CHAPTER 10 SUB-BASIN-WISE WATER DEMAND ESTIMATION FOR DETAILED PRIORITY WRRRS

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CHAPTER 11 DETAILED WATER BALANCE ANALYSIS IN PRIORITY WATER RESOURCES REGIONS

11.1 Water Potential

11.1.1 WRR-VII

(1) Natural Condition in WRR VII

1) Land Area

Central Visayas is an administrative region in the Philippines, numerically designated as Region VII. It consists of four provinces, Cebu, Bohol, Negros Oriental, and Siquijor and three highly urbanized cities: Cebu City, Lapu-Lapu, and Mandaue.

Major islands are the eponymous Cebu, Bohol, and Siquijor, together with the eastern part of Negros. The regional center and largest city is Cebu City. The land area of the region is 15,895.66 km^2, and with a population of 8,081,988 inhabitants, it is the second most populous region in the Visayas[6].

2) General Topography and Geology

Central Visayas consists of the two major island provinces of Cebu and Bohol, as well as the smaller island of Siquijor and several outlying islands. It also includes the eastern half of the larger island of Negros. The straits of Cebu and Tañon are also part of the region as well. The region is bordered to the north by the Visayan Sea, west by the province of Negros Occidental in Western Visayas, south by the Bohol Sea, and east by the Camotes Sea and the island of Leyte in Eastern Visayas.

The terrain of Cebu Island is characterized by highlands with narrow coastal strips. Bohol Island does not have very high mountains and the terrain is rather flat. It is characterized by hills such as Chocolate Hills. The southern part of Negros Island has volcanic topography and is highly permeable. In the eastern and northern parts of Negros Island, rolling plains extend from the hills to the coastline, and sugar cane fields and paddy fields spread out. Siquijor Island has extensive limestone geology, abundant limestone caves and springs, and a gentle topography with no relatively high mountains.

3) Streamflow Data

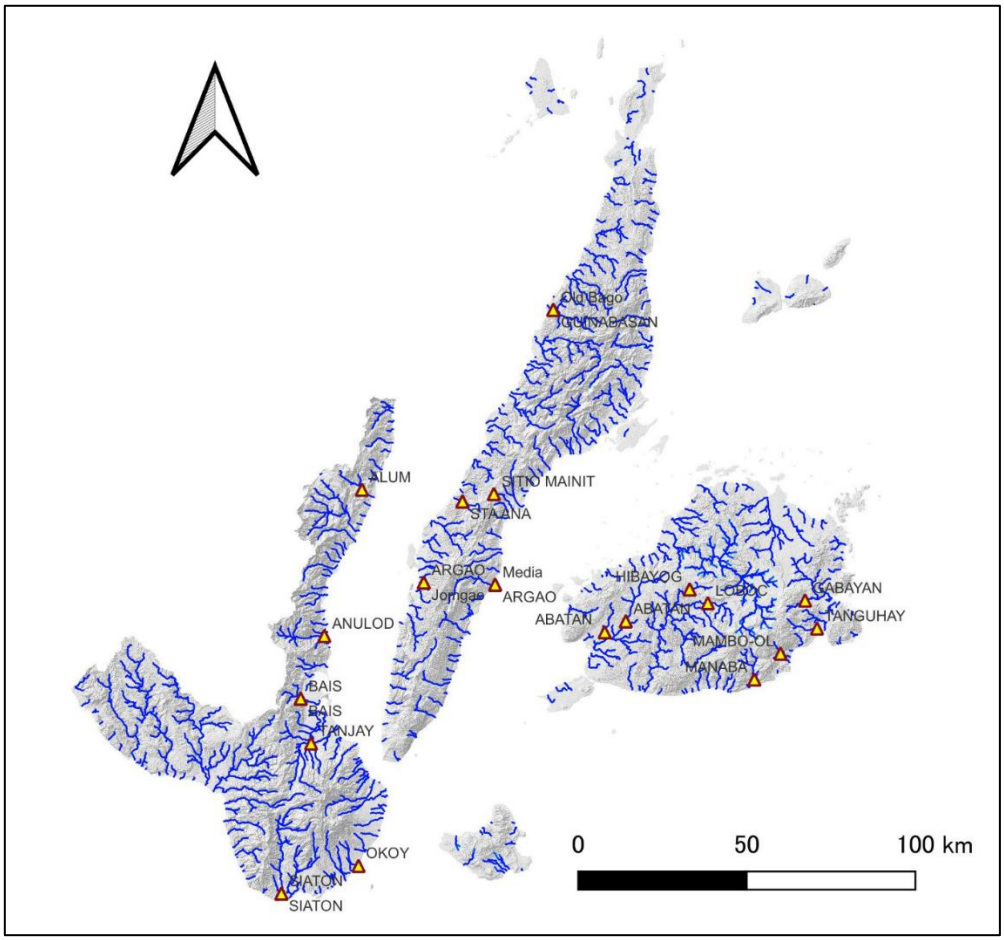
Streamflow data were gathered for many of the stations within the survey area. Streamflow records were obtained from DPWH. A total of 25 daily average discharge data shown in the Figure and Table below were collected and used for low flow analysis of WRR-VII.

[6] https://en.wikipedia.org/wiki/Central_Visayas

Table D-94 Number of Discharge Observation Stations by WRRs

N	N	Station	River	Basin	Agenc	WRR	Province	Town, Village	Latitud	Longitu	Elevatio	C.A.(km	Period
394	1	ABATAN	ABATAN	ABATAN	DPWH	VII	BOHOL	SAN ISIDRO, BALILIHAN, BOHOL	9.7890	123.9570	48.7	140.0	1984-2000
396	2	ABATAN	ABATAN	ANTEQUERA	DPWH	VII	BOHOL	STO. ROSARIO, ANTEQUERA, BOHOL	9.7600	123.9000	44.2	45.0	1984-2016
402	3	LOBOC	LOBOC	CANTIMOC	DPWH	VII	BOHOL	VILLARCAYO, CARMEN, BOHOL	9.8370	124.1790	197.2	91.0	1985-2006
403	4	GABAYAN	GABAYAN	GABAYAN	DPWH	VII	BOHOL	CANAWA, CANDIJAY, BOHOL	9.8430	124.4420	26.1	28.0	1985-2003
405	5	HIBAYOG	HIBAYOG	HIBAYOG	DPWH	VII	BOHOL	LA VICTORIA, CARMEN, BOHOL	9.8740	124.1300	170.7	41.0	1986-2003
406	6	MAMBO-OL	MAMBO-OL	MAMBO-OL	DPWH	VII	BOHOL	MAMBO-OL, DUERO, BOHOL	9.7010	124.3750	10.0	22.0	1987-2011
407	7	MANABA	MANABA	MANABA	DPWH	VII	BOHOL	CANDULAO, G. HERNANDEZ, BOHOL	9.6320	124.3040	68.1	93.0	1984-2016
412	8	TANGUHAY	TANGUHAY	TANGUHAY	DPWH	VII	BOHOL	BULAWAN, GUINDULMAN, BOHOL	9.7680	124.4740	46.8	21.0	1986-2004
304	9	Jomgao	Argao	ARGAO RIVER BASIN	DPWH	VII	Cebu	Jomgao, Argao, Cebu	9.8940	123.4110		71.0	2010-2013
305	10	Media	Argao	ARGAO RIVER BASIN	DPWH	VII	Cebu	Media, Argao, Cebu	9.8880	123.6040		80.0	1985-2009
306	11	Old Bago	Guinabasan	GUINABASAN RIVER BASIN	DPWH	VII	Cebu	Old Bago, Asturias, Cebu	10.6240	123.7630		153.0	1984-2005
307	12	STA ANA	STA ANA	STA ANA RIVER BASIN	DPWH	VII	Cebu	STA ANA, BARILI, CEBU	10.1110	123.5160		45.0	1984-2016
398	13	ARGAO	ARGAO	ARGAO	DPWH	VII	CEBU	MEDIA, ARGAO, CEBU	9.8880	123.6040	11.9	80.0	1985-2002
399	14	ARGAO	ARGAO	ARGAO	DPWH	VII	CEBU	JOMGAO, ARGAO, CEBU	9.8940	123.4110		71.0	2003-2013
404	15	GUINABASAN	GUINABASAN	GUINABASAN	DPWH	VII	CEBU	NEW BAGO, ASTURIAS, CEBU	10.6240	123.7630	18.9	153.0	1984-2005
411	16	STA ANA	STA ANA	STA ANA	DPWH	VII	CEBU	STA ANA, BARILI, CEBU	10.1110	123.5160	43.5	45.0	1984-2016
448	17	SITIO MAINIT	CARCAR	CARCAR	DPWH	VII	CEBU	SITIO MAINIT, GUADALUPE, CARCAR	10.1310	123.6010	94.9	16.0	1984-1989, 1991-2012
395	18	ALUM	ALUM	ALUM	DPWH	VII	NEGROS ORIENTAL	BUENAVISTA, GUIHULNGAN, NEGROS ORIENT	10.1430	123.2440	96.5	61.0	1985-1999
397	19	ANULOD	ANULOD	ANULOD	DPWH	VII	NEGROS ORIENTAL	CABUGAN, BINDOY, NEGROS ORIENTAL	9.7510	123.1420		122.0	2011-2015
400	20	BAIS	BAIS	BAIS	DPWH	VII	NEGROS ORIENTAL	CABANLUTAN, BAIS CITY, NEGROS ORIENTAL	9.5830	123.0780	48.7	56.0	1984-2009
401	21	BAIS	BAIS	BAIS	DPWH	VII	NEGROS ORIENTAL	CABANLUTAN, BAIS CITY, NEGROS ORIENTAL	9.5830	123.0780	48.7	50.0	2010-2015
408	22	OKOY	OKOY	OKOY	DPWH	VII	NEGROS ORIENTAL	PALINPINON, VALENCIA, NEGROS ORIENTAL	9.1350	123.2340	48.2	100.0	1984-2015
409	23	SIATON	SIATON	SIATON	DPWH	VII	NEGROS ORIENTAL	POBLACION, SIATON, NEGROS ORIENTAL	9.0610	123.0260	1.2	220.0	1984-2010
410	24	SIATON	SIATON	SIATON	DPWH	VII	NEGROS ORIENTAL	POBLACION, SIATON, NEGROS ORIENTAL	9.0610	123.0260		220.0	2011-2015
413	25	TANJAY	TANJAY	TANJAY	DPWH	VII	NEGROS ORIENTAL	PINANLAYAAN, PAMPLONA, NEGROS ORIENT	9.4630	123.1060	45.1	163.0	1986-2015

Source: DPWH



Source: JICA Survey Team based on the data of DPWH.

Figure D-303 Location Map of Daily Discharge Observation Stations used for Low Flow Analysis (Total 25 Stations)

Unfortunately, these streamflow data were often missing as shown in Figures in ANNEX-Hydrology. In addition, there are limits to the frequency of discharge observations and the accuracy of the water level-discharge rating curves (H-Q curves), as there are many flows in

which the value of the flood discharge is questionable. There are many data at observatories where the flow duration curves (FDCs) using the specific discharge are strange as shown in Figure below.

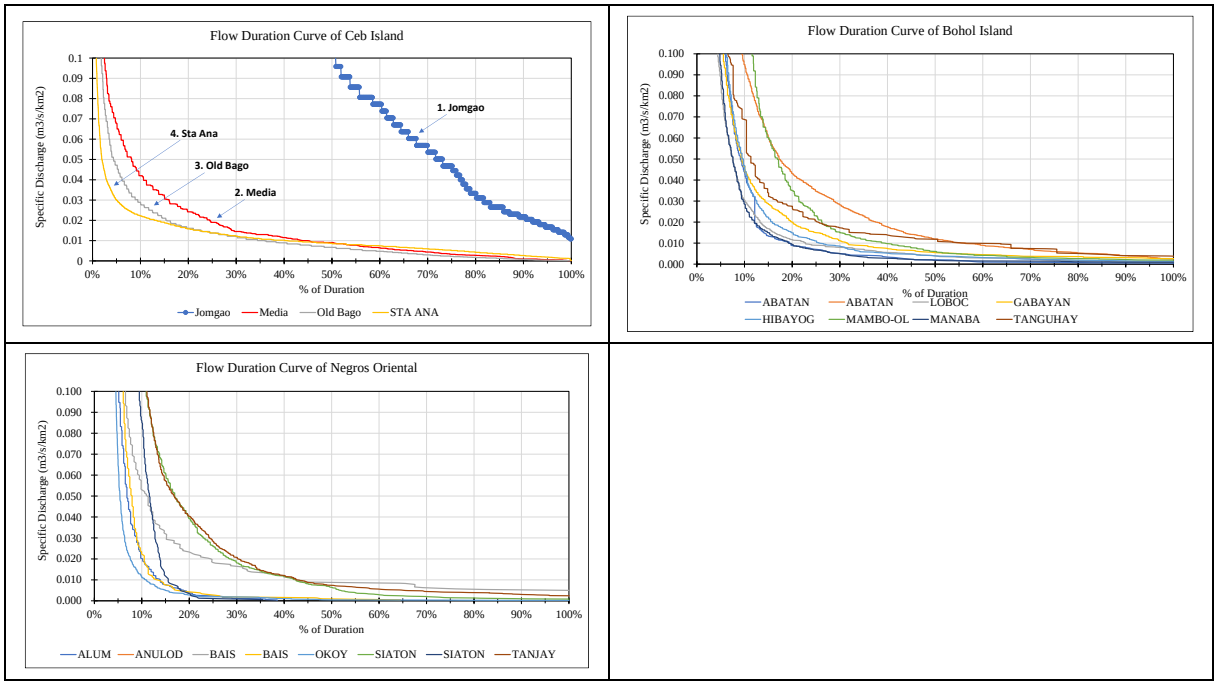


Figure D-304 Flow Duration Curve (FDC) of Observed Daily Discharge in WRR-VII

Also, the annual runoff at some stations exceeds the annual rainfall (runoff coefficient is more than 1.0) as shown in Table below.

Table D-95 Annual Runoff Coefficient of Observed Daily Discharge in WRR-VII

Cebu

Year	Annual Rainfall	Runoff Coefficient			
		304	305	306	307
		Jomgao	Media	Old Bago	STA ANA
		Argao	Argao	Guinabasan	STA ANA
		71 km2	80 km2	153 km2	45 km2
	mm/year	XX	OK	OK	OK
1979	1,622				
1980	2,240				
1981	1,470				
1982	1,294				
1983	1,480				
1984	1,978			0.29	0.44
1985	1,624		0.15	0.31	0.35
1986	1,677		0.37	0.43	0.23
1987	1,174		1.62	0.11	0.32
1988	1,656		1.02	0.20	0.28
1989	1,484		0.96	0.52	0.22
1990	1,574			0.39	0.16
1991	1,268			0.14	0.09
1992	1,045			0.19	0.06
1993	1,614			0.19	0.34
1994	1,566		0.29	0.12	0.44
1995	1,773		0.20	0.29	0.27
1996	1,870		0.20	0.49	0.20
1997	1,276		0.15	0.19	0.12
1998	1,252		0.13	0.40	0.05
1999	2,060		0.11	0.29	0.13
2000	2,048		0.18	0.14	0.44
2001	1,961		0.04	0.36	0.39
2002	1,327		0.08	0.38	0.12
2003	1,758		0.22	0.23	0.19
2004	1,302		0.33	0.28	0.27
2005	1,483		0.12	0.08	0.21
2006	1,733		0.24		0.21
2007	1,723		0.51		0.34
2008	2,245		0.46		
2009	1,762		0.36		
2010	1,712	11.41			
2011	2,729	2.46			
2012	1,815	3.29			0.39
2013	1,900	13.86			0.29
2014	2,120				0.26
2015	1,096				0.35
2016	1,570				0.17
2017	2,189				
2018	1,653				
2019	1,189				
2020	1,767				
Max.	2,729	13.86	1.62	0.52	0.44
Ave.	1,668	7.75	0.37	0.27	0.25
Min.	1,045	2.46	0.04	0.08	0.05

Bohol

	1	2	3	4	5	6	7	8
	354	356	402	403	405	406	407	412
	OK	??	OK	OK	OK	??	OK	OK
	ABATAN	ABATAN	LOBOC	GABAYAN	HIBAYOG	MAMBO-OL	MANABA	TANGUHAY
	ABATAN	ABATAN	LOBOC	GABAYAN	HIBAYOG	MAMBO-OL	MANABA	TANGUHAY
	ABATAN	ANTEQUERA	CANTIMOC	GABAYAN	HIBAYOG	MAMBO-OL	MANABA	TANGUHAY
	DPWH	DPWH	DPWH	DPWH	DPWH	DPWH	DPWH	DPWH
	VII	VII	VII	VII	VII	VII	VII	VII
	BOHOL	BOHOL	BOHOL	BOHOL	BOHOL	BOHOL	BOHOL	BOHOL
	SAN ISIDRO,	BALILIHA	NO, ANTEQ	UINTO, CARMEN,		CANDIJAY	RIA, CARME	OL, DUERO
	9.789	9.760	9.837	9.843	9.874	9.701	9.632	9.768
	123.957	123.900	124.179	124.442	124.130	124.375	124.304	124.474
Annual	48.734	44.200	197.191	26.069	170.690	10.000	68.131	46.840
Rainfall	140.0	45.0	91.0	28.0	41.0	22.0	93.0	21.0
35	1984-2000	1984-2016	1985-2006	1985-2003	1986-2003	1987-2011	1984-2016	1986-2004
Bohol	PKII_Level3	PKII_Level3	PKII_Level3	PKII_Level3	PKII_Level3	PKII_Level3	PKII_Level3	PKII_Level3
(mm/year)	Runoff Coef.	Runoff Coef.	Runoff Coef.	Runoff Coef.	Runoff Coef.	Runoff Coef.	Runoff Coef.	Runoff Coef.
1979	1,864.9							
1980	2,695.6							
1981	1,725.4							
1982	1,516.2							
1983	1,691.3							
1984	2,414.9	0.784	0.927				0.312	
1985	1,854.5	0.726	1.182	0.432	0.598		0.489	
1986	1,911.9	0.537	0.765	0.593	0.549	0.289	0.586	0.691
1987	1,308.2	0.289	0.444	0.331	0.408	0.140	0.898	0.361
1988	1,915.4	0.342		0.269	0.307	0.324	1.015	0.301
1989	1,759.9	0.516			0.357	0.300	1.264	0.236
1990	1,892.0	0.596			0.849	0.432	0.842	0.417
1991	1,395.9	0.436		0.237	0.444	0.236	0.300	0.225
1992	1,215.9	0.141	0.243	0.358	0.407	0.292	0.515	0.106
1993	1,762.4	0.322	0.428	0.454	0.813	0.353	0.566	0.222
1994	1,784.5	0.155	0.568	0.401	0.763	0.871	0.507	0.631
1995	2,053.2	0.231	0.448	0.329	0.563	0.852	0.561	0.670
1996	2,134.5	0.397	1.483	0.412	1.228	0.509	1.184	0.867
1997	1,473.7	0.314	1.045	0.319	0.513	0.634	1.523	0.614
1998	1,264.8	0.475	1.677	0.334	0.445	0.548	1.021	0.219
1999	2,406.2	0.534	3.963	0.263	0.596	0.442	1.069	0.453
2000	2,335.9	0.475	0.663	0.401	0.788	0.495	1.422	0.740
2001	2,389.3		0.583	0.362	0.547	0.386	0.782	0.346
2002	1,687.5		0.472	0.476	0.578	0.334	1.045	0.468
2003	2,156.2		0.662	0.588	0.993	0.406	0.650	0.391
2004	1,427.6		0.645	0.471			0.816	0.224
2005	1,726.9		0.329	0.322			0.549	0.195
2006	1,892.2		0.583	0.345			0.803	0.264
2007	1,997.6		0.762				0.563	0.150
2008	2,460.7		0.924				1.171	0.304
2009	2,133.8		0.582				1.841	0.285
2010	1,695.1		0.758				0.941	0.212
2011	3,029.5		0.766				1.803	0.346
2012	2,129.0		0.764					
2013	2,232.3		0.765					0.366
2014	2,602.2		0.695					1.183
2015	1,427.2		1.408					0.490
2016	1,774.2		0.698					0.092
2017	2,636.9							
2018	2,022.7							
2019	1,441.8							
2020	1,974.7							
Max.	3,029.5	0.784	3.963	0.593	1.228	0.871	1.841	1.183	1.877
Ave.	1,929.5	0.422	0.865	0.388	0.612	0.436	0.938	0.397	0.578
Min.	1,215.9	0.141	0.243	0.237	0.307	0.140	0.300	0.092	0.148

Negros Oriental

	0.46	1.50	0.70	0.48	0.55	0.96	0.85	1.11
	396	397	400	401	408	409	410	413
	??	OK	??	??	OKOY	OK	OK	OK
	ALUM	ANULOD	BAIS	BAIS	OKOY	SIATON	SIATON	TANJAY
	ALUM	ANULOD	BAIS	BAIS	OKOY	SIATON	SIATON	TANJAY
	ALUM	ANULOD	BAIS	BAIS	OKOY	SIATON	SIATON	TANJAY
	DPWH	DPWH	DPWH	DPWH	DPWH	DPWH	DPWH	DPWH
	VII	VII	VII	VII	VII	VII	VII	VII
	NEGROS ORIE	NEGROS ORIE	NEGROS ORIE	NEGROS ORIE	NEGROS ORIE	NEGROS ORIE	NEGROS ORIE	NEGROS ORIE
	SIBULAN,	BAYSAY, NEG	OS CITY, NE	GROS CITY, N	ICAGNA, M	TON, NEGR	TON, NEGR	SIPLONA, I
	10.143	9.751	9.583	9.583	9.135	9.061	9.061	9.463
	123.244	123.142	123.078	123.078	123.234	123.026	123.026	123.106
	96.525		48.740	48.740	48.190	1.178		45.100
	61.0	122.0	56.0	50.0	100.0	220.0	220.0	163.0
	1985-1999	2011-2015	1984-2008	2010-2015	1984-2015	1984-2015	2011-2015	1986-2015
	PKII_Lev	PKII_Lev	PKII_Lev	PKII_Lev	PKII_Lev	PKII_Lev	PKII_Lev	PKII_Lev
	el3	el3	el3	el3	el3	el3	el3	el3
	Runoff Co	Runoff Co	Runoff Co	Runoff Co	Runoff Co	Runoff Co	Runoff Co	Runoff Co
1979								
1980								
1981								
1982								
1983								
1984			1.316		0.594	1.299		
1985	0.816		0.683		0.568	1.149		
1986	0.581		0.352		0.616	1.187		1.388
1987	0.553		0.414		0.634	0.648		0.983
1988	0.871		0.227			0.641		0.685
1989	0.717		0.356			0.576		0.766
1990	0.411		0.416			0.793		1.282
1991	0.658		0.585			1.479		1.258
1992	0.384		2.664		0.368	1.684		1.548
1993	0.294		2.479		0.288	0.927		1.587
1994	0.343		0.579		0.492	1.467		1.188
1995	0.474		0.371		0.436	0.959		0.623
1996	0.248		0.167		0.343	0.939		0.936
1997	0.283		0.264		0.414	1.082		0.775
1998	0.162		0.708		0.465	0.995		0.539
1999	0.096		0.977		0.342	0.716		0.686
2000			0.264		0.481	0.738		0.508
2001			0.506		0.489	0.713		1.067
2002			0.490		0.359	1.086		1.381
2003			0.325		0.356	0.627		1.087
2004			0.388		0.442	0.772		0.936
2005			0.311		0.571	0.771		0.473
2006			0.513		0.525	1.144		1.359
2007			0.473		0.399	0.966		1.229
2008			0.481		0.491	0.743		1.218
2009			0.724		0.596	1.293		1.536
2010				0.181	0.527	0.459		1.679
2011		2.636		0.488	0.428		0.593	
2012		2.759		0.616			0.737	
2013		0.497		0.514	0.465		0.631	1.851
2014		1.868		0.467	0.533		0.726	1.962
2015		1.165		0.608	1.896		1.961	2.675
2016								
2017								
2018								
2019								
2020								
Max.	0.871	2.759	2.664	0.616	1.896	1.684	1.961	2.675
Ave.	0.454	1.479	0.602	0.468	0.577	0.967	0.838	1.185
Min.	0.096	0.497	0.167	0.181	0.288	0.459	0.593	0.473

4) Climate and Climate Regions of the Study Area

There are four climatological types that exist in the Philippines characterized as show in 2.2.2.2.:

In Cebu, Negros Oriental and Siquijor provinces are located in the Type-III and Bohol province is located in the Type-IV of climatological types.



Source: PAGASA (http://bagong.pagasa.dost.gov.ph/information/climate-philippines)

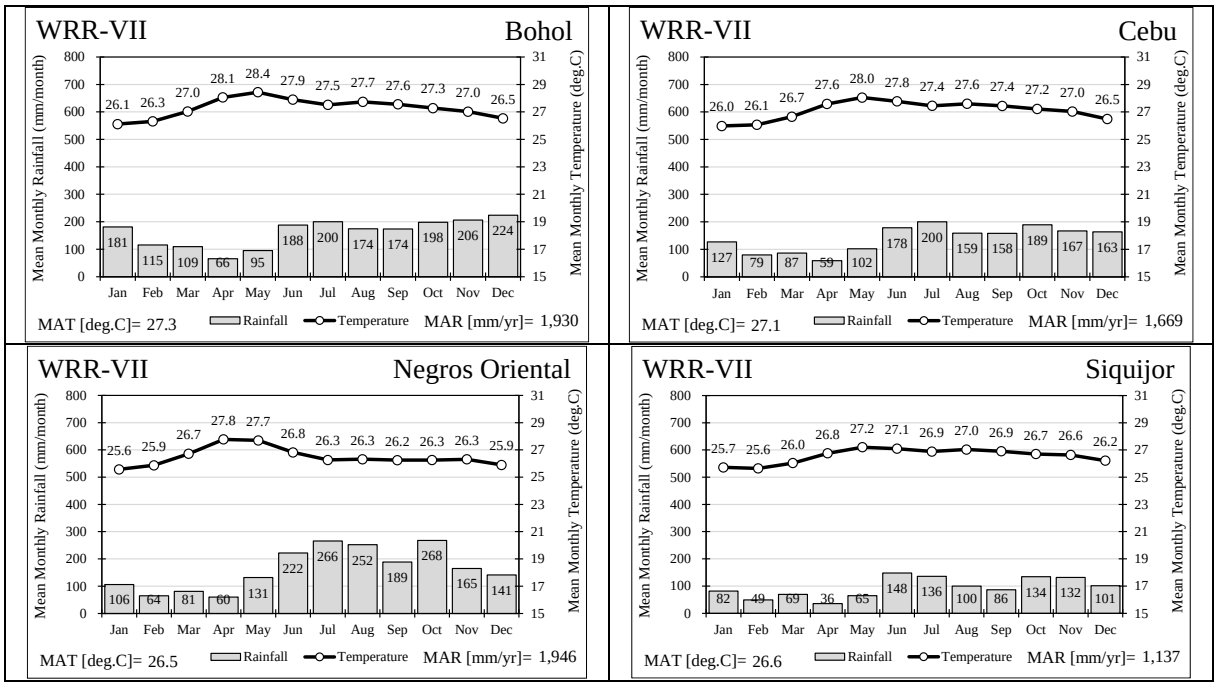
Figure D-305 Climate Regions in Philippines

In WRR-VII, it is classified as the dry season from February to May with little rainfall, and the rainy season from June to January. Eastern Negros has relatively high rainfall during the wet season, while Siquijor has low rainfall throughout the year.

5) Temperature and Rainfall

The average annual temperature in Bohol and Cebu exceeds 27°C, while it is around 26.5°C in eastern Negros and Siquijor. The temperature is stable throughout the year, but the highest temperature is around April to May at the end of the dry season.

Daily mean temperature from 1979 to 2020 of ERA5 (0.25-degree grid; approximately 31 km mesh) were collected from the ECMWF reanalysis data sets. Provincial mean monthly rainfall and mean monthly temperature from 1979 to 2020 (42 years) in each water resources region are shown in Figure below.



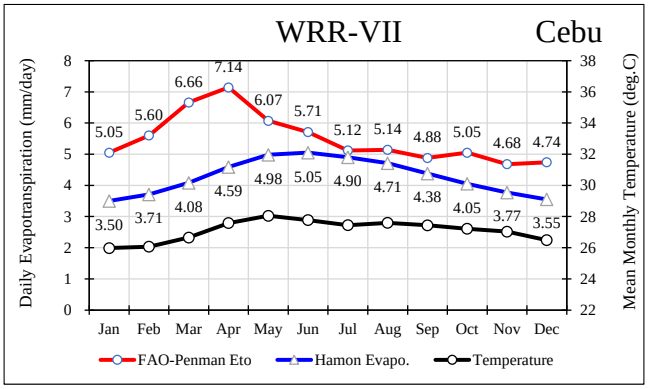
Source: JICA Survey Team, based on ERA5 and CHIRPS data.

Figure D-306 Provincial Mean Monthly Rainfall and Mean Monthly Temperature from 1979 to 2020 (42 Years) in Each Province in WRR-VII

6) Evapotranspiration

Estimated daily potential evapotranspiration (reference crop evapotranspiration) (ETo) averaged by each province by FAO-Penman-Monteith equation was used for paddy fields and estimated daily average potential evapotranspiration by province by Hamon's equation was used for other land use fields. The ten-day reference crop evapotranspiration (ETo) was also used for estimation of the crop water requirement of paddy by province. The evapotranspiration calculation formulas for each estimation are show in 2.2.2.2.

The estimated daily evapotranspiration by FAO-ETo and Hamon methods averaged by province are shown in Figure below.

