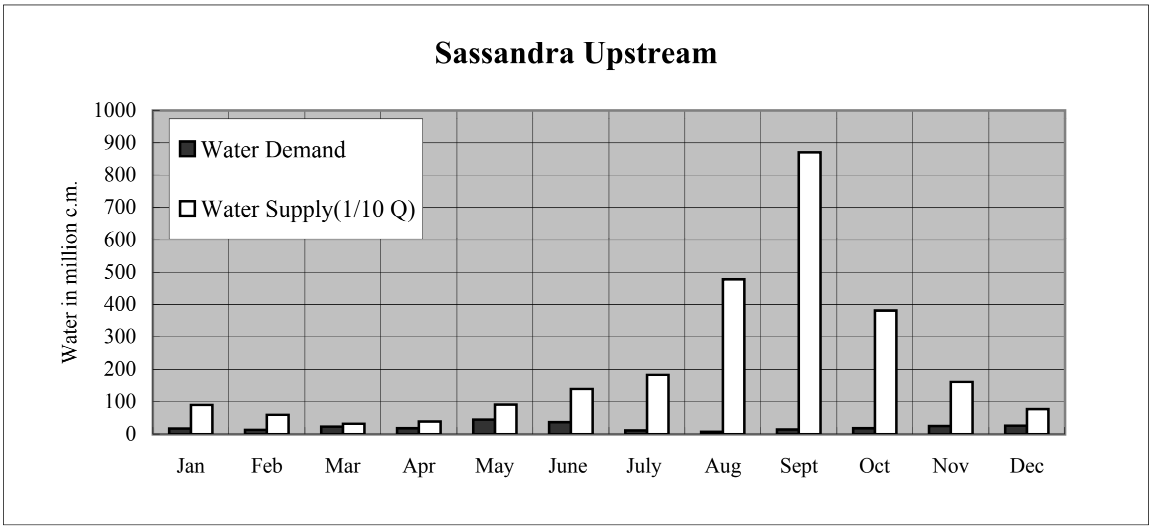
Table 12.2-4 Surface Water Balance in Fututre (AD 2015)

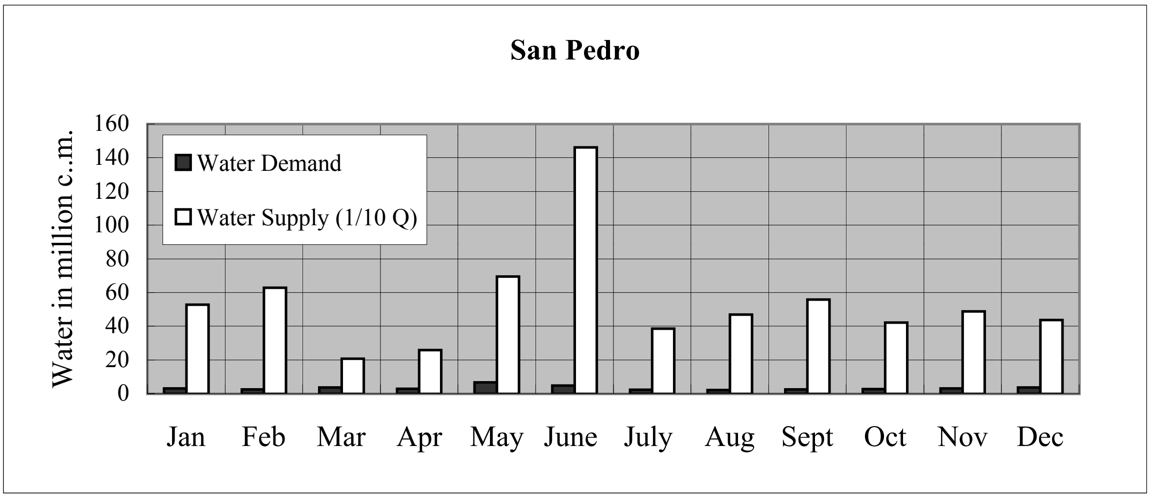
Name		Control Point		Catchment	① Average	Available Water Use		Urban Water Demand		Agricultural Demand					Total Demand	Balance
				Area	Potential	②1/10 Prb.	③ 1/5 Prb.	④	⑤	⑥ Irrigation	⑦Aquaculture	⑧ Live Stock	⑨ Subtotal	⑩ Subtotal	(mm)	(%)
Basin	River	No.	Name	(km^2)	(mm)	(mm)	(mm)	(MCM)	(mm)	(MCM)	(MCM)	(MCM)	(MCM)	(mm)	⑪ = ⑤+⑩	⑪÷②
Sassandra and Surrounding River Basins																
Sassandra	Sassandra	I-C5	Dabala	16,600	325	165	180	5.777	0.348	140.850	46.110	0.654	187.614	11.302	11.650	7.06
		I-C4	Piebly	32,600	170	126	137	13.074	0.401	268.780	181.270	1.039	451.089	13.837	14.238	11.30
		I-C3	Buyo Dam	42,250	217	-	-	98.722	2.337	550.050	528.930	2.555	1,081.535	25.598	27.935	-
		I-C2	Soubre	57,670	148	134	146	111.114	1.927	570.680	555.550	2.635	1,128.865	19.575	21.501	16.05
		I-C1	**Gaoulou Pont**	**70,550**	**173**	**139**	**152**	**124.071**	**1.759**	**608.660**	**606.680**	**2.838**	**1,218.178**	**17.218**	**18.977**	**13.65**
	Tiemba	I-C10	Dioulatiedougou	2,790	176	71	77	0.516	0.185	11.910	4.460	0.189	16.559	5.935	6.120	8.62
	N'zo	I-C8	Khin	4,310	278	283	308	14.774	3.428	113.170	112.230	0.218	225.618	52.348	55.775	19.71
	Bafing	I-C9	Badala (Bafingdala)	5,930	261	194	211	0.885	0.149	31.180	32.930	0.078	64.188	10.824	10.974	5.66
	Davo	I-C6	Dakpadou	6,816	120	99	108	26.728	3.921	37.300	81.970	0.512	119.782	17.574	21.495	21.71
	Lobo	I-C7	Loboville	12,745	139	-	-	27.265	2.139	71.810	89.630	0.615	162.055	12.715	14.854	-
Cavally	Cavally	IV-C2	Toulepleu (Saihibli)	4,670	447	238	286	0.496	0.106	49.050	45.940	0.081	95.071	20.358	20.464	8.60
		IV-C1	**Tate**	**28,800**	**523**	**285**	**342**	**5.340**	**0.185**	**112.850**	**119.880**	**0.277**	**233.007**	**15.744**	**15.929**	**5.59**
San Pedro	Dodo	XI-C3	Weoulo (Ouaoulo)	649	469	414	476	0	0	5.320	6.340	0.034	11.694	18.018	18.018	4.35
	Nero	XI-C2	Rte Grand Bereby	1,266	410	308	354	3.099	2.448	4.920	5.920	0.033	10.873	8.588	11.036	3.58
	San Pedro	XI-C1	San Pedro	3,320	334	321	369	15.879	4.783	23.510	29.150	0.156	52.816	15.908	20.691	6.45
Bani-Niger	Kouroukelle	VI-C5	Iradougou	1,490	211	150	183	0.009	0.006	7.460	2.980	0.117	10.557	7.085	7.091	4.73
(Baoule)	Baoule	VI-C4	Djirila	3,970	151	110	134	3.320	0.836	21.010	7.930	0.331	29.271	7.373	8.209	7.46
	Kankelaba	VI-C3	Debete	5,550	132	48	59	0.000	0.000	75.980	12.400	1.537	89.917	16.201	16.201	33.75
	Bagoe	VI-C2	Kouto Aval	4,740	173	83	122	4.383	0.925	142.160	20.830	2.336	165.326	34.879	35.804	43.14
		VI-C1	Papara	8,950	148	66	97	6.099	0.681	211.500	31.740	4.285	247.525	27.656	28.338	42.94
Cestos	Cestos	V-	-	-	-	-	-	-	-	47.290	44.640	0.074	92.004	-	-	-
Bandama and Surrounding River Basins																
	Bandama	II-C7	Tawara Amont	5,375	76	42	81	2.395	0.446	282.600	77.350	3.862	363.812	67.686	68.132	162.22
		II-C6	Tortiya Amont	14,500	83	42	81	15.582	1.075	675.400	141.310	8.027	824.737	56.878	57.953	137.98
		II-C5	Bada	24,050	76	33	64	18.940	0.788	1,008.440	217.670	11.421	1,237.531	51.457	52.244	158.32
		II-C4	Kossou Dam	32,400	88	-	-	31.150	0.961	1,119.420	247.220	12.260	1,378.900	42.559	43.520	-
		II-C3	Taabo Dam	57,800	107	-	-	124.378	2.152	1,803.340	500.780	18.046	2,322.166	40.176	42.328	-
		II-C2	**Tiassale**	**99,150**	**88**	**26**	**50**	**128.366**	**1.295**	**1,808.470**	**504.160**	**18.117**	**2,330.747**	**22.896**	**24.191**	**93.04**
	*Addition	II-C1	Nzide (River Mouth Bandama)	101,767	126	26	50	130.904	1.286	1,815.870	506.270	18.335	2,340.475	22.998	24.285	93.40
	Bou	II-C16	Rte Boron-Kadyoha	3,754	73	12	14	2.435	0.649	158.040	45.620	2.041	205.701	54.795	55.444	462.03
	Marahoue	II-C14	Mankono	6,700	82	11	21	2.869	0.428	67.350	19.340	0.686	87.376	13.041	13.469	122.45
		II-C13	Zuenoula	16,615	76	11	21	14.689	0.884	130.650	56.160	1.151	187.961	11.313	12.197	110.88
		II-C12	Bouafle	19,800	79	11	21	23.638	1.194	145.720	86.200	1.447	233.367	11.786	12.980	118.00
	Banoroni	II-C15	Kouroukoro	4,810	82	20	23	5.129	1.066	25.380	10.660	0.178	36.218	7.530	8.596	42.98
	Nzi	II-C11	Rte Katiola-Dabakala	6,620	54	10	12	2.596	0.392	45.180	8.930	1.179	55.289	8.352	8.744	87.44
		II-C10	M'Bahiakro	15,700	57	10	12	31.009	1.975	123.480	22.500	2.250	148.230	9.441	11.416	114.16
		II-C9	Dimbokro	24,100	47	10	12	38.916	1.615	149.460	68.040	2.829	220.329	9.142	10.757	107.57
		II-C8	Zienoa (N'zianoa)	35,000	44	20	23	50.332	1.438	363.830	96.140	3.854	463.824	13.252	14.690	73.45
Boubo	Bolo	X-C4	Fresco	1,330	69	10	12	0	0	4.480	8.870	0.052	13.402	10.077	10.077	100.77
	Boubo	X-C2	Grand-Lahou	4,702	63	55	64	0	0	6.510	35.920	0.217	42.647	9.070	9.070	16.49
		X-C1	Adahi Dougeu	2,192	63	55	64	17.290	7.888	1.940	13.520	0.083	15.543	7.091	14.979	27.23
	Niouniourou	X-C3	Dahiri	2,112	195	140	163	0	0	2.020	13.940	0.098	16.058	7.603	7.603	5.43
Comoe and Surrounding River Basins																
Comoe	Comoe	III-C5	Kafolo	21,200	85	27	44	2.159	0.102	105.760	5.950	2.560	114.270	5.390	5.492	20.34
		III-C4	Ganse	43,700	76	23	38	5.153	0.118	244.770	18.840	6.907	270.517	6.190	6.308	27.43
		III-C3	Akakomoekro	57,000	60	18	29	26.802	0.470	394.640	35.800	8.401	438.841	7.699	8.169	45.38
		III-C2	**Abaradinou**	**74,350**	**47**	**19**	**31**	**37.376**	**0.503**	**409.340**	**65.380**	**8.954**	**483.674**	**7.144**	**7.647**	**40.25**
	*Addition	III-C1	Grand Bassam (River Mouth)	77,687	44	19	31	45.268	0.583	418.200	69.180	9.471	496.851	6.396	6.978	36.73
	Ba	III-C6	N'dakro	6,222	28	13	21	14.391	2.313	17.230	6.300	0.510	24.040	3.864	6.177	47.51
Agneby	Agneby	IX-C5	Agboville	4,878	32	25	41	14.809	3.036	17.430	24.080	0.229	41.739	8.557	11.592	46.37
		IX-C4	Kossihouen	7,361	58	25	41	14.809	2.012	45.160	31.260	0.431	76.851	10.440	12.452	49.81
	Me	IX-C3	Lobo Akoudzin	1,274	189	150	246	1.230	0.965	1.330	2.110	0.087	3.527	2.768	3.734	2.49
		IX-C2	Irho	2,458	198	173	284	5.873	2.389	12.250	6.340	0.353	18.943	7.707	10.096	5.84
	Ira	IX-C6	Ira	444	189	169	277	0	0	1.930	0.420	0.125	2.475	5.574	5.574	3.30
	*Addition	IX-C1	Adjin (Lagoon Adjin)	592	198	173	284	0.683	1.154	5.750	0.420	0.110	6.280	10.608	11.762	6.80
Bia	Bia	**VIII-C4**	**Bianouan Aval**	**6,800**	**88**	**60**	**98**	**0.781**	**0.115**	**0.380**	**0.420**	**0.009**	**0.809**	**0.119**	**0.234**	**0.39**
		VIII-C3	Ayame-2 Dam	9,330	142	-	-	1.219	0.131	4.180	3.380	0.099	7.659	0.821	0.952	-
		VIII-C1	Assnie-Mafia	-	-	-	-	10.186	-	8.700	6.770	0.213	15.683	-	-	-
	*Addition	VIII-C2	Krindjabo (Downstream Ayame)	10,033	142	-	-	4.112	0.410	5.500	4.230	0.130	9.860	0.983	1.393	-
Volta-Noire	Kolodio	**VII-C1**	**Kontodou**	**2,097**	**69**	**67**	**89**	**0**	**0**	**8.620**	**2.970**	**0.572**	**12.162**	**5.800**	**5.800**	**8.66**
	Volta-Noire	VII-C2	Vonkoro	111,500	32	76	101	3.799	0.034	11.770	5.940	1.053	18.763	0.168	0.202	0.31

