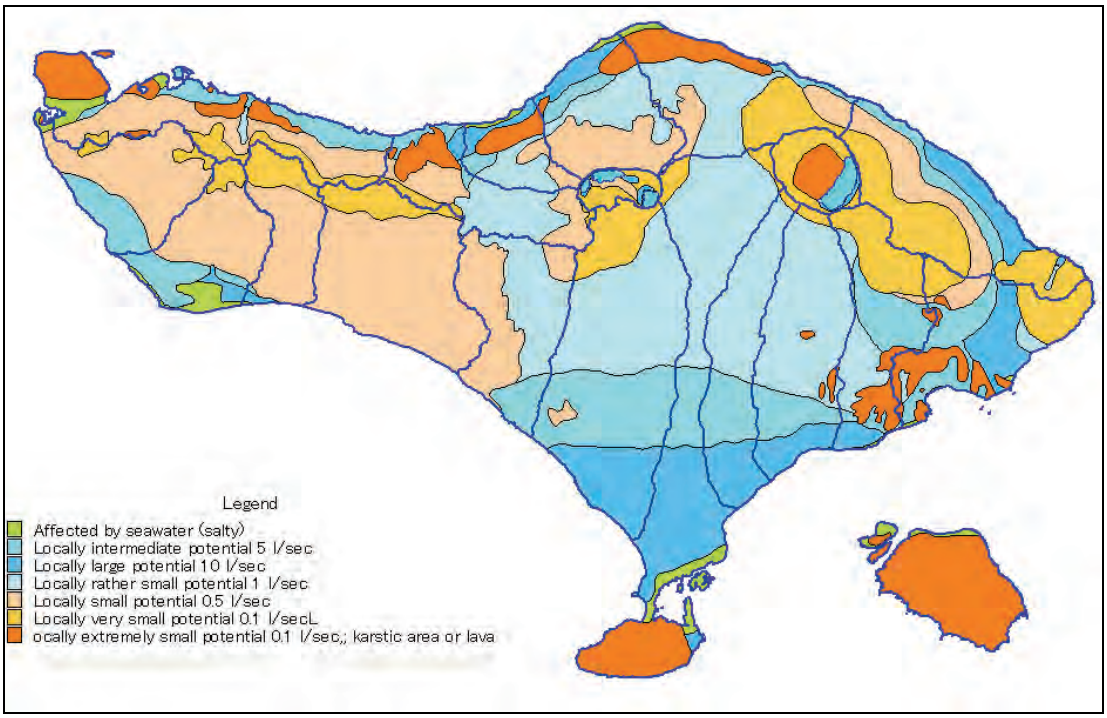


Figure-II-1.6 Isohyetal Map for Bali (1993-2003)

1.5 Hydrogeology

1.5.1 Hydrogeological Features of Formations

Bali is the island covered by volcanic sediments except the west end of the island, which is Mount Prapatagung-Gilimanuk Area, and the south end of the island, which is Bukit Peninsula or Bualu Area, where limestone and calcareous stratums occur. The island of Nusa Penida is also formed by limestone. Hydrogeological feautures of formations are summarized below. Refer to Figure-II-1.7.



Source: Reconnaissance Hydrogeological Map of Bali published by the Geological Survey of Indonesia in 1972.

Figure-II-1.7 Reconnaissance Hydrogeological Map (1972)

Generally, alluvium and young volcanic sediments are highly permeable, and Lower Quaternary and tertiary sediments have wide-ranging permeability due to the formation.

<Alluvial Deposits>

Alluvial deposits are distributed in a narrow zone along the northern west coast, the coastal lowland area located in the south of Negara, and the southern seaside area of Denpasar. The formation has generally high permeability and groundwater has been exploited by dug wells and tube wells for villages. The aquifer, however, is susceptible to saline intrusion.

< Upper Quaternary >

Upper Quaternary volcanic products occur widely in the middle to eastern area of the island. The permeability of the formation varies from moderate to high. There are many production wells drilled in the area, especially in the terrace of southern Bali and the northeast coastal area.

< Lower Quaternary >

Palasari Formation of Lower Quaternary Sediments, is distributed in the western area of Bali. Productive aquifers occur in the formation and have been developed for irrigation in Melaya and Negara, Kabupaten Jembrana. Lower Quaternary Volcanic Rocks are distributed in the western central mountainous districts, the parts of northern area and the east end region of the island. Although the formation generally has low permeability, but the east end of the foot of Mount Seraya has relatively high permeability.

< Tertiary >

Tertiary Volcanic sediments are scattered in the northern area and in the hilly terrain around Manggis of Karangasem Regency. These volcanic formations are low permeable. There are another type of Tertiary Formations, namely Prapatagung Formation and Selatan Formation. They consist mainly of limestone and calcareous sediment. Prapatagung Formation occurs in the west end of the island, and Selatan Formation is distributed in the south end of the island and Nusa Penida. Productive aquifers, which are limited to fractures or solution channels, occur locally.

1.5.2 Aquifer Characteristics

On the basis of the existing drilling data, aquifer characteristics in Bali are summarized as below.

<Number of Wells and Depth of Well>

A number of wells that have the data of pumping tests as shown in Table-II-1.24.

Table-II-1.24 Number of Wells with Pumping Test Data

Regency/City	Number of Wells (Inventory Survey)	Number of Wells with Pumping Tests Data
JEMBRANA	100	73
BULELENG	107	77
KARANGASEM	64	40
TABANAN	16	16
GIANYAR	16	16
KLUNGKUNG	11	9
BADUNG	58	8
BANGLI	2	0
DENPASAR	31	0
Total	405	239

There are 210 wells with the record of the depths. The number of wells drilled up to 90 meters or less is almost 50% of the wells and about 80% of the wells were drilled up to 120 meters or less.

The wells drilled to 50 meters were only 8%, as shown below. Relatively deeper wells have been constructed in the western part, Meraya and Negara areas, and the northwestern part, Gerokgak area, though the depths of wells drilled in the southern area vary widely

<Discharge Rate from Wells>

211 wells were listed with the record of discharge rate at the pumping test as shown in Table-II-1.25. More than half of wells discharge 10 liter/sec and over of groundwater.

Table-II-1.25 Discharge Rate

Discharge Rate (lit./s)	Number of Wells		Accumulative	
<5	30	14.2%	30	14.2%
5=< <10	65	30.8%	95	45.0%
10=< <20	86	40.8%	181	85.8%
20=<	30	14.2%	211	100.0%
Total	211	100.0%		

<Specific Capacity>

Based on the recorded discharge rate and the drawdown, specific capacity of wells is calculated, and is shown in Table-II-1.26.

Table-II-1.26 Specific Capacity

Specific Capacity (lit./s/m)	Number of Wells		Accumulative		Groundwater Supply Potential
<0.1	7	3.3 %	7	3.3 %	Low
0.1=< <1	65	31.0 %	72	34.3 %	Intermediate
1=< <10	99	47.1 %	171	81.4 %	High
10=< <100	37	17.6 %	208	99.0 %	Very High
100=<	2	1.0 %	210	100.0 %	
Total	210	100.0 %	-	-	

1.5.3 Springs

The inventory survey conducted by the JICA Study Team listed the total of 1,273 springs in Bali. The yield of them ranges from less than one litter to several hundreds litters per second. According to the result, there are 9 springs yielding 500 liter/sec or more, and 67 springs yield from 100 to less than 500 lit./sec. Table-II-1.27 summarizes the result of the inventory survey.

Table-II-1.27 Number of Springs in the Inventory Survey by JICA Study Team

Regency/City	Number of Springs	Number of Springs with Yield more than 10 lit./sec	Total Yield (lit./sec)	Average Yield (lit./sec)
BULELENG	327	79	5,630	71.3
KARANGASEM	138	96	9,808	102.2
KLUNGKUNG (NUSA PENIDA)	9	5	522	104.4
KLUNGKUNG	29	5	202	40.4
GIANYAR	79	53	2,981	56.2
BANGLI	423	57	2,736	48.0
BADUNG	30	7	1,291	184.4
TABANAN	177	52	3,808	73.2
JEMBRANA	61	5	85.1	17.0
Total	1,273	359	27,063	75.4

1.6 Environment and Water Quality

1.6.1 Natural Environment

(1) General

The natural environment of Bali had been long modified since ancient times due to human activities, principally due to rice farming (paddy cultivation), which is understandable as being a highly populated small fertile island. Lately, its development as a famous tourism destination in a sense exerts further pressure on the natural environmental resources of the Island. Nevertheless, since it is such natural environmental resources that sustain the tourism development and hence tourism development has also helped in increased awareness on the importance of protection and conservation of natural environment.

The most significant scenic feature of the Island, in addition to the terraced rice fields, is the 4 natural lakes in the central mountainous region, namely Lake Batur, Lake Beratan, Lake Buyan and Lake Tamblingan and the mountains of Gunung Agung and Gunung Batur. In fact the steep topography around the central mountain range renders the area unsuited for agricultural development and hence this region virtually remains as forestation. Most of these highland forests are declared as protected areas and constitute as the principal water catchments for the 4 natural lakes and the numerous rivers of the island.

The significant coastal natural resources having much tourism importance as well include golden (white) sand beaches concentrated in southern coasts of Bali (Sanur, Kuta, Jimbaran and Nusa Dua), and coral reefs concentrated principally in southern coastal waters of Sanur and Nusa Dua as well as the small islands of Nusa Lembongan (and Nusa Ceningan) and also the eastern (Amed and Tulamben areas) and western (Menjangan Island) coastal waters of the mainland Island. The other most significant coastal natural resource of the Island includes its mangrove forestation principally

concentrated in the southeastern coast of the Island along the Benoa Bay that is also declared as a protected coastal forest area (Ngurah Rai Great Forest Park).

(2) Protected Areas

Most of the highland central mountainous region of the island is declared as some form of nature reserve or natural tourism park and hence remains as protected area. Such terrestrial mountainous protected areas include, but not limited to, the following;

- Batukaru Nature Preserve Area located around Batukaru mountain range
- Natural Tourist Park of Lake Buyan-Tamblingan located around these lakes
- Natural Tourist Park of Sangeh located in the tourism area of monkey forest
- Natural Tourist Park of Penelokan located around Lake Batur

The other protected areas that are composed of lowland terrestrial area and/or coastal marine waters include, but not limited to, the following;

- Bali Barat National Park (BBNP) or Taman Nasional Bali Barat located in the western region of Bali including the coastal marine areas around Gilimanuk Bay and Menjangan Island and hence incorporates coastal mangrove vegetation and coral reefs as well
- Ngurah Rai Great Forest Park located around the Benoa Bay at southeast coast, the largest mangrove forest area in the Island

These protected and nature reserve areas of the whole Bali Island is shown in Figure-II-1.8.