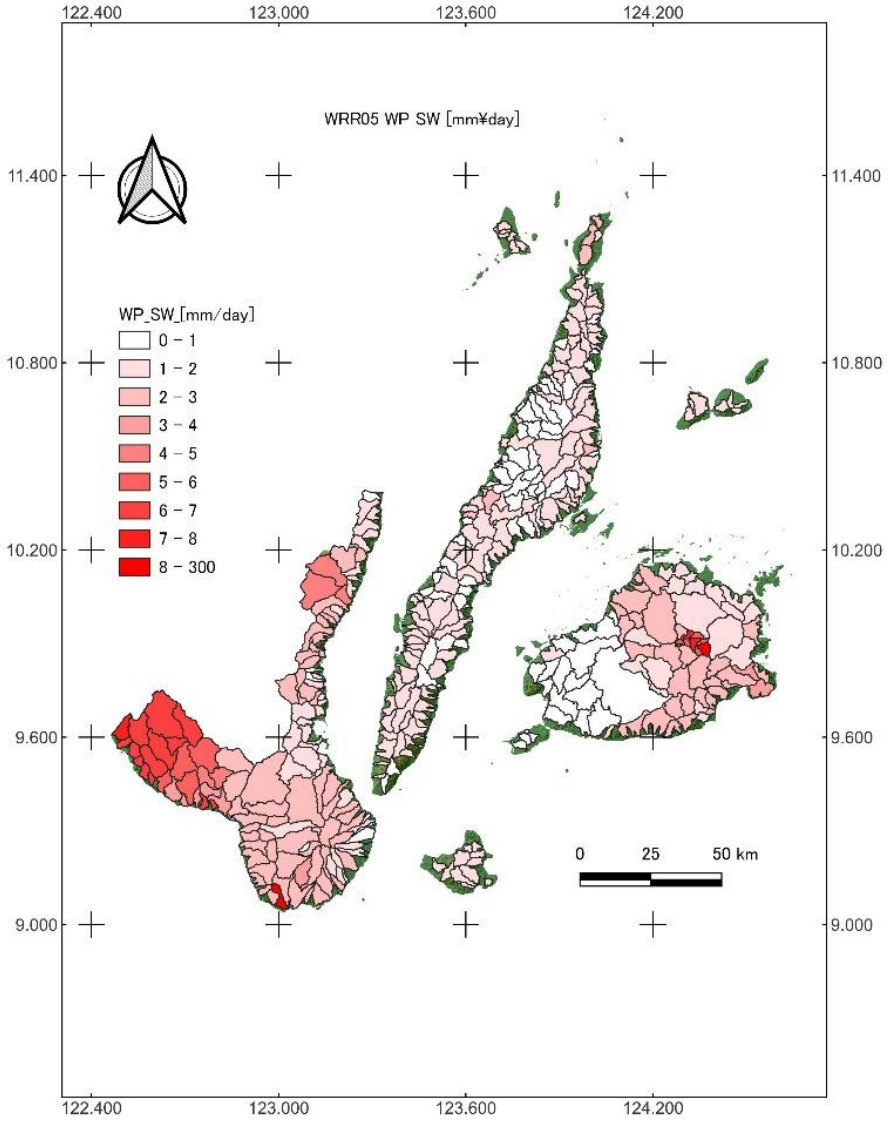


Source: JICA Survey Team, based on ERA5 and FAO-ClimWat data.

Figure D-307 Estimated Daily Potential Evapotranspiration of FAO-ETo and Hamon Method

(2) Surface Water Potential

Surface water potentials (river flow) of each sub-basin in WRR-VII were calculated by the SHER Model as shown in the Figure below. The Surface water potentials are abundant in Western part of Bohol Island du to there are some irrigation purpose dams and hole area of Negros Oriental due to volcanic mountains soils.



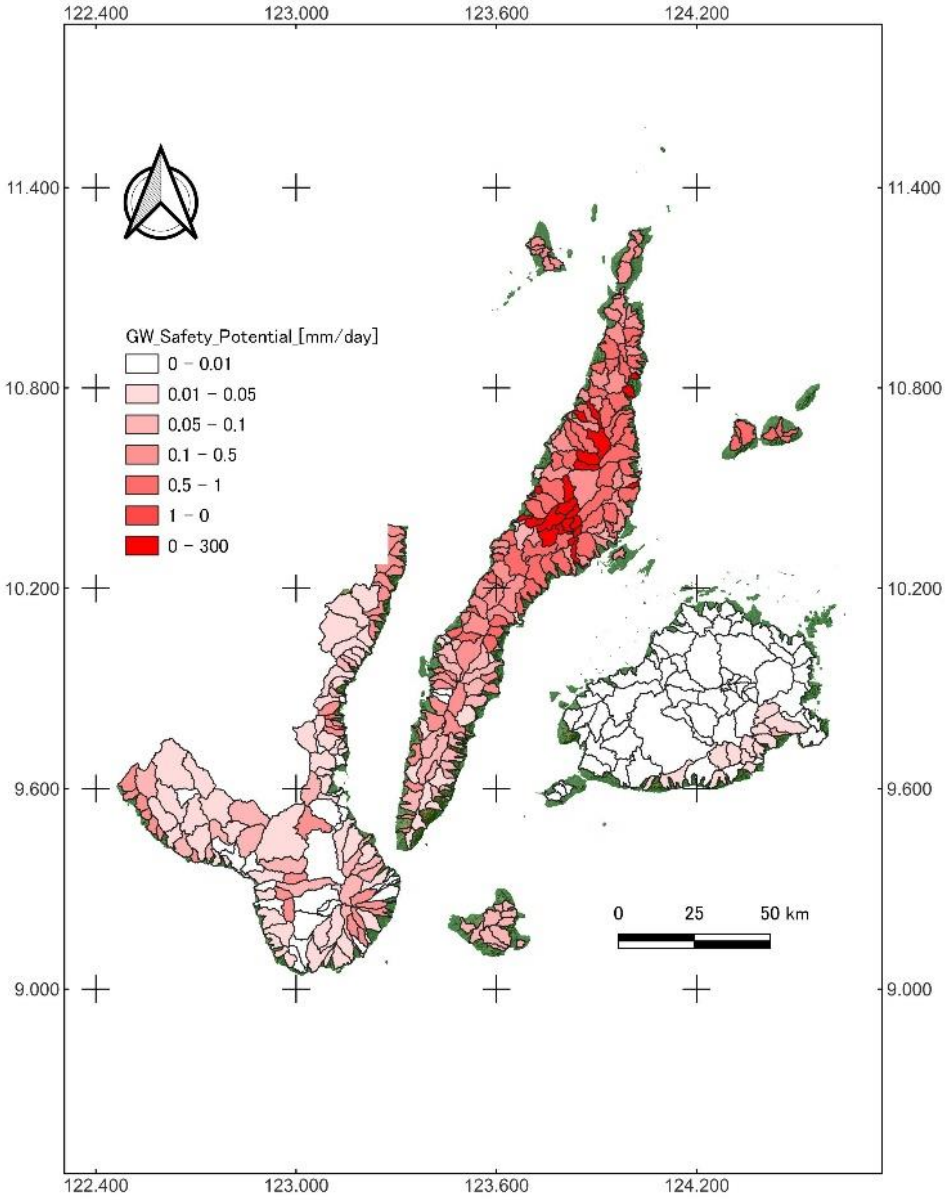
Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-308 Surface Water Potentials (1/5-Dry Year) in WRR-VII

(3) Groundwater Potential

The temporal results of groundwater potentials (groundwater flow) at each block were to be also able to calculate by SHER Model. The groundwater potentials used by the MODFLOW Model will be described in the next section of "Hydrological Analysis (Groundwater).

As shown in the Figure below, the groundwater potentials are relatively abundant in the northern part to central part of Cebu Island due to limestone rocks geology and steep slope of groundwater flow. Groundwater potential was calculated by multiplying the groundwater flow of each block by the safe groundwater pumping rate of 0.7.



Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-309 Groundwater Potentials (1/5-Dry Year) in WRR-VII

(4) Climate Change Impact Assessment

1) Cases of Water Balance Calculations

Cases of water balance calculations are shown in the Table below. For the future cases, due to infiltration (groundwater recharge) of irrigation water at paddy is large at the present condition,

the irrigation water demands, paddy areas and urban areas are set at year of 2020. However, municipal and industrial water demands are set at zero (0), due to the effect of infiltration from municipal and industrial water is not so much.

Table D-96 Cases of Water Balance Calculations

Case No.	Case-Name	Weather (Rain & Evapo)	Paddy Area [ha]	Irrigation WD	Urban Area	Domestic & Industrial WD	Urban Area
0	Calibration	1979-2020	1979-2020	1979-2020	1979-2020	1979-2020	1979-2020
1	Present Condition	1979-2020	2020	2020	2020	0	2020
2	RCP8.5-Low_WD=2020	RCP8.5-Low	2020	2020	2020	0	2020
3	RCP8.5-Mid_WD=2020	RCP8.5-Mid	2020	2020	2020	0	2020
4	RCP8.5-High_WD=2020	RCP8.5-High	2020	2020	2020	0	2020

Source: JICA Survey Team

2) PAGASA's Climate Change Report

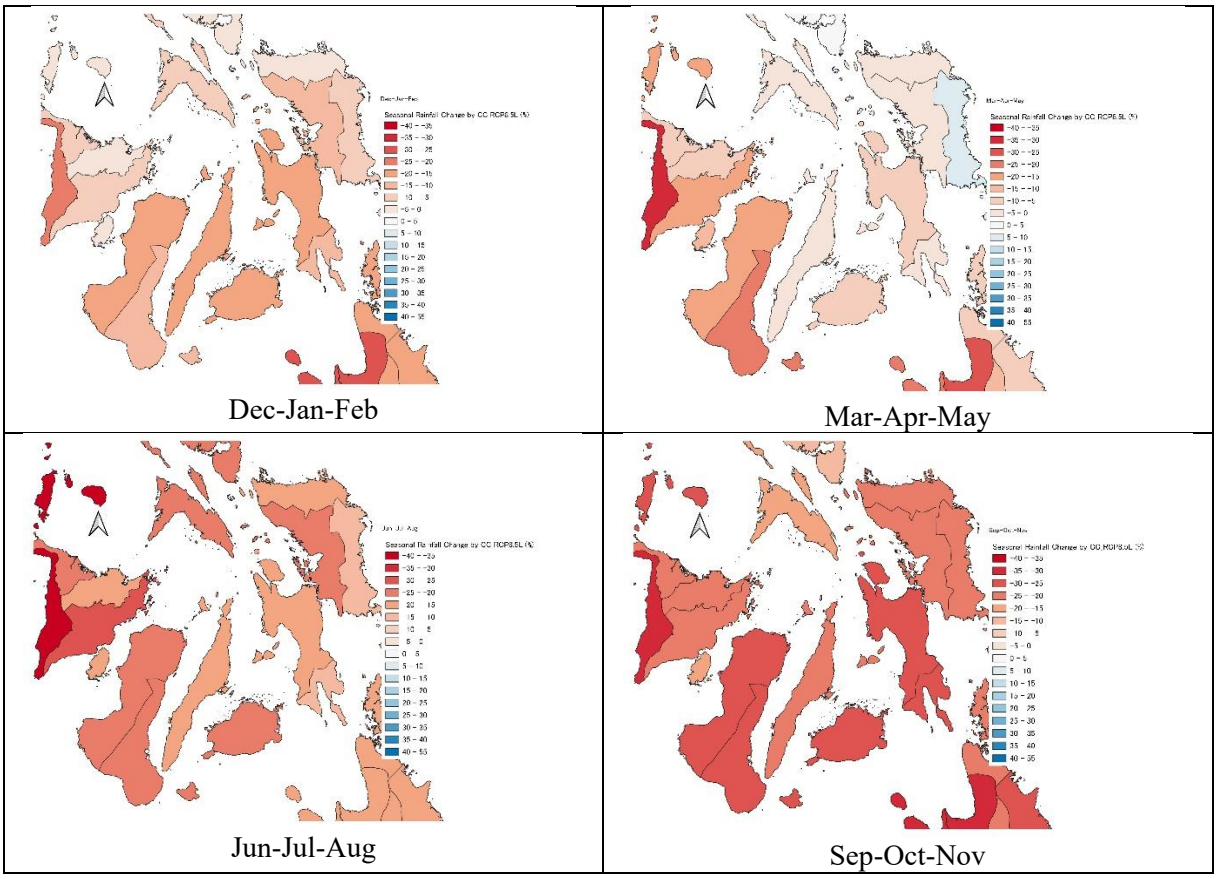


Cases of the climate change was used the data of the DOST-PAGASA's report. The data of PAGASA's report is provincial-wise change of rainfall and temperature by four (4) seasons. CLIRAM of the projected seasonal change in mean temperature and precipitation in the mid-21s century (2036-2065) for all provinces (baseline period: 1971-2000) are shown in the PAGASA's Report. High global emission scenario of RCP8.5 (Representative Concentration Pathways) of lower bound (L), median (M) and upper bound (H) were used for this study. This scenario indicates global average warming levels of 3.2 to 5.4oC by 2090. The changes of rainfall and temperature are deferent by province. The changes of evapotranspiration by Hamon's equation and FAO Penman-Monteith method were calculated by using temperature changes data. The example of data of PAGASA's report is provincial-wise change of rainfall and temperature by four (4) seasons as shown in Table below.

Table D-97 CLIRAM of the Projected Seasonal Change in Annual Total Precipitation (mm/year) in the Mid-21s Century (2036-2065) for all Provinces (baseline period: 1971-2000)

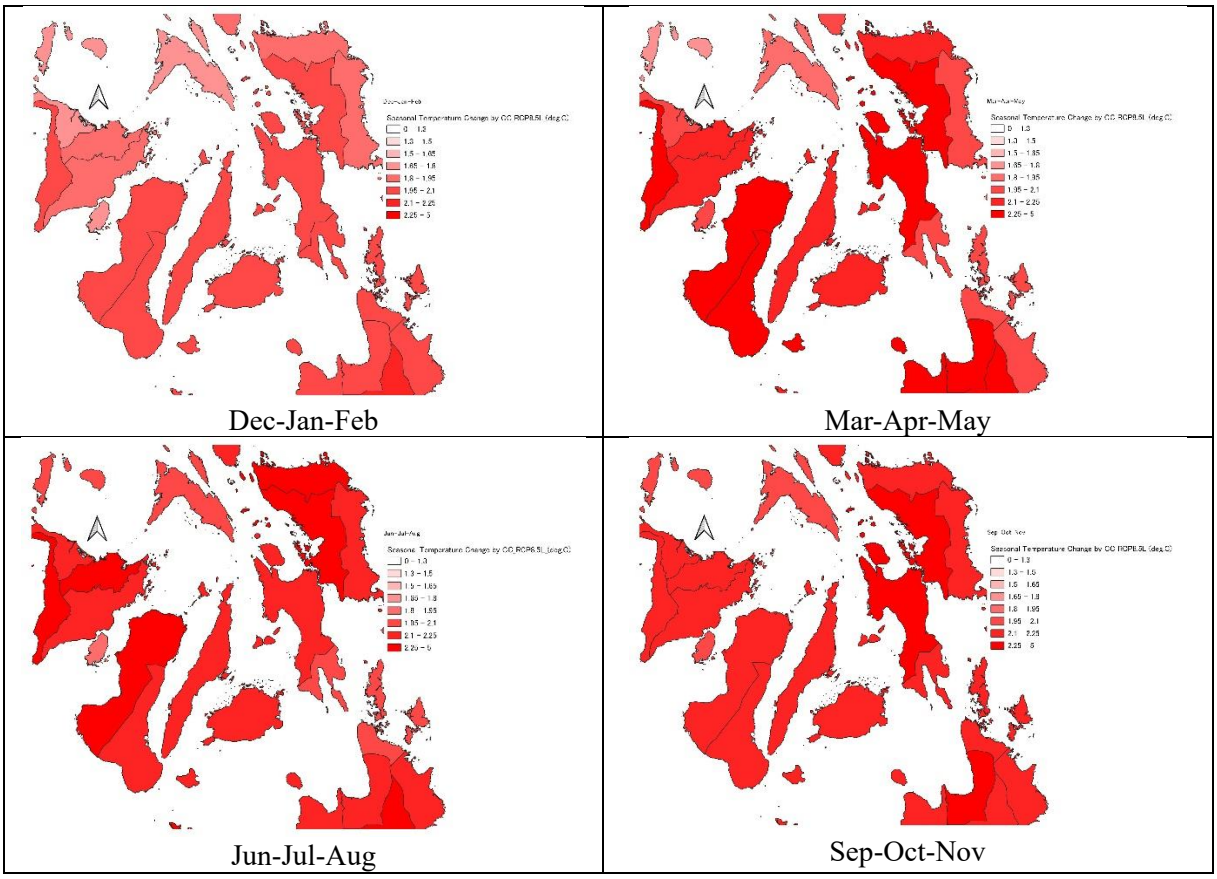
Region	Province	Observed (1971-2000)				Projected (2036-2065)									
								DJF (Dec-Jan-Feb)		MAM (Mar-Apr-May)		JJA (Jun-Jul-Aug)		SON (Sep-Oct-Nov)	
		DJF	MAM	JJA	SON	Scenario	Range*	Percent change	Projected value	Percent change	Projected value	Percent change	Projected value	Percent change	Projected value
Region 7	Bohol	376.1	209.6	412.9	514.5	Moderate Emission (RCP4.5)	Lower Bound	-13.5	325.3	-2.4	204.5	-16.8	343.5	-21.2	405.7
							Median	3.0	387.5	3.9	217.7	-6.5	386.1	-12.2	451.9
							Upper Bound	29.7	487.8	11.9	234.5	13.8	470.1	4.8	539.1
						High Emission (RCP8.5)	Lower Bound	-17.1	311.9	-6.7	195.5	-22.1	321.7	-27.9	370.8
							Median	1.5	381.8	1.8	213.3	-2.3	403.3	-12.3	451.4
							Upper Bound	21.5	457.1	8.5	227.5	13.4	468.2	6.3	546.8
	Cebu	324.0	228.3	595.1	607.4	Moderate Emission (RCP4.5)	Lower Bound	-7.1	301.1	-3.7	219.8	-12.4	521.3	-17.7	499.9
							Median	3.9	336.6	6.6	243.4	-4.9	565.7	-6.0	570.7
							Upper Bound	31.7	426.9	9.2	249.4	1.0	601.2	1.5	616.4
						High Emission (RCP8.5)	Lower Bound	-15.4	274.1	-3.2	221.1	-15.8	501.1	-21.3	478.0
							Median	6.2	344.1	2.1	233.1	-5.4	562.8	-11.5	537.5
							Upper Bound	22.4	396.7	10.2	251.5	3.6	616.6	2.7	623.5

Source: DOST-PAGASA



Source: Prepared by JICA Survey Team based on the data of PAGASA

Figure D-310 Quarterly Change of Precipitation by Province under Climate Change Scenarios from Present Weather in 2050 (RCP8.5-Low Case) in WRR-VII

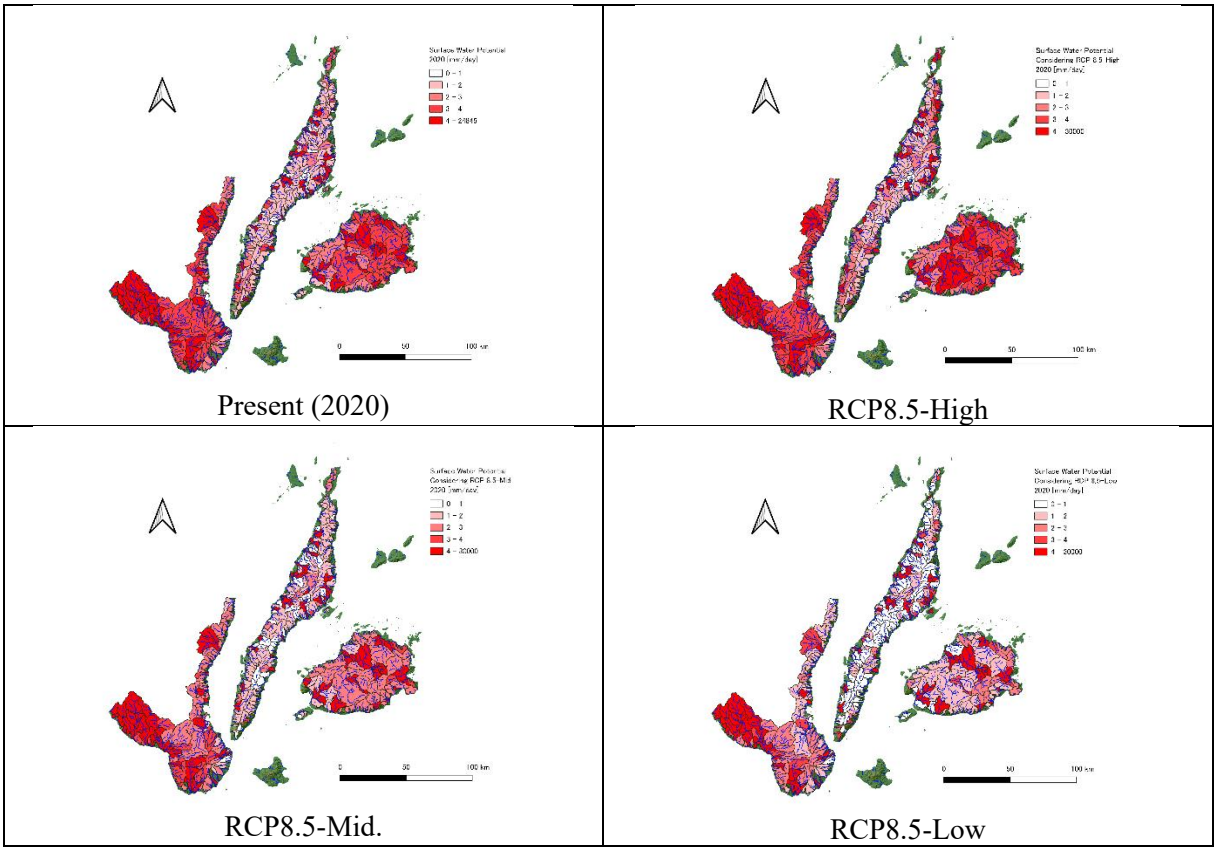


Source: Prepared by JICA Survey Team based on the data of PAGASA

Figure D-311 Quarterly Change of Temperature by Province under Climate Change Scenarios from Present Weather in 2050 (RCP8.5-Low Case) in WRR-VII

3) Results of Water Potential Analysis by Climate Change

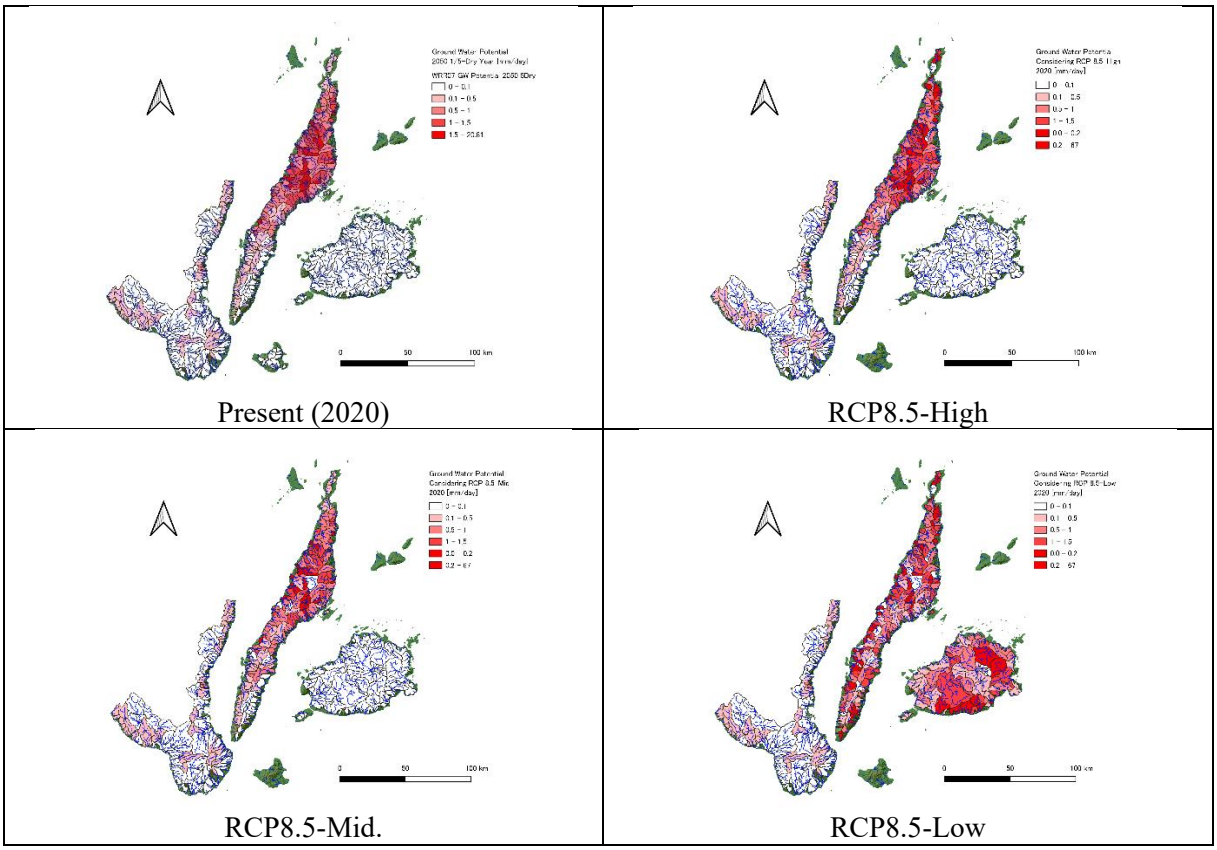
Estimated surface water potentials by climate change cases are shown in figure below. In the case of RCP8.5-Low, surface water potentials will be decrease especially in Bohol, northern part of Cebu and eastern part of Negros Oriental.



Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-312 Surface Water Potentials (Average) in WRR-VII (Unit: mm/day)

Estimated groundwater potentials by climate change cases are shown in figure below. In the case of RCP8.5-Low, groundwater potentials will be increased especially in Bohol and Cebu Islands.



Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-313 Groundwater Potentials (Average) in WRR-VII (Unit: mm/day)

11.1.2 WRR-XI

(1) Natural Condition in WRRXI

1) Land Area

WRR-XI is south-eastern Mindanao and consists of administrative Region-XIII (Caraga), Region-XI (Davao Region) and Region-XII (Soccsksargen) from the north. Metro Davao and Metro General Santos are highly urbanized cities.

The regional center and largest city is Davao City. The land area of the administrative Region-XIII (Caraga), Region-XI (Davao Region) and Region-XII (Soccsksargen) are 21,478.35 km^2, 20,433.38 km^2 and 22,513.30 km^2, respectively, and with a population of each administrative region are 2,804,788, 5,243,536 and 4,360,974 in 2020 census, respectively.

2) General Topography and Geology

The Region-XIII (Caraga) is characterized by mountainous areas, flat and rolling lands. Mountain ranges divide Agusan and Surigao provinces and sub-ranges separate most of the lowlands along the Pacific coast. In the broader physiographic framework of the Philippine archipelago, Caraga Region occupies the northernmost portion of the Eastern Mindanao Ridge or Mindanao Pacific Cordillera, a more than 400 km, NNW-SSE trending orogenic belt comprising eastern Mindanao. The Mindanao Pacific Cordillera is bounded by two major structures that played a key role in the neotectonic evolution of the Philippine Mobile Belt, namely the Philippine Trench and the Philippine Fault Zone.

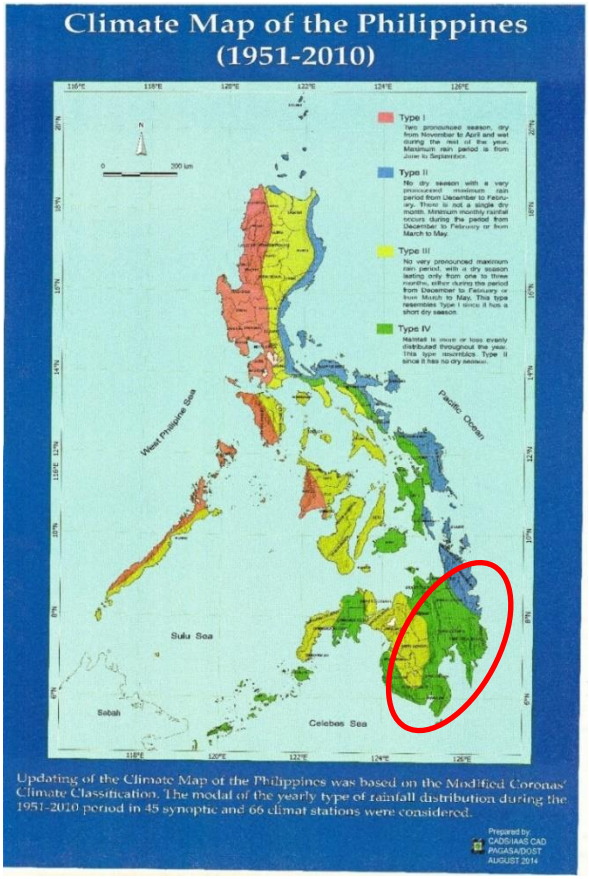
The topography of Region-XI (Davao Region) is dominated by peninsular and island topography characterized by extensive mountain ranges extending along the western border, in the northern central area and in the north-western area leading to the peninsula in the southeast with uneven distribution of plateaus and lowlands. It has a coastline of 1,600 km2. To the west of Davao City is Mt. Apo (altitude 2,954m), the highest volcano in the Philippines. Despite Davao Region location in the Asian portion of the Pacific Ring of Fire, the region has suffered few earthquakes and most have been minor. Mt. Apo, 40 kilometres (25 mi) southwest from the Davao city proper, is a dormant volcano.

The Region-XII (Soccsksargen) is bounded on the east by the Davao Region, and on the southwest by the Celebes Sea. The region has extensive coastlines, valleys and mountain ranges. Known for its river system, the region is the drainage basin of Mindanao, particularly at the Cotabato Basin, a large depression surrounded by mountain ranges on three sides. Within the basin runs the Rio Grande de Mindanao, the longest river in Mindanao and the second longest in the Philippines. The river empties into the Illana Bay of the larger Moro Gulf at the west of Cotabato City. At the south of the basin lie the Tiruray Highlands, a moderately high mountain range blocking the basin from the southern coastline. Southeast of the mountains lie the Sarangani Bay.