Table 12.2-5 Long-term Average Runoff, 1/10 Probability Runoff and Water Demand in AD 2015

(Unit: MCM)

River	Control Point	Control River Basin	Classification of Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Sassandra	I -C4	I -A4, I -A9	Surface Water Runoff	78.7	44.5	46.9	77.5	150.8	233.5	540.0	1,441.0	1,970.2	1,200.7	467.3	189.9	6,441.0
			Water Demand	16.9	12.7	22.8	18.2	44.4	37.0	11.3	7.3	13.4	17.9	24.5	25.3	251.6
			1/10 Probability Runoff	**89.8**	**59.0**	**32.1**	**38.8**	**91.3**	**138.9**	**182.6**	**477.8**	**870.9**	**381.4**	**160.7**	**77.4**	**2,597.5**
	I -C1	I -A0, I -A1, I -A6	Surface Water Runoff	947.6	892.4	987.5	950.5	958.3	1,074.1	881.2	975.5	1,231.7	1,952.8	1,391.9	1,071.1	13,314.6
			Water Demand	16.9	13.3	18.8	13.4	40.1	28.5	11.4	10.5	12.4	13.1	16.4	20.2	215.1
			1/10 Probability Runoff	**1,000.7**	**929.0**	**1,015.6**	**738.2**	**413.5**	**792.1**	**651.4**	**495.0**	**800.4**	**977.1**	**966.3**	**580.7**	**9,389.3**
Bandama	II -C5	II -A5	Surface Water Runoff	9.4	2.4	2.1	6.2	17.4	27.2	84.4	391.8	735.9	393.5	126.7	27.3	1,824.3
			Water Demand	16.9	17.5	27.7	20.3	21.4	14.3	4.4	2.5	7.7	11.1	22.0	24.9	190.5
			1/10 Probability Runoff	**11.5**	**4.8**	**7.6**	**12.0**	**29.1**	**29.8**	**60.9**	**85.6**	**230.1**	**142.3**	**13.4**	**8.7**	**633.7**
	II -C12	II -A12, II -A13, II -A14, II -A15	Surface Water Runoff	5.9	2.4	4.0	7.5	14.2	22.0	67.0	255.3	622.3	409.5	115.6	21.4	1,547.1
			Water Demand	14.6	10.7	26.7	23.6	37.7	30.9	10.8	7.2	15.4	18.8	26.4	28.6	251.3
			1/10 Probability Runoff	**11.2**	**0.4**	**0.0**	**0.0**	**9.5**	**29.9**	**8.9**	**2.0**	**104.4**	**106.9**	**24.1**	**4.2**	**301.1**
	II -C8	II -A8, II -A9, II -A10, II -A11	Surface Water Runoff	1.9	1.0	1.9	3.6	8.6	15.3	68.3	283.9	445.8	344.4	104.5	17.1	1,296.3
			Water Demand	28.0	19.2	46.7	45.4	61.6	51.6	21.9	13.7	30.4	35.0	49.6	51.9	455.2
			1/10 Probability Runoff	**1.8**	**0.6**	**0.1**	**0.0**	**16.0**	**6.2**	**1.4**	**2.6**	**180.5**	**71.6**	**4.7**	**1.7**	**288.1**
Comoe	III-C3	III-A3	Surface Water Runoff	9.1	2.2	3.5	4.9	28.9	57.3	180.0	552.6	1,419.4	893.0	200.9	37.5	3,389.3
			Water Demand	16.5	13.5	12.7	10.5	10.3	5.9	2.5	1.6	3.3	5.1	12.5	13.0	107.5
			1/10 Probability Runoff	**2.9**	**0.0**	**0.0**	**13.4**	**45.4**	**48.0**	**150.1**	**229.5**	**307.3**	**166.9**	**19.5**	**9.2**	**986.3**
Bani-Niger	VI-C4	VI-A4	Surface Water Runoff	3.7	1.5	0.8	0.3	0.8	1.3	16.1	118.4	221.4	158.0	63.0	13.9	599.2
			Water Demand	1.7	1.3	3.5	3.0	4.2	3.4	1.1	0.7	1.8	2.3	3.3	3.7	30.0
			1/10 Probability Runoff	**2.1**	**0.6**	**0.2**	**0.1**	**0.2**	**0.3**	**9.4**	**83.9**	**135.5**	**95.2**	**24.6**	**5.9**	**351.4**
	VI-C2	VI-A2	Surface Water Runoff	5.6	2.4	1.6	3.1	2.1	2.3	22.5	183.2	344.2	184.5	64.0	14.2	829.7
			Water Demand	7.5	4.9	19.7	19.0	20.7	16.4	6.1	3.6	10.6	12.7	18.6	20.6	160.3
			1/10 Probability Runoff	**10.6**	**4.0**	**2.0**	**1.1**	**1.3**	**1.3**	**1.7**	**80.9**	**232.5**	**51.9**	**12.5**	**3.9**	**404.4**
Agneby	IX-C4	IX-A4, IX-A5	Surface Water Runoff	0.3	0.2	0.8	2.1	9.4	27.5	38.3	8.6	14.5	35.1	14.0	1.6	152.4
			Water Demand	12.7	7.9	3.7	2.0	8.3	5.9	2.3	2.4	2.3	2.4	4.4	8.9	63.2
			1/10 Probability Runoff	**0.1**	**0.1**	**0.1**	**0.4**	**1.7**	**22.9**	**25.1**	**0.0**	**0.1**	**0.2**	**1.5**	**3.7**	**4.7**
Boubo	X-C2	X-A2	Surface Water Runoff	1.9	1.2	3.7	7.8	25.7	64.0	61.3	35.9	36.8	57.3	28.5	9.6	333.7
			Water Demand	3.8	3.0	2.9	1.2	8.4	5.8	1.8	1.9	1.6	1.8	2.5	3.5	38.2
			1/10 Probability Runoff	**0.8**	**0.4**	**0.3**	**0.1**	**3.1**	**6.8**	**35.1**	**4.8**	**0.2**	**2.1**	**0.1**	**7.5**	**125.8**
San Pedro	XI-C1	XI-A1	Surface Water Runoff	31.9	42.3	42.9	50.5	92.9	219.8	146.0	76.1	99.3	142.5	110.7	52.8	1,107.7
			Water Demand	3.0	2.4	3.6	2.8	6.6	4.8	2.2	2.0	2.5	2.6	3.1	3.7	39.4
			1/10 Probability Runoff	**52.7**	**62.9**	**20.7**	**25.9**	**69.4**	**146.2**	**38.6**	**46.9**	**55.8**	**42.2**	**48.7**	**43.7**	**657.1**





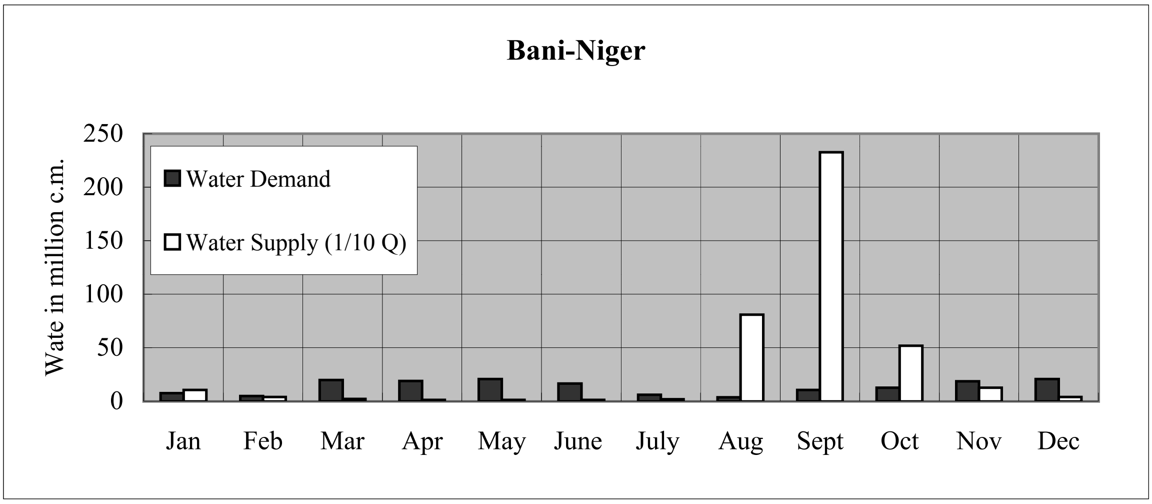


Figure 12.2-1 (1) Monthly Water Balance in 2015 (Sassandra/ San Pedro/ Bani-Niger)