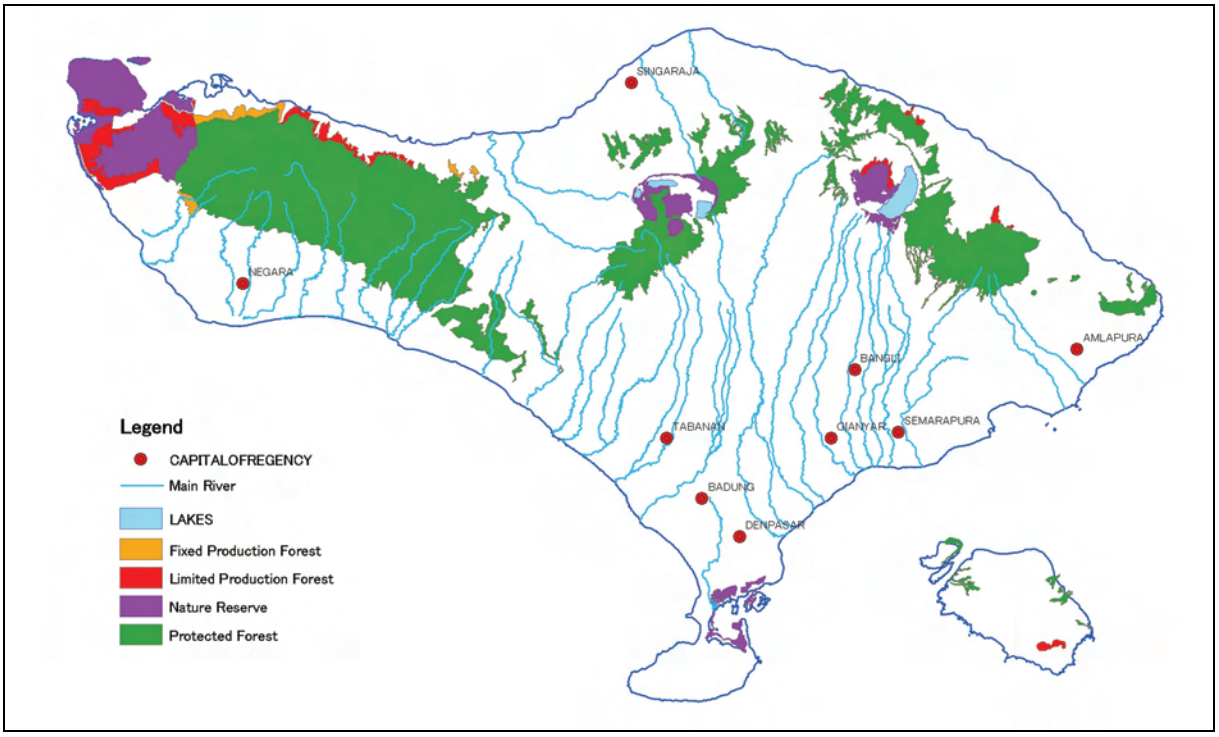


Figure-II-1.8 Map of Protected Areas in Bali

These protected areas, in particular the BBNP, serve also as important habitat for the rare and endangered fauna and flora of the island. BBNP is the habitat of the well-known endangered fauna (bird) species endemic to Bali, the Bali Starling (Leucopsar rothschildi), which is locally known as Jalak Putih/Jalak Bali.

1.6.2 Water Quality

(1) Available Data

Since 1999, PPSA (Proyek Pengembangan dan Pengelolaan Sumber Air/Bali Water Resources Development and Management Project) of Dinas PU, Propinsi Bali (Public Works Service, Bali Province) has been conducting a surface water quality monitoring program, covering all major inland rivers of Bali Province and the 4 major inland natural lakes of Batur, Beratan, Buyan and Tamblingan,

as an integral component of hydraulic monitoring system. The water quality monitoring program has been conducted annually covering both dry and rainy seasons at 60 monitoring stations and water quality data obtained is available in published book format up to the year 2003.

The river systems having more than one (multiple) monitoring stations are Ayung River (6 monitoring stations), Badung River and Mati River (3 monitoring stations for each river) and Unda River (2 monitoring stations one each in Unda River and Telagawaja River both belonging to the same river system). All the remaining rivers and the 4 lakes are represented by one single monitoring station per river/lake. The 60 water quality monitoring stations of PPSA along with the data available has been incorporated into the GIS system developed as per this master plan study.

Moreover, BAPEDALDA of Bali Province has also been conducting a water quality monitoring program annually since 2002 targeting 22 major rivers passing through more than one regency, coastal sea waters in all major beaches around Bali and also some typical wastewaters from domestic, institutional and industrial sources. The river and other water quality data obtained up to the year 2004 is also available in annually published book format.

(2) Measurement by JICA Study Team

The JICA Study Team conducted a comprehensive water quality measurement program encompassing all 3 major sources of inland water bodies, namely, surface water of rivers, lakes/dams and groundwater/springs covering the entire Province of Bali including the Nusa Penida islands. In total 50 inland water sampling locations were selected with 25 in rivers, 5 in lakes/dams and 20 in groundwater/springs. The water quality measurement was conducted during November and December 2004.

All of the 25 river locations and 4 of the lake locations (in total 29 locations) were selected from the existing PPSA water quality monitoring stations. The 4 lakes are the natural ones of Batur, Beratan, Buyan and Tamblingan. Accordingly the sampling locations that were specific to this measurement program are 1 dam location of Palasari dam in Jembrana Regency and all of the 20 groundwater/spring sampling locations spanning the whole Bali Island. An overall evaluation of water quality made both based on the available data and the analysis results obtained as per this measurement program by JICA is summarized below.

(3) Water Quality Standard

Conforming to the Article 14 of the new basic environmental law (No. 23/1997) that stipulates the formulation of environmental quality standards, the Government Regulation No.82/2001 (PP82/2001) was published as also noted above under Item (1). This most up to date regulation of 2001 is concerned to the management of water quality and water pollution control and hence has much relevance to this master plan and feasibility study on water resources development and management.

APPENDIX of this regulation specifies the national water quality standards (NWQS) that are in fact environmental water quality standards based on the intended beneficial use of a fresh water body with no distinction being made on the type of water body such as rivers, lakes or groundwater. This new NWQS overrides all similar previous national and regional beneficial use based on water quality standards that had been in force. Such overridden standards include the national water quality standards specified as the APPENDIX of Government Regulation No.20/1990 (PP20/1990) and also regional (provincial) water quality standards specified by the Decree No.515/2000 of Governor of Bali.

The provincial governments can set their own standards that could only be more stringent than that of the NWQS and also may include standard values for any additional parameter as appropriate to suit the local requirements. The Provincial Government of Bali is in the process of formulating its own water quality standards based on this new NWQS. The new NWQS was formulated envisaging 4 Classes of beneficial use of water as follows:

- Class I Raw water for potable (drinking) water supply with treatment and all other beneficial uses of Class II to Class IV
- Class II Water for contact recreation and all other uses of Class III and Class IV
- Class III Water for freshwater fishery, livestock farming and the use of Class IV
- Class IV Water for irrigation use

The NWQS as of Government Regulation No.82/2001 (PP82/2001) is shown in Table-II-1.28.

Table-II-1.28 National Water Quality Standards (NWQS) of Indonesia (2001)

Parameter	Unit	Class				Remarks
		I	II	III	IV	
Physical						
Temperature	°C	Deviation 3	Deviation 3	Deviation 3	Deviation 5	Temperature deviation from the natural condition
TDS	mg/L	1000	1000	1000	2000	
TSS	mg/L	50	50	400	400	To processing for drinking water as conventional, TSS <5000mg/L
In organic chemistry						
PH		6 - 9	6 - 9	6 - 9	5 – 9	If naturally outside spanning, determine pursuant to natural condition.
BOD	mg/L	2	3	6	12	
COD	mg/L	10	25	50	100	
DO	mg/L	6	4	3	0	Minimum value
Total phosphorus	mg/L	0.2	0.2	1	5	
NO3 as N	mg/L	10	10	20	20	
NH3-N	mg/L	0.5	(-)	(-)	(-)	To fishery, content of free ammonia for sensitive fish≤0.02 mg/L as NH_3
Arsenic	mg/L	0.05	1	1	1	
Cobalt	mg/L	0.2	0.2	0.2	0.2	
Barium	mg/L	1	(-)	(-)	(-)	
Boron	mg/L	1	1	1	1	
Selenium	mg/L	0.01	0.05	0.05	0.05	
Cadmium	mg/L	0.01	0.01	0.01	0.01	
Chromium (VI)	mg/L	0.05	0.05	0.05	1	
Copper	mg/L	0.02	0.02	0.02	0.02	To processing for drinking water as conventional, Cu ≤1 mg/L
Iron	mg/L	0.3	(-)	(-)	(-)	To processing for drinking water as conventional, Fe ≤ 5 mg/L
Lead	mg/L	0.03	0.03	0.03	1	To processing for drinking water as conventional, Pb ≤ 0.1 mg/L

(4) Water Quality Evaluation

<Rivers>

Based on all available data and also the recent measurement results of this JICA study as well as site inspection, the water quality in rural and upstream reaches of most rivers is regarded as good. As a typical example of very good, in fact regarded as pristine, river water quality of the Telagawaja River, which is the upstream rural river reach of Unda River is cited. On the other hand the Badung and Mati Rivers passing through the highly developed Denpasar and Kuta area in South Bali is evaluated as the worst polluted rivers in the whole province, which is also visually discernable. BOD levels even exceeding 70 mg/l were measured in these two rivers. Moreover, water pollution level in these two rivers with respect to toxicity is also regarded as very significant. Untreated disposal of wastes arising from various human activities of domestic, commercial, industrial and other origin is the cause of this severe water quality deterioration.

Other regional rivers of significant water quality deterioration are identified to be located in the most downstream-developed river reaches of relatively arid regions like Negara and Singaraja and their surroundings. This water quality deterioration is regarded as confined to the dry season, though the dry season itself is rather long, principally due to the lack of river water flow in combination with untreated waste disposal consequent to various human activities. Such arid rivers of significant water quality deterioration located in Jembrana Regency and also around Negara city are IJogading River passing through Negara city and the downstream reaches of Biluk Poh, Yeh Embang, Medewi and

Pengiyangan rivers. Similarly, such rivers of Buleleng regency and located around Singaraja city are the downstream reaches of Sabah, Medaum, Banyumala and Daya Sawan rivers.

<Lakes and Dam>

The water quality of all 5 major lakes and dam of Bali Island was investigated in overall, of which the 3 scenic lakes in the central mountainous region, namely, Beratan, Buyan and Tamblingan are regarded as pristine and have the best water quality for a lake. Also the quality of Batur Lake is good though its natural dissolved solid content is rather high. On the other hand Palasari dam is affected by potential eutrophication and hence regarded as the most deteriorated one among the 5 major water bodies.

<Groundwater and Springs>

In overall, the quality of groundwater of South Bali area in the Central Denpasar and further south at Kuta and Nusa Dua is regarded as not suited as potable water sources since their dissolved solids content is high, in addition to the high salinity due to seawater intrusion in case of Kuta and Nusa Dua areas located adjacent to the coast. Moreover the coastal groundwater in Penida Islands of Nusa Penida and Nusa Lembongan is also saline due to seawater intrusion. The groundwater in the other mainland area of Bali Island is regarded as good and suited for unrestricted beneficial use including as source of potable water use.

Concerning the water quality of springs, those in mainland Bali Island are regarded as good and suited for unrestricted beneficial use. On the other hand in Nusa Penida Island it is identified that there is at least one freshwater spring with good water quality named Guyangan Spring, though there may exist additional springs of good water quality. Still it is known that there are also springs either with high dissolved solids content (Sakti Spring) or saline (Angkal Spring) that is basically not suited as a potable source.

