

ANNEX 1

Overview of Bali province physical, administrative and environmental data

Note: Page 19: Water crisis data

Note on sources: Unless specified otherwise, maps and data are principally taken from:

1. “Laporan KLHS Bali - Strategic Environmental Assessment (KLHS)” done by Indonesian and the province of Bali’s environmental authorities - Management and Conservation of Water Resources (Bali Province)
2. “Profil Balai Wilayah Sungai Bali-Penida”, Direktorat Jenderal Sumber Daya Air, Departmen Pekerjaan Umum.

Additional references and recommended reading:

- *A political ecology of water, Equity and Tourism, a case study from Bali* by Stroma Cole, Annals of Tourism Research, Vol. 39, No. 2, pp. 1221-1241, 2012
- *The economics of Village Bali: Three perspectives*, by Mark Poffenberger and Mary S. Zurbuchen, 1979
- *Bali, Balancing environment economy and culture*, edited by Sugeng Martopo and Bruce Mitchell for Bali's Sustainable Development Strategy, Bali Regional Development Planning Development, with funding from the Canadian International Development Agency, 1993 – In collaboration with Udayana University (UNUD) in Bali, Gadjah Mada University (UGM) in Java and the University of Waterloo in Canada
- *Indonesia environmental and Climate Change Policy Brief*, School of Business, Economics and Law, University of Gothenburg, September 2008.
- *Pro-poor Water and Wastewater Management in Small Towns, Sanitation by the Community in Denpasar*, Indonesia (SANIMAS), published for the United-Nations, Economic and Social Commission for Asia and the Pacific
- *Urban Sanitation: Portraits, Expectations, and Opportunities. It's not a private matter anymore!* Published by the National Development Planning Agency (BAPPENAS) in cooperation with the World Bank Water and Sanitation Program – East Asia and the Pacific (WSP-EAP) for the Indonesia Sanitation Sector Development Program (ISSDP)
- *Department of Epidemiology and Population Sciences*, London School of Hygiene and Tropical Medicine, UK), hepatitis A and E, and typhoid fever
- *Indonesia: Urban water and sanitation improvement and expansion project (UWSIEP)*, Report on Sanitation Workshop, prepared for the World Bank by Isabel Blackett and Risyana Sukarma, MAKASSAR, 28-29 APRIL 2005.
- *Land-Based Sources And Activities Affecting the Marine Environment in the East Asian Seas: An Overview*, Chia L. S. and H. Kirkman (2000), Regional Co-ordinating Unit, East Asian Seas Action Plan, UNEP, Bangkok, pp. 73
- *Sources and Nature of Water Quality Problems in Asia and the Pacific*, Economic and Social Commission of Asia and the Pacific (ESCAP) (1998), New York: United Nations
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- *Regional Programme of Action on Land-based Activities Affecting Coastal and Marine Areas in the East Asian Seas*, Koe, L. C. C. and M.A. Aziz (1995), RCU/EAS Technical Reports Series No. 5, Bangkok: UNEP
- *Effects of sewage pollution on coral-reef communities*, Pastorok, R.A. and G.R. Bilyard (1985), *Marine Ecology Progress Series*, 21, 175–189
- *Priests and Programmers: Technologies of Power in the Engineered Landscape of Bali*, Lansing, J. Stephen, Princeton University Press, 1991. Revised 2nd edition 2007. J.I. Staley Prize, School for Advanced Research
- *On Irrigation and the Balinese State*, Lansing, J. Stephen. 2005. *Current Anthropology* 46 (2):305-6
- *Volcanic Fertilization of Balinese Rice Paddies*, Lansing, J. Stephen, Vanda Gerhart, James N. Kremer, Patricia Kremer, Alit Arthawiguna, Suprpto, Ida Bagus Suryawan, I Gusti Arsana, Vernon L. Scarborough and Kimberly Mikita. 2001. *Ecological Economics* 38 (2001):383-390
- *The Functional Significance of Balinese Water Temples: A Reply to Critics*, Lansing, J. Stephen and Thérèse A. de Vet. 2012. *Human Ecology*. Volume 40, Number 3 (2012), 453-467.

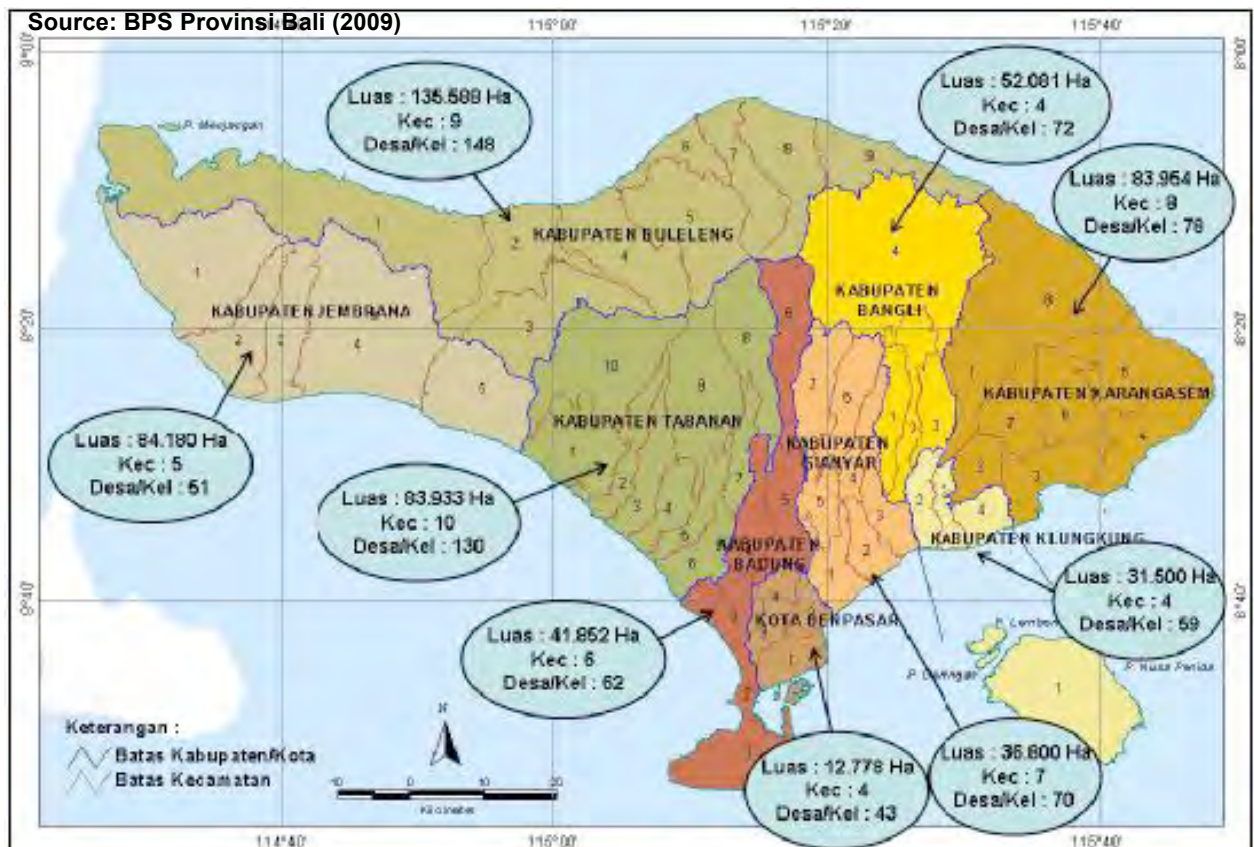
GEOGRAPHICAL AND ADMINISTRATIVE INFORMATION

Bali is one of Indonesia's 34 provinces, established pursuant Act No. 64 in 1958 with following indicative boundaries:

- North: Java Sea
- East: the Lombok Strait
- South: Indian Ocean
- West: the Bali Strait.

The Bali province lies approximately 8 degrees south of the equator and consists of the island of Bali as the main island and several smaller islands: Nusa Penida, Nusa Lembongan, Nusa Ceningan and Pulau Menjangan. The total area is 563,666 ha (0.29% of the land area of Indonesia) and the island of Bali itself is 5,632 km². Administratively, the province of Bali is divided into eight (8) regencies and one city, 57 districts and 713 sub-districts.

The population in 2012 was 4.220.000,00 habitants (4.2 Millions) while in 2010 it was estimated at 3.891.428 Millions.



Population censuses

Name	Capital	Area in km ² .	Population 2000 Census	Population 2010 Census
Jembrana Regency	Negara	841.80	231,806	261,618
Tabanan Regency	Tabanan	839.30	376,030	420,370
Badung Regency	Mangupura	418.52	345,863	543,681
Gianyar Regency	Gianyar	368.00	393,155	470,380
Klungkung Regency	Semarapura	315.00	155,262	170,559
Bangli Regency	Bangli	520.81	193,776	215,404
Karangasem Regency	Amlapura	839.54	360,486	396,892
Buleleng Regency	Singaraja	1,365.88	558,181	624,079
Denpasar City	Denpasar	123.98	532,440	788,445
Totals		5,780.06	3,146,999	3,891,428

WATER RESOURCES

There are 1273 springs, 8 ground water basins, 4 lakes, 4 dams, 5 ponds, and 162 rivers (note: Source 1. Source 2 counts 165 large and small rivers).