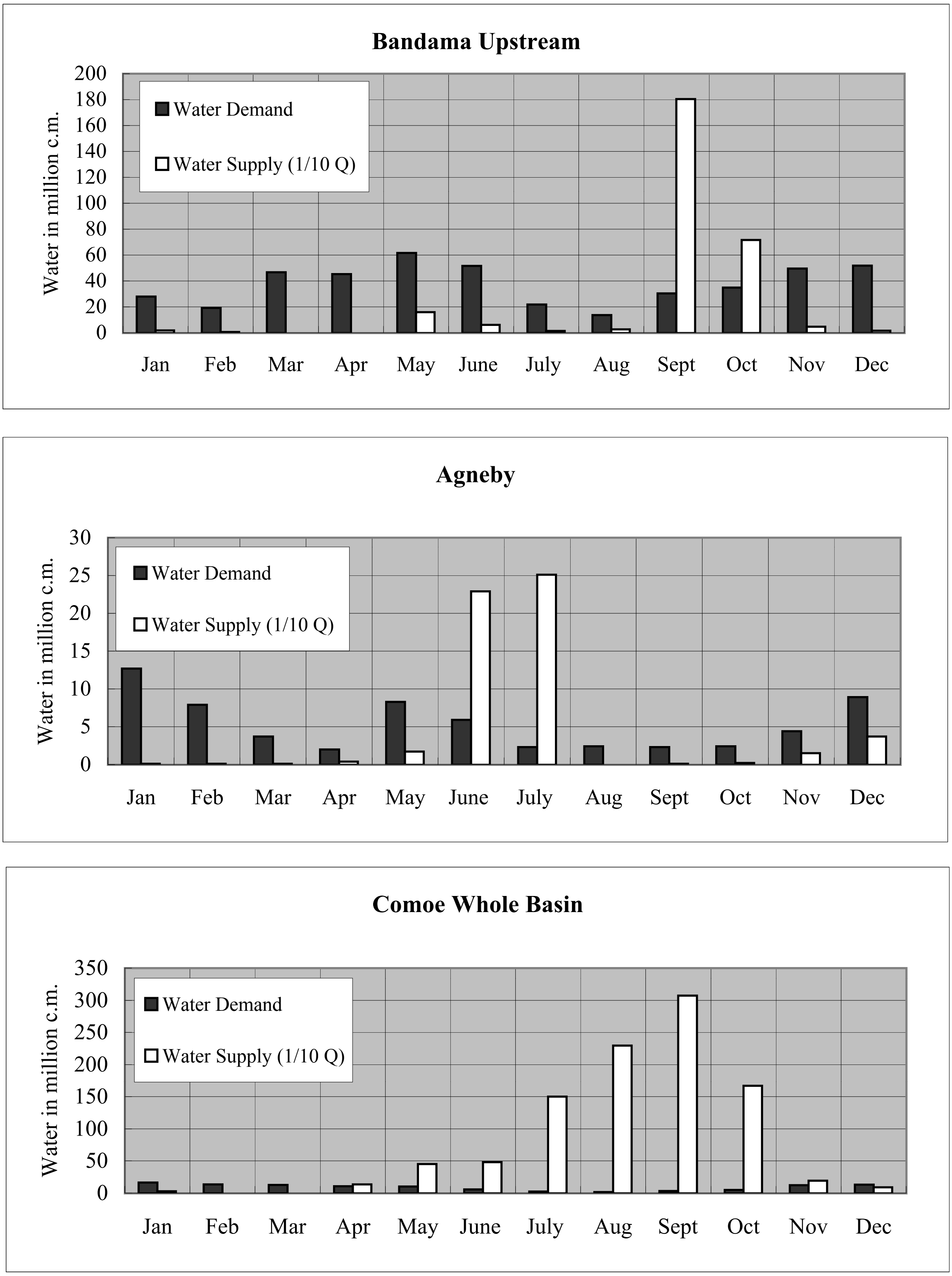


Figure 12.2-1(2) Monthly Water Balance in 2015 (Bandama/ Agneby/ Comoe)

Table 12.3-1 Groundwater balance for river basins (at 2015), presented by water depth (mm)

Hydrogeology	River basin	Area of unit basin	Groundwater potential		Ground water in 1998					Groundwater demand in 2015)					Ratio of demand (2015) for Potential *
					Urban	Rural	Agri	Total	Total	Urban	Rural	Agri	Total	Total	
		(km2)	(mm)	MCM/y	(mm)	(mm)	(mm)	MCM/y	(mm)	(mm)	(mm)	(mm)	MCM/y	(mm)	%
	Total and average of Sassandra and surrounding basin	119,744	148	17,752	0.016	0.09	0.25	42	0.354	0.42	0.18	0.89	178	1.49	1.00
	Total and avarage of Bandama and surrounding absin	111,714	56	6,245	0.002	0.04	0.31	40	0.360	0.35	0.07	1.13	173	1.55	2.75
	Total and of average of Comoe and surrounding basin	82,150	54	4,437	0.058	0.03	0.26	29	0.356	0.50	0.06	0.95	124	1.51	2.79
Total or average of Discontinuous aquifer area		313,608	**91**	28,434	0.022	0.06	0.28	112	**0.357**	0.42	0.11	0.99	475	**1.52**	**1.67**
Total and average of General aquifer area		8,392	**334**	2,803	11.333	0.10	0.99	104	**12.417**	30.25	0.11	3.30	283	**33.67**	**9.87**
Grand total		322,000	**97**	31,238	0.317	0.06	0.29	216	**0.671**	1.19	0.11	1.14	758	**2.35**	**2.40**

Modefied from the "Carte de planification des ressources en eau de Cote d'Ivoire"1978

* Balance between Potential and demand (2015) =100*(Groundwater demand 2015/Groundwater potential)

Table 12.3-2 Groundwater balance for river basins (at 2015), presented by water depth (mm)

Hydrogeology	River basin	Control point (*bold-type* = main Control Point) / Groundwater Basin		Area of unit basin	Groundwater potential		Ground water in 1998				Groundwater demand in 2015 (MCM/y)				Balance Potential (201
							Urban	Rural	Agri	Total	Urban	Rural	Agri	Total	
		No	Name	(km2)	(mm)	MCM/y	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
Dis-continuous aquifer	Sassandra and surrounding basin														
	Sassandra	I-C1	***Gahoulou***	6,064	133	807	0.034	0.21	0.23	0.477	2.14	0.54	0.82	3.49	129.64
		I-C2	Soubre	2,675	78	208	0.011	0.22	0.26	0.492	0.35	0.54	0.92	1.81	75.97
		I-C3	***Buyo Dam***	5,321	147	781	0.059	0.29	0.41	0.758	2.05	0.63	1.48	4.15	142.58
		I-C4	***Piebly***	10,089	124	1,253	0.013	0.06	0.26	0.335	0.64	0.06	0.93	1.62	122.56
		I-C5	Dabala	13,810	116	1,602	0.003	0.00	0.11	0.120	0.06	0.01	0.40	0.47	115.52
		I-C6	Dakpadou	6,816	133	907	0.043	0.17	0.30	0.520	0.92	0.40	1.08	2.40	130.60
		I-C7	Lobovilie	12,745	78	994	0.006	0.22	0.54	0.767	0.07	0.37	1.95	2.39	75.61
		I-C8	Kahin	4,310	216	930	0.012	0.05	0.42	0.483	0.16	0.07	1.50	1.73	213.99
		I-C9	Badala	5,930	144	851	0.003	0.01	0.09	0.101	0.01	0.01	0.33	0.35	143.20
		I-C10	Dioulatiedougou	2,790	116	324	0.004	0.00	0.12	0.124	0.19	0.00	0.38	0.56	115.44
		sub-total Sassandra basin		70,550	123	8,656	0.017	0.12	0.29	0.420	0.57	0.23	1.02	1.83	120.87
	Gavally	IV-C1	***Tate***	8,400	209	1,756	0.004	0.13	0.21	0.348	0.58	0.29	0.75	1.62	207.38
		IV-C2	Toulepleu	10,383	244	2,533	0.000	0.02	0.19	0.207	0.00	0.02	0.68	0.71	243.29
	Ba-Oule	VI-C1	Papala	2033	136	276	0.008	0.01	0.32	0.340	0.10	0.02	1.13	1.25	134.51
		VI-C2	***Kouto Point***	4740	136	643	0.019	0.01	0.26	0.291	0.21	0.02	0.93	1.16	134.59
		VI-C3	Debete	5550	136	753	0.000	0.00	0.15	0.155	0.00	0.00	0.53	0.54	135.22
		VI-C4	***Djirila***	7082	136	961	0.091	0.00	0.13	0.225	0.52	0.00	0.35	0.87	134.88
		VI-C5	Iradougou	3044	136	413	0.000	0.00	0.12	0.125	0.00	0.00	0.69	0.69	135.07
	San Pedro	XI-C1	***San Perdo***	5,215	221	1,153	0.000	0.17	0.25	0.413	0.00	0.41	0.88	1.30	219.70
		XI-C2	Grand Bereby	1,266	221	280	0.000	0.06	0.22	0.285	0.00	0.16	0.79	0.95	220.05
		XI-C3	Weoulo	1,481	221	327	0.000	0.02	0.19	0.209	0.00	0.01	0.66	0.67	220.33
	Total of Sassandra and surrounding basin			119,744	148	17,752	0.016	0.09	0.25	0.354	0.42	0.18	0.89	1.49	146.77
	Bandama and surrounding basin														
	Bandama	II-C1	Nzide	2,228	84	187	0.117	0.21	0.54	0.100	0.99	0.29	1.97	3.25	82.70
		II-C2	***Tiassale***	6,350	50	315	0.000	0.03	0.05	0.072	0.00	0.03	0.18	0.20	49.36
		II-C3	***Taabo Dam***	5,600	44	248	0.056	0.14	0.59	0.783	0.25	0.15	2.11	2.52	41.76
		II-C4	***Kossou***	8,350	45	378	0.021	0.03	0.43	0.479	0.73	0.06	1.53	2.31	42.99
		II-C5	***Bada***	5,796	48	277	0.016	0.03	0.30	0.341	0.16	0.12	1.04	1.32	46.40
		II-C6	***Toritaya***	9,125	68	621	0.030	0.02	0.27	0.320	0.19	0.04	0.96	1.18	66.87
		II-C7	Tawara amount	5,375	74	399	0.019	0.02	0.40	0.446	0.45	0.03	1.47	1.94	72.32
		II-C8	Zienoa	10,900	31	334	0.078	0.03	0.42	0.522	0.93	0.03	1.50	2.46	28.22
		II-C9	Dimbokro	8,400	31	258	0.059	0.02	0.28	0.361	0.35	0.02	1.00	1.36	29.31
		II-C10	***Mbahiakro***	9,080	43	386	0.061	0.01	0.42	0.496	0.21	0.02	1.52	1.75	40.80
		II-C11	Rte Katiola-Dabakara	6,620	42	276	0.002	0.01	0.17	0.179	0.08	0.04	0.63	0.75	40.89
		II-C12	***Bouafle***	3,185	47	150	0.000	0.12	0.50	0.612	0.00	0.21	1.77	1.99	45.14
		II-C13	Zuenola	5,105	50	255	0.027	0.05	0.25	0.322	0.68	0.11	0.89	1.69	48.31
		II-C14	Mankono	6,700	64	427	0.007	0.01	0.21	0.226	0.43	0.04	0.73	1.19	62.57
		II-C15	Kouroukoro	4,810	64	307	0.000	0.00	0.11	0.115	0.00	0.01	0.41	0.42	63.34
		II-C16	Rte Boron-Kadyoha	3,754	53	197	0.006	0.01	0.35	0.367	0.65	0.05	1.26	1.96	50.63
		sub-total Bandama basin		101,378	49	5,015	0.033	0.03	0.32	0.390	0.38	0.06	1.16	1.60	47.87
	Boubo	X-C1	Grand Lahou	2,192	119	261	0.013	0.22	0.18	0.409	0.00	0.31	0.63	0.00	119.00
		X-C2	***Grand Lahou***	4,702	119	560	0.011	0.09	0.26	0.358	0.00	0.11	0.93	1.04	117.96
		X-C3	Dahili	2,112	119	251	0.006	0.08	0.24	0.332	0.00	0.13	0.86	0.99	118.01
		X-C4	Fresco	1,330	119	158	0.076	0.18	0.30	0.554	0.00	0.36	1.07	1.43	117.57
	Total and avarage of Bandama and surroundings			111,714	56	6,245	0.002	0.04	0.31	0.360	0.35	0.07	1.13	1.55	54.35
	Comoe and surrounding basin														
	Comoe	III-C1	Grand Bassan	2,608	101	263	0.124	0.02	1.22	0.097	1.14	0.07	4.40	5.61	100.04
		III-C2	***Abaradinou***	8,561	31	269	0.189	0.08	0.22	0.488	0.78	0.10	0.78	1.66	29.72
		III-C3	Akakomoekro	12,562	39	493	0.004	0.01	0.17	0.186	0.17	0.01	0.62	0.79	38.48
		III-C4	***Ganse***	20,572	41	839	0.001	0.01	0.12	0.133	0.15	0.04	0.45	0.64	40.17
		III-C5	***Kafolon***	5,668	76	433	0.009	0.05	0.17	0.237	0.10	0.11	0.63	0.83	75.64
		III-C6	N'dakro	5,865	31	184	0.246	0.04	0.30	0.582	2.45	0.04	1.07	3.56	27.82
		Sub total Comoe basin		55,836	44	2,482	0.063	0.03	0.22	0.315	0.53	0.05	0.80	1.39	43.07
	Kolodio	VII-C1	***Kontodou***	7,078	46	328	0.000	0.00	0.20	0.207	0.00	0.01	0.73	0.74	45.53
		VII-C2	Vonkoro	5,471	46	253	0.032	0.00	0.08	0.121	0.69	0.01	0.35	1.05	45.22
	Bia	VIII-C1	Mouth Lagoon	0	135	0	0.000	0.00	0.00	0.000	0.00	0.00	0.00	0.00	135.16
		VIII-C2	Krindjaabo	144	135	19	0.371	0.61	3.26	4.247	2.04	0.74	11.60	14.38	120.78
		VIII-C3	***Ayame Dam2***	2,530	135	342	0.011	0.09	0.18	0.283	0.04	0.10	0.67	0.82	134.34
		VIII-C4	***Bian***	236	135	32	0.000	0.61	0.21	0.822	0.00	0.50	0.81	1.30	133.85
	Agneby	IX-C1	Adjin	592	90	53	0.000	0.03	1.45	1.481	0.00	0.04	5.14	5.17	85.15
		IX-C2	***Irho***	1,184	90	107	0.277	0.12	1.51	1.913	1.75	0.17	5.44	7.36	82.97
		IX-C3	Loboakoudzin	1,274	90	115	0.074	0.03	0.36	0.461	0.97	0.05	1.28	2.29	88.03
		IX-C4	***Kossihouen***	2,483	90	224	0.025	0.08	0.46	0.564	0.00	0.10	1.64	1.74	88.59
		IX-C5	Agboville	4,878	90	441	0.096	0.06	0.21	0.368	0.80	0.08	0.75	1.64	88.69
		IX-C6	Ira	444	90	40	0.201	0.09	2.25	2.545	0.00	0.12	8.11	8.22	82.10
	Total and of Comoe and surrounding basin			82,150	54	4,437	0.058	0.03	0.26	0.356	0.50	0.06	0.95	1.51	52.50
Total or average of Discontinuous aquifer				313,608	91	28,434	0.022	0.06	0.28	0.357	0.42	0.11	0.99	1.52	89.15
General aquifer	Coastal area	GA-1	Grand Lahou	1,083	200	217	0.013	0.40	0.52	0.931	4.49	0.31	0.29	4.79	195.21
		GA-2	Mouth of Bandama	389	200	78	0.100	0.18	0.51	0.100	0.84	0.25	1.86	1.09	198.91
		GA-3	Abidjan	3,516	354	1,244	26.910	0.00	1.73	28.642	69.08	0.00	6.23	75.31	278.58
		GA-4	Grand Bassan	729	336	245	0.097	0.05	0.96	0.097	0.89	0.05	2.74	0.94	335.52
		GA-5	Mouth of Lagoon	2,675	381	1,019	0.136	0.10	0.28	0.513	1.93	0.18	1.02	2.11	378.93
Total General aquifer				8,392	334	2,803	11.333	0.10	0.99	12.417	30.25	0.11	3.30	33.67	300.36
Grand total				322,000	97	31,238	0.317	0.06	0.29	0.671	1.19	0.11	1.14	2.35	94.66