1.7 Water Supply for Domestic and Non-Domestic Uses

1.7.1 Water Supply System of Bali Province

(1) Water Supply Enterprises

In Bali Province, ten (10) enterprises, which are 9 PDAM (Persahaan Daerah Air Minum) and PT.TB (PT. Tirtaartha Buanamula), supply domestic and non-domestic water. PDAM is an exclusive water supply enterprise that is wholly owned by the regency/city government. Each regency/city has one PDAM to serve water in its own jurisdiction.

PT.TB is a joint-enterprise, whose 45 % of shares are owned by PDAM Badung and 55 % by two local firms and covers southern area of Badung regency. PT.TB has been awarded with 20-years' concession by Badung Regency Government since 1993.

Covering areas of 9 PDAMs and PT.TB as well as their headquarters are shown in Figure-II-1.9.

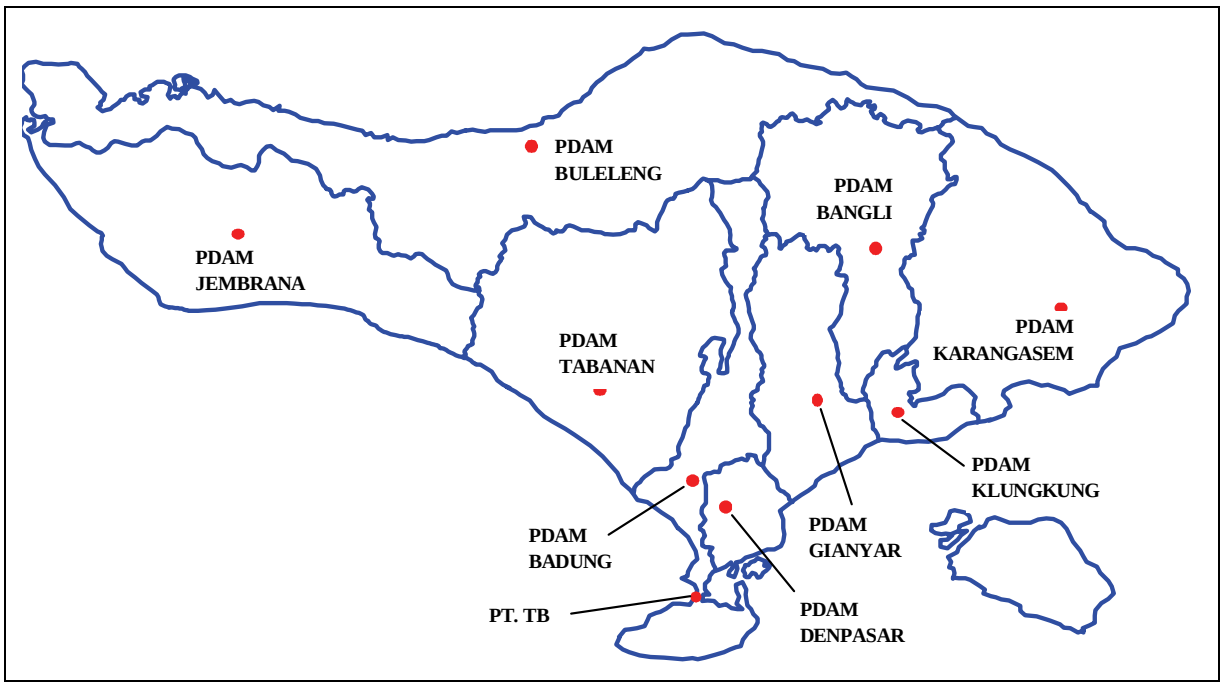


Figure-II-1.9 Covering Areas and Location Map of 9 PDAMs and PT.TB

(2) Water Sources

Table-II-1.29 shows the features of water sources of Bali Province, which are deep well water, spring water and river water, accounting respectively for 28 %, 32 % and 40 %.

Wells are only water source for PDAM Jembrana. Springs are main water source for PDAM Tabanan, Klungkung, Bangli and Buleleng. PDAM Gianyar uses both deep wells and springs for their water sources. Meanwhile, PDAM Badung, Denpasar and PT.TB, which have own large-scale water treatment plants in their districts, take water mainly from river.

(3) Water Supply

Table-II-1.29 shows that monthly supplied water of 9 PDAMs and PT.TB reached 6.6 million m^3 in 2004. However, it should be noted that the sum of PDAM Denpasar, Badung and PT.TB amounted to more than half of whole supply amount in Bali Province.

(4) Customer's Connections

Table-II-1.29 shows number of customer's connections was 250,000 in Bali Province, from which served population was estimated at 1.1 million persons, and service ratio at 34 % on average. Unaccounted water was characterized by low level of 23 % on average in Bali Province.

Table-II-1.29 Water Sources, Supplied Amount and Customers of PDAMs/PT.TB of 2004

PDAM	JEM[1)]	TAB[1)]	BAD	GIA	KLU[4)]		BAN[1)]	KAR	BLE[1)]	DEN	PT.TB	Total /Average
Water Sources (Upper row: No. of Water Intake, Lower row: Amount of Water Intake (liter/second))												
Wells	20	1	18	34	1	1	0	13	14	14	2	1,204 lit/s
	139	5	236	348	5	5	0	69	82	315	0	(28%)
Springs	0	22	8	29	4	1	15	8	14	0	0	1,360 lit/s
	0	458	79	214	75	20	120	82	312	0	0	(32%)
Rivers	0	4	0	0	1	0	0	9	0	3	2	1,734 lit/s
	0	81	0	0	130	0	0	73	0	800	650	(40%)
Total	20	27	26	63	6	2	15	30	28	17	4	4,298lit/s
	139	544	315	562	210	25	120	224	394	1,115	650	(100%)
Amount of Supplied Water on average (1000m3/month)												
Domestic	n/a	456	407	640	244		109	n/a	n/a	1,709	438	-
Commercial /Institution	n/a	87	38	69	12		8	n/a	n/a	371	130	-
Industry/hotel	n/a	6	4	15	11		-	n/a	n/a	42	355	-
Harbor & Others	n/a	-	-	-	-		-	n/a	n/a	-	18	-
Total	290	549	449	724	267		117	379	827	2,122	941	6,665
Total (lit/s)	112	212	173	279	103		45	146	319	819	363	2,571 lit/s
Related Information												
No. of Connection	14,181	33,050	19,943	39,855	16,382		8,528	15,377	25,767	61,887	16,788	252,658
House Connection	14,000[3)]	29,558	18,705	36,854	15,560		8,171	14,546	22,802	53,324	14,480	228,000
Served Population[2)]	70,000	147,790	93,525	184,270	77,800		40,855	72,730	114,010	266,620	72,400	1,140,000
Served Ratio	28%	38%	35%	44%	52%		20%	20%	19%	44%	65%	34%
Unaccounted water	18%	28%	24%	23%	19%		25%	28%	22%	21%	20%	23%
No of Employee	99	238	165	193	87		103	155	201	238	110	1,589

Note: 1) data of year 2003, 2) The served population was estimated by assuming the family size to be 5 persons. 3) House connections are estimated at 14,000. 4) Water sources of Klungkun are divided into 2 areas, "Klungkun-Bali" (left) and Nusa Penida (right).

Source: Study Team based on data and information from PDAMs and PT.TB

(5) Water Price

Based on the data and information collected, actual water price of PDAM Denpasar, Badung, Gianyar and PT.TB is estimated as shown in Table-II-1.30.

Table-II-1.30 Actual Water Price

Unit: Rp./m^3

Customer	PDAM			PT.TB
	Denpasar	Badung	Gianyar	
	Average of Year 2005	Average of Year 2005	Av. of Sept/Dec 2005	Average of Year 2005
Domestic	790	1,210	2,260	1,630
Industrial (including hotels)	3,200	6,840	6,430	7,620
Commercial/Public/Institutional	1,940	2,930	3,210	3,700
Average	1,040	1,460	2,470	4,090
Bulk Water Supply	-	1,310	1,150	1,250

Note: PDAM Badung and PT.TB raised water tariff from Jan. 2005, and PDAM Gianyar from Sept. 2005.

Source: Study Team based on the data and information of respective PDAMs and PT.TB

(6) Financial Conditions of PDAMs

Table-II-1.31 shows financial conditions of 9 PDAMs, which are obviously not sound. Only PDAM Bleleng resulted in surplus due to continuous low operation cost. PDAM Badung and Gianyar are expected to turn into surplus in 2005 due to tariff increase. The rest of PDAMs may continue to be in heavily loss. Furthermore, shareholders' equity account of 5 PDAMs has continuously been negative, which means accumulated losses have exceeded the capital account.

Every PDAM have owed long-term debt mostly to Central Government. According to the interview, Buleleng is the only PDAM that has continued repaying it; however, the rest PDAMs could not repay it caused by their bad financial conditions.

Financial data of PT.TB was not available. However, revenue of water sales of PT.TB could be estimated, by analyzing data of PT.TB, to reach Rp.40billion in 2005, of which more than 60 % might be generated by water sales to industry category including hotels.

Table-II-1.31 Financial Conditions of 9 PDAMs

Unit: million Rp

Items	JEM	TAB	BAD	GIA	KLU	BAN	KAR	BLE	DEN	Total
1. Revenue	4,201	6,235	17,196	15,362	4,745	1,695	4,512	10,922	30,406	95,274
2. Net Income	-1,171	-3,367	-4,868	-1,101	-1,078	-1,172	-1,209	1,161	-7,080	-19,885
(Ratio=2/1)	-28%	-54%	-28%	-7%	-23%	-69%	-27%	11%	-23%	-21%
3. Equity	-5,312	-7,387	17,300	4,897	-3,627	-1,947	1,555	6,407	-14,145	-2,259
4. Debt	5,025	7,719	28,138	13,234	3,639	4,067	1,115	3,653	50,439	117,029
(Ratio=4/1)	120%	124%	164%	86%	77%	240%	25%	33%	166%	123%

Note: 1) Year 2004 financial data for PDAM Denpasar, Badung and Gianyar, and Year 2003 financial data for the rest of PDAMs

2) Debt is sum of short-term debt and long-term debt including accumulated interest payable.

Source: Study Team based on financial data of 9 PDAMs

1.7.2 Present Water Consumption

(1) Customer Classification of and Consumption

Customers of PDAMs are classified into 15 categories as shown in Table-II-1.32. Water tariff rate is set also separately in line with the categories.

Table-II-1.32 Customer Classification of PDAMs

Category			Description
A		Public A & G	Public hydrant, public toilet
B		Public B	Schools and hospitals
D	D1	Household A1	Houses where 0-3.99 meters' width road exist in front
	D2	Household A2	Houses where 4-6.99 meters' width road exist in front
	D3	Household A3	Houses where 7-10 meters' width road exist in front
	D4	Household A4	Houses where more than 10 meters' width road exist in front
	D5	Household B	Houses where small industry exists together
	D6	Institution	Medium government office and other government agency.
E	E1	Small commercial	Kiosk, booth, shop, company office that there is a road which width is 4-6.99 meters in front of it.
	E2	Medium commercial	Kiosk, booth, shop, company office where 7-10 meters' road exist in front
	E3	Big commercial	Shopping complex, kiosk, booth, company office, supermarkets and public/private swimming pool that there is a road where more than 10 meters' width road exist in front
F	F1	Small industry	Handicraft, household craft and other small industry
	F2	Big industry	Star hotel, canning plant, ice plant, cold storage, beverage factory, big ranch, etc
H		Harbor/airport	
J		Special	

Source: Data and information from PDAMs

(2) Unit Consumption

(a) Domestic Water

The actual rate of 6 PDAMs and PT.TB is calculated based on the collected data and presented in Table-II-1.33.