Springs:

The spring water is groundwater that flows according to the local topographic and generally out of rocks. Springs tend to appear at foothills or down from slopes, hills and valleys in the plain areas. See the table below for location of the springs per regencies.

No	Kabupaten/ Kota	N° of Springs	Total Discharge (Liter / second)	Average Discharge (Liter / second)
		Jumlah Mata Air (buah)	Debit Total (liter/detik)	Debit Rata-Rata (liter/detik)
1	Jembrana	61	85,1	17,0
2	Tabanan	177	3.080	73,2
3	Badung	30	1.291	184,4
4	Gianyar	79	2.981	56,2
5	Klungkung (daratan)	29	202	40,4
	Klungkung (Nusa Penida)	9	522	104,1
6	Bangli	423	2.736	48,0
7	Karangasem	138	9.808	102,3
8	Buleleng	327	6.603	71,3
	Jumlah	1.273	27.063	75,4

Sumber: JICA (2005) dalam Bappeda Provinsi Bali (2006)



Source: BLH Provinsi Bali (2009)

Ground water basin reserves (CAT):

Based on the results of research conducted by the Department of Energy (Departemen ESDM - 2005) the ground water basins in the province of Bali are divided into 8 basins, as shown in the table below.

Groundwater Potential in Groundwater Basin in the Province of Bali

No	Cadangan Air Tanah (CAT)	Surface (Hectares)	Rainfall (mm)	Flow w/o pressure (Million m ³ /year)	Flow under pressure (Million m ³ /year)
		Luas (Ha)	Hujan (mm)	Tak-tertekan (juta m ³ /thn)	Tertekan (juta m ³ /thn)
1	Denpasar-Tabanan	208.000	1500 - 3500	894	8
2	Gilimanuk	13.130	1000 - 1500	30	1
3	Negara	41.850	1500 - 2000	73	4
4	Singaraja	50.520	1000 - 2500	215	3
5	Danau Batur	75.050	500 - 2000	188	3
6	Amlapura	19.982	1000 - 2000	60	2
7	Nusa Dua	9.911	1500 - 2000	38	-
8	Nusa Penida	19.790	500 - 1000	79	-
	Jumlah	438.233	-	1.577,00	21
	% thd Bali	77,75			

Sumber: Departemen ESDM (2005) dalam Bappeda Provinsi Bali (2009)

Lakes:

Bali has four lakes namely *Lake Batur* in Bangli, *Lake Beratan* in Tabanan Regency, *Lake Buyan* and *Lake Tamblingan* in Buleleng. *Lake Batur* is the largest lake in Bali with a surface area of 16.05 km². All lakes are volcanic and are placed on the chain of mountains, with an altitude of 1000 - 1200 m. In such a position, the four lakes act as a downstream buffer. *Lake Batur* is highly polluted from fertilizers and pesticides of cultivations taking place close to its borders.

	Name Lake	City / Regency	Capture area (km ²)	Surface area (km ²)	Average depth (m)	Length (km)	Width (km)	Water Volume (million m ³)
No	Nama Danau	Kab/ Kota	Daerah Tangkapan (km ²)	Luas Permukaan (km ²)	Kedalaman Rata-Rata (m)	Panjang (km)	Lebar (km)	Vol Air (juta m ³)
1	Batur	Bangli	105,35	16,05	50,8	7,7	2,7	815,38
2	Beratan	Tabanan	13,4	4,38	12,8	2,0	2,0	49,22
3	Buyan	Buleleng	24,1	3,67	31,7	3,7	1,5	116,25
4	Tamblingan	Buleleng	9,2	1,15	23,5	1,8	0,9	27,00
	Jumlah							1.007,85

Sumber: Bappeda Provinsi Bali (2009)

	Name Lake	Sub-regency	Regency	Surface (km ²)	Quality Tawar: Freshwater	Sediment ation	Rainfall (mm)		
No	Nama Danau	Kecamatan	Kabupaten	Luas (km ²)	Catchment Area (km ²)	Kualitas	Sedimen	Curah Hujan (mm)	
1	Batur	Kintamani	Bangli	16.9	59.20	Tawar	Sedikit	2166	Sedikit: Little
2	Bratan		Buleleng	4.4	15.75	Tawar	Sedikit	2568	
3	Buyan	Banjar	Buleleng	3.8	8.15	Tawar	sedang	2531	Sedang: Medium
4	Palasari	Melaya	Jembrana	1.0	38.31	Tawar	Sedikit	1699	
5	Tamblingan	Banjar	Singaraja	1.9	4.38	Tawar	sedang	2531	

WATER RESOURCES (Cont.)

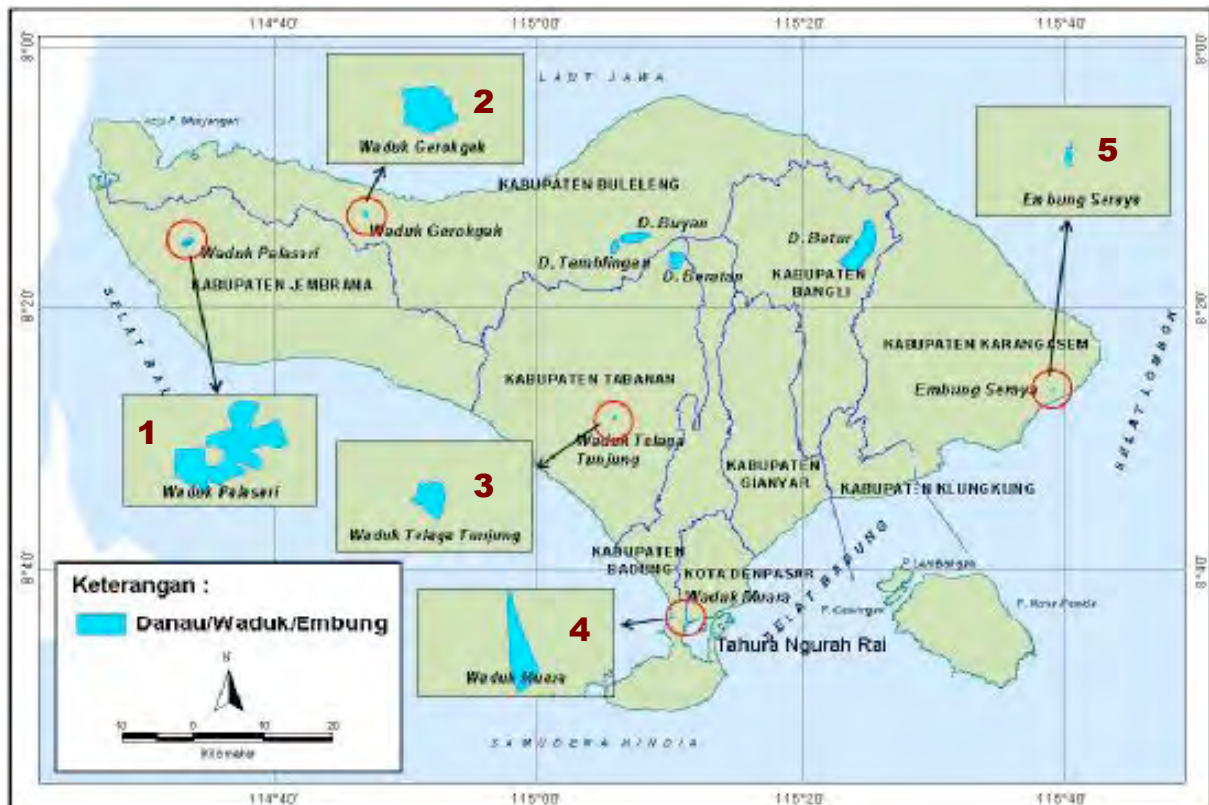
Reservoirs and ponds:

Reservoirs and ponds are man-made reservoirs that serve various purposes such as the provision of irrigation water, drinking water, flood control, etc. There are five dams servicing the *Palasari* reservoir with an area 87 ha located in Jembrana Regency, *Gerokgak* Reservoir covers 350 ha located in Buleleng regency, *Telaga Tunjung* Reservoir covers an area of 17 ha in Tabanan regency, *Muara* Reservoir covers 35 ha in Denpasar and Badung regency, while *Embung Seraya* covers 2 ha in Karangasem.

Tabel 3.