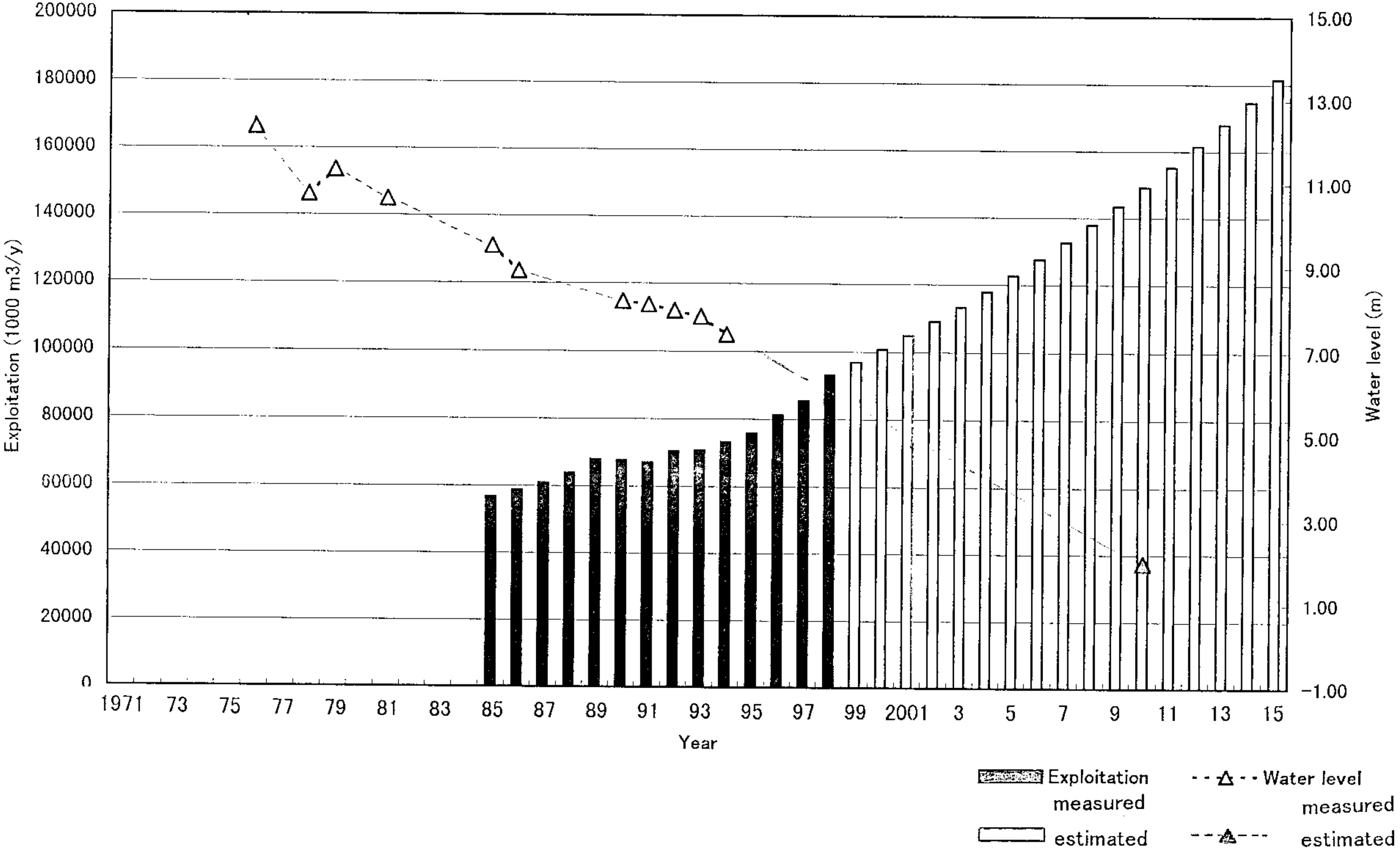
* Balance between Potential and demand (2015) ; mm=Groundwater potential - Groundwater demand in 2015

Table 12.3-3 Groundwater balance for river basins (at 2015), presented by water volume (MCM)