The rate of PDAM Denpasar and PT.TB are more than 200 liter/person/day and the highest among others. PDAM Bangli is the lowest rate of 89 liter/person/day. Incidentally, though the data of PDAM Jembrana, Karangasem and Bleleng could not be obtained, the unit rate of these PDAMs is

considered to be the same as the rate of PDAM Tabanan and Klungkung, which are around 100 liter/person/day.

Table-II-1.33 Unit Consumption Rate of Domestic Water of 6 PDAMs in Year 2004

Item	Denpasar	Badung	PT.TB	Gianyar	Bangli	Tabanan	Klungkung
Litter/person/day	213	146	202	116	89	103	105

Source: Study Team based on data and information from PDAMs and PT.TB

(b) Commercial/public/Institutional Water

Commercial/public/institutional customers are categorized in A, B, D6, E1, E2, E3 and G. According to the data collected, the unit consumption rate of these categories in total is calculated as shown in Table-II-1.34. PDAM Denpasar was ranked the highest due to a lot of Government facilities existing in the area.

Incidentally, the ratio to domestic consumption varies from 30% of PT.TB, 20% of Denpasr and Tabanan, and 10% of the rest. This ratio indicates concentration magnitude of these categories in the respective area.

Table-II-1.34 Present Commercial/Social/Institutional Water Use

Items	Unit	Denpasar	Badung	PT.TB	Gianyar	Bangli	Tabanan	Klungkung
Connection	Number	8,275	1,210	-	2,659	-	-	-
Consumption	m^3/month	371	38	130	69	8	87	12
Unit Consumption Rate	Liter/day	1,494	1,047	-	865	-	-	-
Ratio to Domestic Consumption		21.7%	9.3%	29.7%	10.7%	7.3%	19.1%	4.9%

Source: Study Team based on data and information from PDAMs and PT.TB

(c) Industrial Water

Industry customers are categorized in F including hotels. According to the data collected, the unit consumption rate of the category is calculated as shown in Table-II-1.35. PDAM Denpasar was ranked the highest rate of 4,898 liter/industry/day. The ratio to domestic consumption indicates concentration magnitude of the category in the respective area. It is obvious that the industry sector, mostly hotel industries, is the important customer for PT.TB.

Table-II-1.35 Present Industrial Water Use

Items	Unit	Denpasar	Badung	PT.TB	Gianyar	Bangli	Tabanan	Klungkung
Connection	Number	287	29	-	322	-	-	287
Consumption	m^3/month	42	4	355	15	0	6	42
Unit Consumption	Liter/day	4,878	4,597	-	1,553	-	-	4,878
Ratio to Domestic Consumption		2.5%	1.0%	81.0%	2.3%	0%	1.3%	4.5%

Source: Study Team based on data and information from PDAMs and PT.T

1.8 Agriculture and Irrigation

1.8.1 Agricultural Area

According to Food Crops Agriculture Service of Bali Province, in the last 7 years more than 5,000 ha of paddy field have changed to other functions, such as residential area. The provincial average of decreasing rate is 1.01 %/year equivalent to loss of 870 ha/year. Since factors affecting the decrease in paddy area vary depending on local conditions, the paddy filed in Denpasar, Jembrana and Badung regencies have vanished at much higher rates than the provincial average. This decreasing tendency is mainly due to urbanization stimulated by tourism. See Table-II-1.36.

Table-II-1.36 Area Decrease in Paddy Field

(Unit: ha)

No.	Regency	1997	1998	1999	2000	2001	2002	2003	Average Decrease Ratio (%/year)
01	Jembrana	8,135	8,045	7,889	7,871	7,685	7,339	7,013	-2.44
02	Tabanan	23,836	23,464	23,414	23,358	23,154	22,842	22,639	-0.86
03	Badung	11,578	11,473	10,816	10,705	10,619	10,413	10,334	-1.88
04	Gianyar	15,323	15,227	15,203	15,169	14,966	14,945	14,937	-0.42
05	Klungkung	4,049	4,049	4,016	4,013	3,985	3,965	3,932	-0.49
06	Bangli	2,887	2,887	2,888	2,888	2,888	2,888	2,888	0.01
07	Karangasem	7,308	7,125	7,099	7,066	7,059	7,042	7,034	-0.63
08	Buleleng	11,420	11,361	11,581	11,559	11,472	11,245	11,011	-0.61
71	Denpasar	3,314	3,205	3,165	3,147	3,031	2,882	2,856	-2.45
Total		87,850	86,836	86,071	85,776	84,859	83,561	82,644	-1.01

Source: DINAS Pertanian Tanaman Pangan Propinsi Bali (Food Crops Agriculture Service of Bali Province)

1.8.2 Crop Cultivation

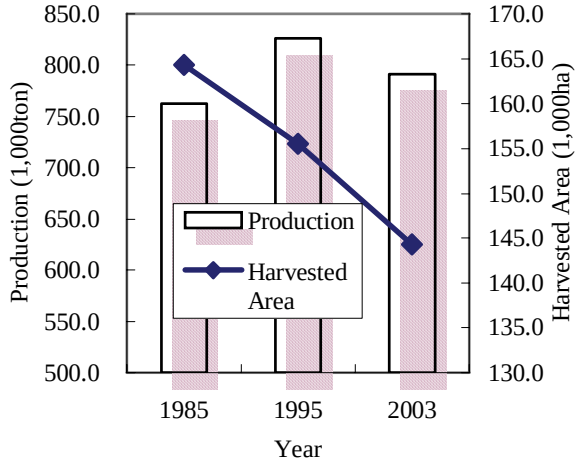
Wetland paddy dominates the crop cultivation in the Bali Province as staple food, followed by secondary food crops, such as maize, cassava, sweet potatoes and so on. Secondary food crops are commonly expressed as Palawija in Indonesian term, defining non-rice food crops.

(1) Paddy

Variation of production and harvested areas of wetland paddy in the last 20 years are shown in Figure-II-1.10. Significant change is a decrease in harvested area from 164,300 ha in 1985 to 144,300 ha in 2003. This is due to change in landuse from paddy field to non-agriculture use, such as housing. Although 20,000 ha of harvested area have vanished in the last twenty years, the annual production of wetland paddy in 2003 (792,000 ton) is larger than production in 1985 (763,000 ton).

This is explained by intensification of cropping. Productivity (husked rice) has improved from 4.6 ton/ha in 1985 to 5.5 ton/ha in 2003. Compared to the national average of Indonesia (4.2 ton/ha), paddy culture in Bali is well managed.

Tabanan Regency famous as rice storage and Gianyar Regency dominate the rice production in Bali, followed by Badung and Buleleng regencies. Since those 4 regencies benefit from water resources, particularly river discharge, paddy cultivation is conducted intensively by irrigation. In 2003, those regencies contribute to 26.2 %, 21.2 %, 14.7 % and 13.0 % of rice production, respectively. As a result, 75 % of rice (almost 600,000 ton) in Bali was produced in those 4 regencies



Year	Production (1,000 ton)	Harvested Area (1,000ha)	Productivity (ton/ha)
1985	762.8	164.3	4.60
1995	826.6	155.5	5.32
2003	791.6	144.3	5.49

Figure-II-1.10 Rice Production and Harvested Area in Bali

If 150 kg per capita/year (FAO estimate for rice consumption in Indonesia) is applied, the present production of husked rice in the Bali Province (792,000 ton) is sufficient to feed the whole population in Bali as shown in Figure-II-1.11. Thus, self sufficiency of staple food has been achieved.

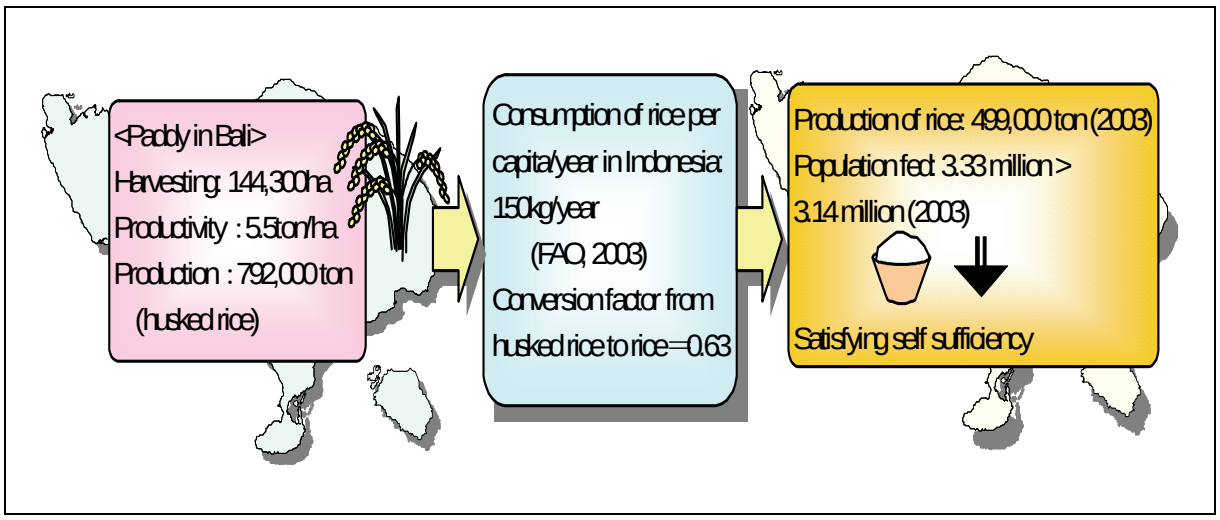


Figure-II-1.11 Self Sufficiency of Rice Production

(2) Palawija

Palawija, which is common Indonesian expression, is defined as non-rice food crops/ secondary food crops. It is cultivated in the paddy field and dry land. In the paddy field, palawija cultivation is practiced during the dry season when irrigation water for paddy is not available. It also benefits to avoid crop diseases and low fertility of soil induced by successive cultivation of rice. Food Crops Agriculture Service of Bali Province recommends a cropping sequence of two paddy followed by palawija even where the irrigation water is available. Unlike paddy, dominant regencies for palawija production are Karangasem, Bangli and Klungkung. See Table-II-1.37. Since those regencies have unfavorable conditions for paddy cultivation, such as lack of water and steep land, alternative crops are cultivated.