Karakteristik Waduk dan Embung di Provinsi Bali						
Name - Dam/Reservoir		City / Regency	Capture area (km ²)	Surface area (km ²)	Depth (m)	Water Volume (million m ³)
No	Nama Waduk/Embung	Kabupaten/ Kota	Daerah Tangkapan (km ²)	Luas Permukaan (ha)	Kedalaman (m)	Vol Air (juta m ³)
1	Waduk Palasari	Jembrana	4.230	87	29	8,00
2	Waduk Gerokgak	Buleleng	2.850	350	42	3,75
3	Waduk Telaga Tunjung	Tabanan	950	17	33	1,26
4	Waduk Muara	Denpasar	2.255	35	2	0,42
5	Embung Seraya	Karangasem	250	2	4	0,10
Jumlah						13,53

Sumber: Bappeda Provinsi Bali (2009)



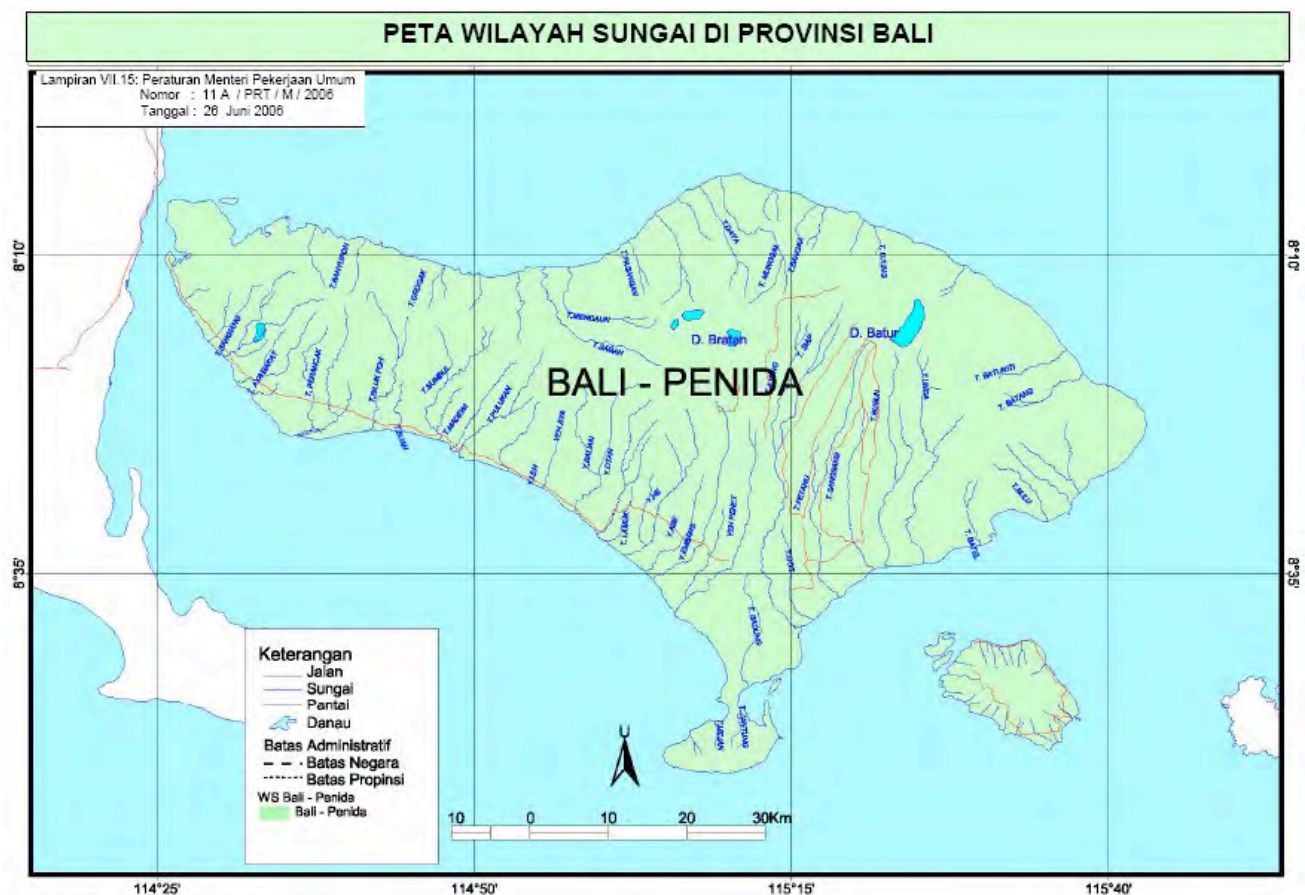
Peta Danau, Waduk dan Embung di Provinsi Bali / Map of Lakes, Dams and Reservoirs in the province of Bali

WATER RESOURCES (Cont.)

Rivers:

Bali Province recorded 401 stems rivers of which 162 empty into the ocean. Of 162 rivers the only 11 rivers have watersheds over 100 km². Rivers are mostly intermittent and annual, so that utilization of water resources of the rivers can not be expected throughout the year. Less than 11% of the rivers flow in the dry season.

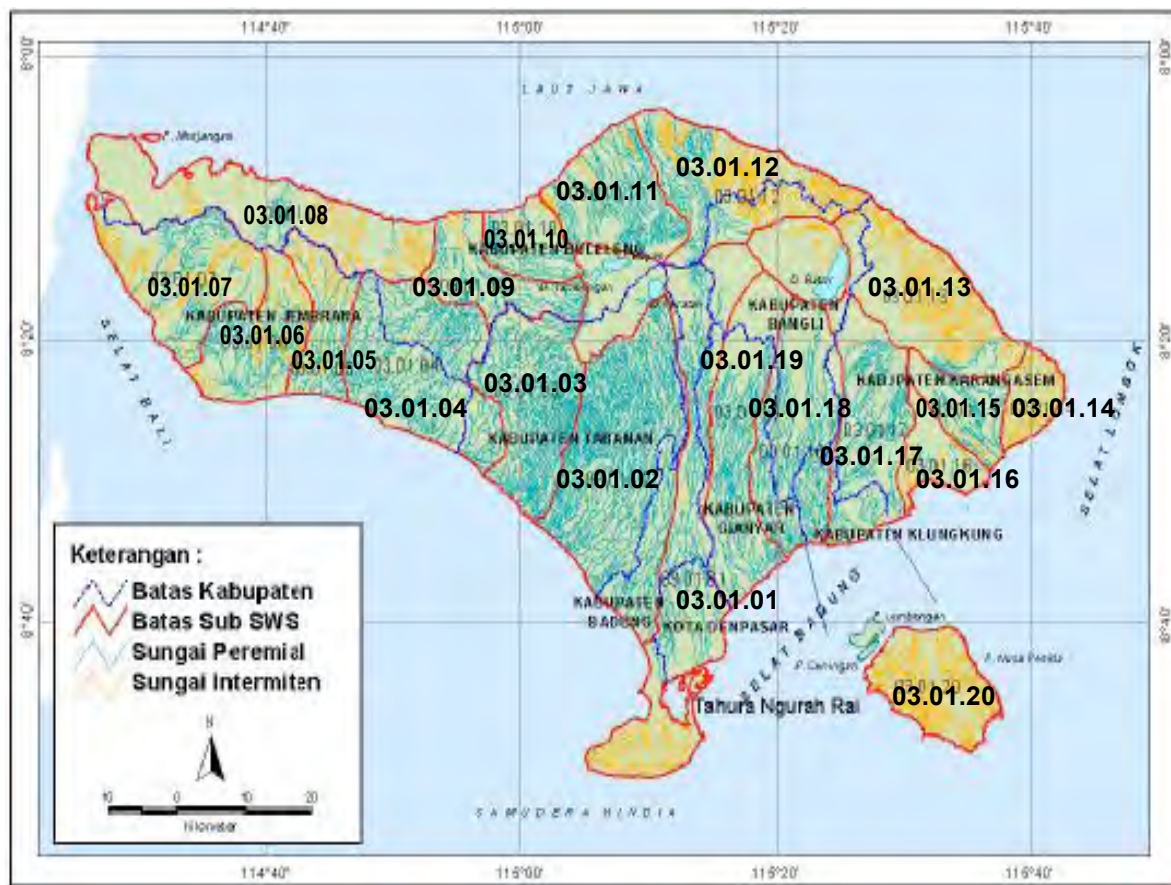
Bali river systems flows from the north to the south as a result of the division of the mountain range stretching from the west to the east of the island. Watershed (DAS) form the basis of management of river ecosystems and surface water resources; DAS is defined as an area bounded by the natural topography, where all the rain that falls in it will flow through a river and out through a outlet on a river, or a unit that describes the hydrology and physical-biological units as well as units of social and economic activities for the planning as a natural resource management). There is a combination of several DAS into a River Basin Unit. Watershed's importance as a complete unit plan is a logical consequence for sustainable use of forest resources, land, and water.



WATER RESOURCES (Cont.)

Rivers (cont.):

The river system in Indonesia is divided into 90 River Region Unit (SWS) by Regulation of the Minister of Public Works No. 39/PRT/1989 which includes more than 5590 DAS. The rivers that exist in Bali Province region as a whole form one River Basin Unit (SWS) or Regional River Unit, **the River Region Penida Bali - coded SWS 03.01**. The rivers found in the River Basin Penida Bali regrouped into 20 sub SWS, (see Figure below) and description of each sub SWS following.