Hydrogeology	River basin	Control point (***bold-type*** = main Control Point) / Groundwater Basin		Area of unit basin	Groundwater potential		Groundwater use in 1998 (MCM/y)				Groundwater demand in 2015 (MCM/y)				Balance be Potentia Demand (2
		No	Name	(km2)	(mm)	MCM/y	Urban	Rural	Agricu	Total	Urban	Rural	Agricult	Total	MCM/y
Dis-continuous aquifer	Sassandra and surrounding basin														
	Sassandra	I-C1	***Gahoulou***	6,064	133	807	0.204	1.30	1.39	2.89	12.96	3.25	4.98	21.19	786.16
		I-C2	Soubre	2,675	78	208	0.031	0.58	0.70	1.32	0.95	1.45	2.46	4.85	203.22
		I-C3	***Buyo Dam***	5,321	147	781	0.314	1.54	2.18	4.03	10.91	3.33	7.86	22.11	758.68
		I-C4	***Piebly***	10,089	124	1,253	0.132	0.63	2.62	3.38	6.41	0.60	9.35	16.36	1,236.55
		I-C5	Dabala	13,810	116	1,602	0.036	0.03	1.58	1.65	0.77	0.11	5.58	6.46	1,595.29
		I-C6	Dakpadou	6,816	133	907	0.290	1.18	2.07	3.54	6.26	2.70	7.39	16.35	890.17
		I-C7	Lobovilie	12,745	78	994	0.078	2.79	6.91	9.78	0.89	4.68	24.90	30.47	963.64
		I-C8	Kahin	4,310	216	930	0.054	0.22	1.81	2.08	0.67	0.30	6.47	7.44	922.29
		I-C9	Badala	5,930	144	851	0.018	0.05	0.53	0.60	0.04	0.06	1.96	2.07	849.19
		I-C10	Dioulatiedougou	2,790	116	324	0.013	0.00	0.33	0.35	0.52	0.01	1.05	1.57	322.07
		sub-total Sassandra basin		70,550	123	8,656	1.168	8.33	20.12	29.62	40.38	16.49	72.00	128.88	8,527.25
	Gavally	IV-C1	***Tate***	8,400	209	1,756	0.033	1.12	1.77	2.92	4.84	2.43	6.30	13.58	1,742.02
		IV-C2	Toulepleu	10,383	244	2,533	0.000	0.16	1.99	2.15	0.00	0.24	7.11	7.35	2,526.10
	Ba-Oule	VI-C1	Papala	2033	136	276	0.017	0.02	0.66	0.69	0.20	0.03	2.30	2.54	273.45
		VI-C2	***Kouto Point***	4740	136	643	0.091	0.04	1.25	1.38	1.00	0.10	4.40	5.50	637.97
		VI-C3	Debete	5550	136	753	0.000	0.01	0.85	0.86	0.00	0.01	2.96	2.97	750.46
		VI-C4	***Djirila***	7082	136	961	0.644	0.01	0.94	1.60	3.70	0.03	2.45	6.18	955.23
		VI-C5	Iradougou	3044	136	413	0.000	0.00	0.38	0.38	0.00	0.01	2.09	2.09	411.14
	San Pedro	XI-C1	***San Perdo***	5,215	221	1,153	0.000	0.87	1.28	2.15	0.00	2.16	4.60	6.76	1,145.75
		XI-C2	Grand Bereby	1,266	221	280	0.000	0.08	0.28	0.36	0.00	0.21	1.00	1.21	278.58
		XI-C3	Weoulo	1,481	221	327	0.000	0.03	0.28	0.31	0.00	0.01	0.98	0.99	326.31
	Total of Sassandra and surrounding basin			119,744	148	17,752	1.954	10.67	29.80	42.43	50.12	21.73	106.19	178.05	17,574.27
	Bandama and surrounding basin														
	Bandama	II-C1	Nzide	2,228	84	187	0.260	0.46	1.21	1.93	2.21	0.65	4.38	7.24	179.45
		II-C2	***Tiassale***	6,350	50	315	0.000	0.16	0.30	0.46	0.00	0.18	1.12	1.30	313.45
		II-C3	***Taabo Dam***	5,600	44	248	0.311	0.78	3.30	4.39	1.39	0.85	11.84	14.09	233.86
		II-C4	***Kossou***	8,350	45	378	0.177	0.25	3.57	4.00	6.10	0.46	12.74	19.30	358.99
		II-C5	***Bada***	5,796	48	277	0.095	0.17	1.71	1.98	0.92	0.67	6.04	7.64	268.95
		II-C6	***Toritaya***	9,125	68	621	0.277	0.21	2.43	2.92	1.71	0.34	8.74	10.79	610.23
		II-C7	Tawara amount	5,375	74	399	0.104	0.12	2.17	2.39	2.39	0.18	7.88	10.45	388.73
		II-C8	Zienoa	10,900	31	334	0.846	0.28	4.56	5.69	10.13	0.33	16.31	26.78	307.61
		II-C9	Dimbokro	8,400	31	258	0.497	0.19	2.35	3.03	2.91	0.19	8.36	11.46	246.24
		II-C10	***Mbahiakro***	9,080	43	386	0.551	0.11	3.84	4.50	1.91	0.15	13.83	15.89	370.49
		II-C11	Rte Katiola-Dabakara	6,620	42	276	0.016	0.05	1.12	1.18	0.56	0.29	4.14	4.99	270.70
		II-C12	***Bouafle***	3,185	47	150	0.000	0.37	1.58	1.95	0.00	0.67	5.65	6.32	143.79
		II-C13	Zuenola	5,105	50	255	0.140	0.24	1.27	1.65	3.49	0.58	4.56	8.63	246.62
		II-C14	Mankono	6,700	64	427	0.048	0.08	1.38	1.51	2.87	0.25	4.86	7.98	419.20
		II-C15	Kouroukoro	4,810	64	307	0.000	0.02	0.54	0.56	0.00	0.03	1.99	2.02	304.65
		II-C16	Rte Boron-Kadyoha	3,754	53	197	0.023	0.04	1.31	1.38	2.44	0.20	4.73	7.37	190.06
		sub-total Bandama basin		101,378	49	5,015	3.345	3.54	32.64	39.53	39.02	6.04	117.17	162.24	4,853.01
	Boubo	X-C1	Grand Lahou	2,192	119	261	0.028	0.48	0.39	0.90	0.00	0.67	1.37	2.05	260.17
		X-C2	***Grand Lahou***	4,702	119	560	0.053	0.42	1.21	1.68	0.00	0.53	4.37	4.90	554.63
		X-C3	Dahili	2,112	119	251	0.012	0.18	0.51	0.70	0.00	0.27	1.81	2.08	249.24
		X-C4	Fresco	1,330	119	158	0.101	0.24	0.40	0.74	0.00	0.48	1.42	1.90	156.37
	Total and avarage of Bandama and surroundings			111,714	56	6,245	0.195	4.86	35.15	40.20	39.02	8.00	126.15	173.18	6,073.43
	Comoe and surrounding basin														
	Comoe	III-C1	Grand Bassan	2,608	101	263	0.322	0.05	3.18	0.38	2.97	0.18	11.47	14.62	248.72
		III-C2	***Abaradinou***	8,561	31	269	1.618	0.70	1.86	4.18	6.70	0.89	6.65	14.24	254.42
		III-C3	Akakomoekro	12,562	39	493	0.046	0.12	2.17	2.34	2.07	0.14	7.77	9.98	483.38
		III-C4	***Ganse***	20,572	41	839	0.027	0.15	2.56	2.73	2.99	0.92	9.20	13.11	826.28
		III-C5	***Kafolon***	5,668	76	433	0.049	0.30	0.99	1.34	0.54	0.62	3.55	4.71	428.72
		III-C6	N'dakro	5,865	31	184	1.441	0.21	1.76	3.41	14.39	0.22	6.28	20.89	163.17
		Sub total Comoe basin		55,836	44	2,482	3.503	1.54	12.52	17.56	29.67	2.96	44.92	77.56	2,404.69
	Kolodio	VII-C1	***Kontodou***	7,078	46	328	0.000	0.02	1.45	1.47	0.00	0.04	5.19	5.23	322.27
		VII-C2	Vonkoro	5,471	46	253	0.175	0.03	0.46	0.66	3.80	0.03	1.91	5.74	247.41
	Bia	VIII-C1	Mouth Lagoon	0	135	0	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		VIII-C2	Krindjaabo	144	135	19	0.053	0.09	0.47	0.61	0.29	0.11	1.67	2.07	17.39
		VIII-C3	***Ayame Dam2***	2,530	135	342	0.027	0.23	0.46	0.72	0.11	0.25	1.70	2.06	339.88
		VIII-C4	***Bian***	236	135	32	0.000	0.14	0.05	0.19	0.00	0.12	0.19	0.31	31.59
	Agneby	IX-C1	Adjin	592	90	53	0.000	0.02	0.86	0.88	0.00	0.02	3.04	3.06	50.41
		IX-C2	***Irho***	1,184	90	107	0.328	0.15	1.79	2.26	2.08	0.20	6.44	8.72	98.23
		IX-C3	Loboakoudzin	1,274	90	115	0.094	0.03	0.46	0.59	1.23	0.06	1.63	2.92	112.15
		IX-C4	***Kossihouen***	2,483	90	224	0.063	0.20	1.14	1.40	0.00	0.25	4.07	4.32	219.96
		IX-C5	Agboville	4,878	90	441	0.470	0.30	1.02	1.79	3.89	0.41	3.67	7.98	432.63
		IX-C6	Ira	444	90	40	0.089	0.04	1.00	1.13	0.00	0.05	3.60	3.65	36.45
	Total and of Comoe and surrounding basin			82,150	54	4,437	4.802	2.78	21.68	29.27	41.08	5.00	78.03	124.11	4,313.07
Total or average of Discontinuous aquifer				313,608	91	28,434	6.951	18.32	86.63	111.90	130.23	34.74	310.37	475.34	27,960.77
General aquifer	Coastal area	GA-1	Grand Lahou	1,083	200	217	0.014	0.43	0.56	1.01	4.86	0	0.31	5.51	211.47
		GA-2	Mouth of Bandama	389	200	78	0.039	0.07	0.20	0.31	0.33	0.10	0.73	1.15	77.38
		GA-3	Abidjan	3,516	354	1,244	94.625	0.00	6.09	100.71	242.91	0.00	21.92	264.83	979.58
		GA-4	Grand Bassan	729	336	245	0.070	0.04	0.70	0.81	0.65	0	2.00	2.68	244.66
		GA-5	Mouth of Lagoon	2,675	381	1,019	0.363	0.26	0.75	1.37	5.16	0	2.74	8.39	1,013.46
Total General aquifer				8,392	334	2,803	95.111	0.80	8.30	104.21	253.91	0.96	27.69	282.56	2,526.55
Grand total				322,000	97	31,238	102.062	19.12	94.93	216.10	384.14	36.66	365.76	757.90	30,487.32

* Balance between Potential and demand (2015) ; MCM/Y=Groundwater potential - Groundwater demand in 2015

Figure 12.3-1 Relation between groundwater level and exploitation (No. 724 observation borehole)



Modefied from Final report of "Etude de la gestion et de la protection de la nappe assurant l'alimentation en eau potable d'Abidjan" (by BNETD & MIE/DH 1997)

PART 5 WATER RESOURCES MANAGEMENT PLAN

CHAPTER 13 BASIC CONCEPT OF WATER RESOURCES MANAGEMENT

13.1 Objective of Water Resources Management

The goal of the water resources management is sustainable water use.

In order to achieve the effective and sustainable water resources management, items required for proper monitoring, evaluating and controlling works are summarized as below;

1. Water quantity
2. Water quality
3. Hydro-meteorological and hydro-geological network
4. Drought management
   (Reservoir operation/ Water diversion)
5. Watershed management
   (Drainage water regulation/Forest protection/Land conservation)
6. Facilities maintenance

The basic concept on the water resources management was studied and established by the Cote d'lvoire Government, then the document on "National Policy and Strategy for Integrated Management of Water Resources" was prepared in 1999. In addition, the document on "National Program of Hydraulics 2000 – 2015" related to the water resources management was also prepared in 1999.

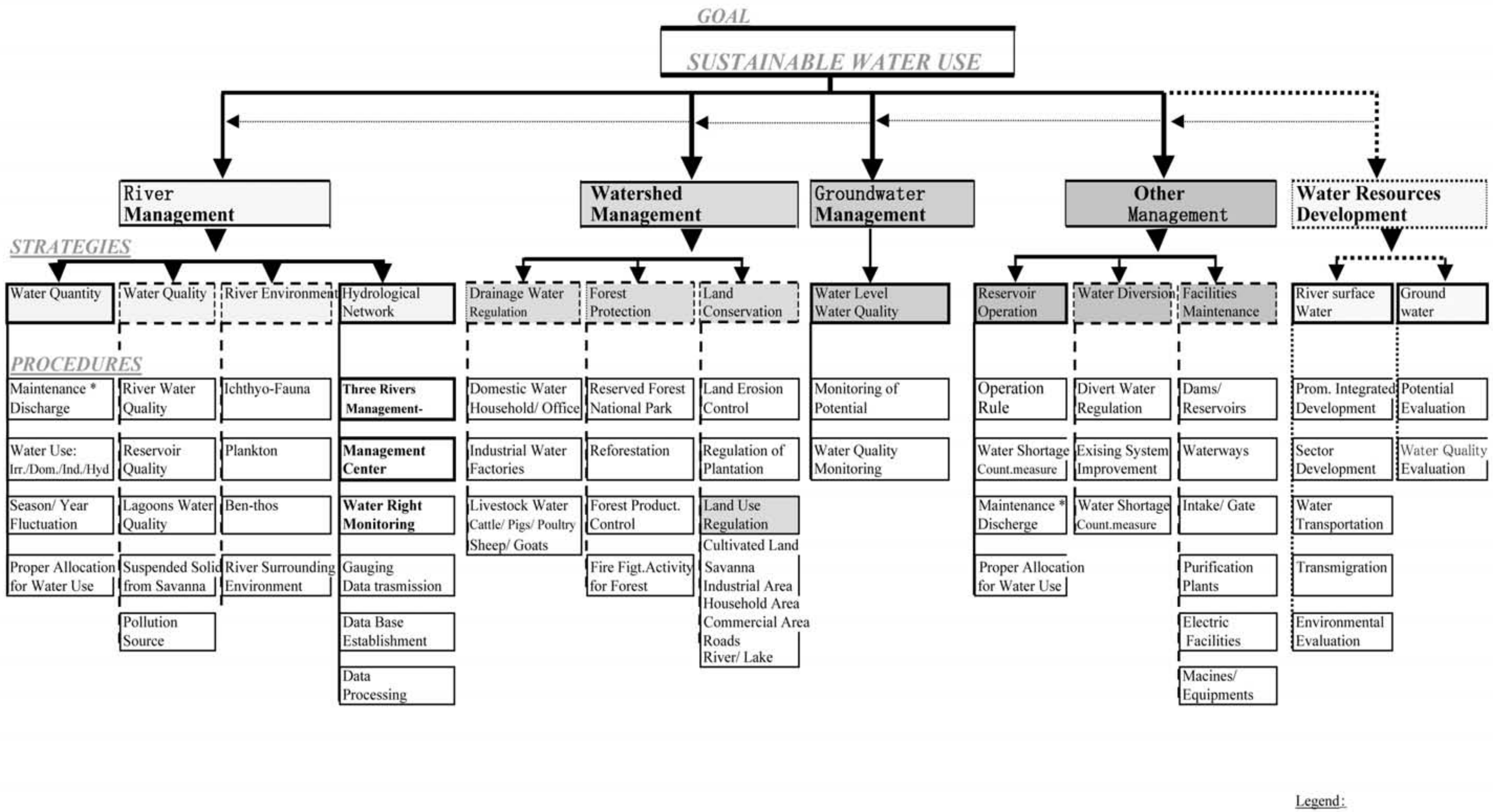
It is judged that the contents described in both documents cover completely and sufficiently the important items related to the water resources management. It is recommendable accordingly that the integrated water resources management in the country will be performed based on those documents.