3) Climate and Climate Regions of the Study Area

There are four climatological types that exist in the Philippines characterized as show in 2.2.2.2.:

Most of WRR-XI are located in the Type-VI of climatological types.



Source: PAGASA (http://bagong.pagasa.dost.gov.ph/information/climate-philippines)

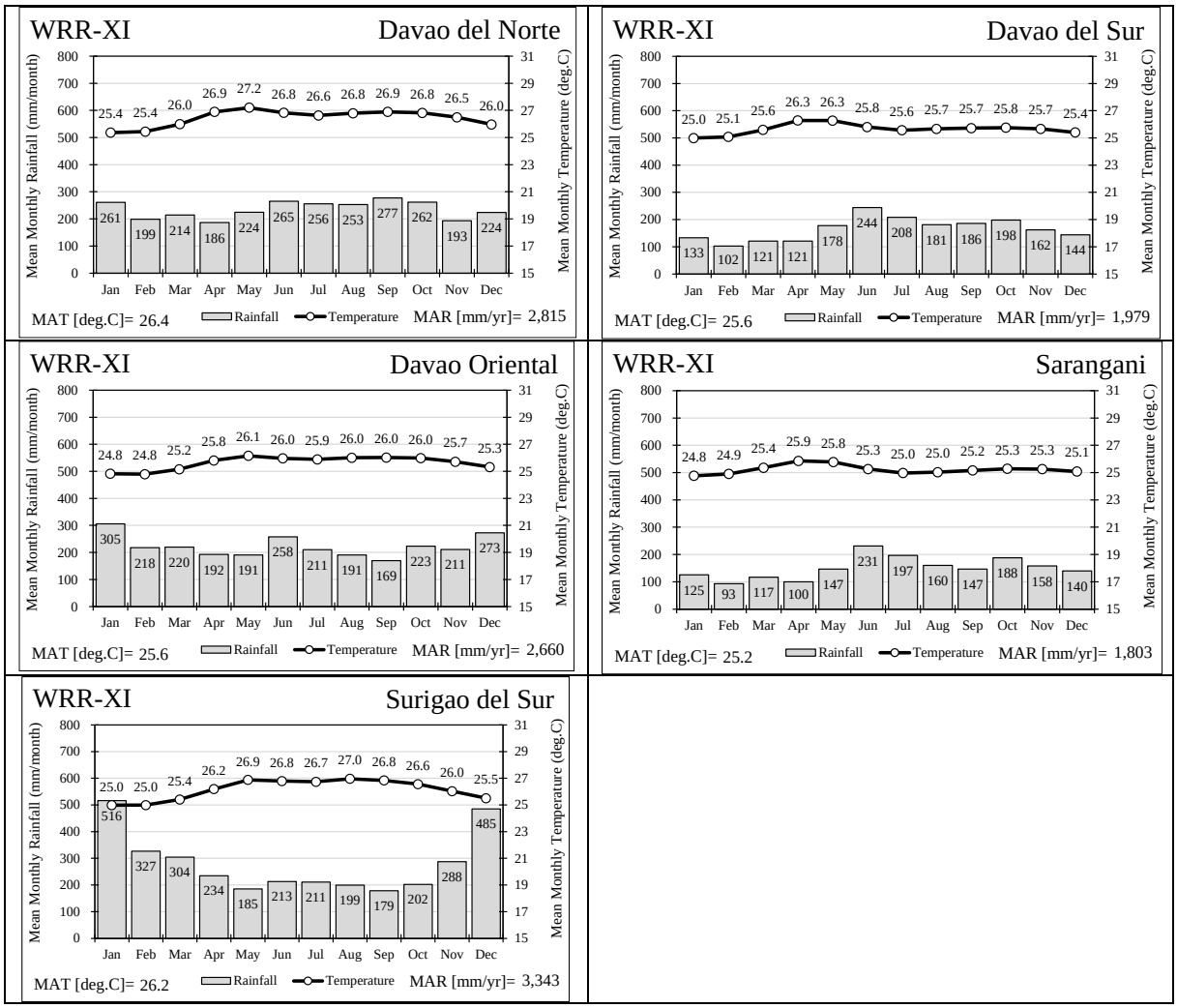
Figure D-314 Climate Regions in Philippines

In the most of WRR-XI in the climate type-VI, rainfall is more or less evenly distributed throughout the year. This climate type resembles the second type more closely since it has no dry season.

4) Temperature and Rainfall

The average annual temperature in Davao del Sul is around 25.6°C. The temperature is stable throughout the year, but the highest temperature is around April to May.

Daily mean temperature from 1979 to 2020 of ERA5 (0.25-degree grid; approximately 31 km mesh) were collected from the ECMWF reanalysis data sets. Provincial mean monthly rainfall and mean monthly temperature from 1979 to 2020 (42 years) in each water resources region are shown in Figure below.



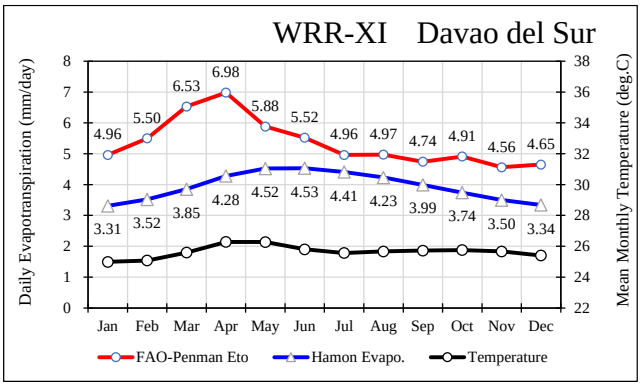
Source: JICA Survey Team, based on ERA5 and CHIRPS data.

Figure D-315 Provincial Mean Monthly Rainfall and Mean Monthly Temperature from 1979 to 2020 (42 Years) in Each Province in WRR-XI

5) Evapotranspiration

Estimated daily potential evapotranspiration (reference crop evapotranspiration) (ETo) averaged by each province by FAO-Penman-Monteith equation was used for paddy fields and estimated daily average potential evapotranspiration by province by Hamon's equation was used for other land use fields. The ten-day reference crop evapotranspiration (ETo) was also used for estimation of the crop water requirement of paddy by province. The evapotranspiration calculation formulas for each estimation are show in 2.2.2.2.

The estimated daily evapotranspiration by FAO-ETo and Hamon methods averaged by province are shown in Figure below.

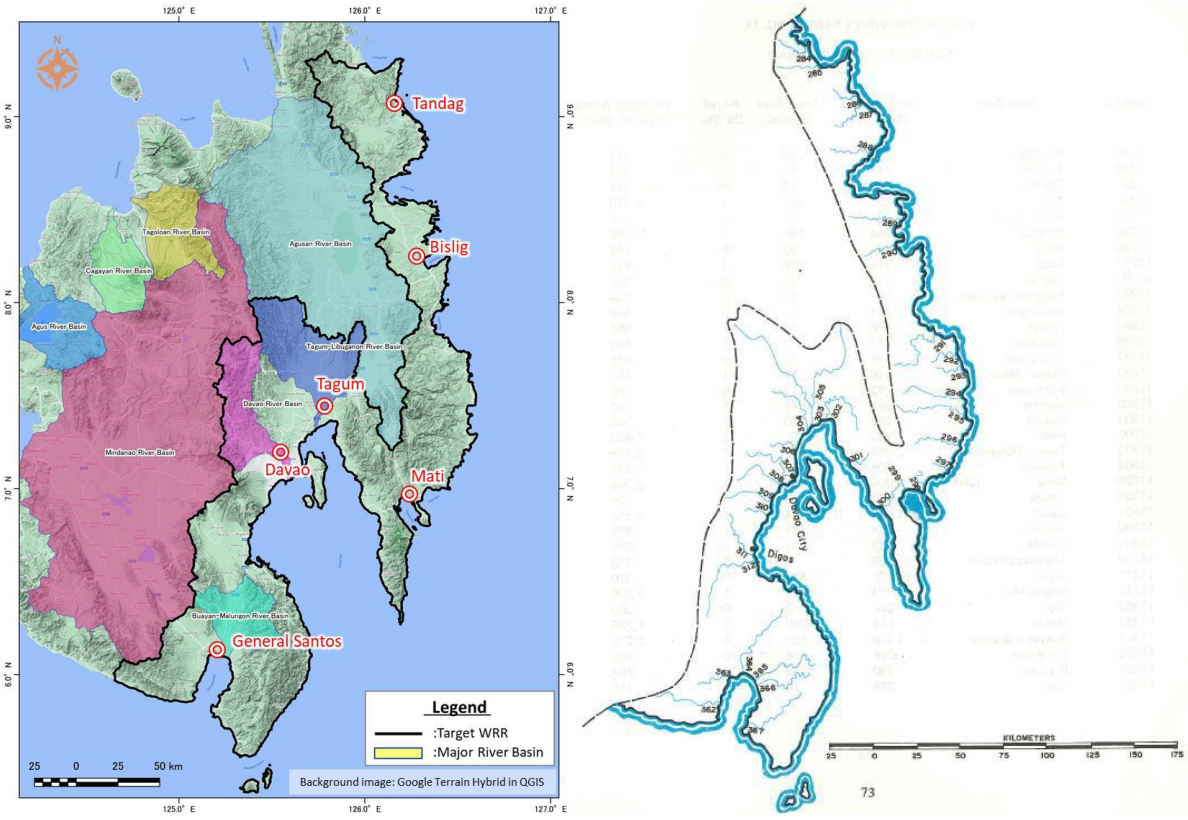


Source: JICA Survey Team, based on ERA5 and FAO-ClimWat data.

Figure D-316 Estimated Daily Potential Evapotranspiration of FAO-ETo and Hamon Method

6) River

Out of the 18 major river basins, there are 3 major river basins, i.e. the Tagum-Libuganon River basin, the Davao River basin and the Buayan-Malungon Rver basin in the WRR XI. There are also several principal river basins as shown in the figure below:



Source: National Water Resources Council (1976) "Principal River Basins of the Philippines"

Figure D-98 Location Map of Major Rivers and Principal Rivers in WRR XI

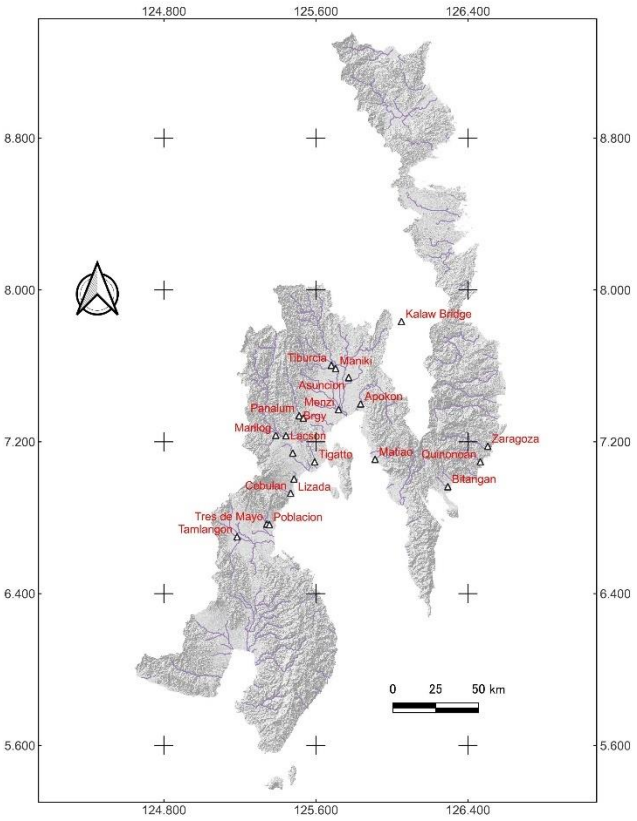
7) Streamflow Data

Streamflow data were gathered for many of the stations within the survey area. Streamflow records were obtained from DPWH. A total of 25 daily average discharge data shown in the Figure and Table below were collected and used for low flow analysis of WRR-XI.

Table D-99 Number of Discharge Observation Stations by WRRs

N	N	Station	River	Basin	Agenc	WR	Province	Town, Village	Latitud	Longitu	Elevati	C.A.(km	Period
218	1	Marilog	Tamugan	Davao	DPWH	XI	Dava del Sur	Marilog, Davao City	7.2333	125.3886	11.6	110.0	2000-2016
175	2	Apokon	Hijo	Hijo	DPWH	XI	Davao del Norte	Apokon, Tagum City	7.3990	125.8350	10.3	634.0	1986-2011, 2013, 2015-16
181	3	Menzi	Tuganay	Tuganay	DPWH	XI	Davao del Norte	Menzi, Sto. Tomas	7.3690	125.7190	12.1	569.0	1985-92, 2001-17
213	4	Kalaw Bridge	Agusan	Agusan	DPWH	XI	Davao del Norte	Kalaw Bridge, Monkayo	7.8333	126.0500		1,355.0	1979-2016
215	5	Tiburcia	Kipaliko	Kipaliko	DPWH	XI	Davao del Norte	Tiburcia, Kapalong	7.6025	125.6808	12.4	147.0	1986-2016
216	6	Maniki	Libuganon	Libuganon	DPWH	XI	Davao del Norte	Maniki, Kapalong	7.5856	125.7033	8.2	1,111.0	2000-2018
217	7	Asuncion	Saug	Saug	DPWH	XI	Davao del Norte	Asuncion	7.5380	125.7720	10.0	779.0	2001-2013
104	8	Lacson	Davao	Davao	DPWH	XI	Davao Del Sur		7.2314	125.4422	10.5	1,469.0	2001-2009
105	9	Tigatto	Davao	Davao	DPWH	XI	Davao Del Sur		7.0939	125.5931	20.0	1,683.0	1984-1999
106	10	Brgy	Lasang	Lasang	DPWH	XI	Davao Del Sur		7.3367	125.5117	15.7	344.0	2002-2010
107	11	Mabuhay	Lasang	Lasang	DPWH	XI	Davao Del Sur		7.3244	125.5339	17.2	354.0	1985-1989
108	12	Angalan II	Talomo	Talomo	DPWH	XI	Davao Del Sur		7.1403	125.4778	13.2	165.0	1986-2010
109	13	Barangay	Lipadas	Lipadas	DPWH	XI	Davao Del Sur		7.0033	125.4844	10.0	149.0	1986-201
170	14	Tamlangon	Balatukan	Balatukan	DPWH	XI	Davao del Sur	Tamlangon, Matanao	6.6990	125.1850	13.8	393.0	1984-2016
172	15	Cebulan	Cebulan	Cebulan	DPWH	XI	Davao del Sur	Cebulan, Sta. Cruz	6.9290	125.4670	18.7	171.0	1986-2016
173	16	Tres de Mayo	Digos	Davao	DPWH	XI	Davao del Sur	Tres de Mayo, Digos	6.7660	125.3410	6.2	131.0	1991-93, 1998-2004, 2008-16
174	17	Poblacion	Digos	Digos	DPWH	XI	Davao del Sur	Poblacion, Digos	6.7630	125.3550	18.1	134.0	1986-1990
176	18	Panalum	Lasang		DPWH	XI	Davao del Sur	Panalum, Paguibato, Davao	7.3370	125.5120		344.0	2010-2018
177	19	Lizada	Lipadas	Lipadas	DPWH	XI	Davao del Sur	Lizada, Toril, Davao City	7.0030	125.4840	2.6	149.0	1986-2005, 2007-18
180	20	Los Amigos	Talomo	Talomo	DPWH	XI	Davao del Sur	Los Amigos, Tugbok, Davao	7.1400	125.4780	13.2	165.0	1986-2017
214	21	Tigatto	Davao	Davao	DPWH	XI	Davao del Sur	Tigatto, Davao City	7.0939	125.5931	-9.7	1,683.0	1984-2011
171	22	Zaragoza	Casauman	Casauman	DPWH	XI	Davao Oriental	Zaragoza, Manay	7.1760	126.5040	-7.6	373.0	1985-1989
178	23	Matiao	Matiao	Matiao	DPWH	XI	Davao Oriental	Matiao, Puntukan	7.1070	125.9110	10.9	167.0	1986-2017
179	24	Quinonoan	Quinonoan	Quinonoan	DPWH	XI	Davao Oriental	Quinonoan, Manay	7.0940	126.4650	14.1	132.0	1986-90, 1994-2003
204	25	Bitangan	Bitanagan	Bitanagan	DPWH	XI	Davao Oriental	Bitangan, Mati	6.9630	126.2940	13.7	84.0	1985-2011

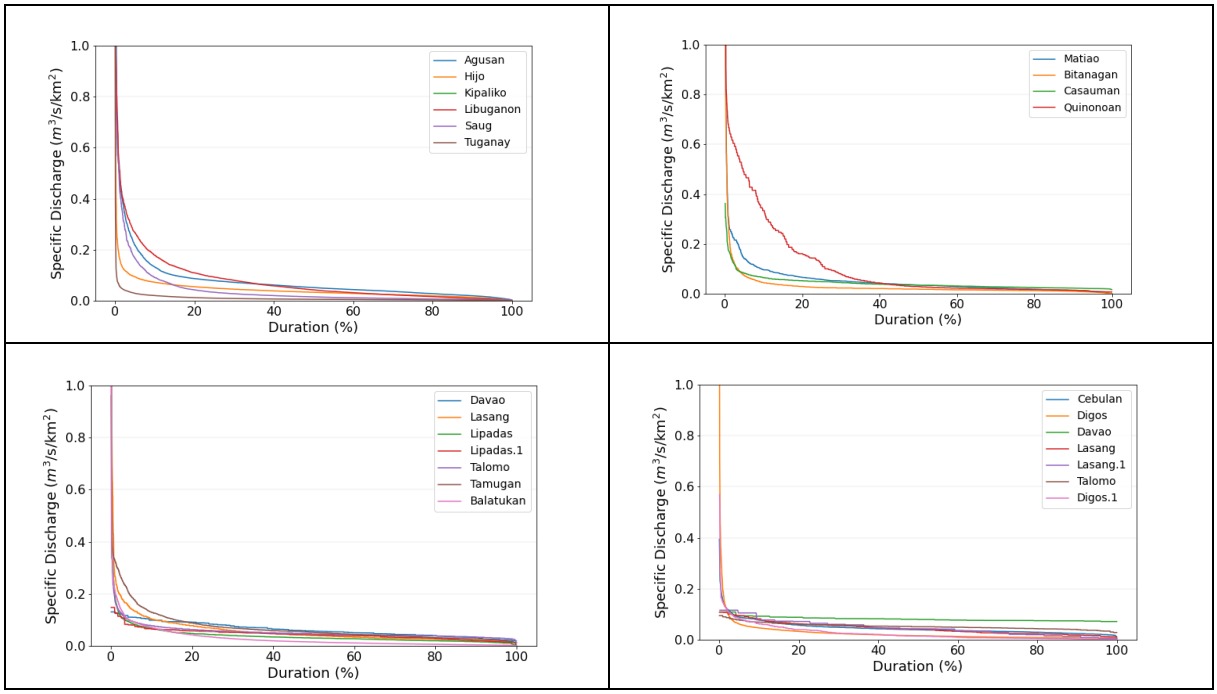
Source: DPWH



Source: JICA Survey Team based on the data of DPWH.

Figure D-317 Location Map of Daily Discharge Observation Stations used for Low Flow Analysis (Total 25 Stations)

Unfortunately, these streamflow data were often missing as shown in Figures in ANNEX-Hydrology. In addition, there are limits to the frequency of discharge observations and the accuracy of the water level-discharge rating curves (H-Q curves), as there are many flows in which the value of the flood discharge is questionable. There are many data at observatories where the flow duration curves (FDCs) using the specific discharge are strange as shown in Figure below.



Source: JICA Survey Team based on DPWH Data

Figure D-318 Flow Duration Curve (FDC) of Observed Daily Discharge in WRR-XI

Also, the annual runoff at some stations exceeds the annual rainfall (runoff coefficient is more than 1.0) as shown in Table below.

Table D-100 Annual Runoff Coefficient of Observed Daily Discharge in WRR-XI (1/2)

Davao del Norte

		1	2	3	4	5	6
		Agusan	Hijo	Kipaliko	Libuganon	Saug	Tuganay
		Kalaw Bridge	Apokon	Tiburcia	Maniki	Asuncion	Menzi
		XI	XI	XI	XI	XI	XI
		Davao del Nor	Davao del Nor	Davao del Nor	Davao del Nor	Davao del Nor	Davao del Nor
	Rainfall	1,355.0	634.0	147.0	1,111.0	779.0	569.0
	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)
1979	1,868.7	1.438					
1980	2,177.9	1.005					
1981	2,258.3	1.244					
1982	2,420.8	0.492					
1983	2,547.8	1.009					
1984	3,469.3	0.731					
1985	2,925.0	0.999					0.313
1986	2,905.8	0.897	0.528				0.198
1987	2,187.3		0.564				0.117
1988	2,868.8	0.586	0.461				0.056
1989	2,991.8	0.547	0.545				0.108
1990	2,513.6	0.615	0.358				0.099
1991	2,191.4	0.370	0.278				0.052
1992	2,056.5	0.907	0.202				0.066
1993	2,820.2	0.872	0.457				
1994	2,749.2	1.036	0.429				
1995	2,824.4	0.980	0.427				
1996	3,086.4	1.318	0.304				
1997	2,884.0	0.395	0.329				
1998	1,889.8	1.654	0.530				
1999	3,773.7	0.932	0.510				
2000	3,329.2	0.660			0.739		
2001	3,246.5	0.589	0.489		0.595	0.247	0.099
2002	2,359.2		0.582		0.853	0.437	0.133
2003	3,048.6		0.473		0.804	0.419	0.134
2004	2,331.3		0.497		0.806	0.456	0.099
2005	2,997.2		0.363		0.488	0.264	0.068
2006	2,851.7		0.427		0.705	0.523	0.093
2007	2,985.5	0.730	0.436		0.813	0.385	0.068
2008	3,360.3	0.704	0.555		0.705	0.469	0.124
2009	3,488.6	0.552	0.550		0.979	0.530	0.095
2010	2,752.3	0.979	0.634		1.006		0.090
2011	4,183.8	1.065	0.374		0.994		0.092
2012	3,459.9	0.858					0.085
2013	3,404.2	0.532	0.544			0.658	
2014	3,062.9	0.319					0.114
2015	2,222.7	1.727	0.534		0.705		0.130
2016	2,479.6	49.195					0.129
2017	3,882.4				1.133		0.154
2018	2,626.9				0.646		
2019	2,173.1						
2020	2,557.0						
Max.	4,183.8	49.195	0.634	0.000	1.133	0.658	0.313
Ave.	2,814.6	2.373	0.459	#DIV/0!	0.798	0.439	0.113
Min.	1,868.7	0.319	0.202	0.000	0.488	0.247	0.052

Selected

Davao Oriental

		1	2	3	4
		Matiao	Bitanagan	Casauman	Quinonoan
		Matiao	Bitangan	Zaragoza	Quinonoan
		XI	XI	XI	XI
		Davao Orienta	Davao Orienta	Davao Orienta	Davao Orienta
	Rainfall	167.0	84.0	373.0	132.0
	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)
1979	2,290.7				
1980	2,767.6				
1981	1,995.4				
1982	2,234.7				
1983	2,284.2				
1984	3,575.7				
1985	2,613.3		0.047	0.34	
1986	2,600.7	0.479	0.167	0.45	0.241
1987	1,995.7	0.619	0.358	0.63	0.369
1988	2,665.7	0.603	0.255	0.59	0.306
1989	2,775.0	0.789	0.356	0.73	0.243
1990	2,289.0	0.240	0.240		0.282
1991	1,992.4	0.246	0.387		
1992	1,799.7	0.210	0.236		
1993	2,532.6		0.386		
1994	2,515.3	2.929	0.237		2.706
1995	2,578.0	1.920	0.268		1.170
1996	2,781.1	0.771	0.275		3.291
1997	2,618.8	0.672	0.338		1.467
1998	1,690.3	0.783	0.309		1.493
1999	3,739.7	0.685	0.931		3.743
2000	3,227.2	0.556	0.731		0.307
2001	3,059.4	0.476	0.602		0.258
2002	2,132.6	0.398	0.346		0.245
2003	2,598.2	0.630	0.404		0.301
2004	1,832.8	0.780	0.314		
2005	2,515.2	0.303			
2006	2,746.9	0.514			
2007	2,895.3	0.526			
2008	3,455.7	0.549	0.363		
2009	3,227.2	0.414	0.138		
2010	2,783.5	0.732	0.223		
2011	4,168.1	0.447	0.372		
2012	3,423.0	0.745			
2013	3,431.2	0.583			
2014	2,890.0	0.333			
2015	2,025.4	0.530			
2016	2,124.0	0.640			
2017	3,774.6	0.637			
2018	2,478.5				
2019	2,084.0				
2020	2,523.0				
Max.	4,168.1	2.929	0.931	0.73	3.743
Ave.	2,660.3	0.669	0.345	0.55	1.095
Min.	1,690.3	0.210	0.047	0.34	0.241

Selected

Source: JICA Survey Team based on DPWH Data

Table D-101 Annual Runoff Coefficient of Observed Daily Discharge in WRR-XI (2/2)

Davao del Sur

		1	2	3	4	5	6	7
		Davao	Lasang	Lipadas	Lipadas	Talomo	Tamugan	Balatukan
		Lacson	Panalum	Lizada	Barangay	Los Amigos	Marilog	Tamlangon
		XI	XI	XI	XI	XI	XI	XI
		Davao Del Su	Davao del Su	Davao del Su	Davao Del Su	Davao del Su	Davao del Su	Davao del Su
	Rainfall	1,469.0	344.0	149.0	149.0	165.0	218.0	393.0
	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)
1979	2,065.2							
1980	2,175.4							
1981	1,551.1							
1982	1,574.6							
1983	1,980.4							
1984	2,437.0							0.301
1985	1,947.9							0.609
1986	1,936.1			0.458		1.197		0.464
1987	1,535.4			0.652		0.933		0.823
1988	1,994.6			0.560		0.799		0.266
1989	2,055.5			0.586		0.837		0.498
1990	1,830.2			0.343		0.810		0.447
1991	1,427.6			0.623		0.993		0.258
1992	1,418.8			0.593				0.363
1993	1,788.8			0.556		0.789		0.192
1994	1,851.6			0.371		0.858		0.660
1995	1,969.7			0.394		0.787		0.757
1996	2,048.0			0.400	0.399			0.387
1997	1,736.8			0.416	0.416	0.884		0.686
1998	1,401.7			1.232	1.231	1.003		0.577
1999	2,532.9			0.877	0.876	0.708		0.874
2000	2,342.7			0.767	0.768	0.794	0.620	0.496
2001	2,207.8			0.668		0.742	0.767	0.479
2002	1,611.4	1.404		0.688	0.689	1.063	0.915	0.445
2003	2,009.3	1.048		0.789		0.969	1.264	0.364
2004	1,710.0	1.182		0.898	0.897	0.963	2.121	0.366
2005	2,100.5	0.686				0.748	1.216	0.347
2006	2,065.5	0.847				0.767	1.752	0.349
2007	2,060.7	0.806		0.940		0.662		0.382
2008	2,475.0	0.862		0.495	0.495	0.636	1.089	0.473
2009	2,260.7	1.093		0.625	0.625	0.814	0.880	0.412
2010	2,025.4		0.675	0.664		0.905	1.745	0.306
2011	2,805.1		0.736	0.580	0.581	0.586	0.631	0.439
2012	2,469.0		0.900	1.008		0.826	0.488	0.567
2013	2,396.3		1.596	0.431		0.796	0.746	0.754
2014	1,953.7		1.219	0.495		1.031	1.068	0.407
2015	1,449.6		0.778	0.825		1.593		0.697
2016	1,828.7		0.531	0.548		0.899	0.576	0.153
2017	2,711.1		0.525	0.363		0.809		
2018	1,859.2		0.405	0.283				
2019	1,596.8							
2020	1,912.8							
Max.	2,805.1	1.404	1.596	1.232	1.231	1.593	2.121	0.874
Ave.	1,978.8	0.988	0.818	0.617	0.698	0.873	1.059	0.473
Min.	1,401.7	0.686	0.405	0.283	0.399	0.586	0.488	0.153