**Rivers Classification:**

- 1) **Sub SWS 03:01:01.** Covering the city of Denpasar and the regencies Badung, Tabanan, Gianyar and Buleleng, with an area of 555.64 km². Most of the rivers in this Sub SWS are perennial rivers, except rivers in the South Kuta district area. *Ayung River Basin* dominates this largest watershed and represents ± 288.37 km², crossing 2 regencies (Badung and Gianyar) and 1 city (Denpasar). Annual rainfall average in the watershed is quite high, reaching 2,000 mm per year.

WATER RESOURCES (Cont.)

Rivers classification (cont.):

- 2) **Sub SWS 03:01:02.** Includes Badung, Tabanan and Buleleng regencies with 601.5 km². The rivers in this sub SWS are mostly perennial. The basin is dominated by *DAS Tukad Yeh Empas* with an area 100.82 km² and the catchment *Tukad Yeh Ho* with a broad 135.76 km² located in Tabanan regency. They receive around 2,200 mm of rainfall per year. Other major watersheds is *Tukad Yeh Penet* stream and includes Tabanan and Badung regencies.
- 3) **Sub SWS 03:01:03.** Covers 288.34 km² in Tabanan regency. This river basin *Balian Tukad* dominates the watershed with an area of 152.9 km². Continuous river flow conditions all year, with around 2,000 mm of rainfall per year. Besides *Tukad Balian*, rivers included in Sub SWS 03:01:03 include *Tk. Yeh Otan*, *Tk. Putrina*, *Tk. Thymus*, *Tk. Pedungan*, *Tk. Payang*, *Tk. Gayam*, *Tk. Yeh Matan*, *Tk. Yeh Putek* and *Tk. Mluang*.
- 4) **Sub SWS 03:01:04.** Includes Tabanan and Jembrana with an area 392.37 km². The rivers in the basin are perennial river, covering *Tk. Selabih*, *Tk. Yeh Leh*, *Tk. Yeh Sumbul*, *Tk. Yeh Satang*, *Tk. Gumbrih*, *Tk. Pengyangan*, *Tk. Daffodils*, *Tk. Pulukan*, *Tk. Wood*, *Tk. Medewi* and *Tk. Lebah*. These rivers mostly flow through forest especially in the middle and upper reaches, while paddy fields are only located downstream.
- 5) **Sub SWS 03:01:05.** Jembrana regency, with an area covering 158.92 km². The principals rivers are *Tk. Yeh Embang*, *Tk. Bilokpoh* and *Tk. Buha*, which is perennial river type. Upstream is a protected forest area, while downstream the water flows through plantations and paddy fields.
- 6) **Sub SWS 03:01:06.** Jembrana regency with an area covering 228.44 km². This river basin is dominated by the broad basin *Tukad* (135.32 km²). The rainfall in this basin about 1,900 mm per year with no permanent river flow spring. In the rainy season the area is frequent flooding. Other rivers in Sub SWS is *Tk. Titis*, *Tk. Mendoyo* and *Tk. Dalem*. The upstream rivers in this basin is in an area of protected forest, while the mid section goes through land plantations and paddy fields and downstream settlements.
- 7) **Sub SWS 03:01:07.** Jembrana district with an area covering 243.52 km². This river basin dominated by *DAS Tukad Daya Barat*. Other rivers include *Tk. Sangyang Gede*, *Tk. Melaya*, *Tk. Yellow Sari*, *Tk. Klatakan*.
- 8) **Sub SWS 03:01:08.** Buleleng regency covers an area 367.22 km². Rivers found in the river basin have relatively short intermittent streams, which flow through the hilly and largely degraded land of the district, so that this Sub SWS presents quite critical watershed conditions. *Tk. Sumaga*, *Tk. Gerokgak*, *Tk. Musi*, *Tk. Tinga-tinga*, *Tk. Yeh Biu*, *Tk. Banyupoh*, *Tk. Pengunbahan* and *Tk. Pule*. Land use in the upper consists of forest agriculture while downstream have dryland conditions.
- 9) **Sub SWS 03:01:09.** Buleleng regency covers an area 222.39 km². This river basin is dominated by the broad basin *Das Tukad Saba* of 130.09 km². Other rivers in the basin are *Tukad Banyuraras* and *Tukad Gemgem*.
- 10) **Sub SWS 03:01:10.** Buleleng regency covers an area 114.24 km². Rivers contained in the basin is generally a semi-permanent and intermittent streams. The rivers in Sub SWS 03:01:10 include *Tk. Manuk*, *Tk. Bengkala*, *Tk. Broken*, *Tk. Tampekan*, *Tk. Binong*, *Tk. Mendaum*, *Tk. Langking* and *Tk. Anakan*. Land use the basin is dominated by dryland farming.
- 11) **Sub SWS 03:01:11.** Buleleng regency covers an area 243.48 km². Rivers include *Tk. Tengah*, *Tk. Batupulu*, *Tk. Serumbung*, *Tk. Asangan*, *Tk. Buleleng*, *Tk. Banyumala*, *Tk. Baas*, *Tk. Penarukan*, *Tk. Yeh Taluh*, *Tk. Buus*, *Tk. Munduk*, *Tk. Sangsit*, *Tk. Pengong* and *Tk. Taluk*. The rivers are generally permanent spring creek. The land in the region in the upper river is made of forests while the downstream is densely populated with residential areas and paddy fields (also includes Singaraja City).
- 12) **Sub SWS 03:01:12.** Buleleng regency covers an area 311.65 km². This river basin is dominated by *DAS Tukad Sawan* with a surface of 107.25 km². Upstream is forest while in the middle and downstream the land is dominated by agricultural land with plantations.

Rivers Classification (cont.):

- 13) Sub SWS 03:01:13.** Includes Buleleng, Karangasem and Bangli with a 357.14 km² surface. The rivers in the basin are generally small river and short because the area flows through a hilly area near the beach. Pattern land use upstream is forest and the mid-to downstream is dominated by a crisis of land and dry land farming. The rivers are mostly intermittent. The rivers in Sub SWS 03:01:13 include *Tk. Batang, Tk. Bangka, Tk. Ketungan, Tk. Puan, Tk. Sumegen, Tk. Baturiti, Tk. Linggah, Tk. Tutung, Tk. Abu, Tk. Maong, Tk. Dalam, Tk. Pangandangan, Tk. Lebahcelagi, Tk. Sapta, Tk. Trukuk, Tk. Cili, Tk. Sayung, Tk. Batang, Tk. Bakalan, Tk. Nusu, Tk. Pale, Tk. Embahapi, Tk. Dadak, Tk. Melaka, Tk. Grembeng, Tk. Dalem, Tk. Pilian, Tk. Sringin, Tk. Daya, Tk. Bumbung, Tk. Timbul, Tk. Santer, Tk. Karanganyar, Tk. Karobelahan, Tk. Legawa, Tk. Bungbung, Tk. Telaga, Tk. Selahu, Tk. Jaka, Tk. Luwah, Tk. Gelar, Tk. Sidepana, Tk. Yeh Bau, Tk. Bonriu, Tk. Tembok, Tk. Bulakan*
- 14) Sub SWS 03:01:14.** Karangasem regency covers an area 295.38 km². The rivers include among others *Tk. Mantri, Tk. Seraya, Tk. Pitpitan, Tk. Bangas, Tk. Bunutan, Tk. Tibidalem, Tk. Belong, Tk. Itam, Tk. Buah, Tk. Pangkuh, Tk. Titis, Tk. Kutumanak, Tk. Kusambi, Tk. Batukeseni, Tk. Bluhu, Tk. Desa, Tk. Pangkung* and *Tk. Aya*. The rivers are partly intermittent and pass critical land in the area of Mount Seraya. The surrounding land is dominated by degraded land and dry land farming.
- 15) Sub SWS 03:01:15.** Karangasem regency covers an area 272.53 km². The rivers in this area have year round flow and the land is dominated by rice cultivation. The three major rivers in Sub SWS 03:01:15 are *Tk. Pedih, Tk. Bangka* and *Tk. Nyuling*. Other rivers are intermittent such as *Tk. Ringuang*. Watershed conditions are quite critical.
- 16) Sub SWS 03:01:16.** Karangasem regency covers an area 342.08 km². River basin is dominated by the broad basin *Tukad Jangga* of 70.125 km². Land use is dominated by paddy fields. The condition of the rivers in this region are on the lava flow area of Mount Agung, especially *Tukad Jangga*. The rivers include *Tk. Prakpak, Tk. Buwatan, Tk. Mengereng, Tk. Jangga, Tk. Telincicing, Tk. Tanahampo, Tk. Buhu, Tk. Sampiang, Tk. Karangan* and *Tk. Alas*.
- 17) Sub SWS 03:01:17.** Includes Karangasem regency, Bangli and Klungkung with an extensive 257.78 km². The area is dominated by river basin *Tukad Unda* with an area of 220.52 km². Other rivers include *Tk. Bugbugan, Tk. Paang, Tk. Cau, Tk. Bethel, Tk. Unda, Tk. Lombok, Tk. Pegatepan*. Rainfall in the basin is relatively high with 3000 mm per year. These rivers have continuous flow year-round, with agricultural land use dominated by wetlands, and upstream area made of forests. The principal river in this area consists of a large groove of lava leaving from Mount Agung. Sedimentation content due to the eruption of Mount Agung still dominates the flow conditions in the river basin *Tukad Unda*. Besides high rainfall, DAS *Tukad Unda* also has many emerging spring water sources large enough to supply wellspring such as *Telaga Waja, Surya, Arca, Tirta Ganga*, and others.
- 18) Sub SWS 03:01:18.** Includes Gianyar, Bangli, Karangasem and Klungkung with 48.84 km². The main rivers in this basin include *Tk. Jinah, Tk. Melangit, Tk. Bubuh, Tk. Sangsang* and *Tk. Parkerisan*, are perennial types and nourish paddy fields down-flow.
- 19) Sub SWS 03:01:19.** Includes Gianyar, Bangli, Badung and Denpasar with 102.19 km². The area is dominated by river basin *Tukad Oos* DAS of a 116.52 km² area. Other rivers include *Tk. Sangku, Tk. Kutul, Tk. Petanu, Tk. Singapadu, Tk. Jerem, Tk. Blahbatuh* and *Tk. Sekatu*. Rivers flow conditions are continuous throughout the year and the land use pattern is dominated by wet agricultural practices. The condition of the rivers in this area have high cliffs with long grooves, with high vertical erosion rates.
- 20) Sub SWS 03:01:20.** Located on the island of Nusa Penida with an area of 208.87 km². Rivers are all intermittent streams, with flows only when it rains, an hour after the rain stops so does the flow. Pattern land use is dominated by dryland farming.