13.2 Framework of Water Resources Management

The framework of strategies of water resources management is as shown in Figure 13.2-1.

The each strategies would be executed based on procedures items.

Figure 13.2-1 FRAMEWORK OF WATER RESOURCES MANAGEMENT



* Maintenance Discharge
The discharge which has been stipulated to be maintained even at the time of low flow, upon overall consideration of *boat transportation/ fishing/ picturesque scenery/ prevention of salt injury/ prevention of blocking of estuary/ protection of river control facilities/ maintenance of groundwater level/ protection of plants・animals/ maintenance of clearance of river flow.*

13.3 Notices Points for Water Resources Management

13.3.1 Water Quantity Management

Items which have to take into account on the water quantity management are as follows;

(1) River Maintenance Water

The maintenance water shall be allocated at each control point taking into account 9 items as shown in Figure 13.2-1.

The river maintenance water in dry season is not existing for time being in small and medium scale rivers. In case of the new water resources development planning with reservoirs, it is essential matter to take into account the river maintenance water.

As standard values of the maintenance water for river in Cote d'Ivoire, the criteria of the Mekong River Committee is realistically, i.e. "monthly average the lowest discharge based on observed record".

(2) River Flow Regime Control at Reservoirs and Weirs

As the river flow will be changed by the water use quantity between the control points, such flow variation shall be always monitored, evaluated and controlled. If the river flow control can not be made properly, the downstream basin will face water shortage problem by the previous water intake at the upstream basin. Accordingly the reservoir outflow and water diversion at weir shall be carried out always taking into account the water right at the downstream river. It is also necessary to monitor the water level and discharge at the downstream control point and check their variation.

(3) Water Allocation

The runoff quantity in each river is limited, while the water resources development will increase year by year. There is a tendency to decrease the water use in the existing project by the water use of the proposed project in the same basin.

The water allocation plan to allocate the water use quantity for each project at each river basin shall be formulated taking into account the available runoff, water uses in the existing and proposed projects and river maintenance water.

(4) Groundwater Use

Following management for groundwater use will be required particularly in Abidjan.

- Location of wells to withdraw groundwater shall be selected taking into account aquifer conditions, distribution density of wells, depth of wells, designed withdraw capacity of wells.

- Designed withdraw capacity shall be determined based on the pumping test at the wells.
- Groundwater level fluctuation during operation of wells shall be monitored by the installed monitoring well, the operation of production wells shall be controlled by the evaluation for the monitoring result of water level, withdraw capacity, water quality.

13.3.2 Water Quality

Items which have to take into account for the water quality management are as follows;

(1) Surface Water Quality

The surface water in the wet season includes a large sediment load and shows the high turbidity and which shall be treated for drinking water.

Besides in the dry season, endemic diseases such as onchoercosis, bilharziosis and malaria related to the water have been generated at swamps and reservoirs with low level condition in northern and western regions. It will be necessary to change these water bodies to dry land or reservoir with deep water depth through the year, in order to eliminate those endemic diseases.

(2) Water Quality in Reservoir

In the small and medium scale reservoir dams, the reservoir presents shallow water depth at the end of dry season due to water uses and its water quality will include organic content due to decomposition of generating aquatic weed. The reservoir for the domestic and industrial water use accordingly shall be designed to place the low water level with sufficient dead water, while the intake structure shall be designed so as to be able to take the clean water with deep water depth in the reservoir.

(3) Groundwater Quality

Groundwater in Abidjan area is going to be polluted by the sea water invasion caused by the lowering of its water level. It is urgently necessary to take counter measures to prevent water pollution by the restriction of water use, recharging of new surface water supply to city.

(4) Lagoon Water Quality

Lagoon water quality is considerably polluted by waste water of Abidjan city and industrial zone and trash deposits along the lagoon coast line.

13.3.3 Hydro-Meteorological and Hydro-Geological Network

In order to achieve the successful and effective water resources management, the monitoring system for rainfall, river flow, groundwater shall be properly established and the variation of rainfall, water level, discharge water quality, water use quantity, etc shall be observed under the system. The system is generally consisting of gauging station, transmission of observed data, data filing and compilation, etc.

It is judged that the management of the existing monitoring system for meteorological and hydrological data is relatively well made in the country. However the monitoring system for water operation practice in the project facility such as reservoir is not set up yet except in the hydropower reservoirs.

There are many available data related to the water resources development and management. However the periodical evaluation work is not made sufficiently. It is recommendable that the Water Authority will carry out the evaluation work for the water resources development and management with cooperation of agencies concerned.

(1) Rainfall

Rainfall gauging stations are sufficiently distributed in the country and their observation is well carried out. Additional stations however will be required at the northern Savanna area where many agriculture projects will be promoted to ward 2015 and consume a large quantity of rainfall.

It is necessary to set up the guideline of effective rainfall for crop cultivation by evaluation of the existing rainfall data. The effective rainfall is changed by the cropping pattern consisting of kinds of crops and cropping calendar and by the rainfall intensity in each river basin. The guideline of effective rainfall at each river basin is very useful to estimate the irrigation requirement in the project.

(2) River Flow

There are about 60 gauging stations to observe the water level fluctuation in the river. Although number of stations is not sufficient always, they are well distributed over the country. Gauging stations are properly installed and maintained except some stations but the stations with automatic recorder are still few. The water level observation and discharge measurement also are well carried out except the flood water. The discharge measurement at the high water level at many stations would not be properly made due to lack of measurement facility at the stations such as cables with basket crossing the river. It is necessary to increase gauging stations in the river basin where many water resources developments are planned and implemented and to improve the discharge measurement in the high water level.

Although the observation data of the river flow are compiled, the hydrological evaluation for the water level and discharge has not been made well. It is recommended that the water Authority will carry out the evaluation work for the river flow taking into account the following items;

- The low water level to guarantee the river maintenance flow and the high water level to prevent the flood damage at the control points.
- Proper water allocation quantity for the existing and proposed project on monthly basis.
- Available river flow in the wet and dry season for the future water resources development in each sub-basin.

(3) Water Monitoring System in Existing Facility

The monitoring system for the water under operation in the existing project facility such as reservoirs and canals is not established year except the hydropower dam. In the existing dams for agriculture and water supply. The automatic gauge or staff gauge to monitor the water level variation shall be installed at the upstream of reservoir, the reservoir intake and the down stream river.

In the existing canal system, the staff gauge also shall be installed at the water diversion points such as regulators and turnouts to carry out the proper water diversion.

(4) Groundwater

Although a number of production wells are installed and under operation. There is no monitoring wells. The monitoring wells shall be provided at the site where many wells are operated like Abidjan area in order to monitor the water level fluctuation and variation of water quality. It is recommended that the Water Authority shall study and prepare some guideline for the operation water level average withdrawn quantity/day, operating hours, etc in each sub-river basin in order to sustain the groundwater uses.

(5) Preparation of Database for River System

The database for the river system is not prepared yet in the country. The river ledger with the following items shall be prepared in order to under stand the river system easily and be able to manage the river flow effectively and smoothly.

- River length, width and slope
- Tributary density in the sub-basin
- Maximum and minimum water level and discharge

Average discharge on monthly level and discharge in dry year with return period of once to 5 and 10 years on monthly level.

13.3.4 Drought Management

(1) Reservoir Operation

As the dry season water is very scarce in every rivers and can not cover the various water demands in the river basin, the reservoir dam will be required for the stabilized and effective water uses.

Although the hydropower reservoirs except the Kossou are properly designed and have been operated well from viewpoint of reservoir water management, the reservoir water in small and medium scale dams constructed for purpose of agricultural and domestic water use are not always operated and managed properly due to lack of information for reservoir inflow and water demand in beneficial area, no reservoir operation rule to control the reservoir water level and outflow to beneficial area, etc. It is necessary to set up the reservoir operation rule for the existing reservoirs by monitor and evaluate the inflow, water demand, reservoir capacity fluctuation, etc in the average and dry year.

Reservoir operation study will be carried out with the following manner;

- The reservoir will reach the full water level at the end of wet season from October to November and approach to the lowest water level at the beginning of wet season from June to July because the reservoir is to store a rich inflow during July to October and release it mainly in the dry season as well as in July at the beginning of the wet season crops.
- If the reservoir water level in case of agricultural dam does not reach the full water level at the end of November, the proposed irrigation area can't be fully irrigated and the area should be reduced depending on the available reservoir water at the end of November.
- The carrying over capacity in the reservoir to supplement the small reservoir inflow in next dry year will be estimated also by the operation study.
- The flood control to cut the peak flood should be studied particularly in Agneby river. The operation rule for flood control should be set up on natural over flow type without gate.
- As the small scale reservoir, it will be not necessary to carry out the detailed reservoir operation study but prepare the reservoir operation guideline.
- It is practical method to prepare the operation rule by "Probability DP(Dynamic Program)" etc.(these method could be obtained by probability analysis and trial/error based on past hydrological data). And it will be possible to estimate the future rainfall based on long term meteorological forecast in the near future.

(2) Water Diversion

The runoff quantity in each river is limited, while the water resources development will increase year by year. There is a tendency to decrease the water use in the existing project by the water use of the proposed project in the same basin.

The water allocation plan to allocate the water use quantity for each project at each river basin shall be formulated taking into account the available runoff, water uses in the existing and proposed projects and river maintenance water.

13.3.5 Watershed Management

(1) Necessity of Watershed Management

The watershed management shall be implemented to preserve the sustainable watershed and to maintain or increase the fostering capacity of water resources in the river basin. Besides, the watershed management shall be carried out so as to be able to mitigate the rainfall with high intensity in the wet season and improve the poor runoff yield in the dry season.

(2) Divided River Basin

The river basins in the country shall be divided into the sub-basins and small sub-basins in order to monitor and evaluate the watershed features and potential runoff yield. In JICA study, the river basins are tentatively divided into 58 sub-basins(control points).

The average catchment area of sub-basins is 7,000 to 14,000 sq.km in the large river and 1,000 to 2,000sq.km in the small river. In the practical watershed management in future, the sub-basins will be further divided into more small sub-basins, because it is rather difficult in the sub-basin area with a large area to carry out the proper watershed management to monitor, evaluate and control .

(3) Drainage Water Regulation

Although the drainage water of household, office, industries and livestock etc. in river basin are not so serious for time being, in the near future serious problem will be generated by them.

The drainage water regulation with countermeasures on the treatment for the drainage water should be established particularly in livestock as soon as possible.

(4) Forest Protection and Land Conservation

The following watershed management related to the forest protection and land conservation could be made by analyzes of the land use.

- Monitor, evaluation and control the slush-burn cultivation area and tree cutting area in the forest.
- Monitor and evaluation of the existing reserved forest and national park areas.
- Monitor, evaluation and control the expanding farm land consisting of actual cultivation area, fallow area, village area, etc.
- Identification of devastated land and land erosion where countermeasures are required.
- Identification of reservoir area and area in rivers by water resources development.
- Identification of increasing area for town, city, industry, etc.

13.3.6 Facilities Maintenance

The facilities maintenance for dam-reservoir, waterway, intake-gate, purification plants, electric facilities and machines -equipment's etc. are essential matter on the water resource management.

It is necessary to prepare the guideline for facilities maintenance.

CHAPTER 14 WATER USE QUANTITY MANAGEMENT

14.1 Necessity and Objectives of Water Use Quantity Control

Available river surface water and groundwater resources in every river basin are limited by rainfall pattern and watershed conditions, while the water use quantity will increase toward 2015 in accordance with promotion of the water resources development in response to increasing various water demands.