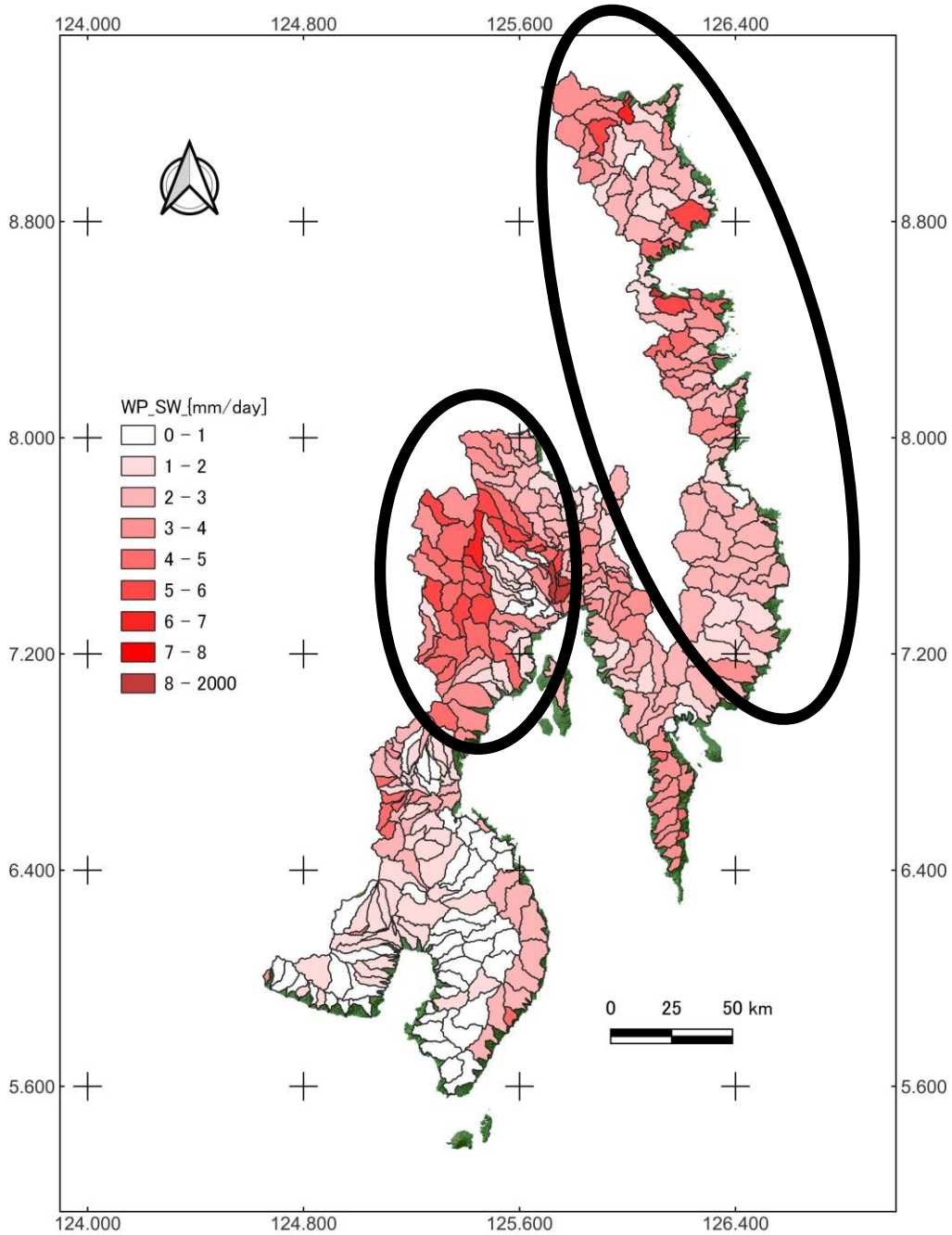
Selected

		1	2	3	4	5	6	7
		Cebulan	Digos	Davao	Lasang	Lasang	Talomo	Digos
		Cebulan	Tres de Mayo	Tigatto	Brgy	Mabuhay	Angalan II	Poblacion
		XI	XI	XI	XI	XI	XI	XI
		Davao Del Su	Davao del Su	Davao del Su	Davao del Su	Davao del Su	Davao del Su	Davao del Su
	Rainfall	171.0	131.0	1,683.0	344.0	354.0	165.0	134.0
	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)
1979	2,065.2							
1980	2,175.4							
1981	1,551.1							
1982	1,574.6							
1983	1,980.4							
1984	2,437.0							
1985	1,947.9							
1986	1,936.1	0.727		1.374		0.885		0.479
1987	1,535.4	0.959				0.776		0.310
1988	1,994.6	0.633						0.421
1989	2,055.5	0.482						0.745
1990	1,830.2	0.668						0.105
1991	1,427.6	0.704	0.313					
1992	1,418.8	0.605	0.210					
1993	1,788.8	0.635	0.174					
1994	1,851.6	0.798		1.339				
1995	1,969.7	1.111						
1996	2,048.0	1.012						
1997	1,736.8	1.203						
1998	1,401.7	1.147	0.697					
1999	2,532.9	0.807	0.437					
2000	2,342.7	0.440	0.220					
2001	2,207.8	0.666	0.317				0.741	
2002	1,611.4	0.835	0.336				1.043	
2003	2,009.3	0.765	0.377		0.626		0.905	
2004	1,710.0	0.741	0.246		0.565		0.964	
2005	2,100.5	0.557			0.568		0.748	
2006	2,065.5	0.539			0.681		0.702	
2007	2,060.7	0.725			0.706		0.666	
2008	2,475.0	0.771	0.412		0.742		0.638	
2009	2,260.7	0.739	0.395		0.766		0.813	
2010	2,025.4	0.709	0.793		0.703		0.900	
2011	2,805.1	0.566	0.496					
2012	2,469.0	0.348	0.559					
2013	2,396.3	1.024	1.332					
2014	1,953.7	0.793	0.327					
2015	1,449.6	0.783	0.275					
2016	1,828.7	0.781	0.222					
2017	2,711.1							
2018	1,859.2							
2019	1,596.8							
2020	1,912.8							
Max.	2,805.1	1.203	1.332	1.374	0.766	0.885	1.062	0.745
Ave.	1,978.8	0.751	0.428	1.357	0.670	0.830	0.822	0.412
Min.	1,401.7	0.348	0.174	1.339	0.565	0.776	0.638	0.105

Source: JICA Survey Team based on DPWH Data

(2) Surface Water Potential

Surface water potentials (river flow) of each sub-basin in WRR-XI were calculated by the SHER Model as shown in the Figure below. Surface Water Potentials (river flows) are abundant in Eastern part of WRR-XI du to much rainfall.



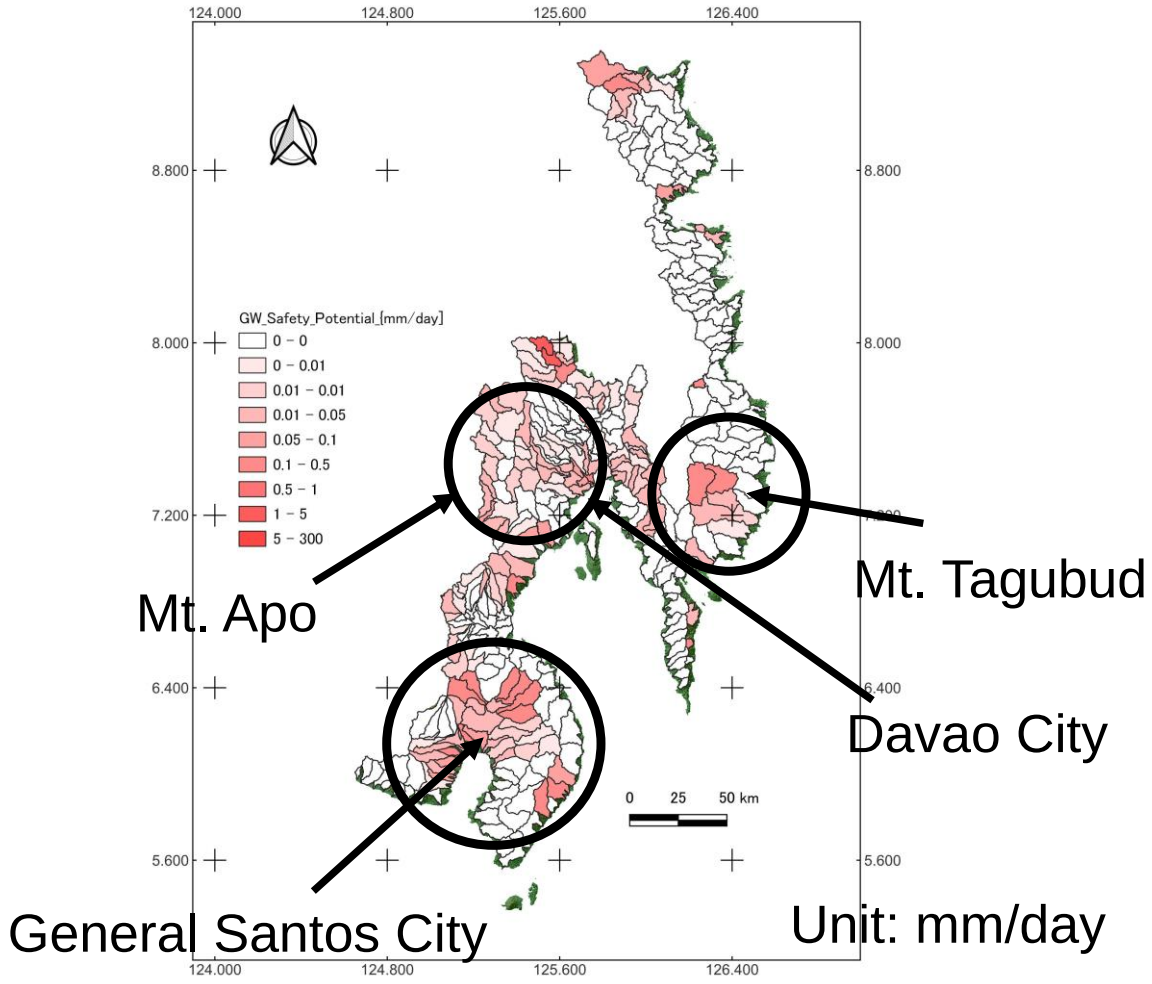
Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-319 Surface Water Potentials (1/5-Dry Year) in WRR-XI

(3) Groundwater Potential

The temporal results of groundwater potentials (groundwater flow) at each block were to be also able to calculate by SHER Model. The groundwater potentials used by the MODFLOW Model will be described in the next section of "Hydrological Analysis (Groundwater).

As shown in the Figure below, the groundwater potentials are relatively high downstream of Mt. Tagubud in the eastern part of WRR-XI, near the Mt. Apo of South-West of the Davao City and near Metro General Santos. Groundwater potential was calculated by multiplying the groundwater flow of each block by the safe groundwater pumping rate of 0.7.



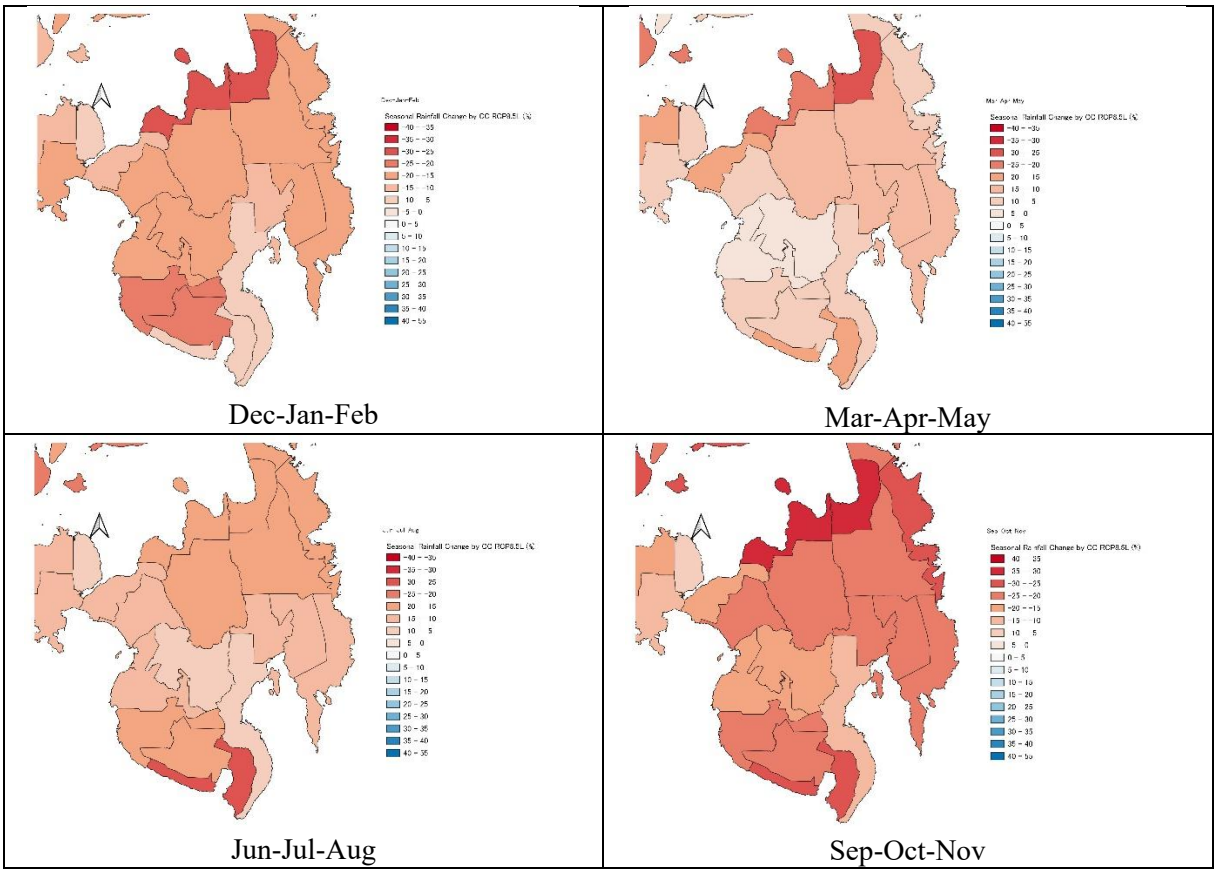
Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-320 Groundwater Potentials (1/5-Dry Year) in WRR-XI

(4) Climate Change Impact Assessment

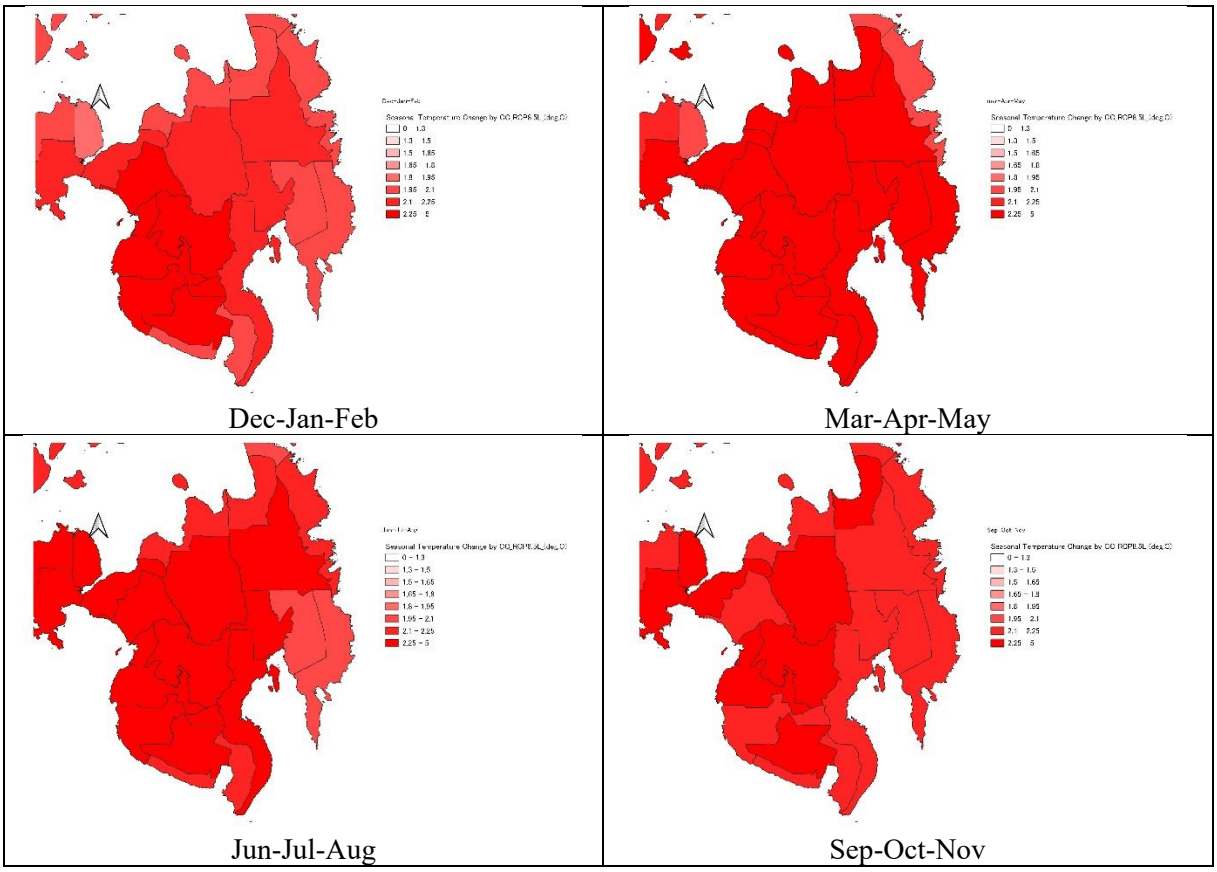
As describe in Section 3.3.4.1, climate change impact in WRR XI was estimated by same method. Estimated surface water potentials by climate change cases are shown in figure below. In the case of

RCP8.5-Low, surface water potentials will be decrease especially in northern part and southern part of WRR-XI.



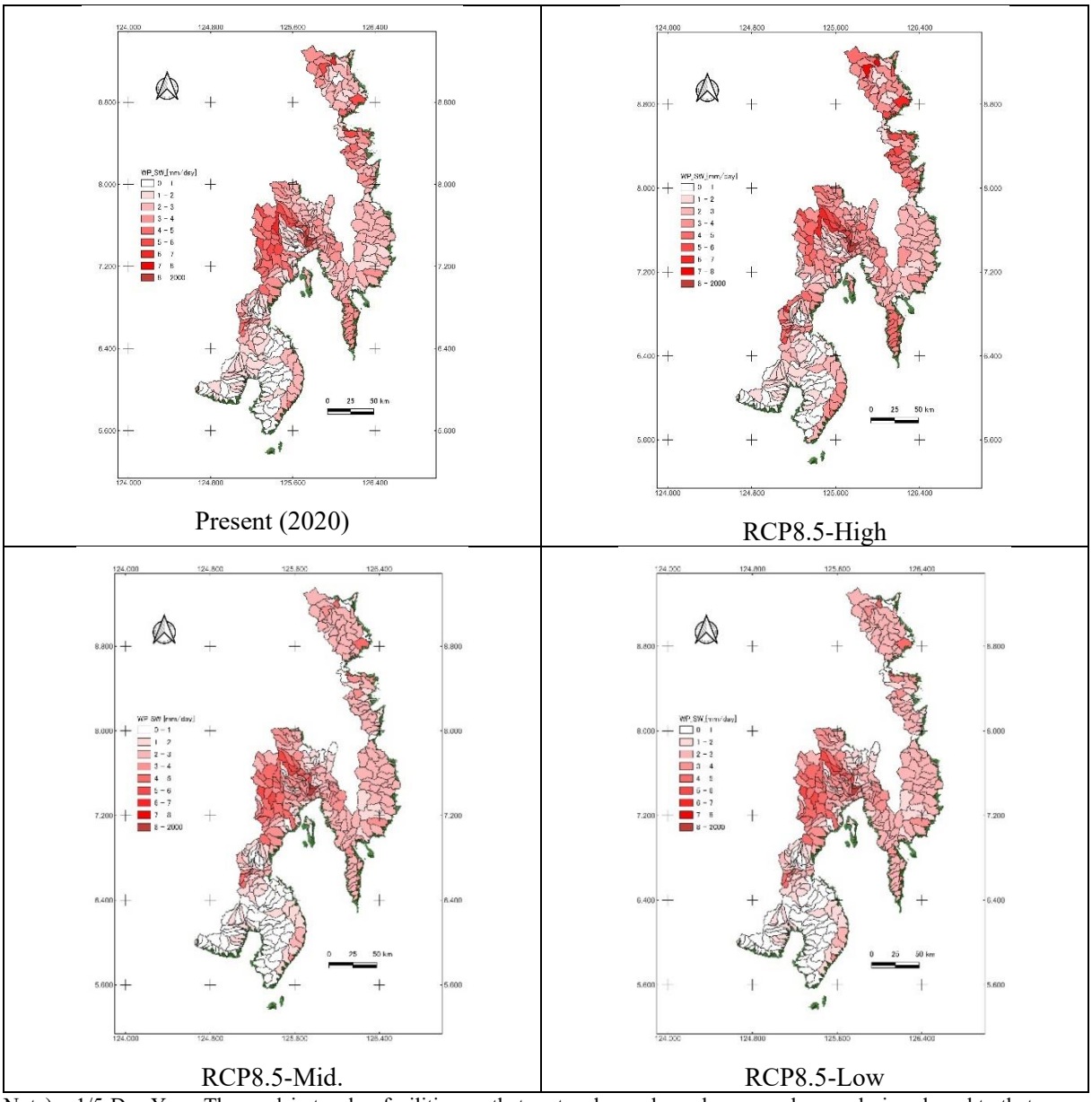
Source: Prepared by JICA Survey Team based on the data of PAGASA

Figure D-321 Quarterly Change of Precipitation by Province under Climate Change Scenarios from Present Weather in 2050 (RCP8.5-Low Case) in Mindanao



Source: Prepared by JICA Survey Team based on the data of PAGASA

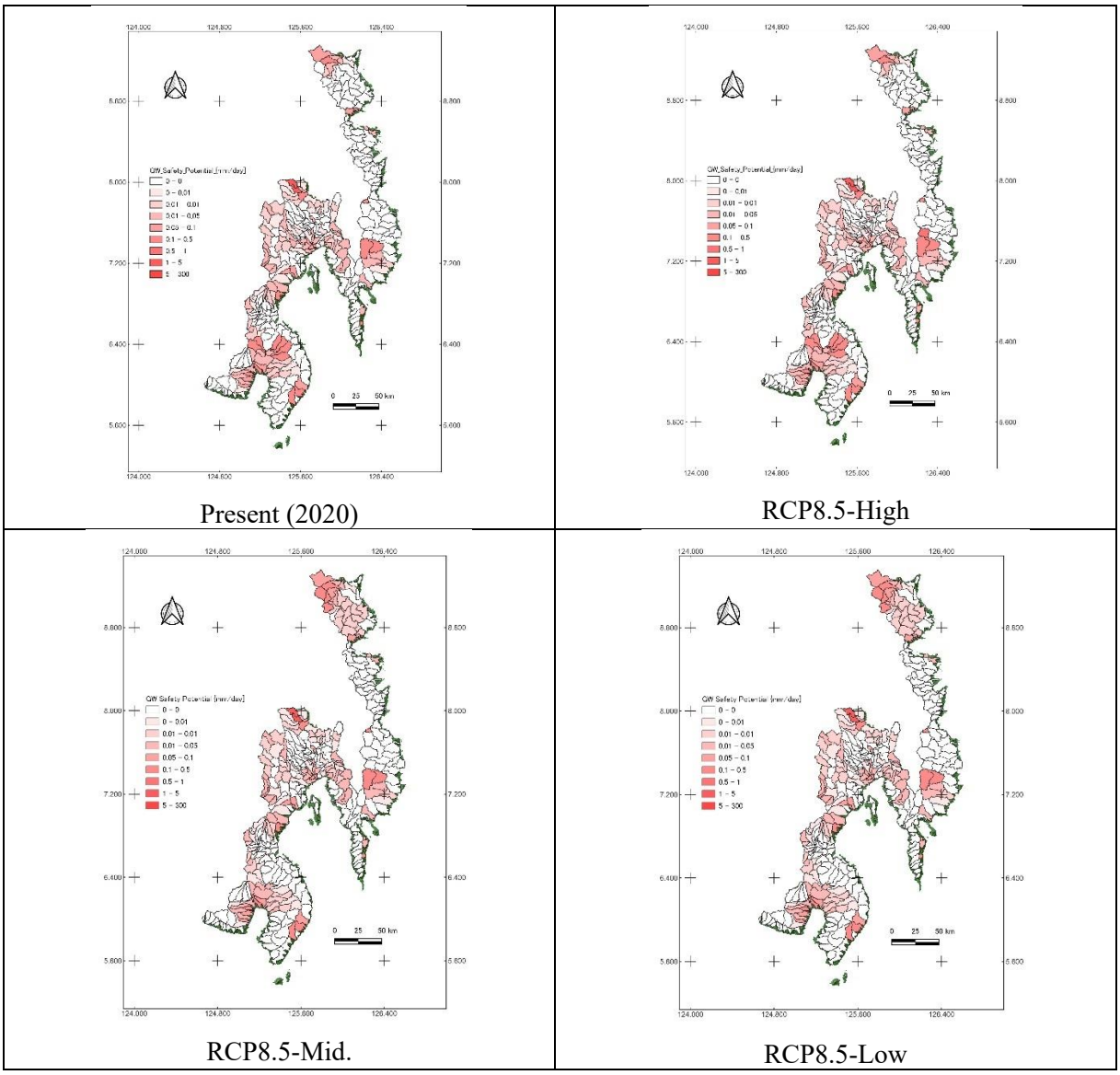
Figure D-322 Quarterly Change of Temperature by Province under Climate Change Scenarios from Present Weather in 2050 (RCP8.5-Low Case) in Mindanao



Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-323 Surface Water Potentials (1/5-Dry-Year) in WRR-XI (Unit: mm/day)

Estimated groundwater potentials by climate change cases are shown in figure below. In the case of RCP8.5-High, groundwater potentials will be increased especially in northern part of WRR-XI. In the case of RCP8.5-Low, groundwater potentials will be increased especially in southern part of WRR-XI.



Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-324 Groundwater Potentials (1/5-Dry-Year) in WRR-XI (Unit: mm/day)

(5) Results of Hydrological Analysis

In detailed hydrological analysis in priority water resource regions, a physically based water cycle model was used to logically calculate river discharge, groundwater recharge and groundwater flow could be estimated using physical parameters calibrated in sub-basins with discharge gauging stations, even in sub-basins where there are no discharge gauging stations. Calibration results were generally good. As a result of reducing the sub-basin division, it was possible to determine the regional water potential (surface water and groundwater) of the target water resource regions in detail. The results of water balance analysis with water resources potential and water demand for each sub-basin are described in the following sections.

11.1.3 WRR-V

(1) Natural Condition in WRR V

1) Land Area

WRR-V belongs mainly to administrative Region-V (Bicol), and part of the north includes administrative Region-IVA (Calabarzon). Naga and Legazpi are highly urbanized cities. Bicol comprises six provinces, four on the Bicol Peninsula mainland (the south-eastern end of Luzon) - Albay, Camarines Norte, Camarines Sur, and Sorsogon - and the offshore island provinces of Catanduanes and Masbate. The regional center is Legazpi City and has one Independent Component City, the pilgrim city of Naga. The region is bounded by the Lamon Bay to the north, the Philippine Sea to the east, and the Sibuyan Sea and Ragay Gulf to the west. The northernmost provinces, Camarines Norte and Camarines Sur, are bordered to the west by the province of Quezon. The land area of the administrative Region-V is 18,155.82 km^2 with population of 6,082,165 in 2020 census.

2) General Topography and Geology

Bicol region is highly volcanic in origin and part of the Pacific Ring of Fire. Known as the Bicol Volcanic Arc or Chain, the volcanoes are the results of the Philippine Sea Plate subducting under the Philippine Mobile Belt, along the Philippine Trench. Mt. Mayon Volcano is the most prominent of the volcanoes in the region, famous for its perfect conical shape and for being the most active in the Philippines. Its eruptions have repeatedly inflicted disasters on the region, but during lulls in activity, it is a particularly magnificent peak. The southernmost tip of the peninsula is dominated by Bulusan Volcano, the other active volcano in the region.

3) Climate and Climate Regions of the Study Area

There are four climatological types that exist in the Philippines characterized as show in 2.2.2.2.:

Most of WRR-V are located in the Type-II and III of climatological types.



Source: PAGASA (http://bagong.pagasa.dost.gov.ph/information/climate-philippines)

Figure D-325 Climate Regions in Philippines

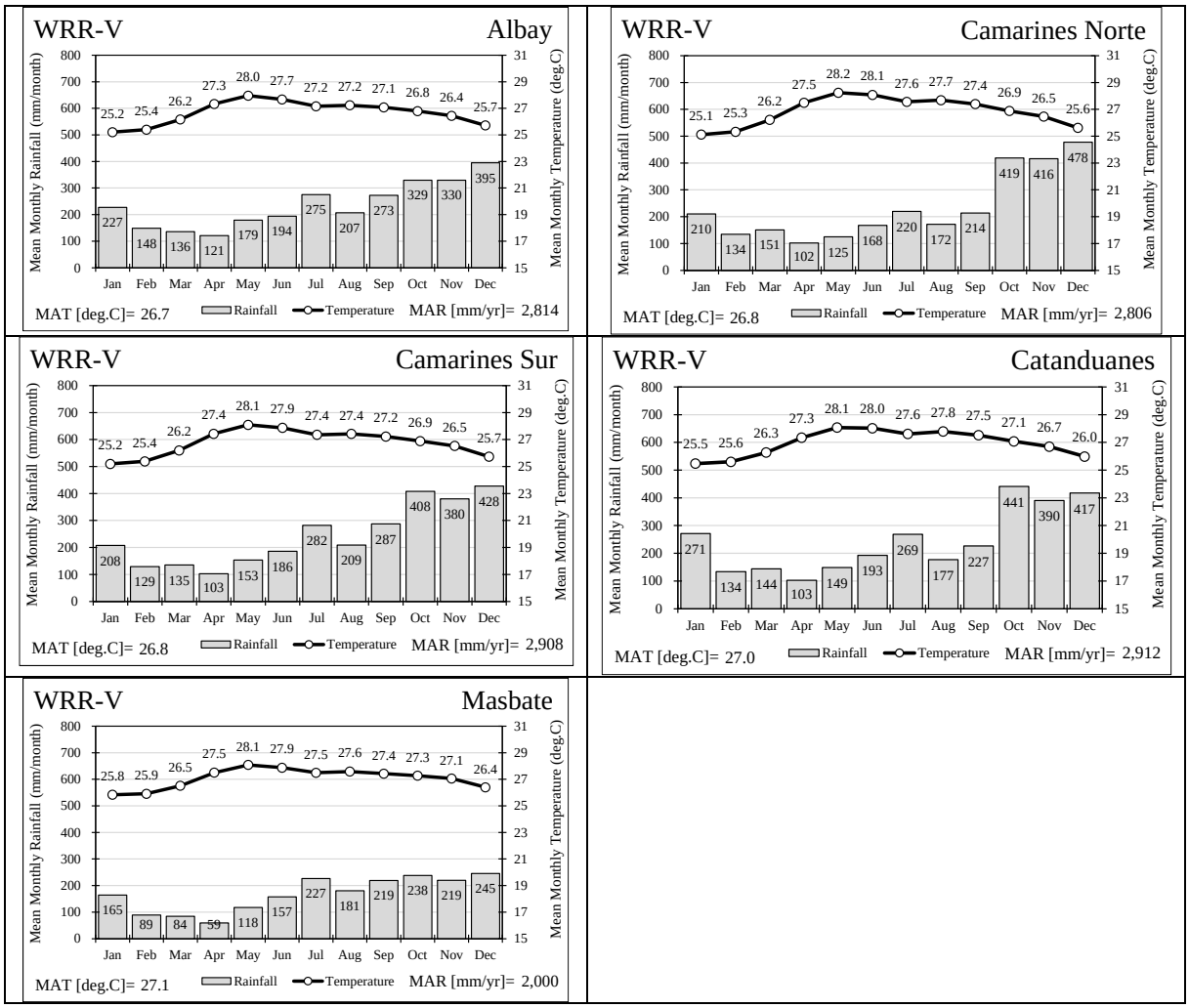
In the northern part of WRR-V in the climate type-II, is no dry season with a very pronounced maximum rain period from December to February in general. There is not a single dry month. Minimum monthly rainfall occurs during the period from March to May.