Table-II-1.37 Dominant Regencies of Palawija Cultivation

Regency/ Municipality		Production in 2003					
		Maize	Cassava	S. Potatoes	Peanuts	Soybeans	M. Beans
		85,952 ton	137,892 ton	64,885 ton	18,454 ton	7,836 ton	1,027 ton
		Ratio (%)	Ratio (%)	Ratio (%)	Ratio (%)	Ratio (%)	Ratio (%)
1	Jembrana	2.2	0.8	0.4	0.7	**27.0**	**22.4**
2	Tabanan	1.6	0.6	3.9	0.3	5.8	1.0
3	Badung	1.6	2.5	9.8	6.4	**27.5**	0.2
4	Gianyar	1.5	3.0	9.0	6.2	**10.2**	0.7
5	Klungkung	**18.6**	**22.1**	3.1	**26.8**	**14.0**	0.0
6	Bangli	8.8	**11.9**	**43.2**	8.6	0.5	0.0
7	Karangasem	**23.0**	**54.1**	**29.9**	**40.9**	2.2	**41.1**
8	Buleleng	**42.6**	5.0	0.7	**10.0**	3.4	**34.6**
9	Denpasar	0.1	0.0	0.0	0.1	9.4	0.0
Total		100.0	100.0	100.0	100.0	100.0	100.0

Source: BPS Statistics of Bali Province and calculation by the JICA Study Team
S. Potatoes: Sweet Potatoes, M. Beans: Mung Beans

(3) Fruit Culture

In Bali, there is a wide variety of fruit culture. If fruits are categorized by production, major fruits whose productions exceed 50,000 ton/year are banana, orange, mango and watermelon as shown in

Table-II-1.38.

Table-II-1.38 Dominant Regencies of Fruit Culture

Major Fruits in Bali	Production in 2003 (ton)	Major Producing Regencies with Contribution (%)					
Banana	102,158	Bangli	39.3	Jembrana	24.1	Buleleng	17.6
Orange	71,391	Bangli	65.3	Badung	24.8	Buleleng	8.3
Mango	55,979	Buleleng	85.4	Bangli	4.7	Karangasem	4.7
Watermelon	54,089	Jembrana	48.6	Denpasar	41.4	Gianyar	4.8
Salacia	34,546	Karangasem	94.1	Bangli	5	Buleleng	0.5
Jack fruit	16,085	Bangli	42.6	Buleleng	34.2	Gianyar	7.6
Rambutan	13,416	Buleleng	74.1	Gianyar	7.7	Tabanan	4.7
Grape	11,069	Buleleng	100.0				
Papaya	10,595	Gianyar	29.2	Buleleng	22.8	Bangli	16.1

Sources: Bali in Figures 2003, BPS Statistics

According to Bali in Figures 2003 (BPS Statistics), banana and orange amounting to 102,000 ton and 71,000 ton respectively are major commodities of Bali society because of use in a great number of religious ceremonies. Other fruit cultures are durian, sepadile, pineapple, avocado, faidium guajava and melon but their productions are limited to less than 7,000 ton/year. Bangli and Buleleng regencies dominate the fruit culture in Bali. Bangli Regency contributes to almost 40 % of banana, 65 % of orange and 43 % of jack-fruit productions, while Buleleng Regency leads mango, rambutan and grape productions.

(4) Horticulture

Table-II-1.39 shows vegetable culture (horticulture) whose productions exceed 10,000 ton/year and dominant producing regencies based on the data in 2003. As long as productions are considered, cabbage, tomato, chili and mustard green are major horticulture in Bali, followed by onion, string beans, kangkung and cucumber. Other vegetables with limited productions (less than 10,000 ton/year) are green beans, potatoes, carrot, spring onions, garlic and egg plant.

Like paddy cultivation, Tabanan Regency dominates horticulture, particularly cabbage, tomato and cucumber whose contributions to provincial production are 68.0 %, 88.1 % and 51.1 % respectively. Tabanan Regency can be named for not only rice but also vegetable storage due to rich agricultural land in terms of water availability, soil fertility and topography.

Table-II-1.39 Dominant Regencies of Horticulture

Vegetables	Production in 2003 (ton)	Major Producing Regencies with Contribution (%)					
Cabbage	51,189	Tabanan	68.0	Bangli	23.7	Buleleng	7.6
Tomato	43,788	Tabanan	88.1	Bangli	9.5	Badung	0.8
Chili	40,478	Tabanan	32.7	Karangasem	23.2	Klungkung	15.8
Mustard Green	35,341	Jembrana	65.9	Buleleng	28.6	Gianyar	2.8
Shallot	10,845	Bangli	80.2	Karangasem	18.7	Buleleng	0.7
String Beans	10,822	Karangasem	45.9	Klungkung	20.6	Tabanan	12.3
Kangkung	10,535	Gianyar	32.8	Denpasar	31.3	Klungkung	14.4
Cucumber	10,321	Tabanan	51.1	Jembrana	23.6	Klungkung	13.9

Kangkung (Indonesia name): Impomea Reptans in English
Source: Bali in Figures 2003, BPS Statistics

(5) Estate Crops

Estate crops/plantation in Bali are mainly coconut, coffee (Arabic and Robusta), clove, cashew and tobacco. In general, these crops have a high export opportunity but simultaneously there are many competitors internally and externally. Table-II-1.40 shows planted area of estate crops in the last twenty years.

Table-II-1.40 Area of Estate Crops

Unit: ha

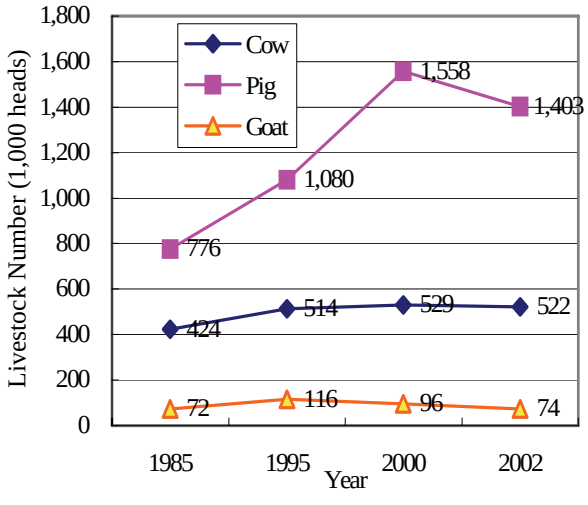
Year	Coconut	Coffee	Clove	Vanilla	Cashew	Tobacco
2003	73,968	36,335	19,668	474	10,738	849
2000	74,652	42,028	22,475	370	15,266	NA
1995	72,534	40,000	29,940	1,836	16,470	1,964
1985	70,340	28,771	29,131	3,817	12,376	1,645

Source: BPS Statistics but original from Estate Service of Bali Province
1) NA: not available, 2) Coconut, coffee and tobacco includes all types.

Coconut and coffee have stable areas; however, areas for other estate crops, particularly vanilla and tobacco, have been decreased. Compared to areas in 1985, areas for vanilla and tobacco in 2003 are limited to only 12 % and 52 %. A decline tendency is considered due to change in demands and result of market competition. Estate crops in Bali are mostly owned by smallholders and there are only 4 large plantations. 4 plantations own 835 ha of coconut area only, while the rest of area (more than 73,000 ha) is owned by 200,000 households with an average area of 0.4 ha.

1.8.3 Livestock

Cow, pig, goat and poultry dominate livestock in Bali from population point of view. As shown in Figure-II-1.12, population of pig had steadily increased until 2000 and reached 1,558,000 heads that is double the population in 1985. On the contrary, populations of cow and goat have been almost constant over the last twenty years at 500,000 and 90,000 heads respectively. Poultry, consisting of mostly chicken and a little of duck (less than 10 %), has increased almost double compared to population in 1985 and maintained at 10 million heads. Cow, pig, goat and poultry are for meet production and dairy cow are very rare, ten's order in population.



unit: 1,000 heads

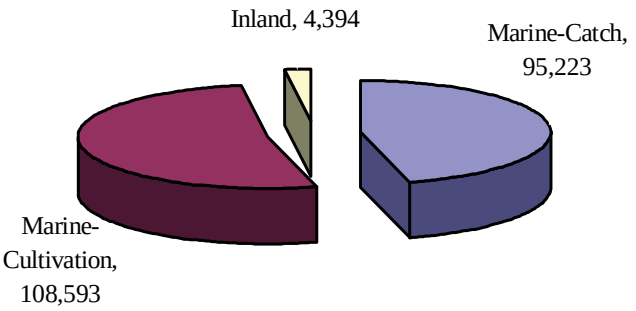
Year	1985	1995	2000	2002
Buffalo	5.6	7.8	11.1	8.4
Horse	0.7	0.9	1.4	1.8
Sheep	0.4	0.1	0.2	0.6
Poultry	5,791	10,728	10,347	10,333

Source: BPS Statistics but original from Livestock Sevice of Bali Province

Figure-II-1.12 Livestock Population

1.8.4 Fishery

Marine fishery dominates the fish production in Bali and its production in 2003 amounted to 204,000 ton equivalent to 97.9 % of the total production. More than half of marine fish production depends on fish cultivation (53.3 %). The fish cultivation is mostly practiced in Klungkung Regency and its share in 2003 reached 95.5 % (103,726 ton). A catch (95,000 ton) is mostly landed in Jembrana, (43.9 %), Denpasar (31.4 %) and Buleleng (8.9 %) because of access to fishing spots and markets. See Figure-II-1.13.



Unit: ton

Fishery Type		Production in 2003
Maine	Catch	95,223
	Cultivation	108,593
Inland		4,394
Total		208,210

Source: BPS Statistics but original from Fisheries Service of Bali Province

Figure-II-1.13 Fish Production in 2003

On the contrary, inland fishery including catch and cultivation contributes to only 2.1 % of total fish production in 2003. Since Bali is benefited from sea, fishery and market are oriented toward marine fishery. Thus, inland fishery is negligibly small in terms of market and production.

1.8.5 Irrigation

(1) Agencies associated with Irrigation

There are several central and local government agencies associated with irrigation in Bali, while subak, which is distinct water users associations in Bali, manages irrigation water distribution to farmers. Tasks and duties of each governmental agencies and subak are summarized in Table-II-1.41. In general, government agencies are responsible for improvement of irrigation facilities and farming technology. On the other hand, subak is responsible for water distribution and cropping in the field.

Table-II-1.41 Agencies involved in Bali Irrigation

Category	Name of Agency	Tasks and Duties on Irrigation
Provincial Government/ Regency Government	Public Works Service	◆ O/M of irrigation facilities belonging to government, such as weirs, primary and secondary canals and so on.
	Food Crops Agriculture Service	◆ Agriculture planning ◆ Technology development for farming ◆ Extension service
Central Government	Bali Irrigation Project	◆ Development of irrigation schemes ◆ Rehabilitation of irrigation schemes
Private	*Subak*	◆ Irrigation management, such as water allocation, water rotation, O/M of irrigation facilities ◆ Cropping management, such as determination of cropping schedule, cropping pattern etc. ◆ Traditional/religious ceremonies

Subak is based on the philosophy (Tri Hita Karana) that happiness can be fulfilled when the Creator, people and nature are in harmony. Therefore, its activities are related to not only water use but also tradition and religion. This matter is clearly specified in Bali Province local regulations, No.02/PD/DPRD/1972, that defines subak as "customary law societies with socio-agrarian-religious nature which were established since long time ago and developed continuously as landholding organizations in the sphere of water distribution and other for rice fields in one irrigation area" (SUBAK in Bali, Public Works Service of Bali Province, 1997).

According to "Subak Irrigation System in Bali" (A. Hafied A. Gany, KIMPRASWIL, 2001), the total number of subak in Bali increased from 1,193 subaks in 1971 to 1,410 subaks in 1993. Although the coverage of each subak ranges from 10 ha to 800 ha (Subak Aseman), an average coverage is 100 ha.