Objective of the water use quantity management is to evaluate the available water resources for the water use in the existing and proposed new project sites and the water use quantity for various water demands and as a result to control the water supply taking into account the balance between available water and water use quantity. The water use quantity management is necessary for the effective and sustainable water uses under the limited and fluctuated available water resources.

The issues to be studied and implemented to achieve the proper and smooth water use quantity management are summarized as follows;

・Establishment of the control points to monitor the water level and discharge.

・Evaluation of the water balance between available water resources and the water use quantity and the water allocation quantity.

・Establishment of the rule for the reservoir operation and the diversion water of the river.

・Establishment of the water use right

14.2 Issues for Water Resources Management

14.2.1 Evaluation of Water Demand and Supply Balance

(1) Comoe Management Basin Area

The water demand and supply balance and issues in the Comoe Management Basin (Comoe river and surrounding rivers) is as shown in Table 14.2-1. The notice issues in Table 14.2-1 are as follows;

① The water balance of the Abidjan city is as very serious. The new water resources development accordingly is urgent matter.

④ It is a high priority issue for the water resources management of Cote d'Ivoire to improve the flow regime and the low water use rate of the Comoe river.
The improvement would be contributed to the big hydro power generation, adequate water supply for the Abidjan urban water/ the agricultural water of coastal area in dry season and the prevention of river mouth/ sediment in lagoon etc.

⑥ The re-construction of a dam in down stream of Ayame No.2 dam would be recommended to use effectively the remain head.

⑦ Inundation in Agboville by flooding of the Agneby river is habitual and serious.

(2) Bandama Management Basin Area

The water demand and supply balance and issues in the Bandama
Management Basin (Bandama river and surrounding rivers) is as shown in Table 14.2-2. The notice issues in Table 14.2-2 are as follows;

① The shortage of urban water supply in local cities except Korhogo-Ferke/Yamousskro cities in the future.

④ The big amount of shortage of agricultural water supply in the future.

⑤ The power production shortage of the Kossou power station due to small inflow into the dam.

(3) Sassandra Management Basin Area

The water demand and supply balance and issues in the Sassandra
Management Basin (Sassandra river and surrounding rivers) is as shown in Table 14.2-3. The notice issues in Table 14.2-3 are as follows;

① The planning of water storage facilities for the domestic water supply of Man city.

⑤ The effective water use on down stream of the Buyo dam.

14.2.2 Issues on River Management

The issues on the river management are as follows;

(1) Criteria and Manual for River Works

Preparation of criteria and manual for river works ; The criteria and manual consists of three parts such as Survey/ Planning/ Design and the contents could be used as a completed text book for river works.

(2) Manual for Water Right

Preparation of manual for the water right evaluation ; The major items are standard year/ maintenance water/ control point/ safety factor/ existing water right/ high water right/ water storage at out of watershed etc. and those items consist of issues and the countermeasure respectively.

(3) Hydro-Meteorological Network System

Establishment of hydrological network system (data observation/ data transmission/ data processing)；The network system is essential matter for monitoring of water right.

(4) Preparation of the River Ledger

Preparation of the river ledger and flow diagram along the river system showing a catchment area, river length, river slope, river flow regime on average and dry years, and sediment etc.

Table 14.2-1 Water Demand/Supply Balance & Issues in COMOE Management Basin Area：2015 Year Target

Item	Unit	Water Demand			Water Supply					
		Comoe Main River	Agneby River	Bia Area	Comoe Main River		Agneby River		Bia Area	
					Source	Quantity	Source	Quantity	Source	Quantity
Domestic water										
A・Urban water										
1) Abidjan city	m^3/day		**570,000**				**Underground**	**380,000**		
2) Agneby other cities(IX-C1/C2/C4)	m^3/day		58,600				River+Ground	58600?		
3) Comoe main river (Ⅲ-C1):Cities in Comoe	m^3/day	124,000			River+Ground	124,000				
4) Bia (Ⅷ-C1)：Cities in Bia	m^3/day			27,900					River+Ground	27900?
B・Rural water	m^3/day	8,400	2,800	2,700	Underground	8,400	Underground	2,800	Underground	2,700
Agricultural water										
1) Comoe river (Ⅲ-C1)：Total area	mm	7			River-1/5*0.2	7				
2) Come upstream (Ⅲ-C3)：Up-Daukr	mm	8					River-1/5*0.2	6		
3) Agneby (IX-C1/C2/C4)	mm	11					River-1/5*0.2	40		
4) Bia (Ⅷ-C1)	mm	10							River-1/5*0.2	20
Hydroelectric Power	1) Ayame-1	Planning HWL：90 m Planning Head ：25m			Reservoir capacity 900 MCM			Actual HWL:88~90m Actual power production;as same as planning		
	2)Ayame-2	Planning HWL：69 m Planning Head ：30m			Reservoir capacity 69 MCM					

Issues	
1) Domestic water	①・For time being, the domestic water supply of Abidjan city is carried out by the underground water.(About 220,000m3/day) ・The water demand in 2015 would be estimated to be 570,000m3/day based on a consuming water per-capita of 100 l/day and a population growth rate of 3.9%. ・Besides, since the available maximum underground water supply would be estimated to be 380,000m3/day, a water supply shortage of about 190,000m3/day will be probably generated. ・Although above estimation is executed based on 100 l/day per-capita,as a matter of fact, it's more than 300 l/day at major cities in foreing countries. Therefore, in case of 300 l/day the water supply shortage will be estimated to be more than 1.3 million. It is very serious condition on water supply and it also wolud be generating a big social problem.
	② It is difficult to supply the steady water for other cities in dry season. Because, the big amount of underground water couldn't be supplied in northern area. Therefore, the shortage of urban water supply in local cities on the Comoe river upstream would be generated in the future.
	③ The rural water supply could be possible by underground water in case of the water demand of 25 l/day per-capita.
2) Agricultural water	④ The water use rate in the Comoe river is about 20% of 1/5 year probablity runoff and it is low percentage compared to Bandama river.
	⑤ Since the rainfall in the coastal area is abundant, there is adequate surface water as potential, but the rainfall in dry season is very small, therefore, it wolud make difficult conditions for water supply and agricultural production would be limited.
3) Hydroelectric power	⑥ The Ayame No.1 and No.2 dams are constructed on two steps and the controled water by No.1 dam is using effectively by No.2 power station, moreover threre is a remain head of about 30m, therefore the reconstruction in downstream of No.2 dam would be recommended.
4) Flood Inundation	⑦ Inundation in Agboville city caused by flooding in the Agneby river is habitual and serious.

Note： ・River-1/5*0.2= Controled ration (Reservoir capacity / river runoff) of 20% for the river surface water with probability 1/5 ・?=Question for supply possibility
・River+Ground=River surface water+ underground

Table 14.2-2 Water Demand/Supply Balance & Issues in BANDAMA Management Basin Area

Item	Unit	Water Demand			Water Supply					
		Bandama Main River	Nzi River	Boubo Area	Bandama Main River		Nzi River		Boubo Area	
					Source	Quantity	Source	Quantity	Source	Quantity
Domestic water										
A・Urban water										
1) Korhogo・Ferke・Yamoussoukro	m^3/day	51,500			Dam-Reservoir	49,800				
2) Bandama main river other cities	m^3/day	162,300			River+Ground	162,300				
3) Nzi (Ⅱ-C8): Cities in Nzi river	m^3/day		137,900				River+Ground	137,900 ?		
4) Boubo (Ⅹ-C2): Cities in Boubo	m^3/day			40,300					River	40,300
B・Rural water	m^3/day	12,500	2,700	6,300	Ground water	15,200	Ground water	2,700	Ground water	6,300
Agricultural water										
1) Bandama upstream (Ⅱ-C5)	mm	52			River-1/5*0.5	32				
2) Marahoue (Ⅱ-C12): Up-Biouafle	mm	12			River-1/5*0.5	11				
3) Nzi (Ⅱ-C8): Up-Confluence	mm	14			River-1/5*0.5	12				
4) Boubo (Ⅹ-C2): Up-Grand Lahou	mm	10							River-1/5*0.5	6
Hydroelectric Power	1) Kossou	Planning average inflow: 152m^3/s Planning HWL: 196 m				Actual average inflow: about 80-90 m^3/s Actual HWL: about 185-187m				
	2)Taabo	Planning average inflow: 154m^3/s Planning HWL: 124m				Actual average inflow: 190-196 m^3/s Actual HWL: 122-124 m				
Issues										
1) Domestic water	① Urban water supply for Korhogo/Ferke/Yamoussoukro cities could be carring out by controled water of dams.									
	② It is verry difficult to supply the steady water for other cities in dry season. Because, the big amount of underground water couldn't be supplied in northern area. Therefore, the big amount shortage of urban water supply in local cities would be generated in the future.									
	③ The rural water supply could be possible by underground water in case of the water demand of 25 l/day per-capit.									
2) Agricultural water	④ Even if the controled ration (reservoir capacity/Inflow) of 50% with adequate dams construction could be keeped, the big amount of shortage of agricultural water supply would be generated in the future.									
3) Hydroelectric power	⑤ The power production of Kossou power station is considerably small compared to the planning due to small inflow in to the dam.									

Note: River-1/5*0.5= Controled ration (Reservoir capacity / river runoff) of 50% for the river surface water with probability 1/5
・?= Question for suuply posibility

Table 14.2-3 Water Demand/Supply Balance & Issues in SASSANDRA Management Basin Area : 2015 Year Target

Item	Unit	Water Demand			Water Supply					
		Sassandra River	San Pedro River	Bani-Niger Area	Sassandr River		San Pedro River		Bani-Niger	
					Source	Quantity	Source	Quantity	Source	Quantity
Domestic water										
A・Urban water					Weir intake	Dry season (Year average)				
1) Man (I -C8)	m^3/day	17,000			River-1/10	1,300(31,000)				
2) San Pedro (X I -C1)	m^3/day		37,000				Dam-Reservoir	2,580,000		
3) Sassandra river other cities (I -C1)	m^3/day	340,000			River+Ground	20,000,000				
4) Bani-Niger (VI-C1/C3/C4/C5)	m^3/day			52,000					River+Ground	52,000
B・Rural water	m^3/day	45,000	4,700	600	Underground	45,000	Underground	4,700	Underground	600
Agricultural water						Dry season (Year average)				
1) Sassandra river (I -C1)	mm	18			River-1/5	76(152)		Dry season (Year average)		
2) San Pedro (X-C1/C2/C3)	mm	15					River-1/5	140(400)	Dam-Reservoir	Dry (Year)
4) Bani-Niger (VI-C1/C3/C4/C5)	mm	20							River-1/5	10(120)
Hydroelectric Power	1) Buyo	Planning HWL :200 Reservoir capacity 8,300 MCM Planning Head : 36 m						Actual energy production:As same as planning		

Issues	
1) Domestic water	① The domestic water of Man city is suppied from a river surface water, but since the river runoff in dry season is less than 1/10 of the planning supply water, the storage facilities are essencial for the steady water supply.
	② Although the domestic water in other local cities are supplied from underground water and river surface water in rainy seasons, it seams to be no problem in sassandra basin since the river is plenty of surface water.
	③ The rural water supply could be possible by underground water in case of the water demand of 25 l/day per-capit.
2) Agricultural water	④ ・Although the rivers are plenty of surface water, since the surface water in dry season is about half of average. Therefore,the agriculture are limited products such as cacao, banana etc which are low water consumption. ・To promote the rural electrification
3) Hydroelectric power	⑤ The controled water by Buyo dam is not using effectivelly in down stream, therefore it is recommended to construct new dams which is also a re-regulation dam in down stream.