In the southern part of WRR-V in the climate type-III, is no very pronounced maximum rain period, with a short dry season lasting only from one to three months, either during the period from December to February or from March to May in general. This climate type resembles type I since it has a short dry season.

4) Temperature and Rainfall

The average annual temperature in Camarines Sur is around 26.8°C. The temperature is stable throughout the year, but the highest temperature is around April to July.

Daily mean temperature from 1979 to 2020 of ERA5 (0.25-degree grid; approximately 31 km mesh) were collected from the ECMWF reanalysis data sets. Provincial mean monthly rainfall and mean monthly temperature from 1979 to 2020 (42 years) in each water resources region are shown in Figure below.



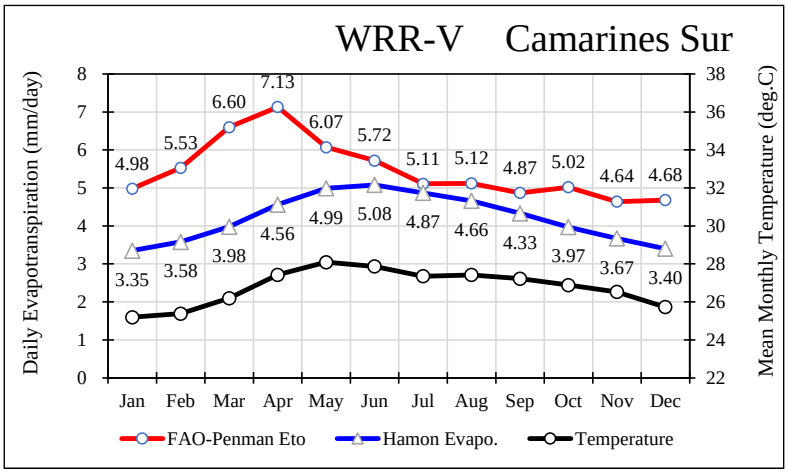
Source: JICA Survey Team, based on ERA5 and CHIRPS data.

Figure D-326 Provincial Mean Monthly Rainfall and Mean Monthly Temperature from 1979 to 2020 (42 Years) in Each Province in WRR-V

5) Evapotranspiration

Estimated daily potential evapotranspiration (reference crop evapotranspiration) (ETo) averaged by each province by FAO-Penman-Monteith equation was used for paddy fields and estimated daily average potential evapotranspiration by province by Hamon's equation was used for other land use fields. The ten-day reference crop evapotranspiration (ETo) was also used for estimation of the crop water requirement of paddy by province. The evapotranspiration calculation formulas for each estimation are show in 2.2.2.2.

The estimated daily evapotranspiration by FAO-ETo and Hamon methods averaged by province are shown in Figure below.

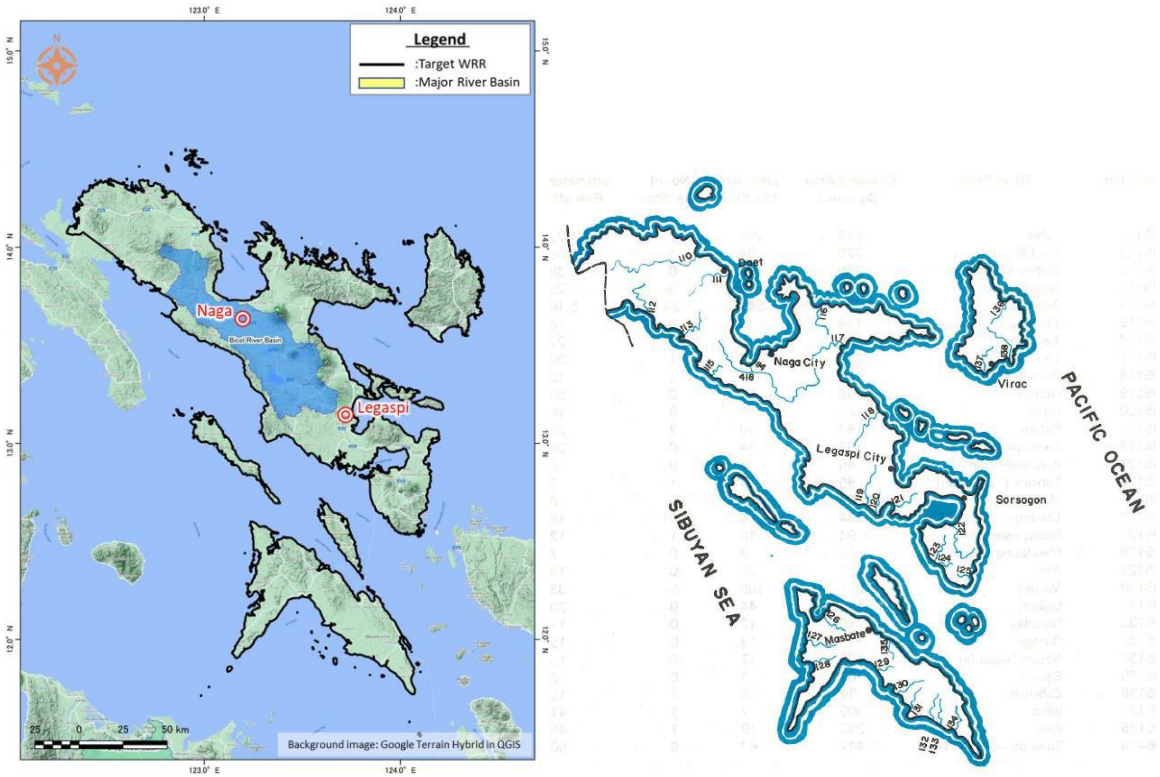


Source: JICA Survey Team, based on ERA5 and FAO-ClimWat data.

Figure D-327 Estimated Daily Potential Evapotranspiration of FAO-ETo and Hamon Method

6) River

Out of the 18 major river basins, there is one major river basins, i.e. the Bicol River basin. There are also several principal river basins as shown in the figure below:



Source: (left)The Survey Team, (right) National Water Resources Council (1976) "Principal River Basins of the Philippines"

Figure D-102 Location Map of Major Rivers and Principal Rivers in WRR V

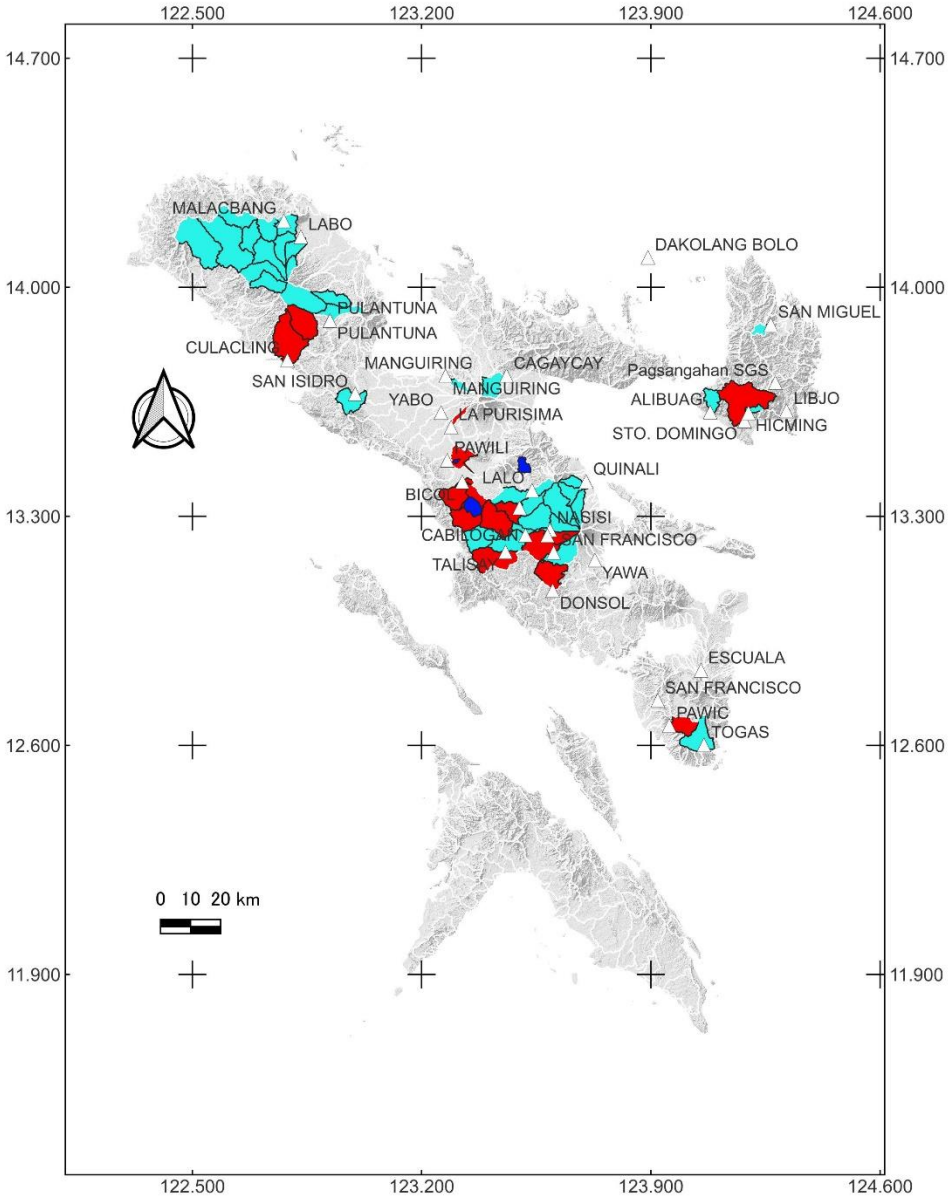
7) Streamflow Data

Streamflow data were gathered for many of the stations within the survey area. Streamflow records were obtained from DPWH. A total of 35 daily average discharge data shown in the Figure and Table below were collected and used for low flow analysis of WRR-V.

Table D-103 Number of Discharge Observation Stations by WRRs

N	N	Station	River	Basin	Agenc	WRR	Province	Town, Village	Latitud	Longitu	Elevatio	C.A.(km	Period
361	1	DONSOL	DONSOL RIVER	DONSOL RIVER BASIN	DPWH	V	Albay	Calzada, Jovellar	13.0730	123.6000	82.578 & 81	94.0	1981-1998, 2000-2003
365	2	NASISI	NASISI RIVER	NASISI RIVER BASIN	DPWH	V	Albay	Nasisi, Ligao	13.2580	123.5920	104.4	39.0	1982-1985
371	3	QUINALI	QUINALI RIVER	BICOL RIVER BASIN	DPWH	V	Albay	Balza, Malinao	13.4060	123.7020	0.7	146.0	1980-1993, 1995-1998, 2000-2005
372	4	SAN AGUSTIN	SAN AGUSTIN RIVER	SAN AGUSTIN RIVER BASIN	DPWH	V	Albay	San Agustin, Libon	13.3260	123.4990	0.0	262.0	1982-1997
377	5	TALISAY	TALISAY RIVER	TALISAY RIVER BASIN	DPWH	V	Albay	Alliang, Ligao	13.1910	123.4560	6.7	90.0	1982-1987, 1991-1999, 2002-2005
380	6	YAWA	YAWA RIVER	BICOL RIVER BASIN	DPWH	V	Albay	Bogtong, Legaspi City	13.1660	123.7290	1.7	60.0	1980-1988
445	7	BINANOWAAN	OGSONG	OGSONG	DPWH	V	Albay	BINANOWAAN, LIGAO	13.2410	123.5840	3.3	14.0	1982-1989, 1991-2009
358	8	CABILOGAN	CABILOGAN RIVER	BICOL RIVER BASIN	DPWH	V	Albay	Bobongsoran, Ligao	13.2420	123.5170	35.6	129.0	1982-1999, 2000, 2002-2005
362	9	LABO	LABO RIVER	LABO RIVER BASIN	DPWH	V	Camarines Norte	Anahaw, Labo	14.1540	122.8310		800.0	2006-2016
364	10	MALACBANG	MALACBANG RIVER	MALACBANG RIVER BASIN	DPWH	V	Camarines Norte	Paracale	14.2030	122.7790		25.0	2007-2015
440	11	DAKOLANG BOLO	DAET	DAET	DPWH	V	Camarines Norte	DAKOLANG BOLO, IMELDA	14.0910	123.8910	8.7	66.0	1982-1986
357	12	BICOL	BICOL RIVER	BICOL RIVER BASIN	DPWH	V	Camarines Sur	Sto. Domingo, Nabua	13.4050	123.3240	0.5	905.0	1982-1989
359	13	CAGAYCAY	CAGAYCAY RIVER	CAGAYCAY RIVER BASIN	DPWH	V	Camarines Sur	Cagaycay, Goa	13.7290	123.4590	52.3	50.0	1982-2004
360	14	CULACLING	CULACLING RIVER	BICOL RIVER BASIN	DPWH	V	Camarines Sur	Del Rosario, Lupi	13.7770	122.7900	3.6	64.0	1982-1987, 1989-1999
363	15	LALO	LALO RIVER	BICOL RIVER BASIN	DPWH	V	Camarines Sur	Antipolo, Buhi	13.3790	123.5370	14.2	22.0	1982-2016
368	16	PAWILI	PAWILI RIVER	BICOL RIVER BASIN	DPWH	V	Camarines Sur	San Roque, Bula	13.4710	123.2780	0.2	240.0	1980-1985
369	17	PULANTUNA	PULANTUNA RIVER	BICOL RIVER BASIN	DPWH	V	Camarines Sur	Napulidan, Lupi	13.8980	122.9200	40.8	172.0	1980-2005
370	18	PULANTUNA	PULANTUNA RIVER	BICOL RIVER BASIN	DPWH	V	Camarines Sur	Napulidan, Lupi	13.8980	122.9200		172.0	2005-20016
379	19	YABO	YABO RIVER	YABO RIVER BASIN	DPWH	V	Camarines Sur	San Isidro, Naga City	13.6170	123.2590	45.7	19.5	1982-1984
437	20	LA PURISIMA	ANAYAN	ANAYAN	DPWH	V	Camarines Sur	LA PURISIMA, PILI	13.5720	123.2900		5.0	2005-2016
438	21	SAN ISIDRO	ASLONG	ASLONG	DPWH	V	Camarines Sur	SAN ISIDRO, LIBMANAN	13.6740	122.9970		10.0	2007-2016
441	22	MANGUIRING	HINAGUIANAN	HINAGUIANAN	DPWH	V	Camarines Sur	MANGUIRING, CALABANGA	13.7290	123.2730		18.0	1982-1994, 2000-2009
442	23	MANGUIRING	HINAGUIANAN	HINAGUIANAN	DPWH	V	Camarines Sur	MANGUIRING, CALABANGA	13.7290	123.2730		15.0	2010-2016
59	24	Pagsangahan SGS	Kaliwa	Bicol	DPWH	V	Catanduanes	Kilikilihan, San Miauel	13.7080	124.2800		218.0	2002
366	25	PAGSANGAHAN	PAGSANGAHAN RIVE	PAGSANGAHAN RIVER BAS	DPWH	V	Catanduanes	Kilikilihan, San Miguel	13.7080	124.2800		100.0	2005-2014
376	26	STO. DOMINGO	STO. DOMINGO RIVER	STO. DOMINGO RIVER BAS	DPWH	V	Catanduanes	Sto. Domingo, Virac	13.5910	124.1860		150.0	2012-2014
436	27	ALIBUAG	ALIBUAG	ALIBUAG	DPWH	V	Catanduanes	ALIBUAG, DATAG, SAN ANDRES	13.6180	124.0810	3.3	10.0	1982-1989, 1991-2004
439	28	HICMING	CAWAYAN	CAWAYAN	DPWH	V	Catanduanes	HICMING, VIRAC	13.6160	124.1980	8.8	12.0	1982-1999, 2002-2004
443	29	LIBJO	LIBJO	LIBJO	DPWH	V	Catanduanes	LIBJO, BATO	13.6220	124.3140	3.6	4.0	1991-2002, 2004-2008
446	30	SAN MIGUEL	PAYO	PAYO	DPWH	V	Catanduanes	SAN MIGUEL, PANGANIBAN	13.8860	124.2660	8.9	18.0	1982-1998, 2000-2005
367	31	PAWIC	PAWIC RIVER	PAWIC RIVER BASIN	DPWH	V	Sorsogon	San Isidro, Bulan	12.6600	123.9560	12.5	42.0	1981-2005
373	32	SAN FRANCISCO	SAN FRANCISCO RIVE	SAN FRANCISCO RIVER BA	DPWH	V	Sorsogon	San Francisco, Bulan	12.7370	123.9210	16.0	20.0	1982-2002
374	33	SAN FRANCISCO	SAN FRANCISCO RIVE	BICOL RIVER BASIN	DPWH	V	Sorsogon	Guinobatan Albay	13.1890	123.6030	13.1	70.0	2003-2006
378	34	TOGAS	TOGAS RIVER	TOGAS RIVER BASIN	DPWH	V	Sorsogon	Balocawe, Matnog	12.6010	124.0620	1.6	27.0	1981-1985
444	35	ESCUALA	NAMUAT	NAMUAT	DPWH	V	Sorsogon	ESCUALA, CASIGURAN	12.8290	124.0530	5.6	2.0	1985-2005

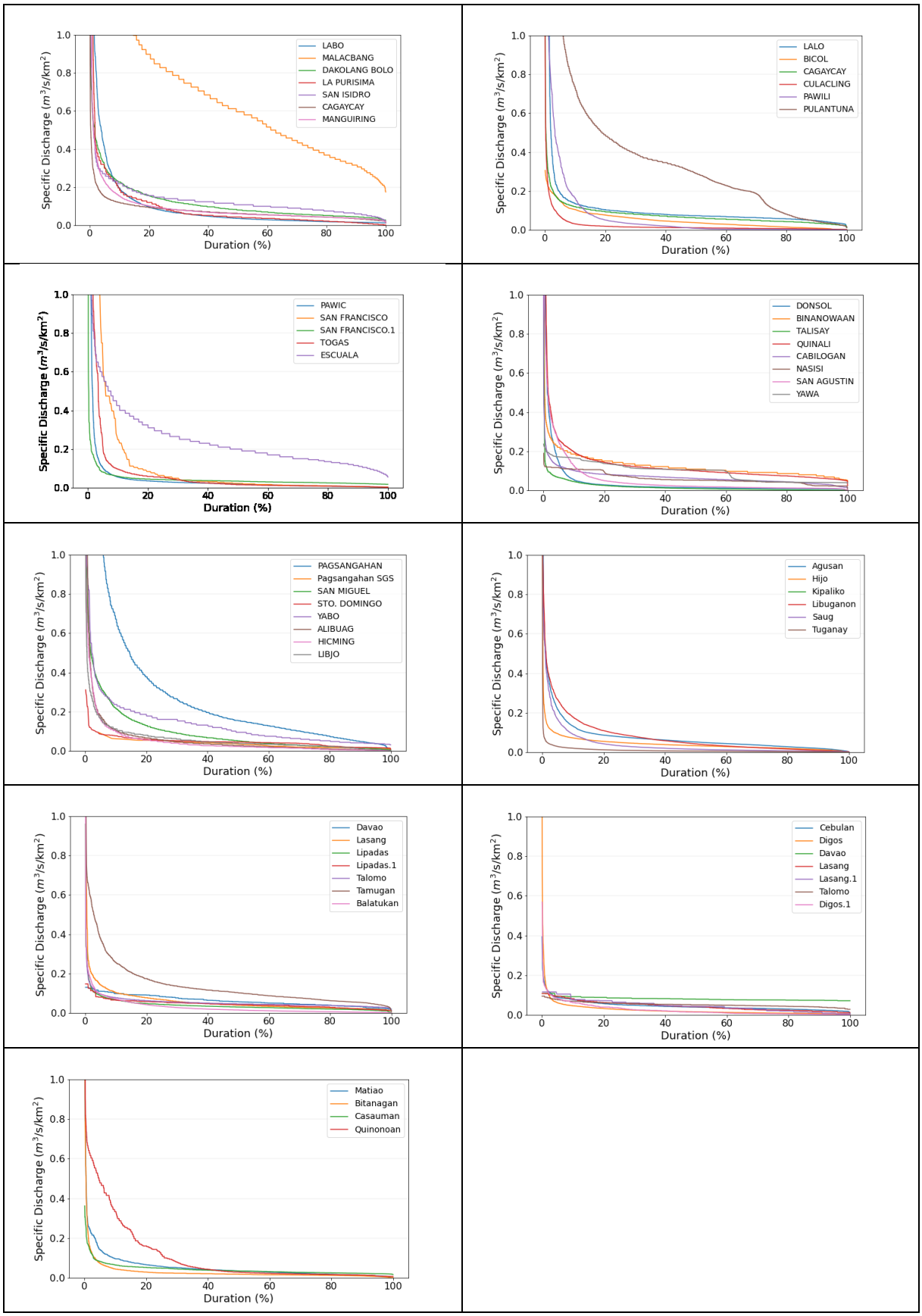
Source: DPWH



Source: JICA Survey Team based on the data of DPWH.

Figure D-328 Location Map of Daily Discharge Observation Stations used for Low Flow Analysis (Total 35 Stations)

Unfortunately, these streamflow data were often missing as shown in Figures in ANNEX-Hydrology. In addition, there are limits to the frequency of discharge observations and the accuracy of the water level-discharge rating curves (H-Q curves), as there are many flows in which the value of the flood discharge is questionable. There are many data at observatories where the flow duration curves (FDCs) using the specific discharge are strange as shown in Figure below.



Source: JICA Survey Team based on DPWH Data

Figure D-329 Flow Duration Curve (FDC) of Observed Daily Discharge in WRR-V

Also, the annual runoff at some stations exceeds the annual rainfall (runoff coefficient is more than 1.0) as shown in Table below.

Table D-104 Annual Runoff Coefficient of Observed Daily Discharge in WRR-V (1/2)

Camarines Norte

		1
		LABO
		LABO
		LABO
		V
		Camarines
	Rainfall	800
	(mm/year)	(mm/year)
1979	2,559.2	
1980	2,238.3	
1981	2,828.8	
1982	3,008.2	
1983	1,769.7	
1984	2,504.3	
1985	2,645.6	
1986	2,707.7	
1987	2,078.8	
1988	2,682.3	
1989	2,721.5	
1990	2,534.6	
1991	2,087.9	
1992	2,108.5	
1993	2,941.2	
1994	2,435.4	
1995	3,181.5	
1996	2,419.9	
1997	1,816.4	
1998	2,891.0	
1999	4,070.4	
2000	4,378.7	
2001	3,097.9	
2002	2,515.5	
2003	1,864.0	
2004	2,402.5	
2005	3,248.6	
2006	2,856.4	1.171
2007	2,979.7	1.236
2008	3,949.0	1.322
2009	3,322.1	1.347
2010	3,250.6	0.194
2011	3,953.6	0.178
2012	3,336.1	0.180
2013	3,154.8	1.462
2014	2,843.7	2.185
2015	2,157.3	1.868
2016	2,697.1	1.629
2017	3,707.4	
2018	2,877.3	
2019	1,865.3	
2020	3,167.1	
Max.	4,378.7	2.185
Ave.	2,806.1	1.161
Min.	1,769.7	0.178

Selected

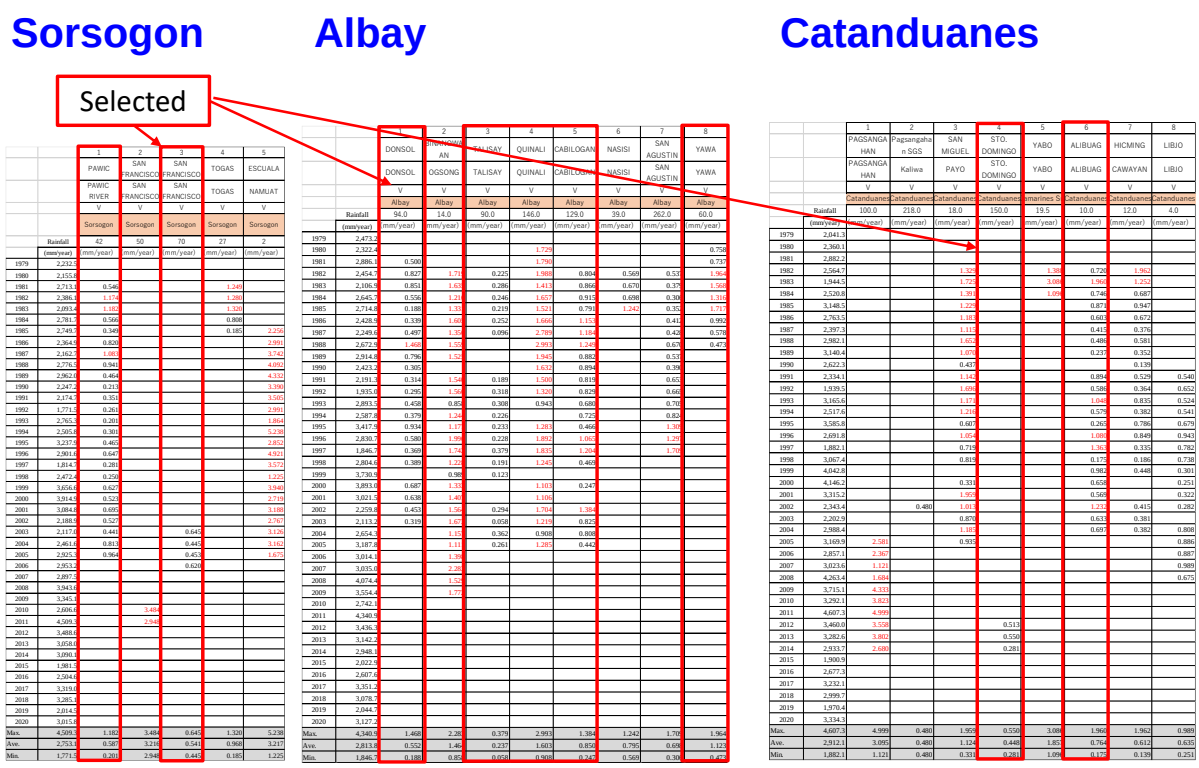
Camarines Sur

		1	1	1	1	1	1
		MALACBANG	DAKOLANG BOLO	LA PURISIMA	SAN ISIDRO	CAGAYCAY	MANGUIRING
		MALACBANG	DAET	ANAYAN	ASLONG	CAGAYCAY	HINAGUIAN
		V	V	V	V	V	V
		Camarines Sur	Camarines Sur	Camarines Sur	Camarines Sur	Camarines Sur	Camarines Sur
	Rainfall	25	66	5	10	50	18
	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)
1979	2,526.9						
1980	2,189.6						
1981	2,998.7						
1982	2,800.1		1.161			0.972	0.898
1983	2,026.0		1.423			0.817	1.053
1984	2,588.7		1.384			0.806	0.958
1985	2,848.3		1.523			0.880	0.864
1986	2,744.2		1.318			0.759	0.774
1987	2,310.2					0.735	1.571
1988	2,818.4					0.704	2.222
1989	2,945.4					0.730	1.127
1990	2,573.7					0.800	0.826
1991	2,263.5					0.679	0.596
1992	2,219.3					0.783	0.609
1993	3,130.7					0.611	0.772
1994	2,635.1					0.957	0.350
1995	3,509.6					1.279	
1996	2,651.7					1.300	
1997	1,926.0					1.127	
1998	3,061.5					0.767	
1999	4,008.2					0.548	
2000	4,208.6					0.637	0.464
2001	3,148.4					0.988	1.952
2002	2,344.2					0.793	1.161
2003	2,044.7					1.058	1.012
2004	2,727.9					1.086	2.133
2005	3,395.1			2.625			0.933
2006	2,986.4			2.352			0.914
2007	3,169.2	5.940		1.751	0.861		0.875
2008	4,015.0	5.865		0.462	0.879		1.033
2009	3,609.2	5.167		1.733	0.928		1.052
2010	3,205.8	5.835		0.387	0.959		0.564
2011	4,291.4	4.781		2.637	0.960		0.993
2012	3,378.4	7.887		0.354	1.547		4.089
2013	3,228.7	9.957		0.183	1.670		0.628
2014	2,847.0	12.315		12.819	2.462		1.131
2015	2,103.6	14.381		60.428	3.100		1.668
2016	2,699.7			2.600	1.301		0.875
2017	3,565.6						
2018	3,035.9						
2019	2,072.8						
2020	3,287.8						
Max.	4,291.4	14.381	1.523	60.428	3.100	1.300	4.089
Ave.	2,908.1	8.014	1.410	7.362	1.462	0.862	1.137
Min.	1,926.0	4.781	1.318	0.183	0.861	0.548	0.350