(2) Irrigation Crops

Wetland paddy dominates irrigation in Bali and an application of irrigation to other crops, such as fruit

culture and horticulture, is negligibly small in terms of area and water consumption. Therefore, cropping pattern and calendar of wetland paddy was analyzed as the irrigation crop in the Bali Province.

Transplanting areas of paddy are available in "Statistics of Agriculture of Food Crops in 2003 (Statistik Pertanian Tanaman Pangan Tahun 2003)", Food Crops Agriculture Service of Bali Province. Seasonal variation of transplanting areas explains regional characteristics of cropping calendar. Transplanting of first paddy starts in November/December and successively its area reaches the peak in January/February. Second paddy and third paddy start in May/June and in August/September, respectively.

Cropping pattern and intensities in paddy field were identified from the agriculture data from regency. Each year, an agriculture service of regency surveys crop intensities for 13 typical cropping patterns in paddy field. Based on the regency data in 2003, crop intensities and cropping pattern were identified as shown in Table-II-1.42 and successively crop intensity was calculated. There is some discrepancy in crop intensities between the Study Team and Food Crops Agriculture Service of Bali Province (herein after referred as DINAS Agriculture). This is due to adjustment of areas with cropping pattern adopted from regencies to total paddy area of regency adopted from Food Crops Agriculture Service of Bali Province. Since the data quite varies depending on the source, the adjustment is often necessary. Considering the yearly variation of cropping pattern, this discrepancy is considered as allowable level.

Table-II-1.42 Cropping Pattern and Crop Intensities in Paddy Field (2003)

No.	Regency	Paddy Area in 2003 (ha)	Cropping Pattern (% to Total Area)				Crop Intensity (%)	
			3 crops/ year	2 crops /year	1 crop /year	Fallow /Others	JICA Study Team	DINAS AGRI.
1	Jembrana	7,013	21.7	53.0	20.2	5.1	191.3	186.82
2	Tabanan	22,639	35.9	57.1	5.0	2.0	226.9	227.02
3	Badung	10,334	85.8	10.7	2.0	1.5	280.8	225.82
4	Gianyar	14,937	39.9	49.5	6.8	3.8	225.5	231.95
5	Klungkung	3,932	84.6	9.0	6.4	0.0	278.2	269.07
6	Bangli	2,888	83.4	16.6	0.0	0.0	283.4	251.00
7	Karangasem	7,034	83.8	9.9	3.2	3.1	274.4	243.82
8	Buleleng	11,011	77.0	22.5	0.2	0.3	276.2	213.83
71	Denpasar	2,856	53.8	31.8	4.2	10.2	229.2	262.92
Total		82,644					245.5	228.10

Source: Report on Cropping Pattern in Paddy Fields in 2003 from 8 regencies and Denpasar for "Cropping Pattern"
Food Crops Agriculture Service of Bali Province for "Paddy Area in 2003"
"Crop Intensity JICA Study Team": calculation based on the data collected
"Crop Intensity DINAS AGRI": Statistics of Food Crops Agriculture 2003 (Statistik Pertanian Tanaman Pangan Tahun 2003, DINAS Pertanian Tanaman Pangan Propinsi Bali)

Crop intensity in paddy field includes not only number of paddy culture per year but also other crop cultures, such as palawija and vegetables. The crop intensity in the Bali Province is almost 250 %. Spatial characteristics of cropping pattern are distinct. In Badung, Klungkung, Bangli, Karangasem and Buleleng, 3 cropping (3 paddy/2 paddy + palawija) dominates cultivation in paddy field, while 2 cropping (2 paddy and fallow) dominates in Jembrana, Tabanan and Gianyar regencies. The cropping pattern in Denpasar has a wide range due to crop diversification.

(3) Irrigation Method

Paddy area (sawah) is available in DINAS PU (Public Works Service of Bali Province) and DINAS PTPP (Food Crops Agriculture Service of Bali Province); however, DINAS PU counts the paddy area in terms of irrigation facilities, while DINAS PTPP counts the paddy area actually cultivated. Besides, different use of the terminology makes the paddy area more complicated. Therefore, the paddy areas between 2 agencies deviate more than 10,000 ha. Through the discussion with DINAS PU and DINAS PTPP, the present paddy area has been determined as shown in Table-II-1.43.

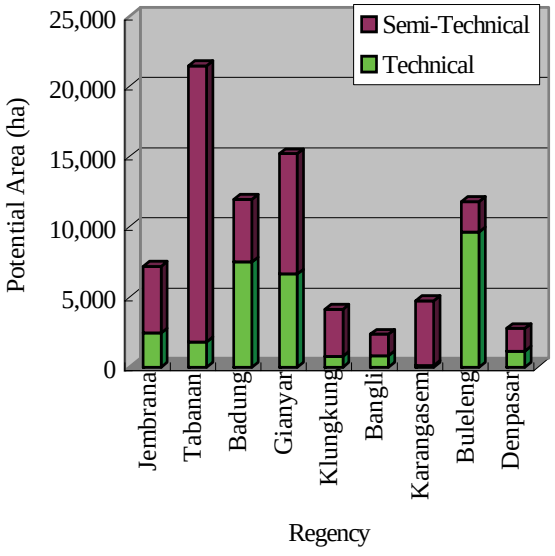
Table-II-1.43 Present Area of Paddy Field

Regency	Potential Area (ha)			Functional Area (ha)
	Gov.	Non-Gov.	Total	
JEMBRANA	7,195	1,849	9,044	7,013
TABANAN	21,464	1,997	23,461	22,639
BADUNG	11,961	106	12,067	10,334
GIANYAR	15,187	2,022	17,209	14,937
KLUNGKUNG	4,126	304	4,430	3,932
BANGLI	2,334	957	3,291	2,888
KARANGASEM	4,714	3,710	8,424	7,034
BULELENG	11,807	2,403	14,210	11,011
DENPASAR	2,762	0	2,762	2,856
Total	81,550	13,348	94,898	82,644

Gov.: Government Scheme, Non-Gov.: Non-government Scheme, Functional Area: paddy area cultivated in 2003
Source: Public Works Service of Bali Province for "Potential Area" in 2004
Statistics of Food Crops Agriculture in 2003 (Food Crops Agriculture Service of Bali Province) for "Functional Area" in 2003

Table-II-1.43 summarizes physical areas of paddy field but not transplanting/seeding areas. Potential area is defined as the maximum irrigable area in terms of irrigation facilities. It implies that an application of irrigation can extend to 94,898 ha as long as there is sufficient water. However, in 2003, 82,644 ha of paddy field out of 94,898 ha (potential area) were cultivated, including paddy and other crops, such as palawija and vegetables. Irrigation is normally applied to only the paddy culture in Bali. Therefore, more than 80,000 ha of paddy field were irrigated in 2003. In average, 86 % of irrigable paddy field belong to the government schemes and have either technical or semi-technical irrigation system, while non-government schemes with primitive irrigation system is limited to 14 %. It means that an improvement of irrigation system has extended at high rate and this is one of the reason that Bali has high productivity of rice, 5.5 ton/ha.

Figure-II-1.14 shows ratios of technical and semi-technical irrigation systems in government schemes. Although the data describes ratios of irrigation systems in 2000, it is assumed as the present system classification. More than 40 % of irrigation systems are the technical in Badung, Gianyar, Buleleng and Denpasar, while almost all systems are the semi-technical in Tabanan and Karangasem (more than 90 %).



Potential Area (Government Scheme)

	System (%)		Area Total (ha)
	Technical	Semi-Technical	
Jembrana	33.4	66.6	7,195
Tabanan	8.3	91.7	21,464
Badung	62.6	37.4	11,961
Gianyar	43.5	56.5	15,187
Klungkung	18.8	81.2	4,126
Bangli	34.2	65.8	2,334
Karangasem	2.7	97.3	4,714
Buleleng	81.5	18.5	11,807
Denpasar	40.7	59.3	2,762
Total	37.6	62.4	81,550

Source:
System (%): "Rekapitulasi Daftar Inventarisasi Jaringan Irigasi Pemerintah", DINAS PU, 2002
Area Total: DINAS PU in 2004

Figure-II-1.14 System Classification of Potential Area in Government Scheme

Table-II-1.44 specifies the water resources of irrigation in 2000.

Table-II-1.44 Water Resources of Irrigation

(Unit: number of use)

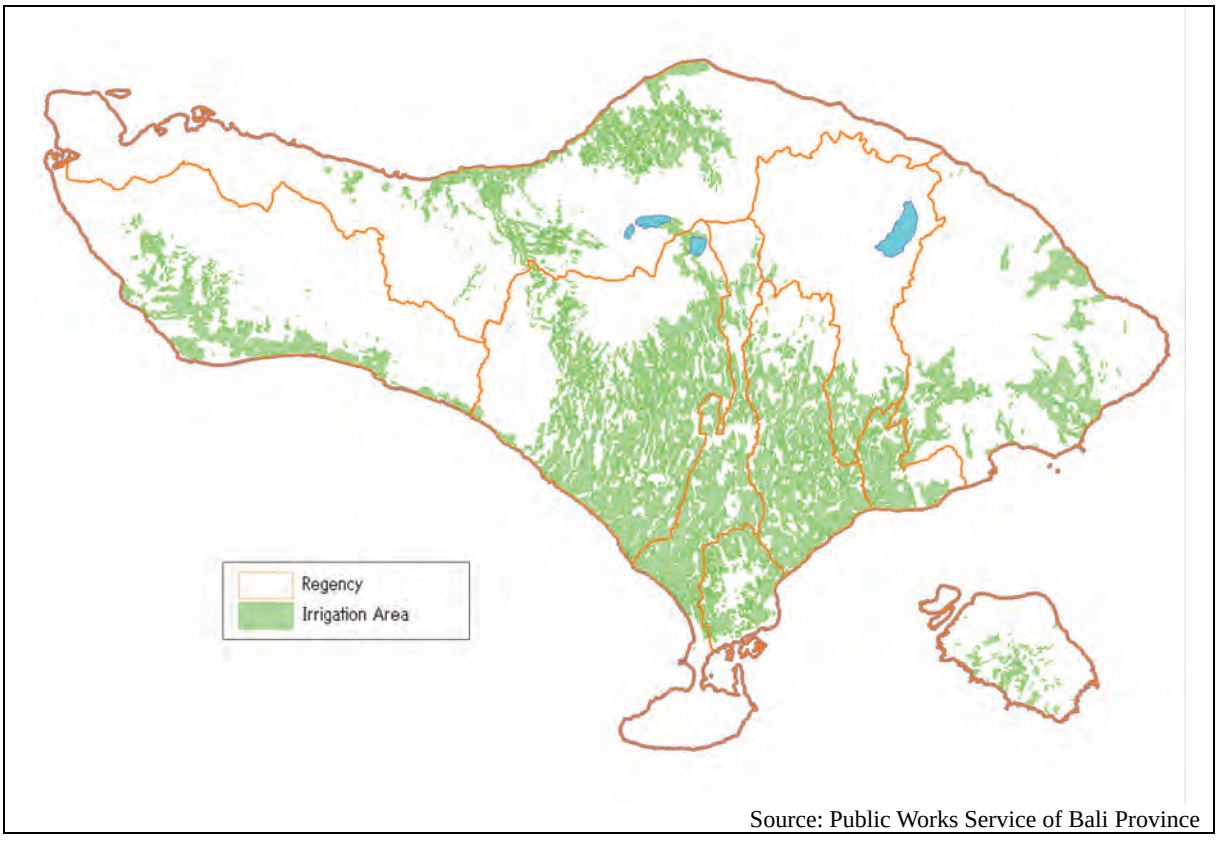
Regency	Government		Non-Government		
	River	Groundwater	River	Spring	Groundwater
JEMBRANA	34	8*	17	2	14
TABANAN	95	0	123	22	0
BADUNG	19	0	0	6	0
GIANYAR	44	0	78	6	0
KLUNGKUNG	20	0	NA	NA	NA
BANGLI	27	0	11	1	0
KARANGASEM	49	0	72	16	0
BULELENG	47	0	102	20	2
DENPASAR	12	0	0	0	0
Total	347	8*	403	73	16

River: number of weirs/free intakes, Groundwater: number of wells, *: deep wells, Spring: number of springs

Source: "Rekapitulasi Daftar Inventarisasi Jaringan Irigasi Desa", DINAS PU (Public Works Service of Bali Province), 2002, but the data in 2000

Although the area irrigated by each water resources is unknown, it can be concluded that dominant water resource of irrigation is surface water (river water) because only 8 wells are utilized for the government schemes that cover 86 % of provincial paddy field. Since the non-government scheme is normally at small scale with primitive infrastructures, their water resources include river, groundwater and even spring water. Groundwater use for irrigation is limited to Jembrana and Buleleng regencies.