Note: River-1/5=River surface water with probability of 1/5

14.3 Use of Control Points

The control points will be mainly used for following purpose related to water use control :

① To execute the hydrological analysis /water balance calculation and the monitoring of water quantity/quality at the control points

② To grasp the flow regime in the basins by observing of water level - discharge

③ To judge of water supply quantities by observing of water level - discharge

④ To be monitoring the river maintenance discharge

14.4 Water Use Right

14.4.1 Water Safety Factor

As reference the safety factor in French and Japan, the water safety factor in Cote d'Ivoire shall be basically decided on the basis of design drought having a return period of 10 years taking "The Drought management" into consideration.

The safety factor for each sector are recommended in Table 14.4-1.

14.4.2 River Maintenance Discharge

The river maintenance discharge could be defined as "The discharge which has been stipulated to be maintained even at the time of low flow, upon overall consideration of boat transportation / fishing / picturesque scenery / prevention of salt injury / prevention of blocking of estuary / protection of river control facilities / maintenance of ground water level / protection of plants animals / maintenance of clearance of river flow".

The examples of foreign country and the proposed maintenance discharge are as shown in Table 14.4.-1.

It could be recommended to decide the maintenance discharge based on 9 items study as above-mentioned and it is realistically for Cote d'Ivoire to use as a standard figure "The monthly average the lowest discharge "

14.4.3 Decision of Development Discharge

The development discharge should be decided based on studies of the above-mentioned water safety factor on water planning.

In case of insufficient water safety factor, following countermeasure should be studied.

・To divert water from tributaries (Inter-basin diversion plan).

・To divert water from out of the basin (Wide area diversion plan)

・To down the scale of development

・To study alternative plans

14.4.4 Design Drought Year

As above mentioned, "Design Drought Year" shall be basically decided on the basis of design drought having a return period of 5 or 10 years taking "The Drought Management" into consideration**.** Besides, in Cote d'Ivoire, projects concerning water resources are planning based on a drought year of 1983. We have studied the relation between the probable drought discharge and discharge in 1983 and as a result of the studies, it could be considered that the return period of 1983 is equivalent to a return period of approximately 20 years.

In case of reservoir's capacity which would be controlled for one year period and weir's intake, the development discharge at proposed development sites could be calculated by following formula using adjustment factor for return period 1/10 years vs. development discharge in 1983.

$Q_{1/10}$=Adjustment factor $\times Q_{1983}$

$Q_{1/10}$=Development discharge for return period 1/10 years

Q_{1983}=Development discharge calculated based on discharge in 1983

Moreover, the actual water balance calculation with big capacity reservoirs which would be controlled by carrying over for several years should be executed for 5～10 years terms including 1983 year.

14.4.5 Other Criteria

(1) Water Supply Diffusion Rate

The supply rate is assumed to be 100 % by the target year.

(2) Food Self-Supply Rate

The self-supply rate in a national level will be estimated. The study on possibility of import reduction and export increase to reach to a satisfactory level will be made.

(3) Water Quality of Water Source

The preliminary study are made about the water quality at the control points. According to the study, although no serious problem in big rivers which have plenty water, there are rivers showing slightly high value of suspended solids (SS), electrical conductivity (EC) and chemical oxygen demand (COD) in the dry season water. While the high turbidity in the wet season water caused by soil erosion in devastated watershed.

Those phenomenon of the water quality pollution should be taking care in the water resource development and management plan.

The criteria of the water quality is using for time being the criteria of WHO. The New criteria for Cote d'voire is under preparation by SIAPOL.

Table 14.4-1 Major Criteria to Establish the Water Use Right

Division	Items/ Contents
(1) Water use safety factor	(A) Agricultural use It is assumed that the agricultural yield in the standard year should be 80% or more of the mean projected yield. The cropping pattern and water management rules in case of the dry year will be proposed. Consequently, the water safety factor shall be decided on the basis of design drought having a return period of 5 years and as the drought management. (B) Domestic / Industrial use The water safety factor shall be decided on the basis of design drought having a return period of 10 years taking “The drought management” in to consideration. (C) Hydro-power use The installed capacity and power generation is planned for 10-yers mean flow. In case of reservoir type power station, the minimum guarantee output is planned for the lowest case of 10-years period. In case of run-of river type power station, the minimum guarantee output are planned for a mean dry-discharge of 10-years period.
(2) River Maintenance Discharge	(A) Example for the river maintenance discharge in foreign countries The actual example concerning the river maintenance discharge are very limited. In French, America and England, they don't have stipulated criteria's. In Japan, although it has been decided in case by case based on above definition, as results of fact, it has been indicted 1.0 $m^3/s/100km^2$ to 0.2～0.3 $m3/s/100km^2$ according to the development condition. We have could found a very lucid case at the Mekong River Committee. They have stipulated to use “monthly average the lowest discharge based on observed record” for the river maintenance discharge. (B) Proposed river maintenance discharge in Cote d'Ivoire It could be recommended to decide the maintenance discharge based on 9 items study as described in 14.4.2. But, It is realistically for Cote d'Ivoire to use as a standard figure “ The monthly average the lowest discharge ” .According to studies by JICA Study Team, The monthly lowest discharge in rivers in Cote d'Ivoire is 0.01 $m^3/s/100\ km^2$. Therefore, the project plan shall be formulated so as to the minimum discharge of more than 0.01 $m3/s/100\ km^2$.

14.5 Control of Surface Water Use

14.5.1 Necessity and Procedure to be setting-up the Reservoir Operation Rules in Dry Year

It is necessary to set up operation rules based on the save water utilization of the reservoir in order to be carrying out effective operation and to be minimizing the damage in dry year-season.

According to our experience, it is a practical method to prepare the operation rule by "Probability DP(Dynamic Program) Method" etc. (these method could be obtained by probability analysis and trial /error based on past hydrological data) and we are expecting that it will be possible to estimate the future rainfall based on long term meteorological forecast in a near future.

14.5.2 Surface Water Use Control of Each Sector

(1) Agriculture, Livestock and Fishery

The surface water source with dam for agriculture which have reservoir capacities of more than 1,000,000 m^3 is as shown in Table 14.5-1.

- It is necessary to be setting-up operation rules by "Probability DP(Dynamic Program) Method" (drought damage will be minimized) etc. for these dams. Especially, dams of multipurpose (Rice + other purpose) must be setting-up the operation rules as soon as possible.
- It is necessary to establish the water use right as custom water use for the existing dams / intake facilities and the permitted water use for new dams / intake facilities.

(2) Domestic Water Supply

The surface water source with dam for urban water supply is as shown in Table 14.5-2.

- It is necessary to be setting-up operation rules by "Probability DP(Dynamic Program) Method" (drought damage will be minimized) etc. for these dams. Especially, dams of multipurpose (AEP + other purpose) must be setting-up the operation rules as soon as possible.
- It is necessary to establish the water use right as custom water use for the existing dams / intake facilities and the permitted water use for new dams / intake facilities.

(3) Hydro-electric Power

The dams and reservoirs for hydro-electric power is as shown in Table 14.5-3.

- It is necessary to be setting-up operation rules by "Probability DP(Dynamic Program) Method" (drought damage will be minimized) etc. for these dams as soon as possible.

・It is necessary to establish the water use right as custom water use for the existing dams / intake facilities and the permitted water use for new dams / intake facilities.

・It is necessary to install small hydro-electric powers for regional electrifying on the existing and planning dams / water ways.

Table 14.5-1　Surface Water Source with Dams for Agriculture(Existing)

River Basin Name	Name of Dam	Construction on (Year)	Present Use Purpose	Catchment Area (km^2)	Dam Height (m)	Reservoir Capacity (1000 m^3)
Agneby	Eglin-1	----	Banana+Ananas	------	11.00	1.000
Bandama	Ndakonnankro	1972	Rice	6	7.00	1.600
Bandama	Yaora	1974	Rice	48	10.00	4.000
Bandama	Sema	1972	Rice	22	7.00	1.600
Bandama	Subiakro	1972	Rice + fish	38	9.00	2.000
Bandama	Zatta	1972	Rice	48	7.00	1.500
Bandama	Yabra-2	1974	Rice	22	8.00	1.150
Bandama	Yabra-1	1974	Rice	61	11.00	8.700
Bandama	Kongobo	1979	Rice	25	12.50	2.200
Bandama	Nabyon	1981	Rice	220	16.00	45.000
Bandama	Sakassou	1990	Rice	594	13.50	8.000
Bandama	Morrisson	1975	Sugar cane	9000	12.00	79.000
Bandama	Nafoun	1976	Rice	144	15.00	60.000
San-Pedro	Fahe		Potable water supply + Rice	2424	10.00	25.000
Sassandra	Kibouo	1970	Rice + Fish	6	12.00	2.000
Total				12,658		242,750

Note: Dams with reservoir capacity of more than 1,000,000 m^3 have been selected in the table,

Total of dam = 15 dams >V=1,000,000 m^3 + 529 dams< V=1,000,000 m^3 =544 dams

Table 14.5 –2 Surface Water Source with Dams for Urban Water Supply(Existing)

	River Basin Name	Name of Dam	Construction (Year)	Present Use Purpose	Catchment Area (km²)	Dam Height (m)	Reservoir Capacity (1000 m^3)
1	Agneby	Ehuikro	1971	AEP	20	12.00	3,000
2	Agneby	Bongouanou	1986	AEP	4	6.00	500
3	Agneby	Assie-Akpesse		AEP		5.00	1,500
4	Agneby	Agboville		AEP		5.00	1,500
5	Agneby	Rubino	1978	AEP		10.00	1,000
6	Bandama	Loka	1978	AEP + PISCICULTURE	127	12.00	22,300
7	Bandama	Lokpoho	1972	AEP + CANNE A SUCRE	1200	8.50	10,500
8	Bandama	Korhogo		AEP	18		2,131
9	Comoe	Daukro	1976	AEP	4		
10	Comoe	Adengourou		AEP			
11	Comoe	Abengourou	1977	AEP	39	12.00	5,000
12	Comoe	Segbono	1978	AEP + RIZ + PISCICULTURE	60	14.00	7,800
13	Comoe	Ouangolo		AEP		5.00	
14	Marahoue	Seguela	1986	AEP + PISCICULTURE	54	13.77	2,500
15	ME	Bingerville		AEP + PISCICULTURE		10.00	3,000
16	NIGER	Tengrela	1975	AEP	68	8.25	4,400
17	N'ZI	Konggoulo-1	1970	AEP	39	12.14	3,800
18	N'ZI	Trenou	1968	AEP	19	20.00	2,800
19	N'ZI	Nikolo	1974	AEP		4.00	
20	N'ZI	Niankara	1977	AEP		4.00	
21	San-Pedro	San-Pedro		AEP + RIZ	2424	10.00	25,000
22	Sassandra	Duekoue	1980	AEP		6.00	
	Total				4,076		96,731

Total of dams = 22 dams

Table 14.5-3 Surface Water Source with Dams for Hydroelectric Power (Existing)

River Basin Name	Name of Dam	Construction (Year)	Present Use Purpose	Catchment Area (km²)	Dam Height (m)	Reservoir Capacity (million m^3)
Sassandra	Buyo		Hydropower	46,250	37	8,300 (7,000)
Bandama	Kossou		Hydropower	32,400	58	30,211 (25,800)
Bandama	Taabo		Hydropower	57,700	34	630 (340)
Bia	Ayame- Ⅰ		Hydropower	9,320	30	900 (849)
Bia	Ayame- Ⅱ		Hydropower	9,330	35	69 (68)
San Pedro	Faye (Grah)		Hydropower	2,424	10	25 (25)
Total				148,094		40,135 (34,082)

Note: The values in ( ) of reservoir capacity are effective volume ; total = 6 dams

14.6 Control of Ground Water

The groundwater potential seems totally enough compare with the water demand, except Abidjan City. Considering a small capacity of discontinuous aquifer, the concentration of bore-holes may be unavoidable in case of urban water use. Therefore, the study for capacity of aquifer, simulation and monitoring for groundwater level change will be required for areas with concentrated groundwater development. The aquifer protection in Abidjan is the most important issue for groundwater development in the country. The study for counter measure for the future water supply in Abidjan is very important matter.