		1	2	3	4	5	6
		LALO	BICOL	CAGAYCAY	CULACLING	PAWILI	PULANTUNA
		LALO	BICOL	CAGAYCAY	CULACLING	PAWILI	PULANTUNA
		V	V	V	V	V	V
		Camarines Sur	Camarines Sur	Camarines Sur	Camarines Sur	Camarines Sur	Camarines Sur
	Rainfall	22	905	50	64	240	172
	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)	(mm/year)
1979	2,526.9						
1980	2,189.6					0.72	1.928
1981	2,998.7					1.81	1.577
1982	2,800.1	1.161	0.602	0.972	0.265	1.06	1.418
1983	2,026.0	1.126	0.384	0.817	0.344	0.65	1.632
1984	2,588.7	0.859	0.573	0.806	0.333	0.18	1.534
1985	2,848.3	0.956	0.517	0.880	0.156	0.05	1.508
1986	2,744.2	0.946	0.379	0.759	0.227		
1987	2,310.2	1.230	0.641	0.735	0.288		
1988	2,818.4	1.009	1.020	0.704			
1989	2,945.4	1.255	0.706	0.730	0.286		
1990	2,573.7	1.001		0.800	0.207		
1991	2,263.5	1.082		0.679	0.253		
1992	2,219.3	0.828		0.783	0.240		
1993	3,130.7	0.669		0.611	0.142		
1994	2,635.1	0.809		0.957	0.240		
1995	3,509.6	0.792		1.279	0.271		
1996	2,651.7	1.279		1.300	0.314		
1997	1,926.0	1.021		1.127	0.235		
1998	3,061.5	0.523		0.767	0.145		
1999	4,008.2	0.521		0.548	0.232		
2000	4,208.6	0.591		0.637			
2001	3,148.4	0.946		0.988			
2002	2,344.2	0.926		0.793			
2003	2,044.7	1.390		1.058			
2004	2,727.9	0.964		1.086			
2005	3,395.1	0.722					3.103
2006	2,986.4	0.803					2.635
2007	3,169.2	1.202					2.753
2008	4,015.0	0.514					2.108
2009	3,609.2	1.185					2.066
2010	3,205.8	1.338					10.457
2011	4,291.4	8.767					9.366
2012	3,378.4	5.648					6.015
2013	3,228.7	6.359					5.992
2014	2,847.0	1.904					6.864
2015	2,103.6	27.992					9.529
2016	2,699.7	2.774					5.804
2017	3,565.6						
2018	3,035.9						
2019	2,072.8						
2020	3,287.8						
Max.	4,291.4	27.992	1.020	1.300	0.344	1.81	10.457
Ave.	2,908.1	2.317	0.603	0.862	0.246	0.75	4.238
Min.	1,926.0	0.514	0.379	0.548	0.142	0.05	1.418

Source: JICA Survey Team based on DPWH Data

Table D-105 Annual Runoff Coefficient of Observed Daily Discharge in WRR-V (2/2)



	Rainfall (mm/year)	1 PAWIC PAWIC RIVER V Sorsogon (mm/year)	2 SAN FRANCISCO SAN FRANCISCO V Sorsogon (mm/year)	3 SAN FRANCISCO SAN FRANCISCO V Sorsogon (mm/year)	4 TOGAS TOGAS V Sorsogon (mm/year)	5 ESCUALA NAMUAT V Sorsogon (mm/year)
		42	50	70	27	2
1979	2,232.2					
1980	2,155.6					
1981	2,713.1	0.546			1.249	
1982	2,386.6	1.174			1.280	
1983	2,093.4	1.182			1.320	
1984	2,781.7	0.566			0.808	
1985	2,749.3	0.349			0.885	2.256
1986	2,364.9	0.820				2.991
1987	2,162.7	1.083				3.742
1988	2,776.1	0.941				4.092
1989	2,962.0	0.464				4.332
1990	2,247.2	0.213				3.390
1991	2,174.7	0.351				3.505
1992	1,771.1	0.261				2.991
1993	2,765.3	0.201				1.864
1994	2,505.6	0.301				5.238
1995	3,237.0	0.465				2.852
1996	2,901.6	0.647				4.921
1997	1,814.7	0.281				3.572
1998	2,472.4	0.250				1.225
1999	3,656.6	0.627				3.940
2000	3,914.9	0.523				2.719
2001	3,084.8	0.695				3.188
2002	2,188.9	0.527				2.767
2003	2,117.0	0.441			0.645	3.126
2004	2,461.6	0.813			0.443	3.162
2005	2,925.3	0.964			0.453	1.675
2006	2,953.2				0.620	
2007	2,897.5					
2008	3,943.0					
2009	3,345.1					
2010	2,686.6			3.486		
2011	4,509.3			2.946		
2012	3,488.6					
2013	3,058.0					
2014	3,090.1					
2015	1,981.5					
2016	2,504.6					
2017	3,319.0					
2018	3,285.1					
2019	2,014.3					
2020	3,015.8					
Max.	4,509.3	1.182	3.486	0.645	1.320	5.238
Ave.	2,753.6	0.587	3.216	0.541	0.968	3.217
Min.	1,771.1	0.201	2.946	0.445	0.885	1.225

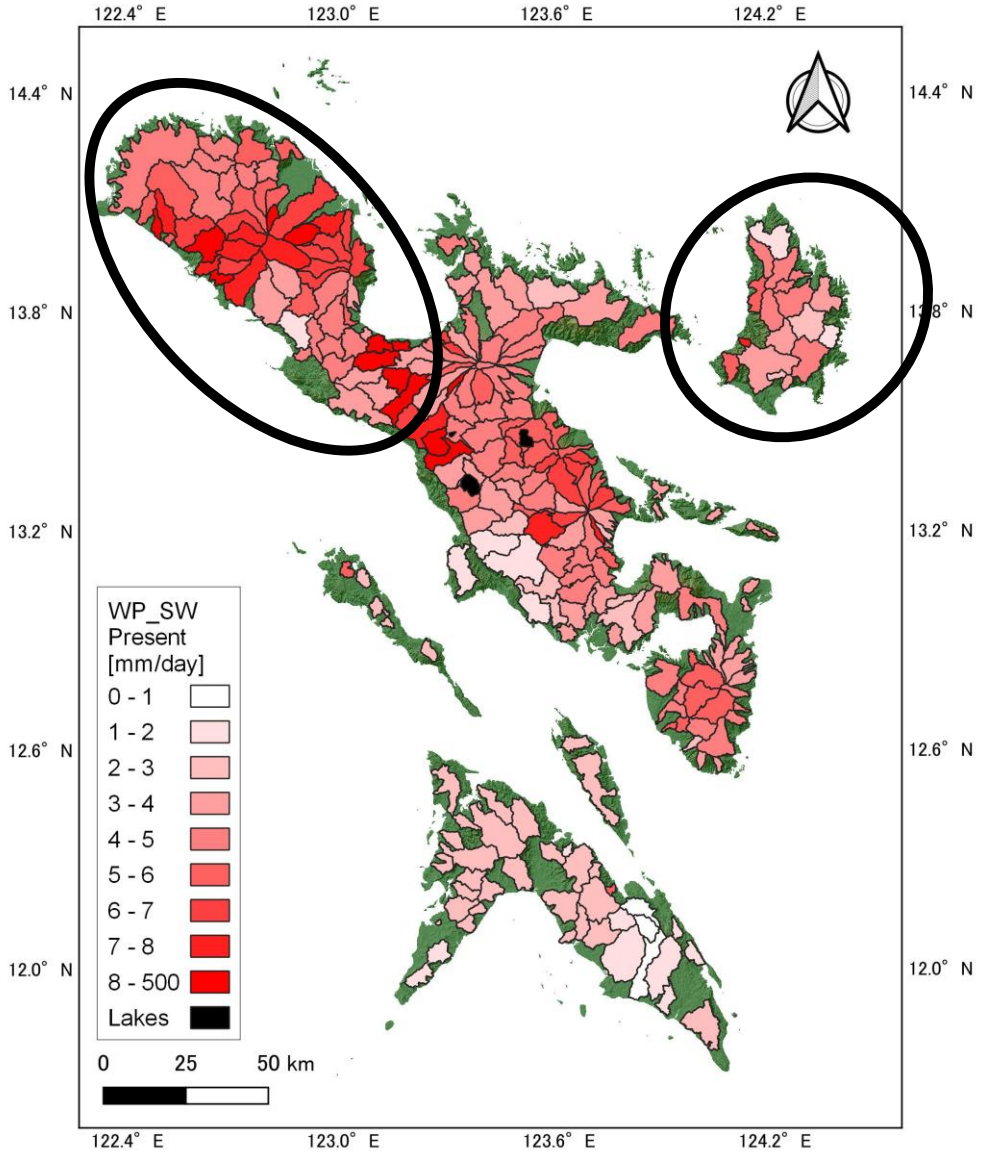
	Rainfall (mm/year)	1 DONSOL DONSOL V Albay (mm/year)	2 BULUSAN BULUSAN OGSONG V Albay (mm/year)	3 TALISAY TALISAY V Albay (mm/year)	4 QUINALI QUINALI V Albay (mm/year)	5 CABILOGAN CABILOGAN V Albay (mm/year)	6 NASISI NASISI V Albay (mm/year)	7 SAN AGUSTIN SAN AGUSTIN V Albay (mm/year)	8 YAWA YAWA V Albay (mm/year)
		94.0	14.0	90.0	146.0	129.0	39.0	262.0	60.0
1979	2,473.2								
1980	2,322.5				1.729				0.756
1981	2,886.1	0.500			1.750				0.725
1982	2,454.7	0.827	1.710	0.225	1.988	0.804	0.569	0.537	1.964
1983	2,106.9	0.851	1.631	0.286	1.413	0.866	0.670	0.377	1.568
1984	2,645.7	0.556	1.211	0.246	1.657	0.915	0.698	0.308	1.310
1985	2,714.8	0.188	1.331	0.219	1.521	0.791	1.242	0.351	1.717
1986	2,428.5	0.339	1.691	0.252	1.666	1.153		0.411	0.992
1987	2,249.5	0.495	1.322	0.096	2.789	1.184		0.422	0.576
1988	2,672.2	1.468	1.527		2.993	1.249		0.671	0.472
1989	2,914.8	0.796	1.521		1.945	0.882		0.531	
1990	2,423.2	0.395			1.632	0.894		0.398	
1991	2,191.3	0.314	1.549	0.189	1.500	0.819		0.651	
1992	1,935.0	0.295	1.504	0.318	1.320	0.825		0.662	
1993	2,893.5	0.458	0.854	0.308	0.943	0.680		0.701	
1994	2,587.8	0.379	1.248	0.226		0.725		0.824	
1995	3,417.9	0.934	1.177	0.233	1.283	0.466		1.307	
1996	2,830.7	0.580	1.598	0.228	1.892	1.065		1.297	
1997	1,846.7	0.369	1.741	0.379	1.835	1.204		1.701	
1998	2,804.6	0.389	1.228	0.191	1.245	0.468			
1999	3,730.5		0.986	0.123					
2000	3,893.1	0.687	1.317		1.103	0.247			
2001	3,021.5	0.638	1.407		1.106				
2002	2,259.8	0.453	1.566	0.294	1.704	1.384			
2003	2,113.2	0.319	1.677	0.058	1.219	0.825			
2004	2,654.3		1.153	0.362	0.908	0.808			
2005	3,187.8		1.111	0.261	1.285	0.442			
2006	3,014.1		1.362						
2007	3,033.0		2.281						
2008	4,074.4		1.521						
2009	3,554.4		1.771						
2010	2,742.1								
2011	4,340.9								
2012	3,436.3								
2013	3,142.2								
2014	2,948.1								
2015	2,022.0								
2016	2,607.0								
2017	3,351.2								
2018	3,078.7								
2019	2,044.2								
2020	3,127.2								
Max.	4,340.9	1.468	2.281	0.379	2.993	1.384	1.242	1.701	1.964
Ave.	2,813.8	0.552	1.462	0.237	1.603	0.850	0.795	0.691	1.123
Min.	1,846.7	0.188	0.854	0.058	0.908	0.247	0.569	0.308	0.472

	Rainfall (mm/year)	1 PAGSANGAHAN PAGSANGAHAN V Catanduanes (mm/year)	2 Pagsangahan SGS Kaliwa V Catanduanes (mm/year)	3 SAN MIGUEL PAYO V Catanduanes (mm/year)	4 STO. DOMINGO STO. DOMINGO V Catanduanes (mm/year)	5 YABO YABO V Camarines S (mm/year)	6 ALIBUAG ALIBUAG V Catanduanes (mm/year)	7 HICMING CAWAYAN V Catanduanes (mm/year)	8 LIBIO LIBIO V Catanduanes (mm/year)
		100.0	218.0	18.0	150.0	19.5	10.0	12.0	4.0
1979	2,041.3								
1980	2,360.1								
1981	2,882.2								
1982	2,564.7			1.325		1.385	0.726	1.962	
1983	1,944.5			1.722		3.088	1.969	1.252	
1984	2,520.8			1.391		1.095	0.746	0.687	
1985	3,148.5			1.222			0.871	0.947	
1986	2,763.5			1.182			0.601	0.672	
1987	2,397.3			1.113			0.413	0.376	
1988	2,982.1			1.462			0.488	0.581	
1989	3,140.4			1.070			0.237	0.352	
1990	2,622.3			0.437				0.139	
1991	2,334.1			1.142			0.894	0.529	0.540
1992	1,939.5			1.690			0.586	0.364	0.652
1993	3,165.6			1.172			1.048	0.835	0.524
1994	2,517.6			1.210			0.578	0.382	0.541
1995	3,585.8			0.607			0.265	0.786	0.679
1996	2,691.8			1.054			1.080	0.849	0.943
1997	1,882.1			0.715			1.383	0.335	0.782
1998	3,067.4			0.815			0.175	0.186	0.738
1999	4,042.8						0.981	0.448	0.301
2000	4,146.2			0.331			0.658		0.251
2001	3,315.2			1.955			0.569		0.322
2002	2,343.4		0.480	1.013			1.213	0.415	0.282
2003	2,202.9			0.870			0.633	0.381	
2004	2,988.4			1.182			0.693	0.382	0.808
2005	3,169.9	2.581		0.933					0.886
2006	2,857.1	2.367							0.887
2007	3,023.6	1.121							0.989
2008	4,263.4	1.684							0.675
2009	3,715.1	4.333							
2010	3,292.1	3.823							
2011	4,607.3	4.999							
2012	3,468.0	3.558			0.510				
2013	3,282.6	3.802			0.550				
2014	2,933.7	2.680			0.281				
2015	1,900.9								
2016	2,677.3								
2017	3,232.1								
2018	2,999.7								
2019	1,970.4								
2020	3,334.3								
Max.	4,607.3	4.999	0.480	1.955	0.550	3.088	1.969	1.962	0.989
Ave.	2,912.1	3.095	0.480	1.124	0.448	1.857	0.764	0.612	0.635
Min.	1,882.1	1.121	0.480	0.331	0.281	1.095	0.175	0.139	0.251

Source: JICA Survey Team based on DPWH Data

(2) Surface Water Potential

Surface water potentials (river flow) of each sub-basin in WRR-V were calculated by the SHER Model as shown in the Figure below. Surface water potential (river flows) is abundant throughout WRR-V, especially in the northern part of WRR-V and Catanduanes Island, where precipitation is high and surface water potential is also abundant. Also, the groundwater potential is abundant in Catanduanes Island. On the other hand, surface water potentials are relatively low in the southern part of WRR-V, especially in Masbate Island due to less rainfall.



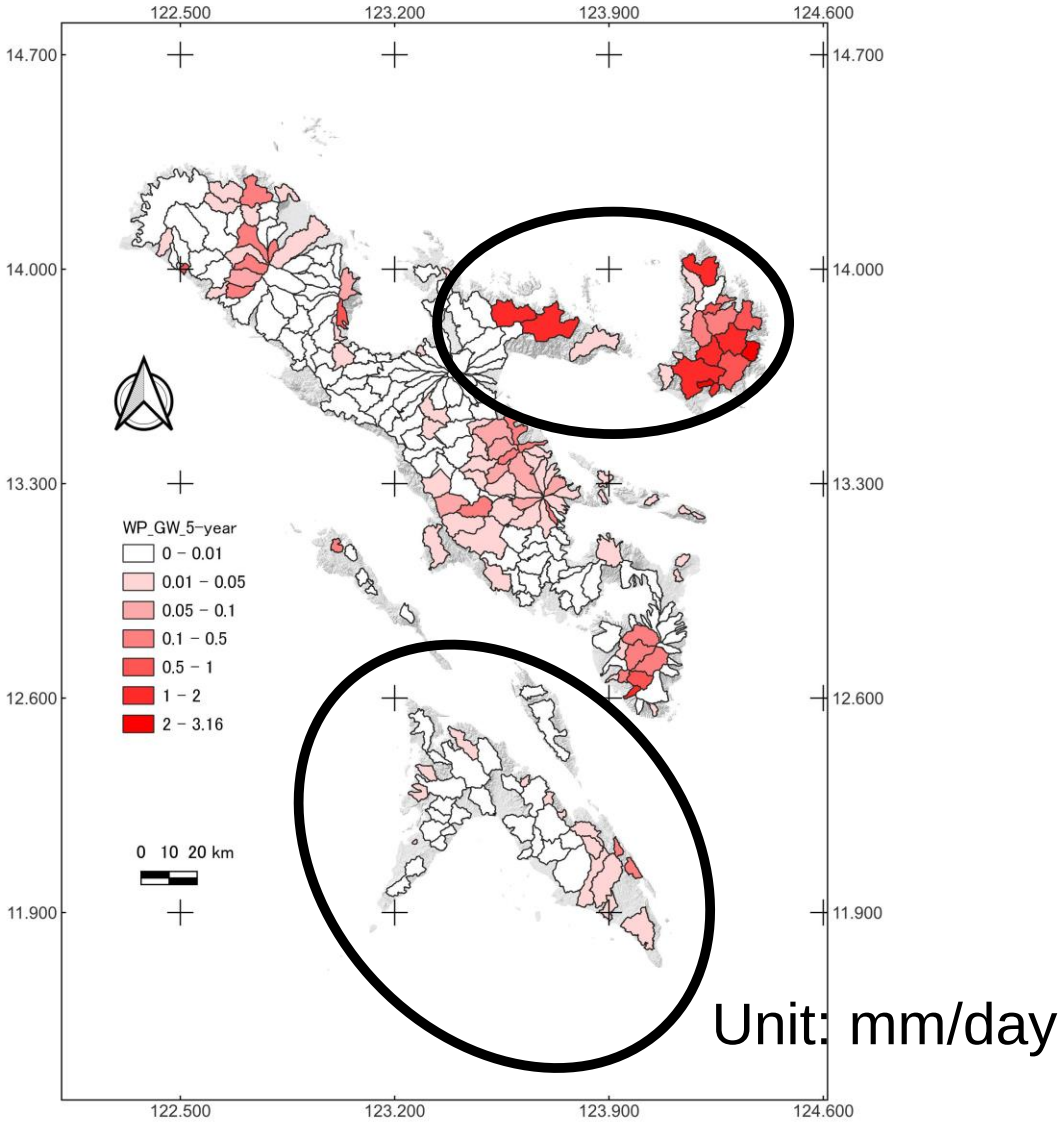
Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-330 Surface Water Potentials (1/5-Dry Year) in WRR-VII

(3) Groundwater Potential

The temporal results of groundwater potentials (groundwater flow) at each block were to be also able to calculate by SHER Model. The groundwater potentials used by the MODFLOW Model will be described in the next section of "Hydrological Analysis (Groundwater).

As shown in the Figure below, the groundwater potentials are relatively abundant in the northern eastern part to WRR-V due to much rainfall. On the other hand, the groundwater potentials are relatively low in the southern part of WRR-V, especially in Masbate Island. Groundwater potential was calculated by multiplying the groundwater flow of each block by the safe groundwater pumping rate of 0.7.



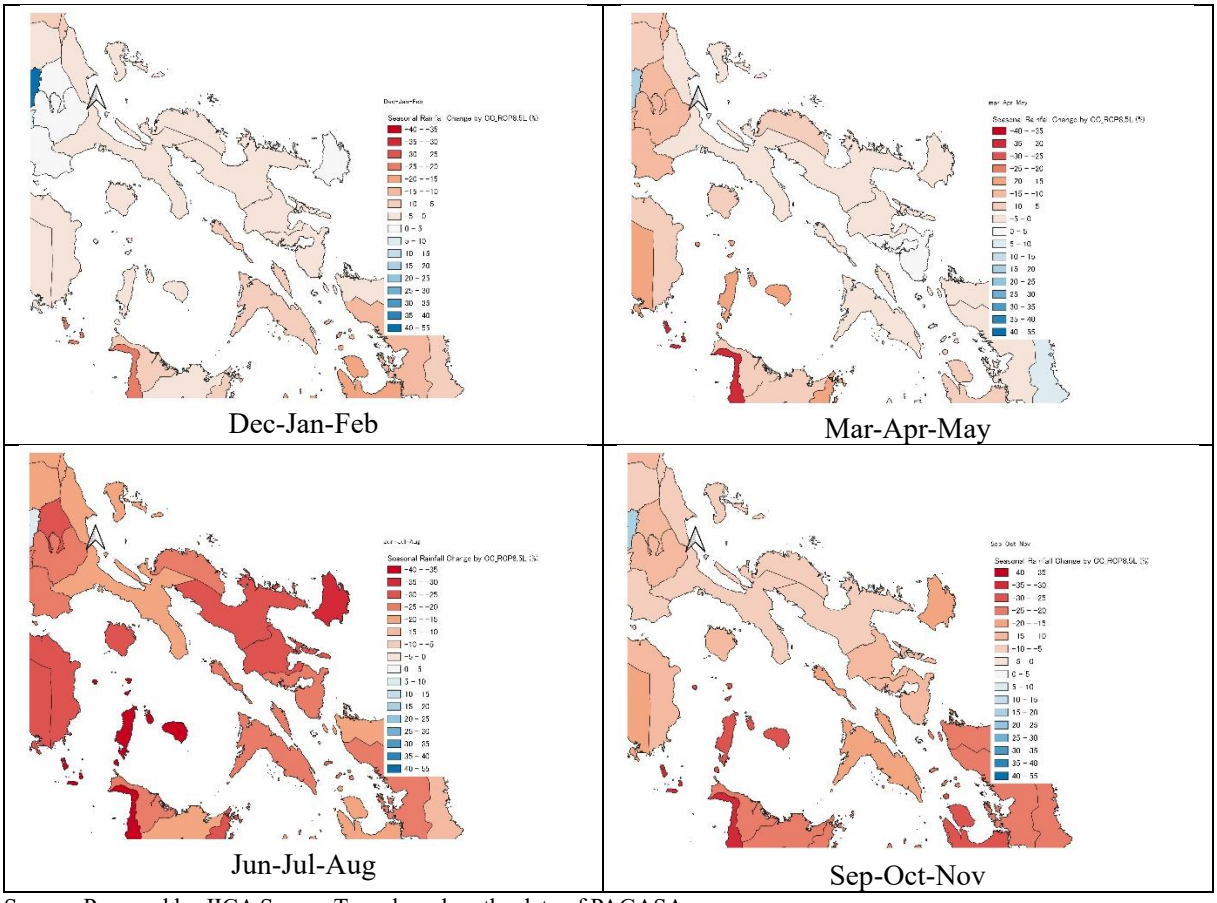
Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-331 Groundwater Potentials (1/5-Dry Year) in WRR-VII

(4) Climate Change Impact Assessment

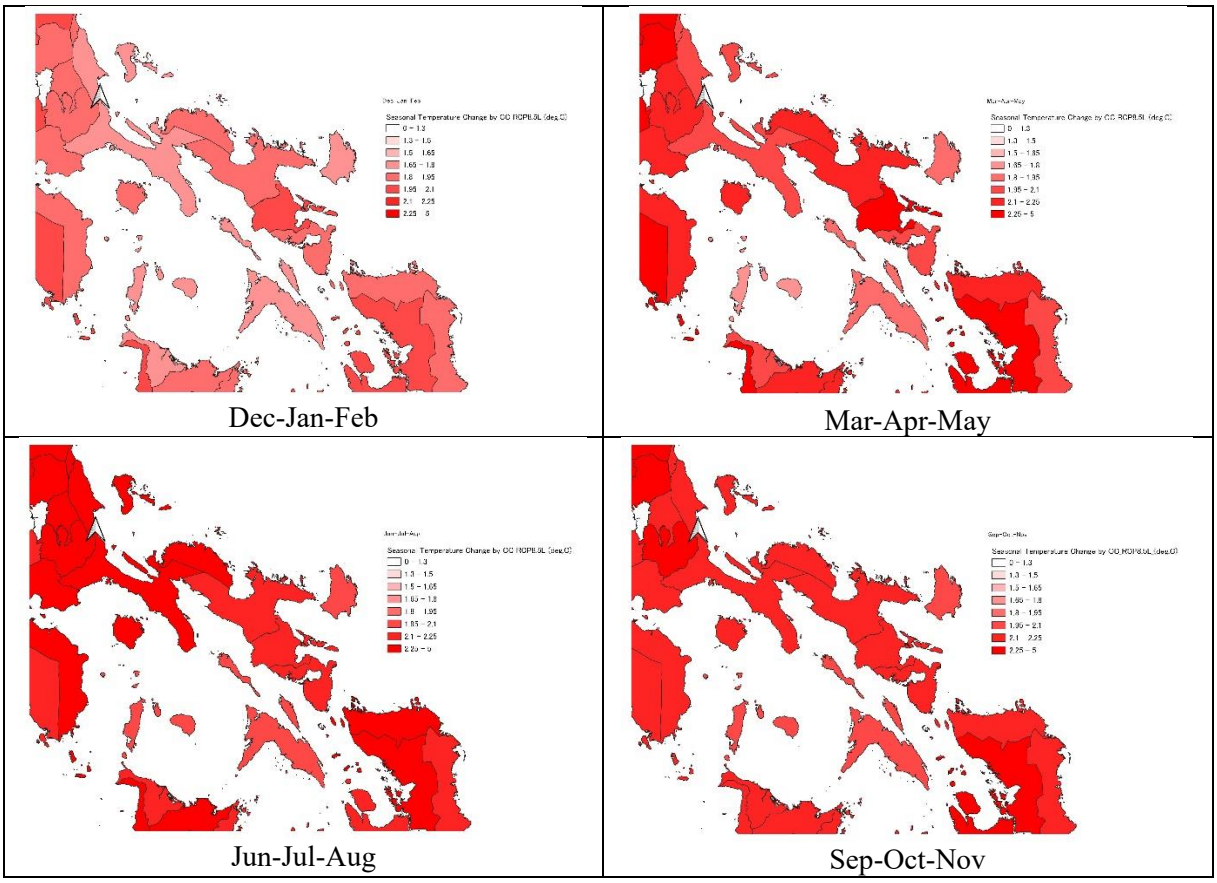
As describe in Section 3.3.4.1, climate change impact in WRR XI was estimated by same method.

Estimated surface water potentials by climate change cases are shown in figure below. In future climate change cases of surface water potential, it is predicted that the surface water potential of northern part of WRR-V and Masbate Island will decrease slightly in the RCP8.5-Low case.