Although exact boundaries of irrigation schemes (a group of paddy field using the same water resources, such as weir, free intake, well etc.) or locations of irrigation schemes are not available, there is a map to show the extension of wetland paddy field. As shown in Figure-II-1.15, most of the paddy field is located extensively in Tabanan, Badung, Gianyar and Buleleng regencies and this extension is consistent with figures in Table-II-1.40 that the total area of paddy field in these 4 regencies covers 70 % of the provincial functional area.



Source: Public Works Service of Bali Province

Figure-II-1.15 Wetland Paddy Field in Bali

(4) Irrigation Rehabilitation and Development

Since 1980s, tremendous rehabilitation works of irrigation facilities have been continuously conducted, using internal and external funds. For example, the Bali Irrigation Sector Project funded by ADB (Asian Development Bank) loan was conducted for 10 years from 1981 to 1989. APBN (national budget) has also applied continuously to improve irrigation facilities. Rehabilitation works improve irrigation efficiency by means of upgrading structures, aiming improvement of crop intensities, crop productivity, and water management. As a result of rehabilitation works, the government scheme covers 86 % of paddy field with technical and semi-technical irrigation system.

Recently, two projects, "Decentralize Irrigation System Improvement Project in Eastern Region of Indonesia" and "Sustainable Development of Irrigated Agriculture in Buleleng and Karangasem", are ongoing. Those projects intend not only rehabilitation but also development of new irrigation schemes using groundwater. However, as shown in Table-II-1.45, the target area of new irrigation schemes is at the order of several hundred ha. It means that the potential area for a new irrigation scheme is very limited in terms of availability of arable land and water resources.

Table-II-1.45 Recent Projects of Irrigation Rehabilitation and Development

Project Name	Decentralize Irrigation System Improvement Project in Eastern Region of Indonesia	Groundwater Development Project for Irrigation and Drinking Water in North Bali	Sustainable Development of Irrigated Agriculture in Buleleng and Karangasem
Budget	JBIC Loan IP-509	European Union (EU)	European Union (EU)
Executing Agency	Directorate General of Water Resources	Bali Irrigation Project	Bali Irrigation Project
Period	2003 – 2007 (ongoing)	1993 – 1999 (completed)	2003 – 2006 (ongoing)
Scope	1) Irrigation improvement for existing schemes constructed in 1980s by APBN (national budget) 2) Groundwater development for new irrigation schemes 3) Establishment / strengthening of WUAs	1) Mapping, groundwater study 2) Well and pipe networks construction 3) Agriculture development 4) Management information system	1) Establishment of irrigation system for 15 production wells drilled in Phase I. 2) Drilling of 9 wells with irrigation system 3) Re-drilling of 2 wells which has a technical problem (discharges < 10 liter/sec)
Site/ Water Resources	The project site is selected from the followings after the study. Regency River <Irrigation Improvement> 1) Jembran- Dava 1,047 2) Tabanan Ye Hoo 2,488 3) Badung Ayung 888 Sungi 3,999 4) Gianyar Sangsang 888 5) Klungkung Bubuh & Bangli 948 6) Karangasem Unda 1,932 7) Buleleng Saba 1,915 <Groundwater Development> 1) Jembrana 150 2) Karangasem 100 3) Buleleng 150	- Project areas were spread in Buleleng and Karangasem Regencies. - The groundwater development study was conducted in 90 locations with a total area of 1,500 ha. - After the study, 15 production wells with irrigation system and 15 production wells without irrigation system were constructed. - 15 locations for irrigation are 13 in Buleleng Regency and 2 in Karangasem Regency. - The total service area of irrigation is 240 ha.	This is a continuation project of NBGIWSP (North Bali Groundwater Irrigation and Water Supply) - Irrigation systems for 15 production wells drilled in Phase I: 12 locations in Buleleng and 3 locations in Karangasem - 9 production wells with irrigation system: 4 locations in Buleleng and 5 locations in Karangasem - Re-drilling of 2 wells in Buleleng
Total Project Area (ha)	- Irrigation Improvement: 9,920 ha - Groundwater Development: 500 ha	Irrigation development: 240 ha	
Data Source	Inception Report on Consulting Services for DISIMP, October 2003, Nippon Koei, DGWR	The Activity Summary of Groundwater Development, March 2000, Bali Irrigation Project	Project Summary

JBIC: Japan Bank for International Cooperation

1.9 Government Institutions on Water Resources in Bali

(1) Overview

This section reviews key features of the existing government institutions, centering on water resources related functions of Dinas PU both at provincial and regency levels. Other organizations related to water supply, environment, forestry, and revenue collection are included in the analysis to the extent relevant.

In other parts of Indonesia, there have been two types of institutions introduced to manage water resources in recent years: (i) state-owned corporations called Perum Jasa Tirta (PJT) established in large river basins and (ii) water resources management offices called Balai PSDA formed as part of the existing Dinas in smaller river basins. Two PJTs operate in Java (in the Brantas and Citarum river basins) and a third PJT is currently under consideration. The key to the success of the corporatization approach is revenue generation. Where the revenue generation potential is less, Balai PSDAs have been created in over 40 river basins (or river basins units) in Java, Sulawesi and Sumatra to be in charge of technical implementation (as opposed to policy, regulatory and administrative functions of the Dinas). In either case, comprehensive river basin management is yet to be achieved, as it will require consolidation of authorities over all water resources related activities including watershed, forestry conservation, which is politically unfeasible at least for the short to medium term. What has been going on instead in the two institutional innovations is the consolidation and rationalization of functions that are more directly related to water resources.

In Bali, some discussion took place a few years ago on the possible introduction of Balai PSDAs, but has not resulted in any decision. The features and issues of the existing institutional arrangement must be understood clearly. The key features and issues are:

- The jurisdictions over water resources management between the province and the regencies/city are not clearly defined and different interpretations prevail.
- The roles and responsibilities of Dinas PU/Sub-Dinas SDAPP vis-à-vis those of other WR related organizations are sometimes not clearly defined. Coordination between relevant government offices can be more systematized and duplications need to be reduced.
- In Sub-Dinas SDAPP of Dinas PU, part of routine technical activities is still conducted by APBN work units using the central government budget, and not by the Sub-Dinas using the provincial government budget.

(2) Existing Allocation of Water Resources Management Responsibilities

Elaborating on the three key features mentioned above, the allocation of major water resources related responsibilities in the exiting institutional framework is described below.

<Construction and O&M of Facilities: Table-II-1.46>

Water resources related facilities at the provincial and regency/city levels are much dependent on the central government in terms of budget and asset ownership (though the province is becoming increasing responsible for O&M budget). Water supply and drainage facilities are included in this matrix, as they need to be considered as integral part of the water supply capacity.

Table-II-1.46 Allocation of WRM Responsibility (Construction and O&M)

Responsibilities	Central Gov't	Province		Regency/City	
		APBN	APBD I	APBN	APBD II
Construction and O&M : Dinas PU/Sub-Dinas SDAPP; Sub-Dinas TRP					
Construction					
• WR development	X (APBN projects -Sub-Din SDAPP)		x		
• Flood control & coastal protection	X (APBN projects –Sub-Din SDAPP)		x		
• Irrigation facilities	X (within regency/city – ABPN projects-Sub-Din SDAPP)		X (trans-regency/city – Sub-Din DAPP)		x
• Beach Conservation	X (APBN projects –Sub-Din SDAPP)		x		x
• Water supply	X (APBN projects-Sub-Din TRP)				
• Waste water	X (APBN projects-Sub-Din TRP)				
O&M					
• WR development	X (APBN projects-Sub-Din SDAPP)		x		
• Flood control & coastal protection	X (APBN projects-Sub-Din SDAPP)		x		
• Irrigation facilities			X	X	X
• Water supply					X - *PDAM*
• Waste water		*Will be managed by a new regional entity.*			

Responsibilities	Central Gov't	Province		Regency/City	
		APBN	APBD I	APBN	APBD II
Asset ownership	X (All WR facilities constructed by APBN projects still belong to the projects, i.e., the legal ownership is with the central government)				X - *PDAM*

Source: Interviews by Study Team

<Water Quantity Management: Table-II-1.47>

Water quantity monitoring is mostly handled by the Hydrology Office of the Bali Water Resources Development and Management Project. Regency/City Dinas PU is also engaged in water quantity data collection to some extent but there is no particular mechanism to send the data to Provincial Dinas PU. Also, there is no systematic data sharing by BMG or BP-DAS Unda Anyar (of the Ministry of Forestry).

Table-II-1.47 Allocation of WRM Responsibility (Water Quantity Management)

Responsibilities	Central Gov't	Province		Regency/City	
		APBN	APBD I	APBN	APBD II
Water quantity monitoring: BMG, BP-DAS Unda Anyar, DinasPU/Sub-Dinas SDAPP					
Meteorological data	X (by BMG)				
	X (by BP-DAS Unda Anyar)				
	X (by APBN project-Sub-Din SDAPP)				
Hydrometric data	X (by ABPN project-Sub-Din SDAPP)				X (depends)

Source: Interviews by Study Team

<Water Quality Management: Table-II-1.48>

Water quality monitoring is conducted by both Provincial Dinas PU (by the Hydrology Office of the Bali Water Resources Development and Management Project and by Technical Planning Section of Sub-Dinas SDAPP) and BAPEDALDA. Provincial Dinas PU monitors the quality of 60 rivers, while BAPEDALDA monitors 21 rivers every year. Both send the sampling data to universities for an analysis and study. UPTD of Dinas PU has Water Quality Examination Section but has not received any request yet due to the limitation of their capacity to conduct evaluation of the analysis results. Dinas PU and BAPEDALDA share the information with each other, but reporting is done separately. Water quality standards are in place but the enforcement is a problem. While the monitoring system is in place, an effective water quality control system is virtually non-existent.