RIVERS: The total potential provided by Bali's River Basin Sub Unit is 196.4 m³/second or 6195.3 million m³/year. High flowing rivers are particularly contained in the Sub SWS 03:01:02 with 29.09 m³/second.

Potential river water based on river areas (Sub SWS) in the province of Bali

Potensi Air Sungai menurut Sub Satuan Wilayah Sungai di Provinsi Bali

No	Sub SWS	Catchment Area	Average Rainfall	Annual Runoff of All the River Basins		
		(km ²)	(mm/year)	Total		Runoff Depth
				(mil. m ³)	(m ³ /sec)	(mm)
1	03.01.01	555,64	2.078	718,5	22,78	1.293
2	03.01.02	601,75	2.450	917,4	29,09	1.525
3	03.01.03	288,34	2.582	501,7	15,91	1.740
4	03.01.04	392,37	2.360	406,5	12,89	1.036
5	03.01.05	158,92	2.112	198,7	6,30	1.250
6	03.01.06	228,44	1.978	278,2	8,82	1.218
7	03.01.07	243,52	1.583	237,2	7,52	974
8	03.01.08	367,22	1.365	328,8	10,42	895
9	03.01.09	222,39	2.096	305,8	9,70	1.375
10	03.01.10	114,24	1.704	169,5	5,37	1.484
11	03.01.11	243,48	2.005	383,1	12,15	1.574
12	03.01.12	311,65	1.792	255,7	8,11	820
13	03.01.13	357,14	1.798	164,6	5,22	461
14	03.01.14	295,38	1.911	144,7	4,59	490
15	03.01.15	272,53	1.629	276,2	8,76	1.013
16	03.01.16	342,08	2.237	476,0	15,09	1.392
17	03.01.17	257,78	2.337	374,9	11,89	1.454
18	03.01.18	48,84	2.700	-	-	-
19	03.01.19	102,19	1.809	-	-	-
20	03.01.20	208,87	1.079	57,8	1,83	277
Total/average		5612,77	1.980	6.195,3	196,42	1.014

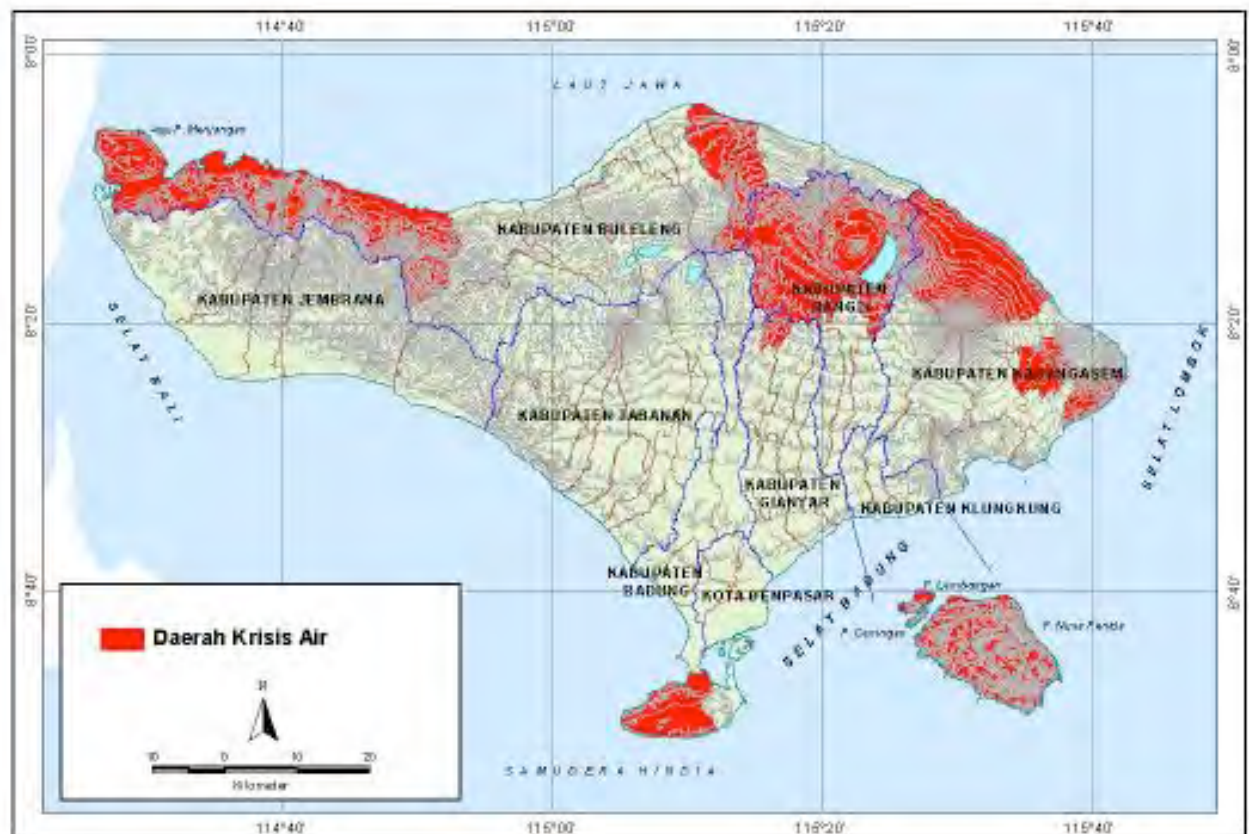
Sumber: Bappeda Provinsi Bali (2009)

WATER CRISIS

Areas of intrusion of seawater into freshwater aquifer:



Areas with critical low availability of water (water crisis):

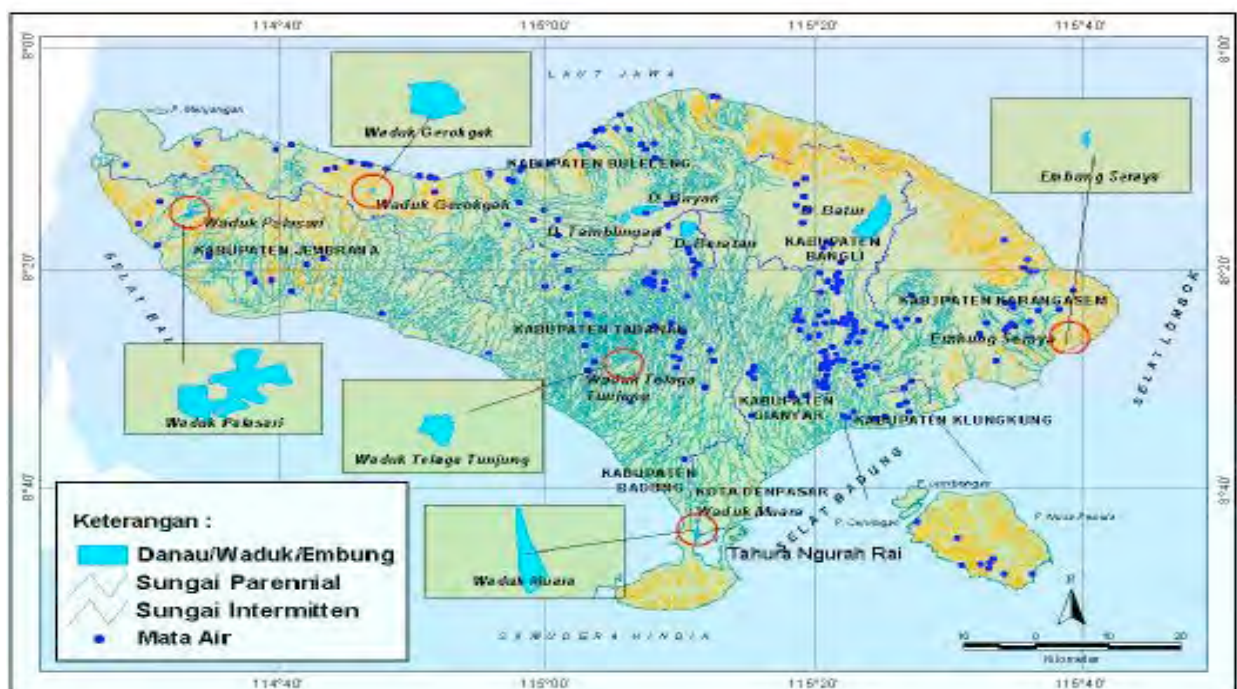


WATER CRISIS (cont.)