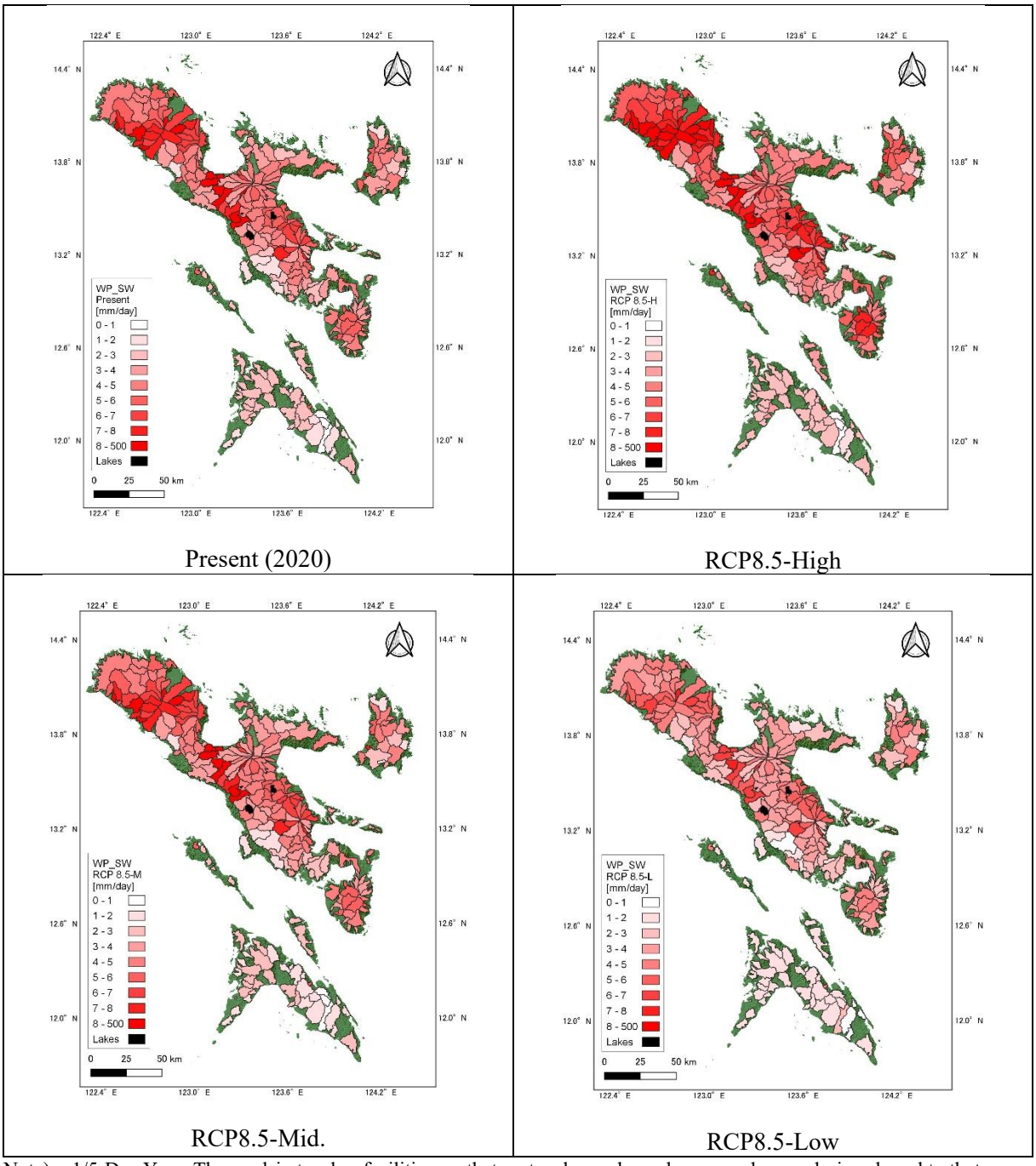
Source: Prepared by JICA Survey Team based on the data of PAGASA

Figure D-332 Quarterly Change of Precipitation by Province under Climate Change Scenarios from Present Weather in 2050 (RCP8.5-Low Case) in WRR-V



Source: Prepared by JICA Survey Team based on the data of PAGASA

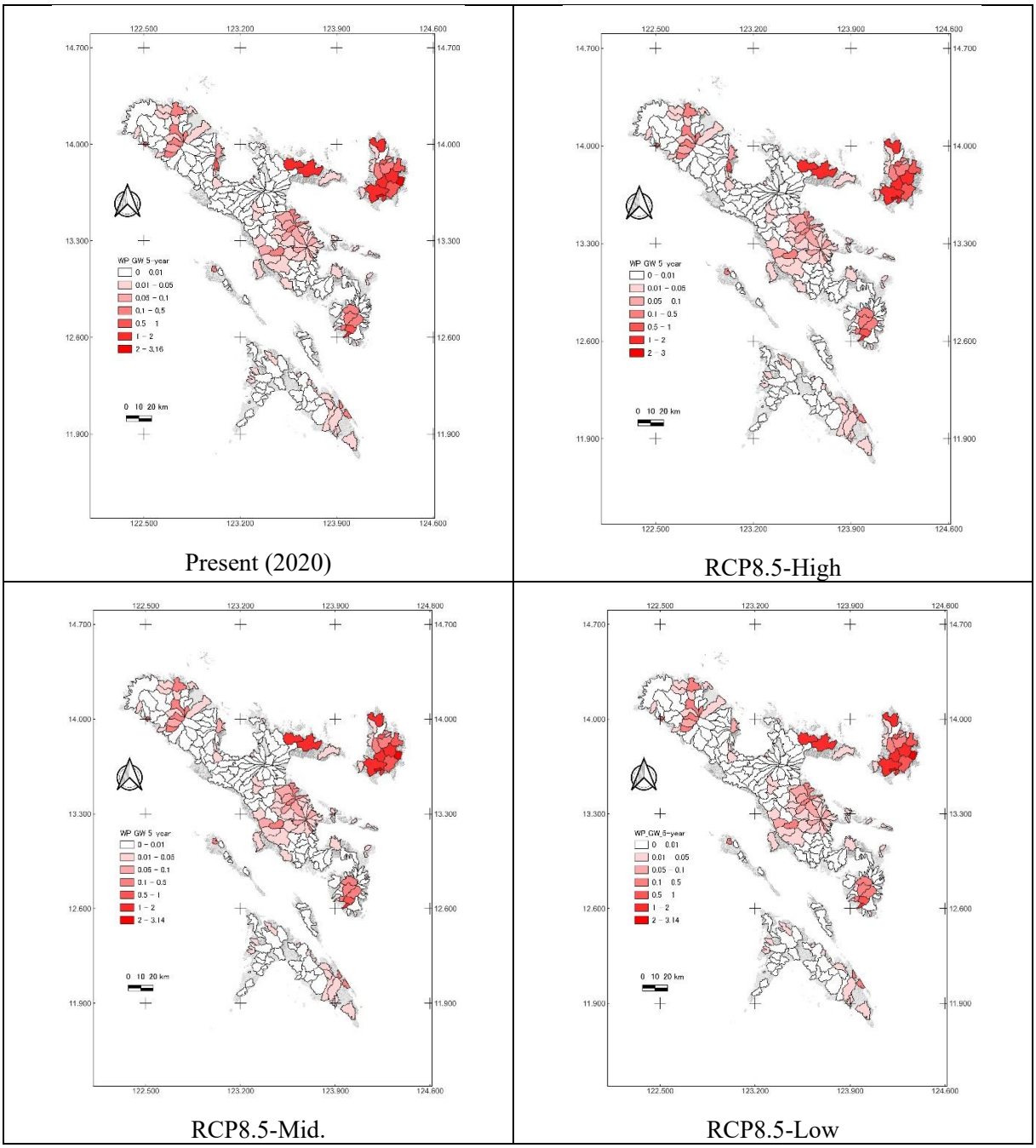
Figure D-333 Quarterly Change of Temperature by Province under Climate Change Scenarios from Present Weather in 2050 (RCP8.5-Low Case) in WRR-V



Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-334 Surface Water Potentials (1/5-Dry-Year) in WRR-V (Unit: mm/day)

Estimated groundwater potentials by climate change cases are shown in figure below. In the future climate change case of groundwater potential, it is not much change, but in the RCP8.5-Low case, the groundwater potential in Masbate Island and the Central part of WRR-V will be projected to decrease slightly.



Note) 1/5-Dry Year: The goal is to plan facilities so that water demand can be secured even during droughts that occur approximately once every five years (20% probability occurrence).
Source: JICA Survey Team

Figure D-335 Groundwater Potentials (1/5-Dry-Year) in WRR-V (Unit: mm/day)

(5) Results of Hydrological Analysis

In detailed hydrological analysis in priority water resource regions, a physically based water cycle model was used to logically calculate river discharge, groundwater recharge and groundwater flow could be estimated using physical parameters calibrated in sub-basins with discharge gauging stations, even in sub-basins where there are no discharge gauging stations. Calibration results were generally good. As a result of reducing the sub-basin division, it was possible to determine the regional water potential

(surface water and groundwater) of the target water resource regions in detail. The results of water balance analysis with water resources potential and water demand for each sub-basin are described in the following sections.

11.2 Sub-Basin-wise Water Demand

11.2.1 WRR-VII

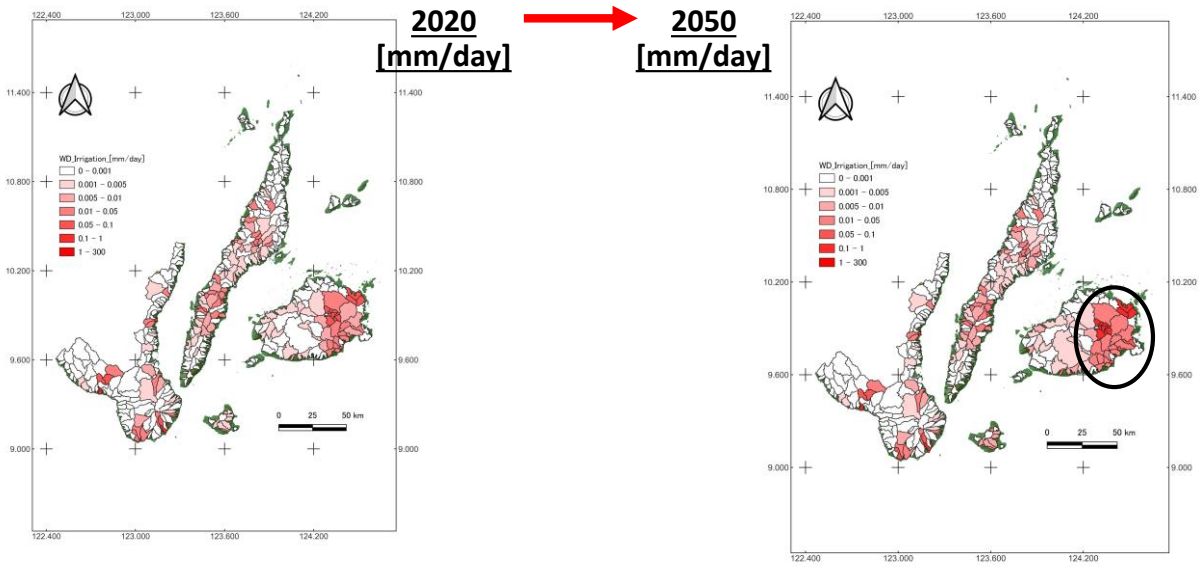
(1) Sub-Basin wise Water Demand

1) Irrigation Water Demand (SW&GW)

Provincial-wise irrigation water demands were estimated by Section 3.2.6-(2). The water demand of each sub-basin in SHER Model and for water balance was calculated by multiplying the area of each province by the area ratio of each municipality included in each sub-basin as follows.

(Sub-Basin-wise Irrigation WD) = (Provincial-wise Irrigation WD) x (Area Ratio of Municipality in Province) x (Area Ratio of Sub-basin in Municipality)

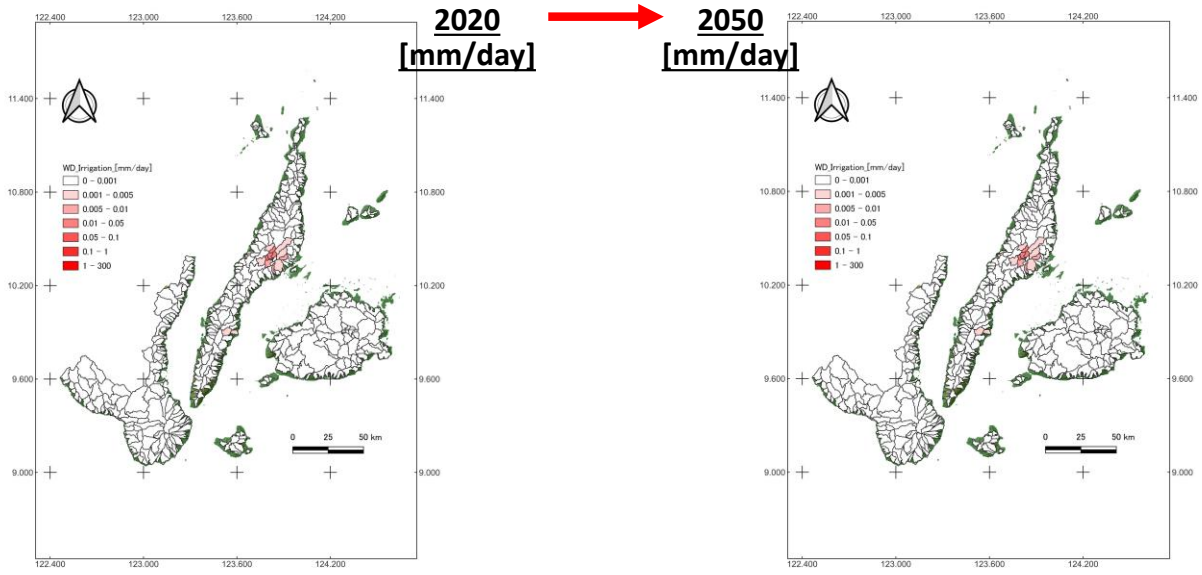
Irrigation water demand of surface water at present and future in WRR-VII were estimated by each sub-basin as shown in Figure below. Irrigation water demand of surface water of 2050 will be increased especially in eastern part of Bohol Island.



Source: JICA Survey Team

Figure D-336 Irrigation Water Demand of Surface Water in WRR-VII

Irrigation water demand of groundwater at present and future in WRR-VII were estimated by each sub-basin as shown in Figure below. Irrigation water demand of groundwater of 2050 will be not so changed in future in the WRR07.



Source: JICA Survey Team

Figure D-337 Irrigation Water Demand of Groundwater in WRR-VII

2) Livestock Water Demand (SW&GW)

Provincial-wise livestock water demands were estimated by Section 3.2.6-(2). The water demand of each sub-basin in SHER Model and for water balance was calculated by multiplying the area of each province by the area ratio of each municipality included in each sub-basin as follows.

(Sub-Basin-wise Livestock WD) = (Provincial-wise Livestock WD) x (Area Ratio of Municipality in Province) x (Area Ratio of Sub-basin in Municipality)

3) Fishpond Water Demand (SW&GW)

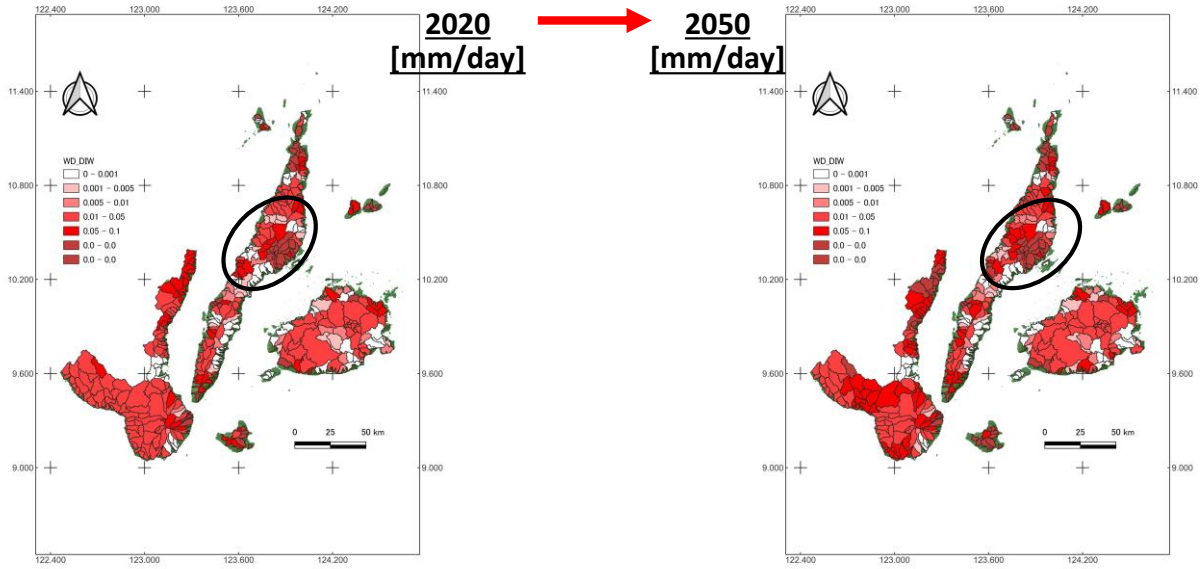
Provincial-wise fishpond water demands were estimated by Section 3.2.6-(2). However, in this water balance study, the fishpond water demands are not considered in SHER Model and for water balance. This is because the fishpond water demand is considered to be almost equal to the amount of water intake and the amount of return, and the water consumption in the fishpond is considered to be negligible small.

4) Municipal and Industrial Water Demand (SW&GW)

Provincial-wise and municipality-wise Municipal and industrial water demands were estimated by Section 3.2.6-(3). The water demand of each sub-basin in SHER Model and for water balance was calculated by multiplying the area ratio of each municipality included in each sub-basin as follows.

(Sub-Basin-wise MIWD) = (Municipality-wise MIWD) x (Area Ratio of Sub-basin in Municipality)

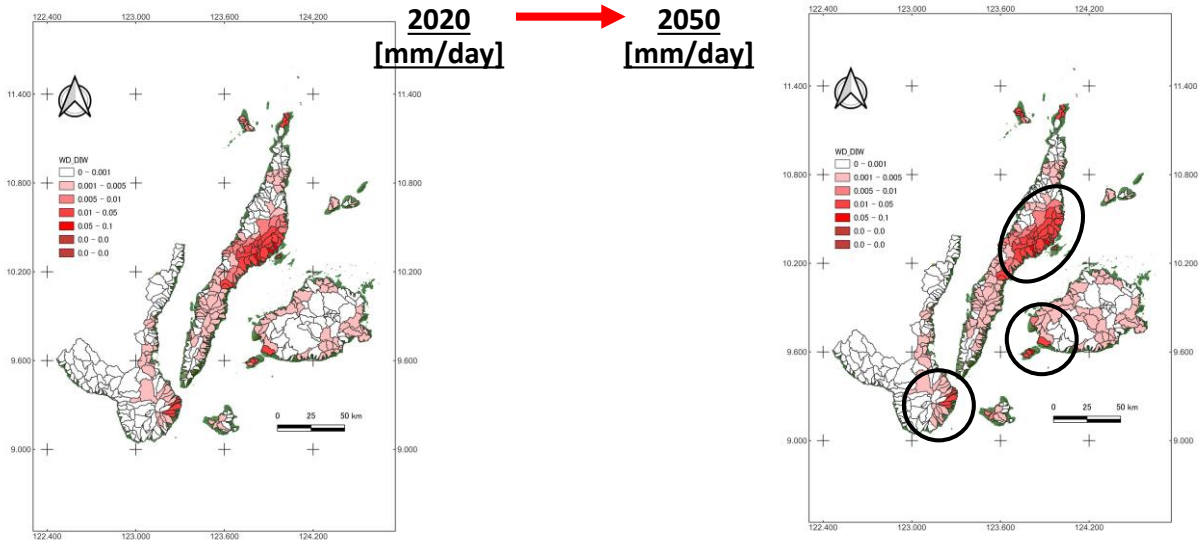
Municipal and industrial water demand of surface water at present and future in WRR-VII were estimated by each sub-basin as shown in Figure below. Municipal and industrial water demand of surface water of 2050 will be increased in Cebu Island, especially in the Metro Cebu Areas.



Source: JICA Survey Team

Figure D-338 Municipal and Industrial Water Demand of Surface Water in WRR-VII

Municipal and industrial water demand of groundwater at present and future in WRR-VII were estimated by each sub-basin as shown in Figure below. Municipal and industrial water demand of groundwater of 2050 will be increased in Cebu Island, especially in the Metro Cebu Areas, Tagbilaran City in Bohol Island and Dumaguete City in Negros Oriental Province.



Source: JICA Survey Team

Figure D-339 Municipal and Industrial Water Demand of Groundwater in WRR-VII

5) Other Water Demand (SW&GW)

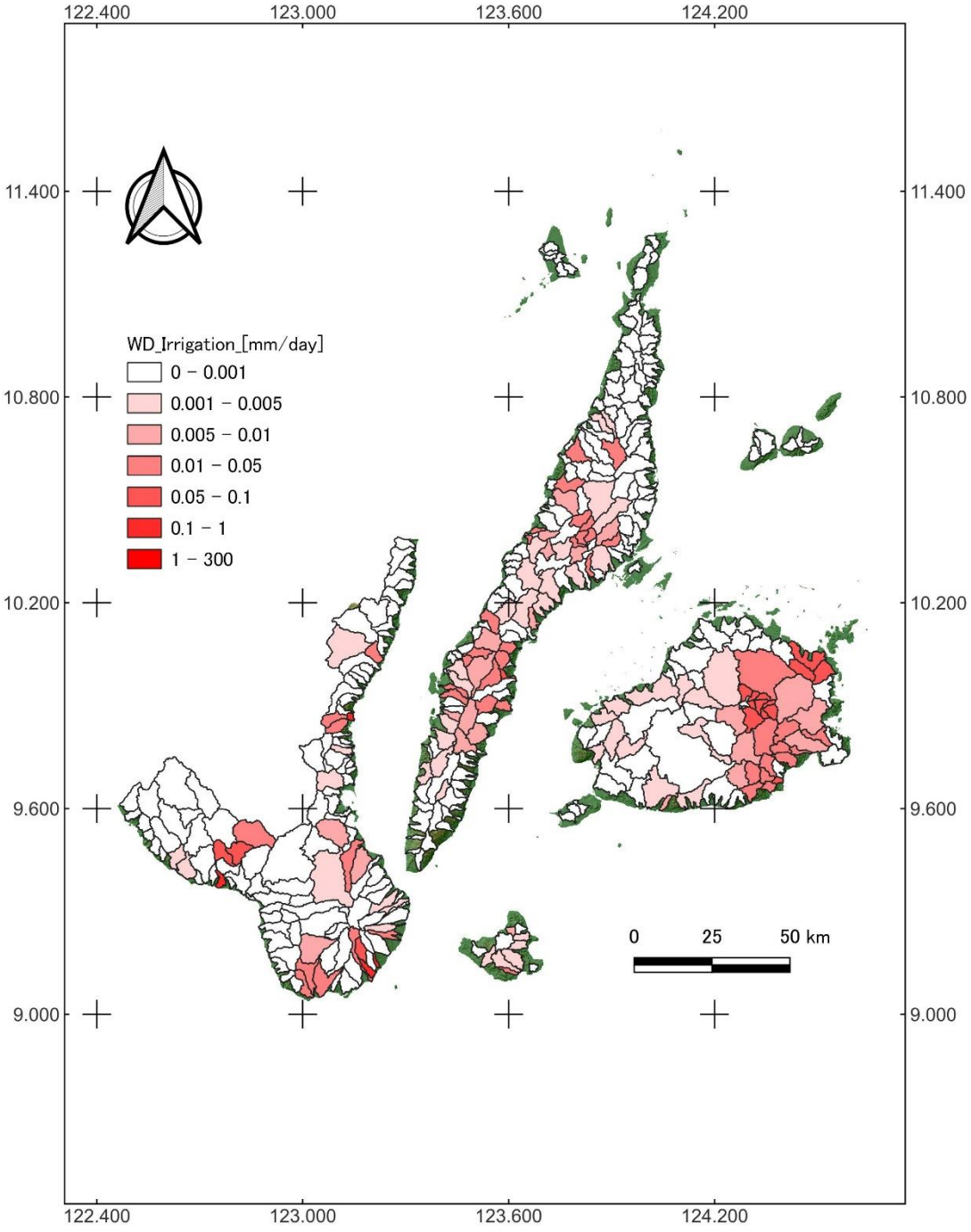
"Other water demand" is estimated by multiplying the construction water demand by Sub-Basin by the ratio of construction water demand and other water demand of NWRB water rights in each province.

(Sub-Basin-wise Other WD) = (Sub-Basin-wise MIWD) x (Ratio of water rights of MIWWD and Other WD)

In the water balance calculation of this study, the water demand for power generation was assumed to be so small that the water consumption could be ignored.

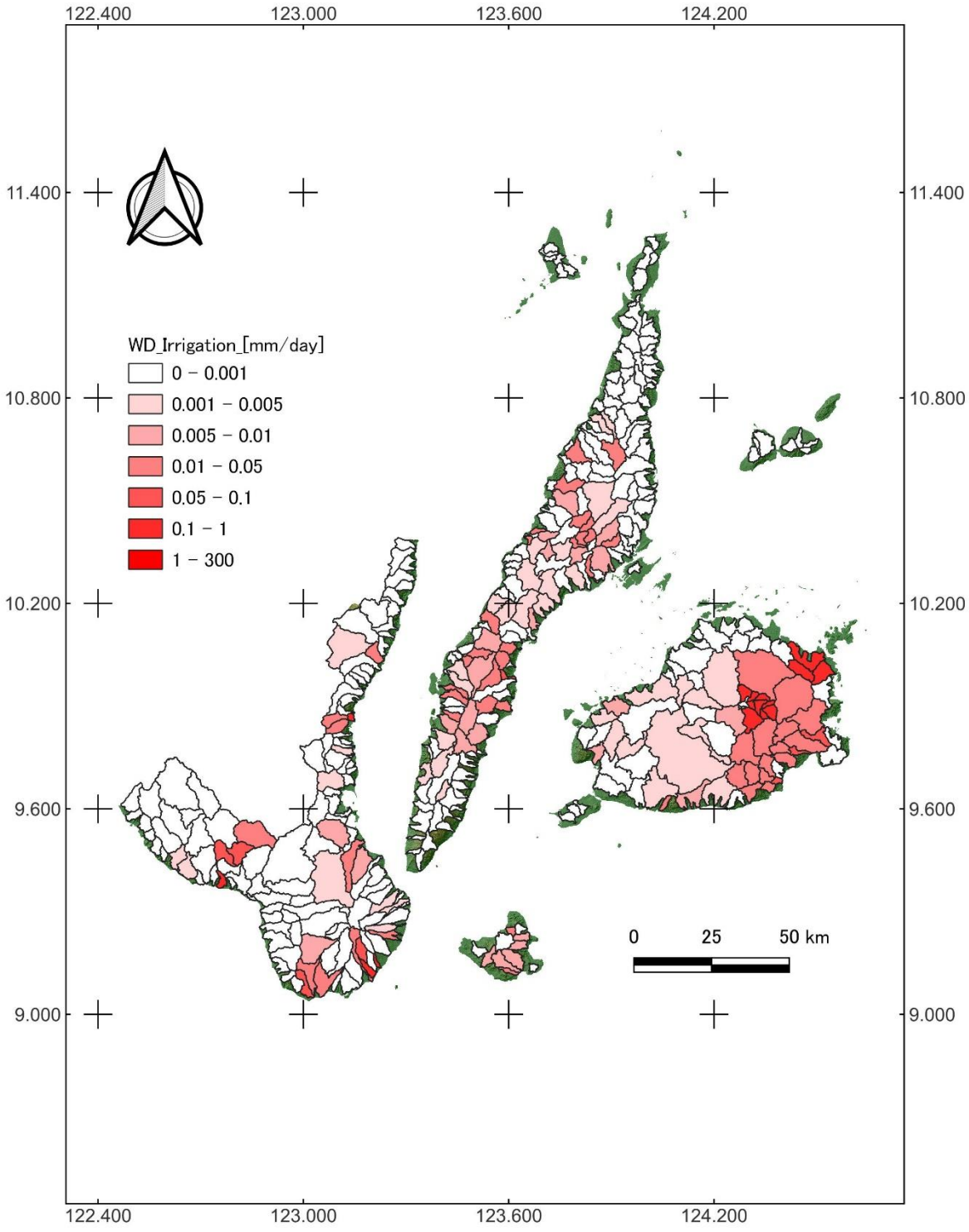
(2) Maps of Sub-Basin wise Water Demand

1) Irrigation Water Demand (SW&GW)



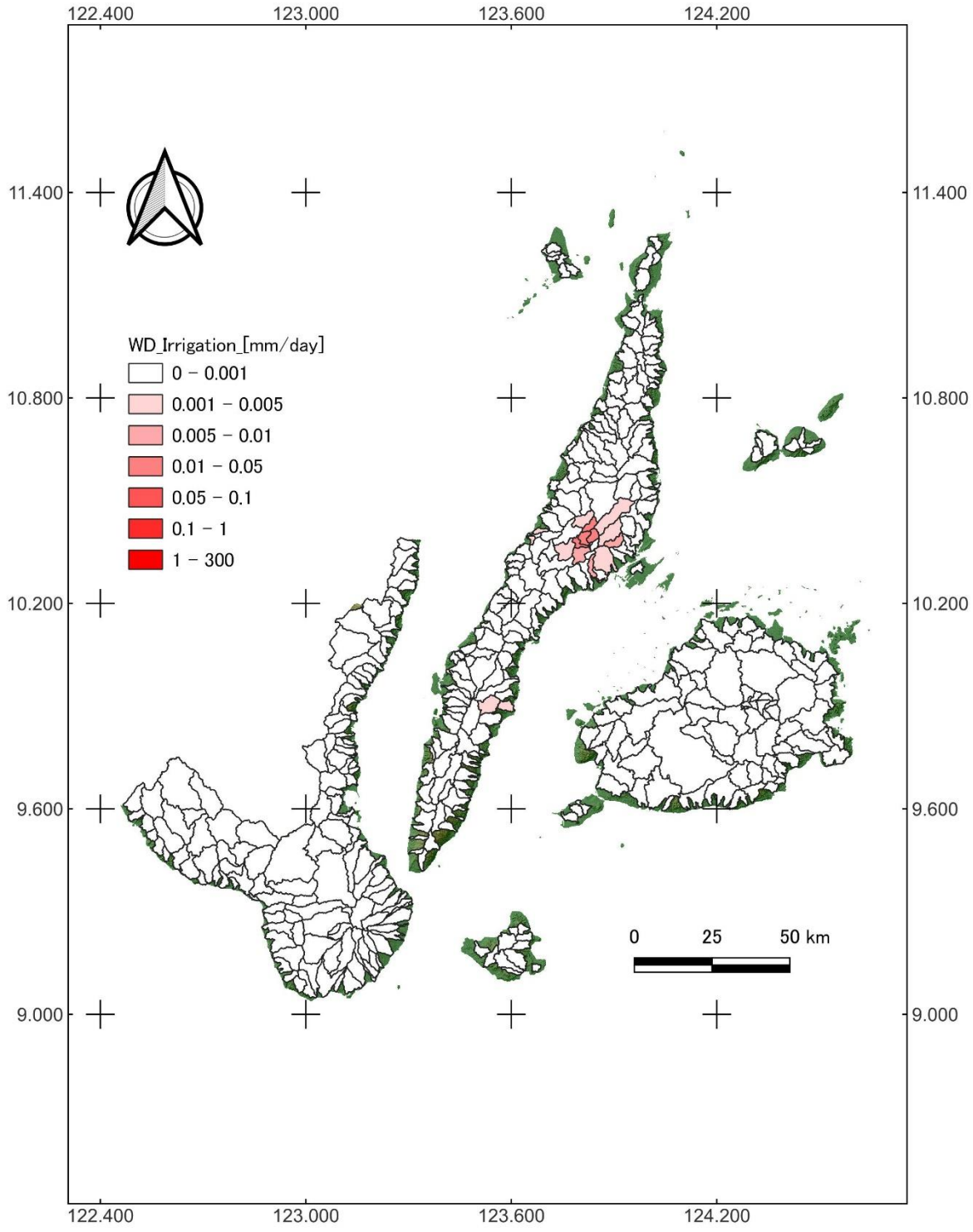
Source: JICA Survey Team

Figure D-340 Irrigation Water Demand of Surface Water in WRR-VII (2020)