Table-II-1.48 Allocation of WRM Responsibility (Water Quality Management)

Responsibilities	Central Gov't	Province		Regency/City	
		APBN	APBD I	APBN	APBD II
Water quality monitoring: Dinas PU/Sub-Dinas SDAPP, BAPEDALDA					
21 rivers			X (BAPEDALDA)		
60 rivers	X (by APBN project-Sub-Din SDAPP)		X (Sub-Din SDAPP)		
Other rivers					X (depends)
River water pollution control			X (BAPEDALDA -- Prokashi)		
Drinking (tap) water					X (Dinas Health)

Source: Interviews by Study Team

<Licensing for Raw Water Use: Table-II-1.49>

Commercial use of raw water requires a license. For the use of surface water, the head of Provincial Dinas PU issues licenses on behalf of the governor after technical assessment by a team chaired by the head of Sub-Dinas Program and Control. The licensing authority for groundwater and spring has been transferred to the regencies/city (though most of the regencies/city have not exercised the authority yet, and many officials are not even aware of the authority transfer). Provincial Dinas PU's Groundwater Section (Sub-Dinas Mining) is supposed to conduct technical assessment for the regencies/city before issuing a license.

Table-II-1.49 Allocation of WRM Responsibility (Licensing for Raw Water Use)

Responsibilities	Central Gov't	Province		Regency/City	
		APBN	APBD I	APBN	APBD II
Licensing: Dinas PU/Sub-Dinas SDAPP, Sub-Dinas Mining, Sub-Dinas Program and Control					
Surface water			X (Dinas PU/ Team chaired by Sub-Din Program & Control)		
Ground water			x (technical assessment)		X (since 2005)
Spring water			x (technical assessment)		X (since 2005)

Source: Interviews by Study Team

<Charges on Raw Water Use: Table-II-1.50>

Licenses for raw water use are valid for three years. When they are issued and renewed, fees are collected by the respective license issuing offices. The authority to charge for the use of raw water (both groundwater/spring and surface water) is now with the Provincial Dinas Revenue (DISPENDA), which collects provincial tax (70% of which are distributed to the regencies/city). DISPENDA doesn't have access to the water license information (that is supposed to be maintained by Provincial Dinas PU and Regency/City Dinas PU) but has its own database and investigation capacity at its UPTD located in each regency/city. The annual collection target set by DISPENDA for 2005 is Rp.7,500 million (out of which Rp.2,655 million has been collected as of May 2005). Both the fees and taxes are transmitted to the local government treasury and become part of the local government revenue.

Table-II-1.50 Allocation of WRM Responsibility (Charges for Raw Water Use)

Responsibilities	Central Gov't	Province		Regency/City	
		APBN	APBD I	APBN	APBD II
Charges on raw water use: Dinas PU, DISPENDA					
Licensing fees on surface water			X (Dinas PU)		
Licensing fees on groundwater and spring					X (since 2005)
Tax on commercial use of surface, ground and spring water			X (DISPENDA)		

Source: Interviews by Study Team

<Flood Control>

Flood control is at the provincial level and focuses on mitigations. Flood control related construction takes place under three projects of Provincial Dinas PU (South Bali Beach, Flood Control and Coastal Protection, and Water Resources Development and Management), which look after O&M as well. Financing arrangements for O&M are now under consideration. Land use regulations for flood-prone areas are provided as part of the provincial spatial plan (updated in 2005) but lack clarity and thus enforceability. Forecasting, warning and evacuation systems are yet to be in place.

<Land Use of River Border Areas: Table-II-1.51>

The definitions of river border areas are provided both in the Public Works Ministry Reuglation No.63/1993 and followed by Provincial and Regency/City Dinas PU. Another set of definitions are available in the Bali provincial regulation on the spatial plan (updated in 2005), which exist only on paper. More specifc, river-wise regulations have been introduced in Denpasar. Monitoring is by Dinas Tata Kota in Denpasar and Dinas PU/Sub-Dinas TRP in Badung (both of which are responsible for issuing construction permits), and enforcement by BKPRD.

Table-II-1.51 Allocation of WRM Responsibility (Land Use of River Border Areas)

Responsibilities	Central Gov't	Province		Regency/City	
		APBN	APBD I	APBN	APBD II
Land regulation in river areas: BAPPEDA, BKPRD, Dinas PU/Sub-Din.TRP					
Land use regulation - general	X		X (Governor, BAPPEDA through spatial plan)		
Land use regulation - specific					X (Walikota & Sub-Din TRP in Denpasar)
Monitoring			X (Sub-Din. TRP)		X (Dinas Tata Kota in Denpasar & Sub-Din. TRP in Regencies)
Enforcement	X (state lands - BKPRN)		X (trans-regency-BKPRD)		X (BKPRD)

Source: Interviews by Study Team

<Water Supply >

Water supply services are provided by PDAM, an enterprise wholly owned by the regency/city government. In addition, there is one company with private participation: PP.TB, 45% of which is owned by the Badung regency government and the rest by two private firms. PDAMs suffer from poor financial conditions as described in 1.6 above, resulting from the low tariff level and political interferences (which hamper autonomous, rational management decisions). There was once a proposal to merge the PDAMs in Denpasar, Badung, Giaynar, Tabanan, and Kulungkun (collectively called SARBAGITAKU), where there are increasing needs for trans-regency water conveyance. It did not materialize due to opposition from the regency/city governments that have vested interests in PDAM operations. In the absence of the merger, establishment of a bulk water supply (or 'water production') entity is currently under consideration, to be owned jointly by the province, the five regencies/city, and perhaps the central government. This proposal will be discussed in Chapter 7. With regard to waste water, a new entity will be set up soon to manage the sewerage system currently under construction in Denpasar and Badung. The entity will be jointly owned by the Province, Denpasar City and Badung Regency, and will be converted into a private company when fee collection can result in sufficient profitability.

<Watershed Conservation: Table-II-1.52>

BP-DAS Unda Anyar of Ministry of Forestry is responsible for planning and evaluation of activities for state forests, while Dinas Forestry at the provincial and regency/city levels undertake implementation in their respective jurisdictions. BP-DAS Unda Anyar also arranges central government funding to support village groups that have been formed for forestry and land management.

Table-II-1.52 Allocation of WRM Responsibility (Watershed Conservation)

Responsibilities	Central Gov't	Province		Regency/City	
		APBN	APBD I	APBN	APBD II
Watershed conservation: BP-DAS Unda Anyar, Dinas Forest, BAPPEDA, Dinas PU/Sub-Din.TRP					
Planning & Evaluation	X (BP-DAS Unda Anyar)		X (Dinas Forestry)		
Preservation of state forest			X (Dinas Forestry with Forest Police)		
Preservation outside state forest			X (trans-regency –Dinas Forestry)	X (within regency –Dinas Forestry)	

Source: Interviews by Study Team

<Coordination and Dispute Resolution: Table-II-1.53>

There is no formal mechanism to receive, process and resolve complaints on or to negotiate water allocation and other issues. Public consultation prior to licensing for commercial use does not take place. Though Provincial Water Resources Coordination Committee (PTPA) was established in Bali in 1996 through a Governor's Decree (based on the Regulation of Minister of Public Works No.67/1993), it has met rarely.

Table-II-1.53 Allocation of WRM Responsibility (Coordination and Dispute Resolution)

Responsibilities	Central Gov't	Province		Regency/City	
		APBN	APBD I	APBN	APBD II
Dispute resolution on water allocation:					
Receiving complaints from water users (particularly Subaks) and facilitating solutions			X (Dinas PU, Governor, etc.)		X (Sedahan Agung, Bupati, etc.)

Source: Interviews by Study Team

(3) Jurisdictional Issue

The confusion over the demarcation of the responsibilities between the province and regencies/city stems from the two principles introduced in the recent legislation of the country. One principle is derived from the decentralization laws and regulations that say that province is responsible for matters which crosses or covers two or more regencies/city and guidance and support to regencies/city, while regency/city is responsible for matters within their jurisdiction. Embracing this principle, Government Regulation No.82/2001 on Management of Water Quality and Control of Water Pollution provides that province is responsible for trans-regency/city water quality, while regency/city has responsibility over water quality within the regency/city.

The other principle is provided in the Water Resources Law No.7/2004 that says province is responsible for water resources management in trans-regency/city river basins as well as technical assistance to regencies/city, while regency/city is responsible for water resources management in river basins located within the regency/city (Articles 15 & 16). An exception to this is the irrigation responsibility, for which Article 41 and its elucidation provides the following arrangement:

Central Government:	Over 3,000 ha irrigation areas ("IAs") (In Bali only O&M is relevant and the work is performed by the province)
Province:	Trans-regency/city IAs or IAs between 1,000 – 3,000 ha
Regency/City:	IAs of less than 1,000 ha located within the regency/city

Under the Decree of the Minister of Public Works No.39/1989, Bali was classified as one "river basin unit" (*satuan wilayah sungai*, SWS). But the concept of "river basin units" no longer exists in the Water Resources Law No.7/2004, which instead provides "river basins" (*wilayah sungai*) and "groundwater basins." DGWR of MPW is currently in the process of identifying "river basins" and "groundwater basins" for the entire country based on a certain set of criteria which are also being developed. If Bali is determined as one river basin, then it automatically follows that the province is

responsible for its management, except for the management of irrigation areas for which the responsibilities are shared between the province and the regencies/city as described above. In the latter half of 2005, discussions on this issue took place in Bali and with the central government, through which a consensus has emerged that Bali is one river basin. The rationales provided by the study team were as follows:

- Decentralization has resulted in serious fragmentation of information flow and coordination systems between the province and regencies/city. The tight water balance in Bali requires effective non-structural measures in addition to water supply capacity development and such measures must be based on non-disruptive, systematic and coherent management. This is particularly important in view of the needs for trans-regency/city water resources re-allocation though the water transmission systems in SARAGITAKU.
- Exact flow mechanisms of groundwater and spring in Bali have not been identified. The situation requires one monitoring and technical assessment system covering the whole island.

(4) Laws and Regulations on Water Resources

<Regulatory Gaps>

In order to implement the Water Resources Law No.7/2004, the central government is presently in the process of preparing government regulations and related decrees on some 35 subjects. Provincial and regency/city governments will have to prepare and adopt corresponding regulations or measures in accordance with the law and the government regulations. In addition, administrative arrangements to enable integrated management of water resources in Bali will require regulatory measures.

<Enforcement>

Many laws and regulations are already in place but their enforcement is often a problem. For example, water quality standards with penalty provisions are provided in a series of government regulations and ministerial decrees. The latest standards are available in Government Regulation No.82/2001 on Management of Water Quality and Control of Water Pollution. In Bali, Provincial Regulation No.16/1988 on Monitoring and Control of Environmental Pollution by Sewerage and Governor's Decree No.515/2000 on Environmental Quality Standards have been issued. Water quality examination is conducted periodically in view of the standards stipulated in them. However, according to concerned government officials, there has been no incidence where the penalty was imposed, largely out of consideration for protecting small and medium industries and jobs.

In relation to the issue of enforcement, there is a general need to enhance the culture and mindsets in the government and stakeholder communities to look for and think in terms of laws and regulations. One thing that has come to the attention of the study team is lack of easy access to legal and regulatory documents in government offices. Whether certain laws and regulations are available depends very much on the awareness of the officers. And legal documents belong to individuals, rather than to the office or the organization. This is one area of information management that needs to be addressed in the water resources related organizations.