Excessive exploitation of the water resource compared to actual availability:



Critical decline of water levels in freshwater supply zones:



Overview of overall water resources

Potential water resource (10^3 m^3) (Source 2)

Sub WS	Total Potensi (10^3 m^3)			Total (10^3 m^3)
	Mata Air	Air Tanah	Sungai	
	<i>Springs</i>	<i>Ground</i>	<i>Rivers</i>	
03.01.01	46.399,64	41.341,22	349.400,00	437.140,86
03.01.02	100.955,69	5.330,53	411.240,00	517.526,22
03.01.03	9.236,89	1.776,84	394.910,00	405.923,74
03.01.04	566,10	12.437,90	425.200,00	438.204,01
03.01.05	927,16	4.145,97	241.770,00	246.843,13
03.01.06	966,26	11.095,40	147.210,00	159.271,66
03.01.07	455,38	17.294,61	228.440,00	246.189,99
03.01.08	25.726,60	23.849,19	45.500,00	95.075,78
03.01.09	16.699,57	7.225,83	223.700,00	247.625,40
03.01.10	18.411,66	9.792,38	144.900,00	173.104,04
03.01.11	74.540,26	14.728,06	94.000,00	183.268,31
03.01.12	57.490,44	10.305,69	128.900,00	196.696,13
03.01.13	14.837,60	19.940,13	30.220,00	64.997,73
03.01.14	3.405,89	8.015,54	17.310,00	28.731,43
03.01.15	70.548,81	2.842,95	68.400,00	141.791,76
03.01.16	67.707,79	37.155,77	52.700,00	157.563,56
03.01.17	98.552,21	24.757,35	390.900,00	514.209,56
03.01.18	134.865,63	0	411.700,00	546.565,63
03.01.19	22.546,19	0	295.180,00	317.726,19
03.01.20	16.543,79	0	24.000,00	40.543,79

LAKES: The total volume of lake water in Bali is 1007.85 million m^3 , of which 80.9% are found in Lake Batur, 11.5% in Lake Buyan, Lake Beratan 4.9% and 2.7% in Lake Tamblingan.

WATER RESERVOIRS AND PONDS: Total volume of water reservoirs and ponds in Bali is estimated at a total of 13.53 million m^3 comprising the *Palasari Reservoir* with 8.00 million m^3 , 3.75 million m^3 for the Gerokgak Reservoir, *Reservoir Telaga (lake) Tunjung* with 1.26 million m^3 , Muara Reservoir with 0.42 million m^3 and 0.10 million m^3 for the Embung pond.

SPRING: The flow of the 1,273 springs varies from one liter/sec to several hundred liters/sec. Total water discharge by springs throughout Bali is estimated at 27,063 liters/sec with an average discharge of 75.4 liters/second.

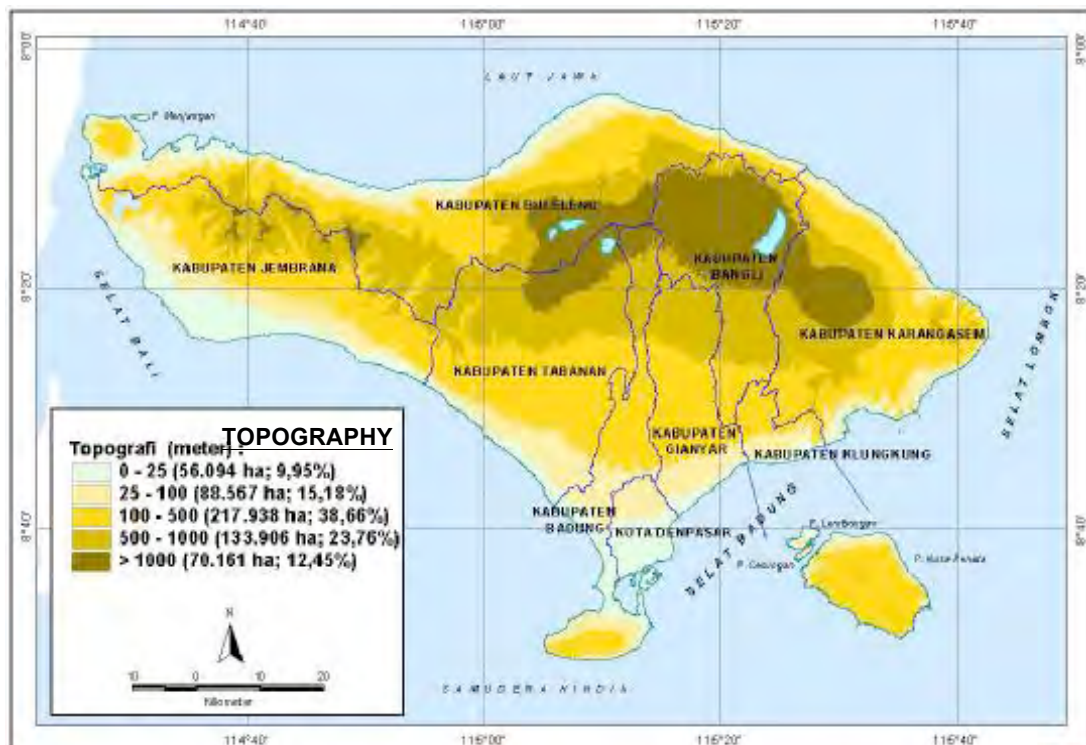
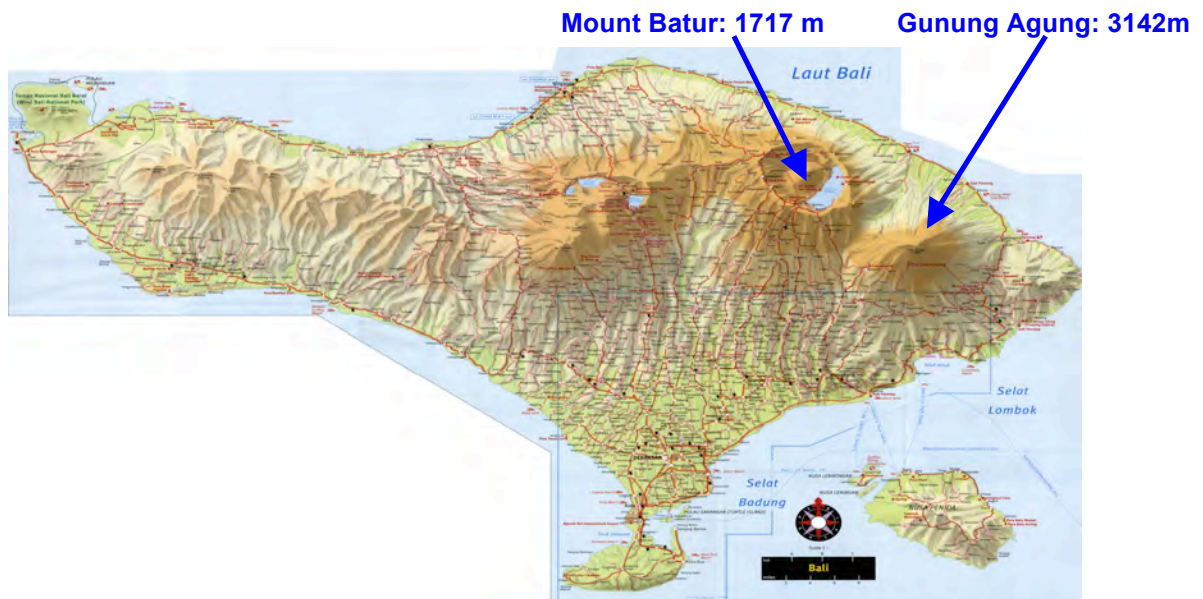
GROUNDWATER: potential groundwater in the Bali Province is estimated at 1577.00 million m^3/year .

Note: if we project an average of 150 Liters/person per day (average in Bali is currently between 20 Liters and 120 Liters +/- per person for a population of 4,2 Million (in 2012), Bali needs 630,000,000 liters/day (630 Million liters or 630,000 m^3/day or 229,950,000 m^3/year or 229,950 $10^3 \text{ m}^3/\text{year}$) minimum, not including water for rice cultivation (Subak), agricultural and industrial activity, nor tourism.

Needs for the tourism industry: If we estimate a use per tourist of 350 Liters/day (middle average) with an annual visit of 4 Million tourist, the province needs an additional 1,400,000,000,00 Liters/year or 1,4 Million m^3/year or 3,8 m^3/day .

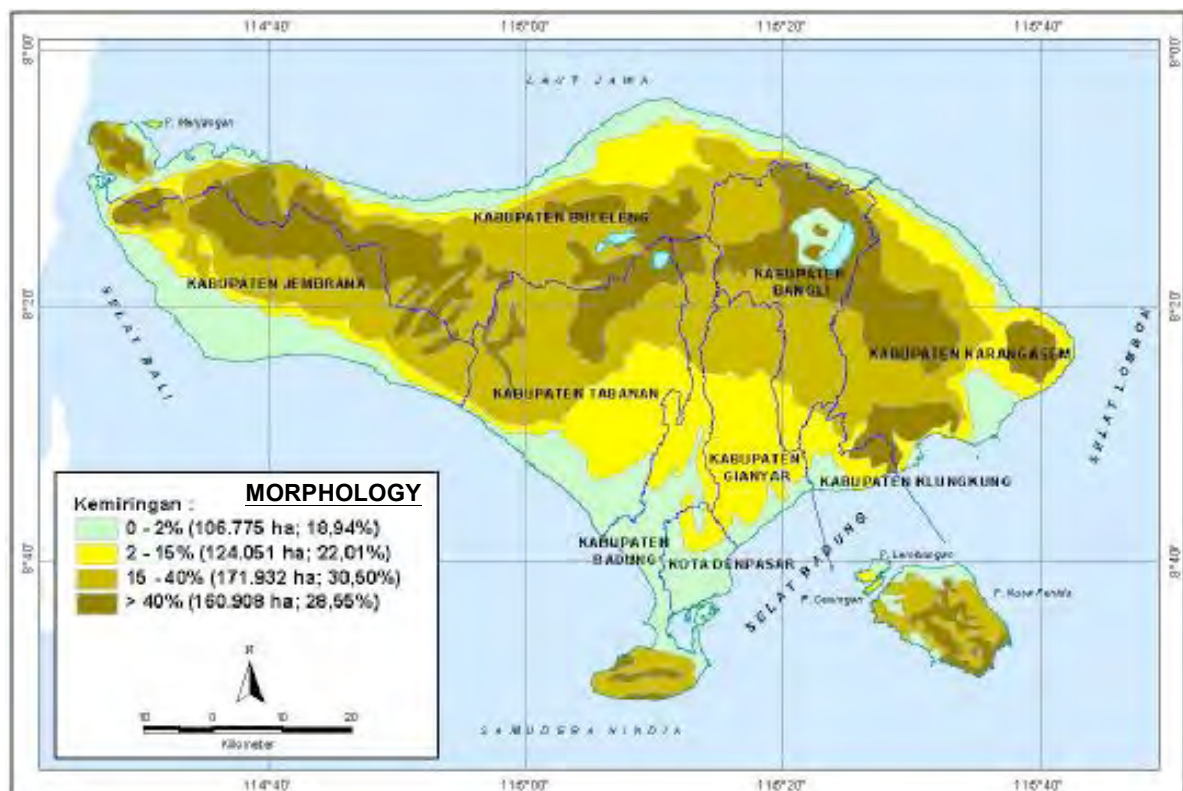
TOPOGRAPHY

The island of Bali is a mountain chain that extends from the West to the East with volcanoes in Mount Batur (1717 m) and Gunung Agung (3142 m) still active . The mountain chain that runs along the island of Bali causes morphological regions of Bali to be divided into several topographic and physiographic units.



MORPHOLOGY

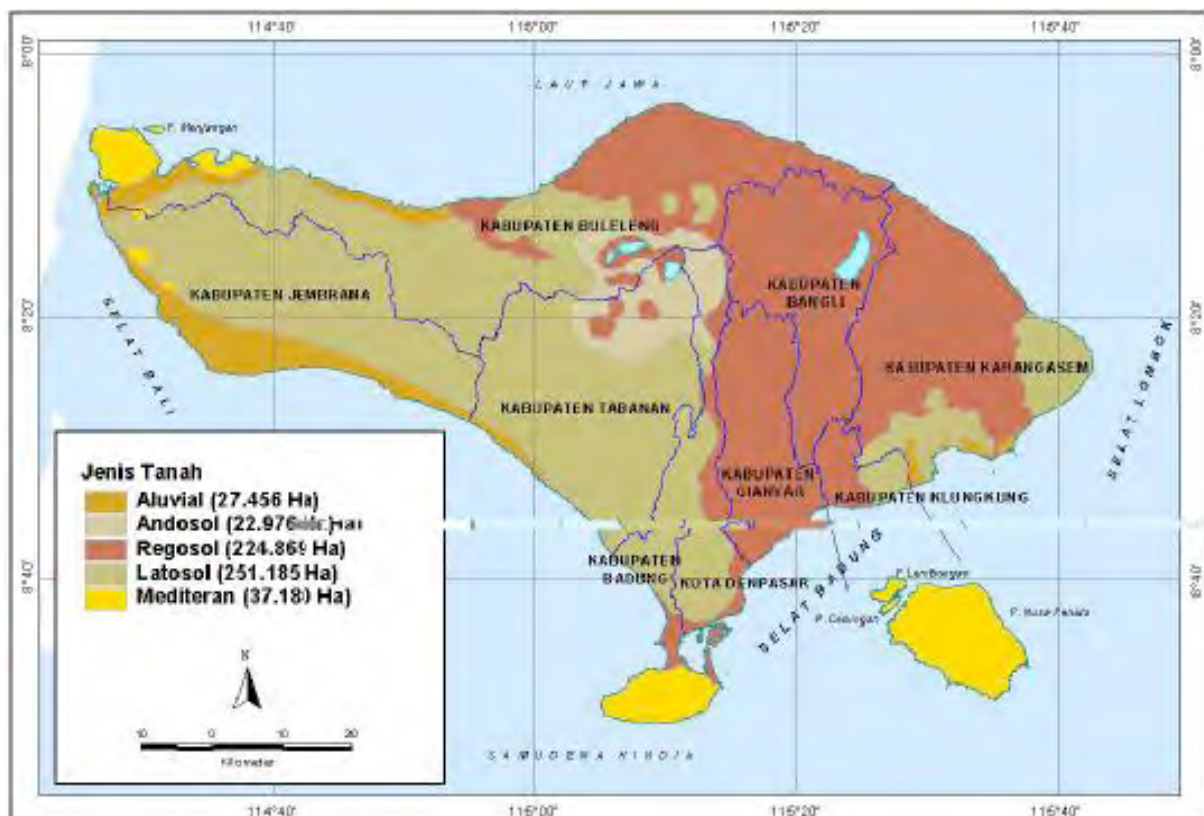
Overall the island of Bali is dominated by a slope over 15%. Land with a slope between 15 - 40% represent 171,932 ha or 30.50% of the province and the slope of over 40% extent to 160,908 ha (28.55%). The sloped area of 15-40% is predominantly found in the central section of Bali and covers the mountain range that stretches from west to east, through the regencies of Jembrana, Tabanan, Klungkung, Bangli and Karangasem. The areas with slopes of 0-2% cover 106,775 ha (18.94%) while areas of 2-15% slope represent 124,051 ha (22.01%). Land dominated by a slope terrain of less than 15% is found in Denpasar and in Gianyar and Badung regencies. See maps below.



TYPE OF SOILS

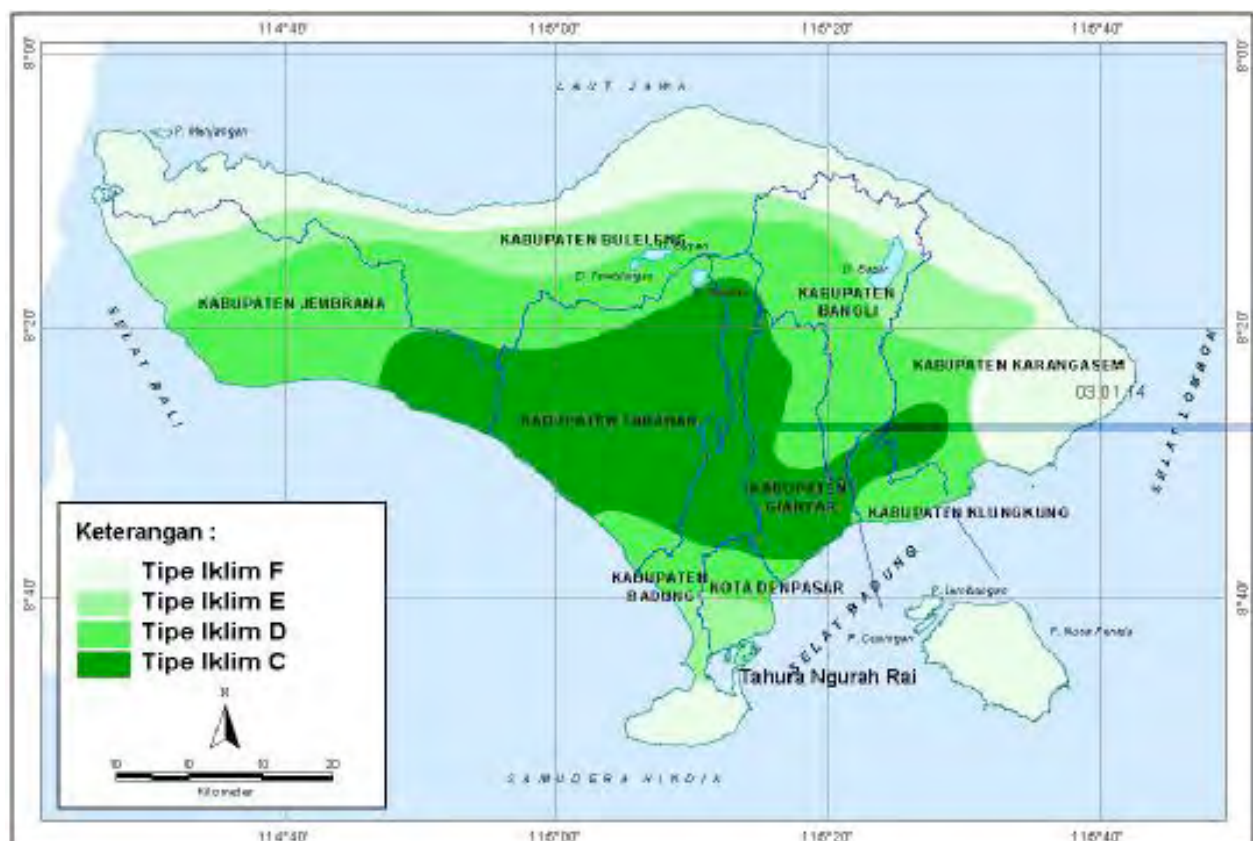
There are five main types of land in the province of Bali according to Bali Map Land Preview (1970). The five soil types are (see below map):

- 1) **Alluvial**, consists of Alluvial and Alluvial Hidromorf Brown Grey, cover 27,456 ha (4.8%), scattered in the Jembrana, Klungkung, Buleleng and Karangasem regencies.
- 2) **Regosol**, consisting of Regosol Brown Grey, Regosol Grey, Brown and Regosol Regosol Berhumus. 224 869 ha (39.9%), spread in Badung regency, Denpasar, Gianyar, and Jembrana.
- 3) **Gray Brown Andosol**, with a total of 22,976 ha (4.1%) dispersed in Buleleng, Tabanan and Badung regencies.
- 4) **Latosol**, consisting Latosol Yellowish brown, Latosol Brown, Reddish Brown Latosol and Litosol. This soil type dominates the region with an area of 251,185 ha (44.6%) in Buleleng, Tabanan, Badung, Denpasar, Jembrana and Klungkung.
- 5) **Mediterranean**, consisting of Mediterranean Chocolate Brown and Mediterranean Red, representing about 37,180 ha (6.6%), scattered in Jembrana, Badung and Klungkung regencies.



CLIMATE

Based on average monthly rainfall, Bali has a pattern of monsoon based climate. Monsoon pattern occurs due to the air circulation changing direction every six months across the Indonesian region, known as the south-west monsoon and east monsoon. South-west monsoon generally raises a lot of rain (rainy season) that occurs around January, while the eastern monsoon generally cause less rainfall conditions (dry season) that occurs around August. Based on the Schmidt-Ferguson classification, Bali has a distribution of climate type C through F as shown in the figure below . Climate type F are scattered in Bali coastal north and east areas, a small hilly region of southern Bali and Nusa Penida., while the type C climate is found at the center of the island and type D in the central and western parts of the island. (See maps). Temperatures vary between 22 C and 28.7 °C.



CLIMATE (cont.)

Average Values of Meteorological and Geophysical Condition by Station, 2011

(Source: Badan Pusat Statistik Provinsi Bali)

Description	Station			
	Meteorologi Ngurah Rai	Geofisika Sanglah	Geofisika Karangasem	Klimatologi Negara
(1)	(2)	(3)	(4)	(5)
1. Temperature (Celcius)				
Maximum	30.1	31.8	29.6	30.2
Minimum	24.5	23.5	23.0	23.1
Average	26.8	27.2	26.5	26.1
2. Percentage of Relative Humidity				
Maximum	91	89	89	91
Minimum	73	73	67	75
Average	83	81	78	84
3. Air Pressure (mb)				
	1 009.0	1 009.6	1 008.2	1 012.5
4. Wind Velocity (knot)				
	6	5	7	3
5. Rainfall*) (mm)				
	1 890.2	2 171.7	1 881.5	1 716.6
6. Sunshine (%)				
	72	70	53	67
*) Total Rainfall in a year, not every day rain				

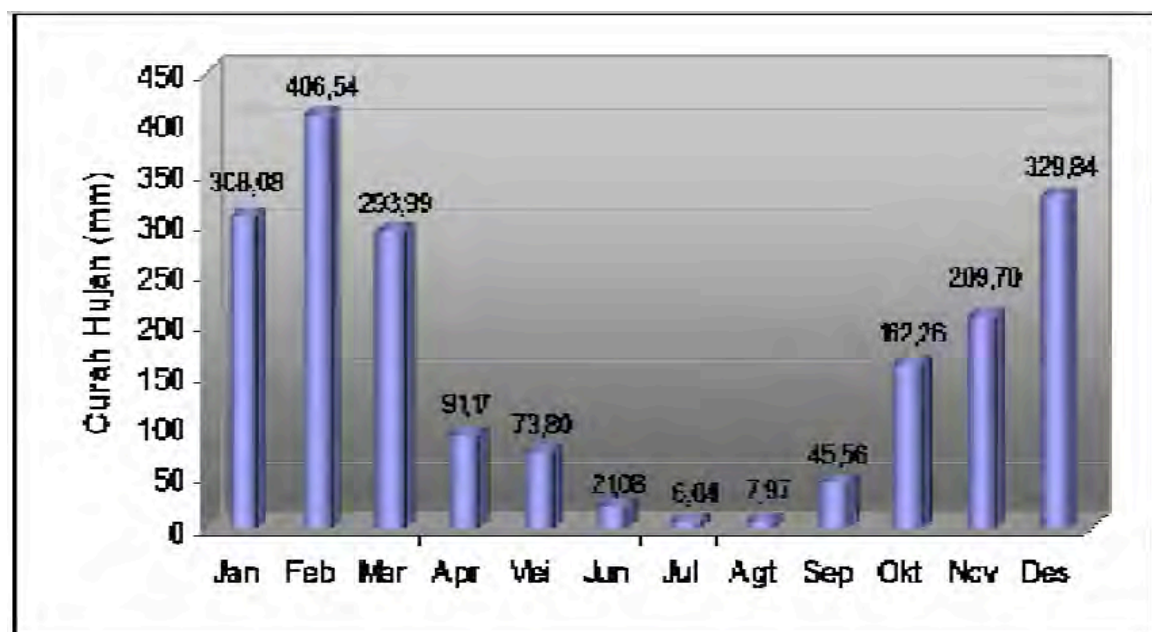
Meteorological and Geophysical Condition of Bali by Regencies

(Source: Badan Pusat Statistik Provinsi Bali)

Regency / City		Temperature (Celcius)	Relative Humidity (%)	Rain Fall (mm)	Wind Velocity (knot)
(1)		(2)	(3)	(4)	(5)
1	Dembrana	26.1	84	1 716.6	3
2	Tabanan	19.0	89	4 041.0	5
3	Badung	26.8	83	1 890.2	6
4	Gianyar	25.7	82	1 862.0	6
5	Klungkung	26.6	86	1 815.0	6
6	Bangli	23.9	68	1 637.0	7
7	Karangasem	26.5	78	1 881.5	7
8	Buleleng	27.2	76	1 215.0	7
9	Denpasar	27.2	81	2 171.7	5

RAINFALL

Annual rainfall average in Bali during 2008 was 1956.04 mm while it ranged from 1660.42 to 2436.56 mm. The highest rainfall is in the regencies of Tabanan and Klungkung. Monthly rainfall average in Bali ranges from 6.04 to 406.54 mm, with the wettest months in February and the driest month in July. The wettest months of rainfall above 100 mm in 2008 lasted for six months from January to December (Figure below). The regencies of Jembrana, Tabanan, Denpasar and Karangasem experience 7 wet months per year while other regencies had 6 wet months in 2008.



---- end of Annex 1 ---