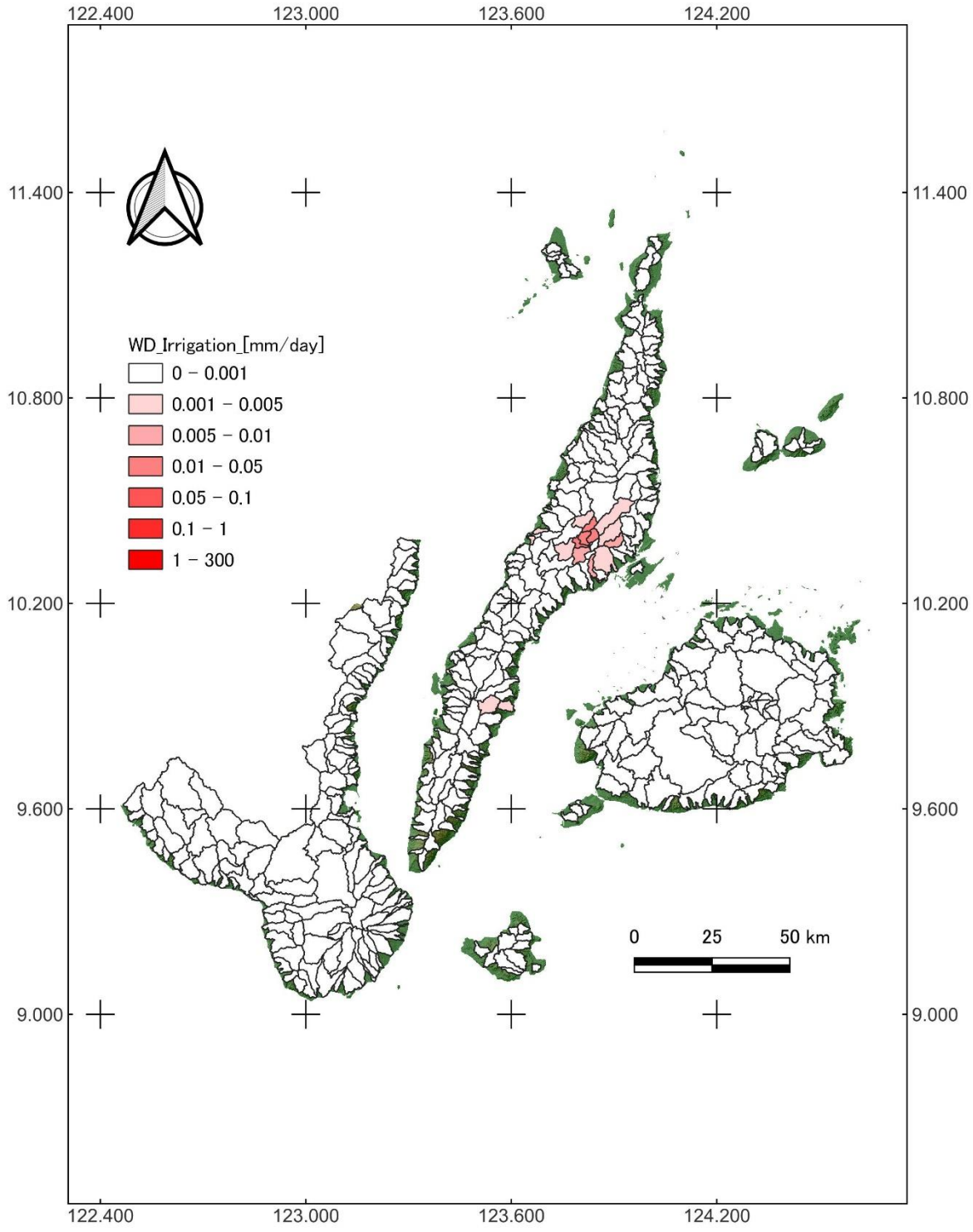
Source: JICA Survey Team

Figure D-341 Irrigation Water Demand of Surface Water in WRR-VII (2025)



Source: JICA Survey Team

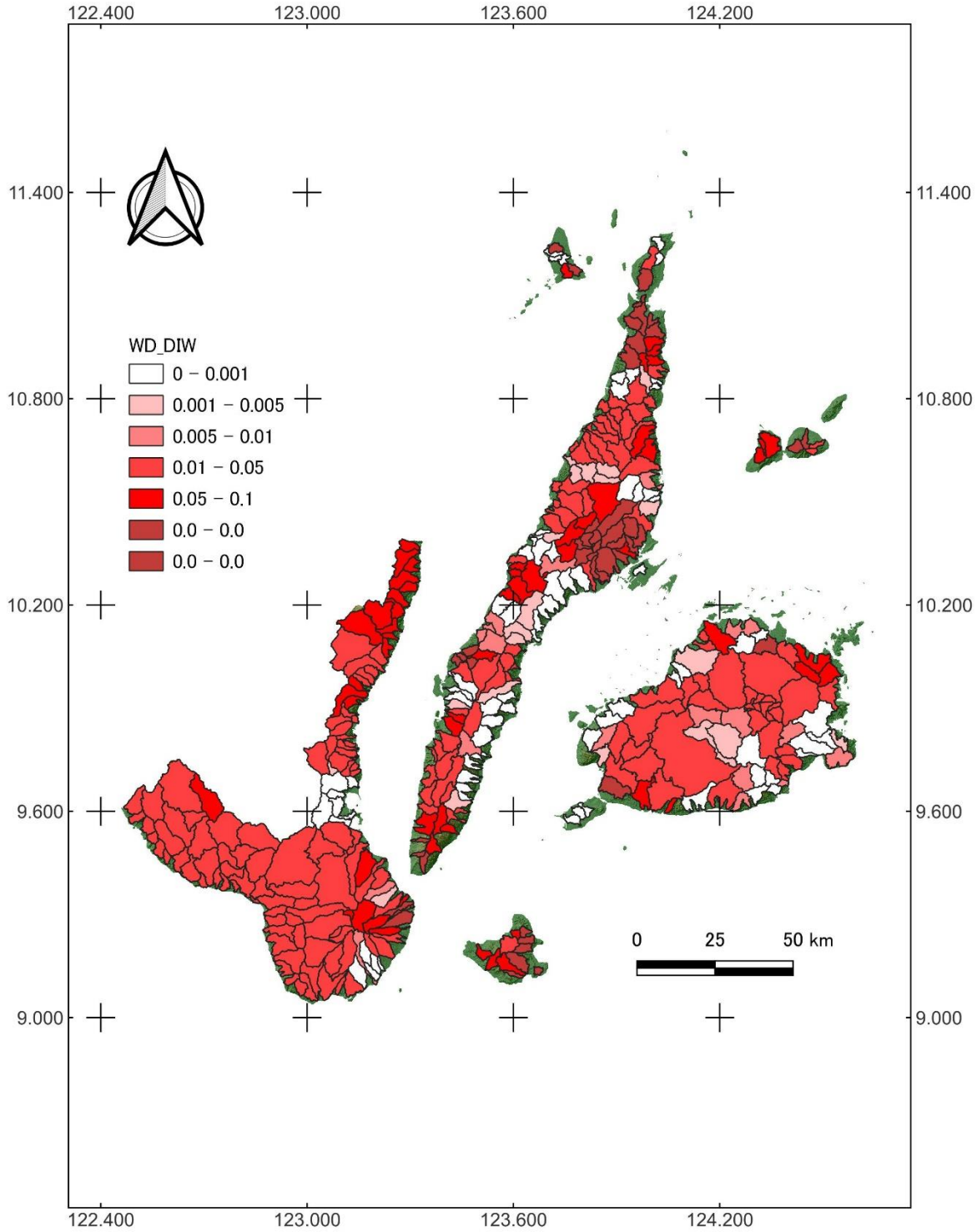
Figure D-342 Irrigation Water Demand of Groundwater in WRR-VII (2020)



Source: JICA Survey Team

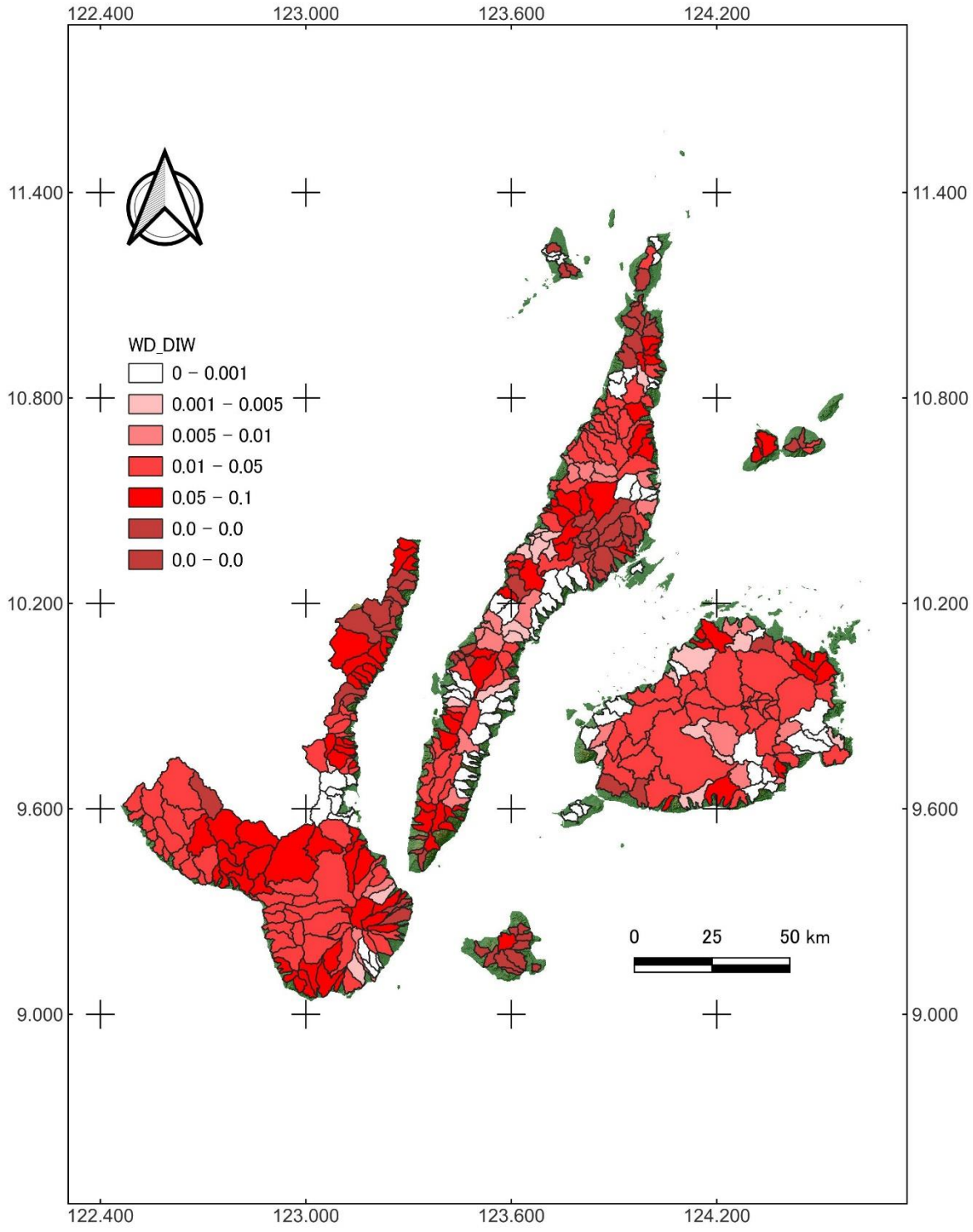
Figure D-343 Irrigation Water Demand of Groundwater in WRR-VII (2025)

2) Municipal and Industrial Water Demand (SW&GW)



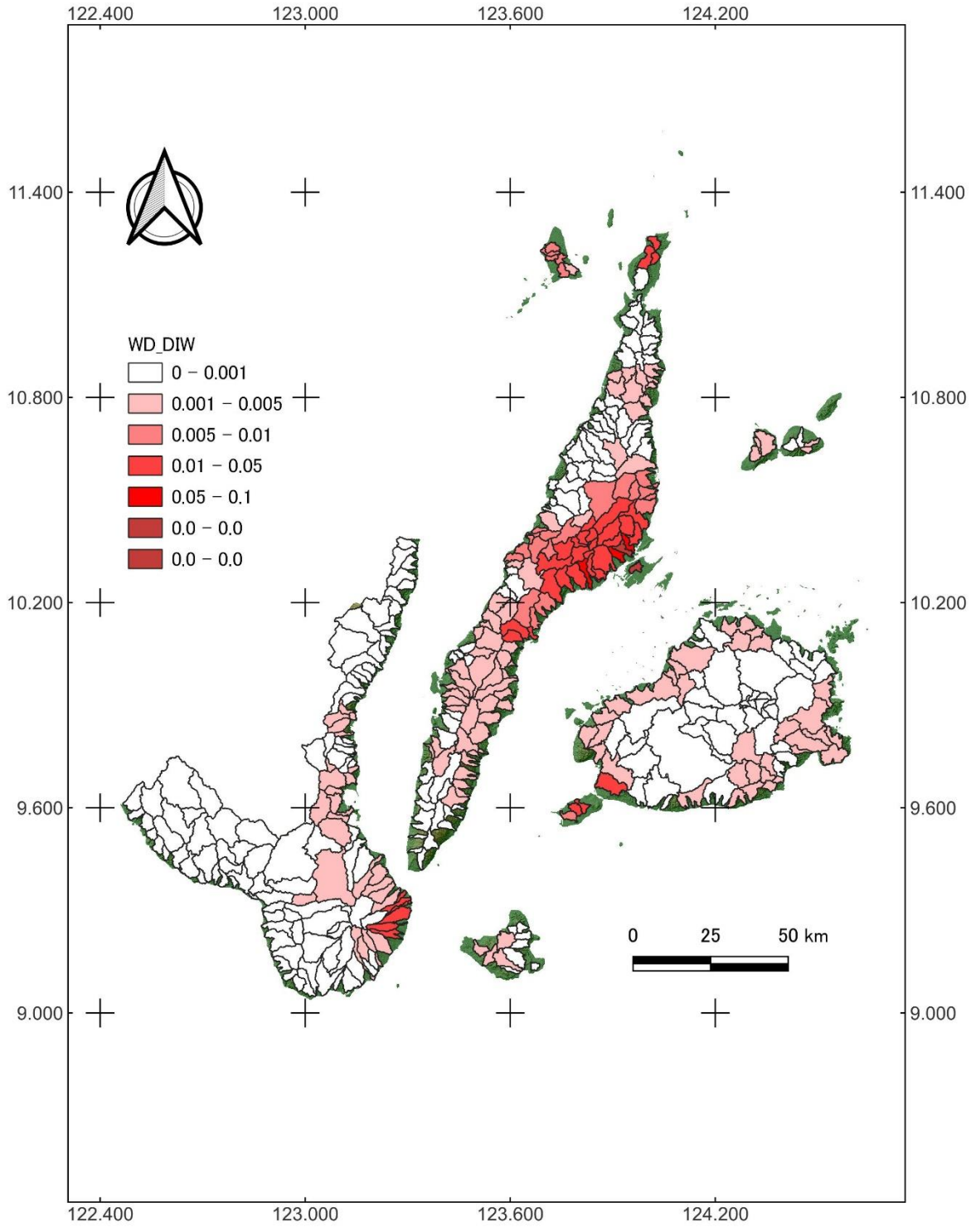
Source: JICA Survey Team

Figure D-344 Municipal and Industrial Water Demand of Surface Water in WRR-VII (2020)



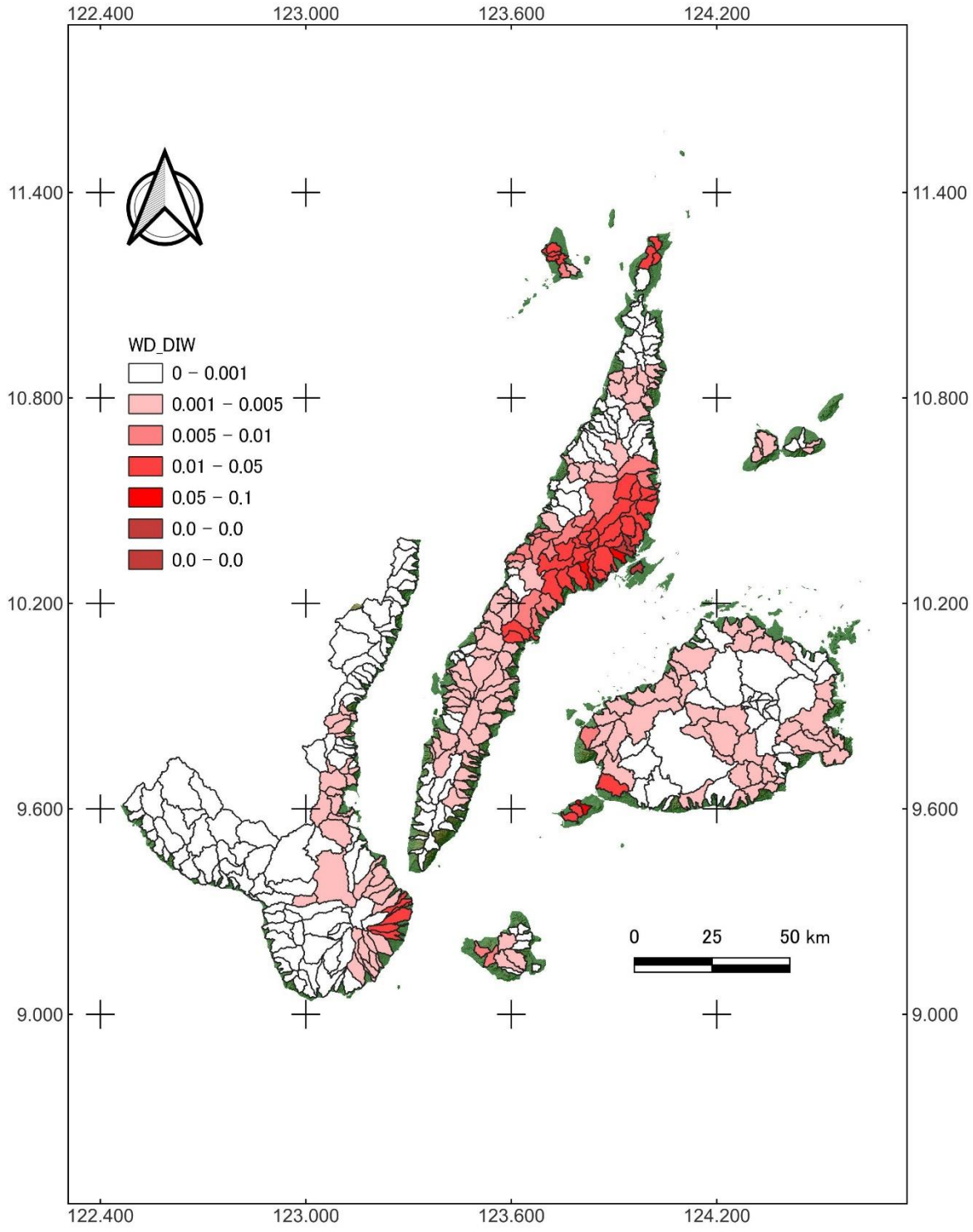
Source: JICA Survey Team

Figure D-345 Municipal and Industrial Water Demand of Surface Water in WRR-VII (2020)



Source: JICA Survey Team

Figure D-346 Municipal and Industrial Water Demand of Groundwater in WRR-VII (2050)



Source: JICA Survey Team

Figure D-347 Municipal and Industrial Water Demand of Groundwater in WRR-VII (2050)

11.2.2 WRR-XI

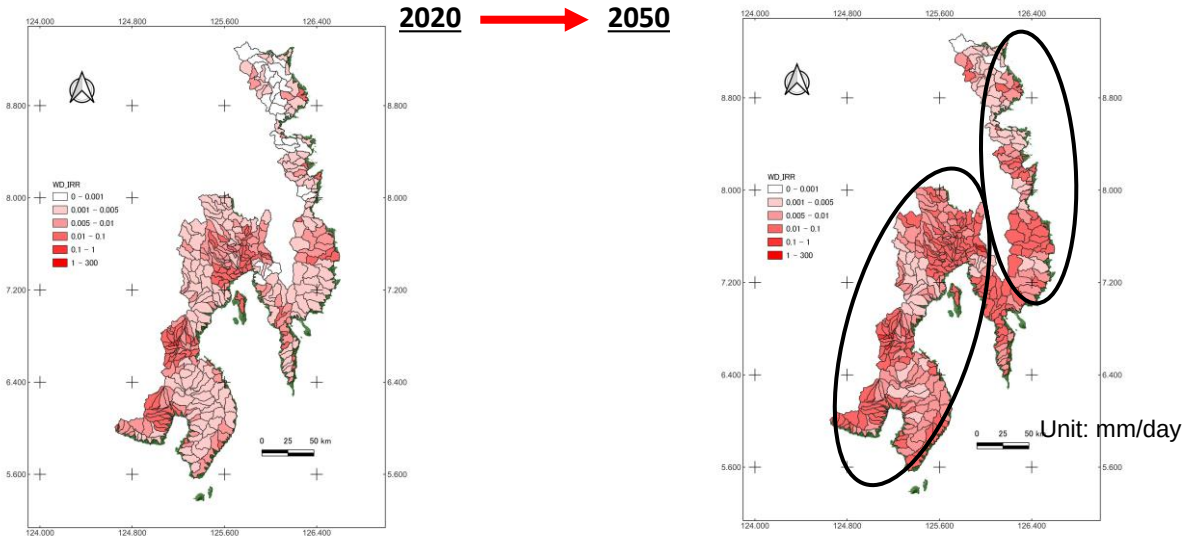
(1) Sub-Basin wise Water Demand

1) Irrigation Water Demand (SW&GW)

Provincial-wise irrigation water demands were estimated by Section 3.2.6-(2). The water demand of each sub-basin in SHER Model and for water balance was calculated by multiplying the area of each province by the area ratio of each municipality included in each sub-basin as follows.

(Sub-Basin-wise Irrigation WD) = (Provincial-wise Irrigation WD) x (Area Ratio of Municipality in Province) x (Area Ratio of Sub-basin in Municipality)

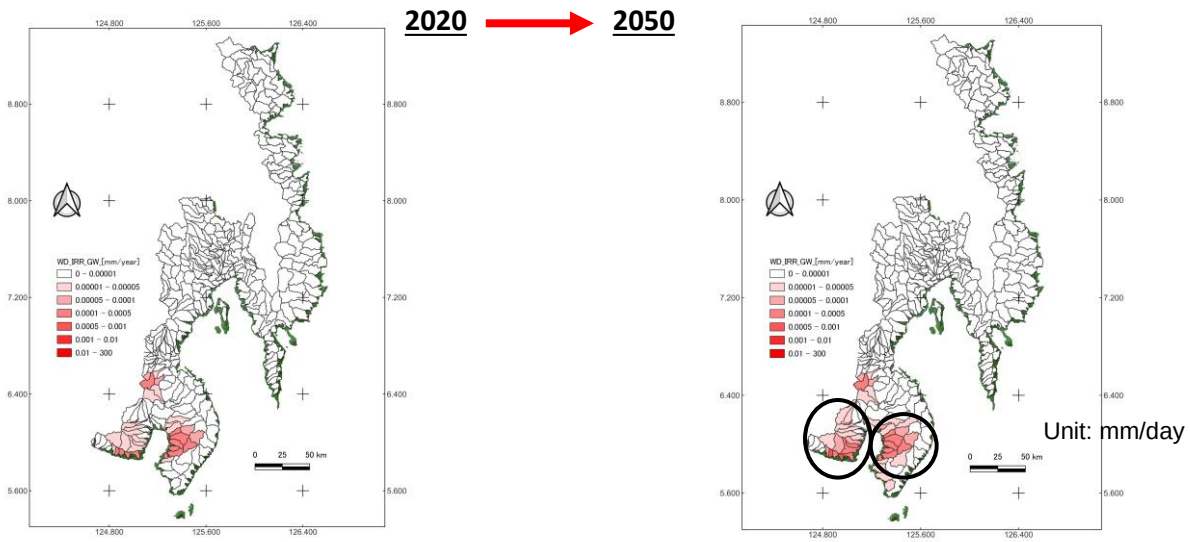
Irrigation water demand of surface water at present and future in WRR-XI were estimated by each sub-basin as shown in Figure below. Irrigation water demand of surface water in 2050 will be increased especially in Eastern Part of WRR-XI.



Source: JICA Survey Team

Figure D-348 Irrigation Water Demand of Surface Water in WRR-XI

Irrigation water demand of groundwater at present and future in WRR-XI were estimated by each sub-basin as shown in Figure below. Irrigation water demand of groundwater of 2050 will be not so changed in future in the WRR-XI.



Source: JICA Survey Team

Figure D-349 Irrigation Water Demand of Groundwater in WRR-XI

2) Livestock Water Demand (SW&GW)

Provincial-wise livestock water demands were estimated by Section 3.2.6-(2). The water demand of each sub-basin in SHER Model and for water balance was calculated by multiplying the area of each province by the area ratio of each municipality included in each sub-basin as follows.

(Sub-Basin-wise Livestock WD) = (Provincial-wise Livestock WD) x (Area Ratio of Municipality in Province) x (Area Ratio of Sub-basin in Municipality)

3) Fishpond Water Demand (SW&GW)

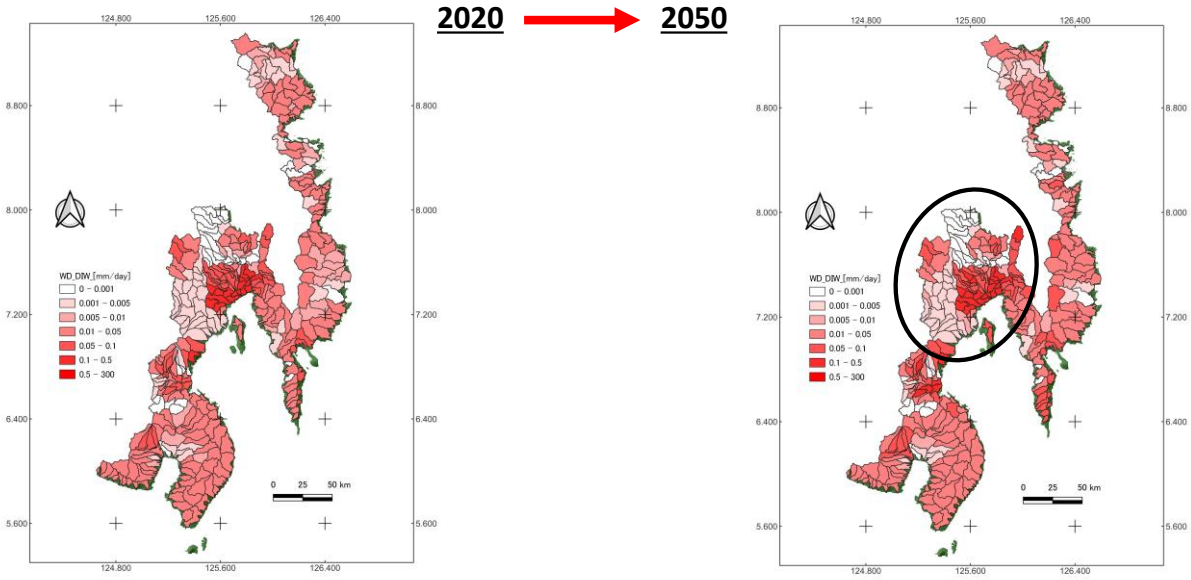
Provincial-wise fishpond water demands were estimated by Section 3.2.6-(2). However, in this water balance study, the fishpond water demands are not considered in SHER Model and for water balance. This is because the fishpond water demand is considered to be almost equal to the amount of water intake and the amount of return, and the water consumption in the fishpond is considered to be negligible small.

4) Municipal and Industrial Water Demand (SW&GW)

Provincial-wise and municipality-wise Municipal and industrial water demands were estimated by Section 3.2.6-(3). The water demand of each sub-basin in SHER Model and for water balance was calculated by multiplying the area ratio of each municipality included in each sub-basin as follows.

(Sub-Basin-wise MIWD) = (Municipality-wise MIWD) x (Area Ratio of Sub-basin in Municipality)

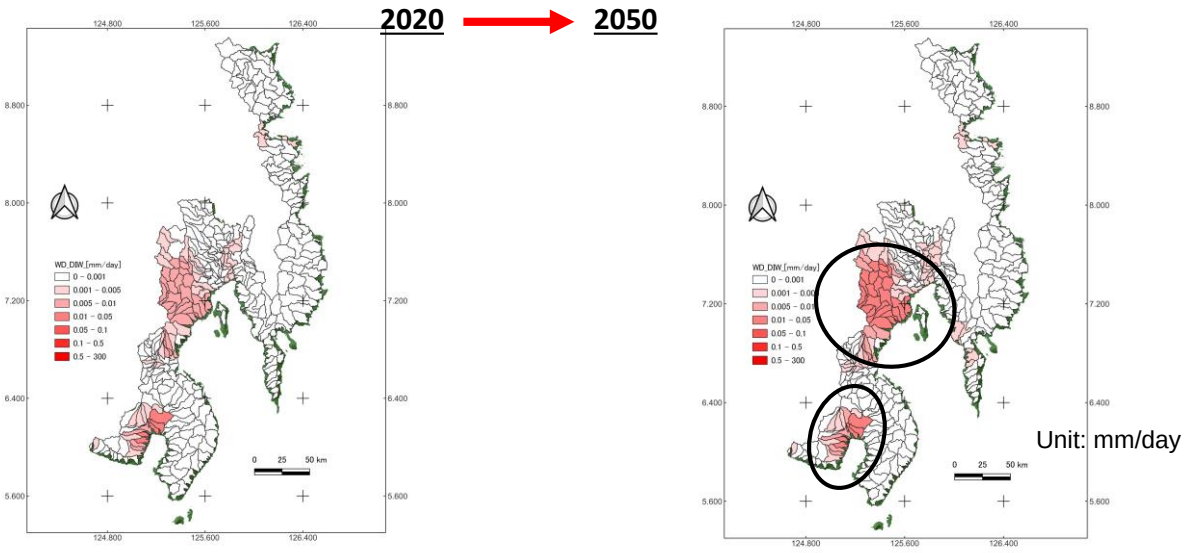
Municipal and industrial water demand of surface water at present and future in WRR-XI were estimated by each sub-basin as shown in Figure below. Municipal and industrial water demand of surface water of 2050 will be not so changed in future in the WRR-XI.



Source: JICA Survey Team

Figure D-350 Municipal and Industrial Water Demand of Surface Water in WRR-XI

Municipal and industrial water demand of groundwater at present and future in WRR-XI were estimated by each sub-basin as shown in Figure below. Municipal and industrial water demand of groundwater of 2050 will be increased in near Metro Davao City and Metro General Santos areas.



Source: JICA Survey Team

Figure D-351 Municipal and Industrial Water Demand of Groundwater in WRR-XI

5) Other Water Demand (SW&GW)

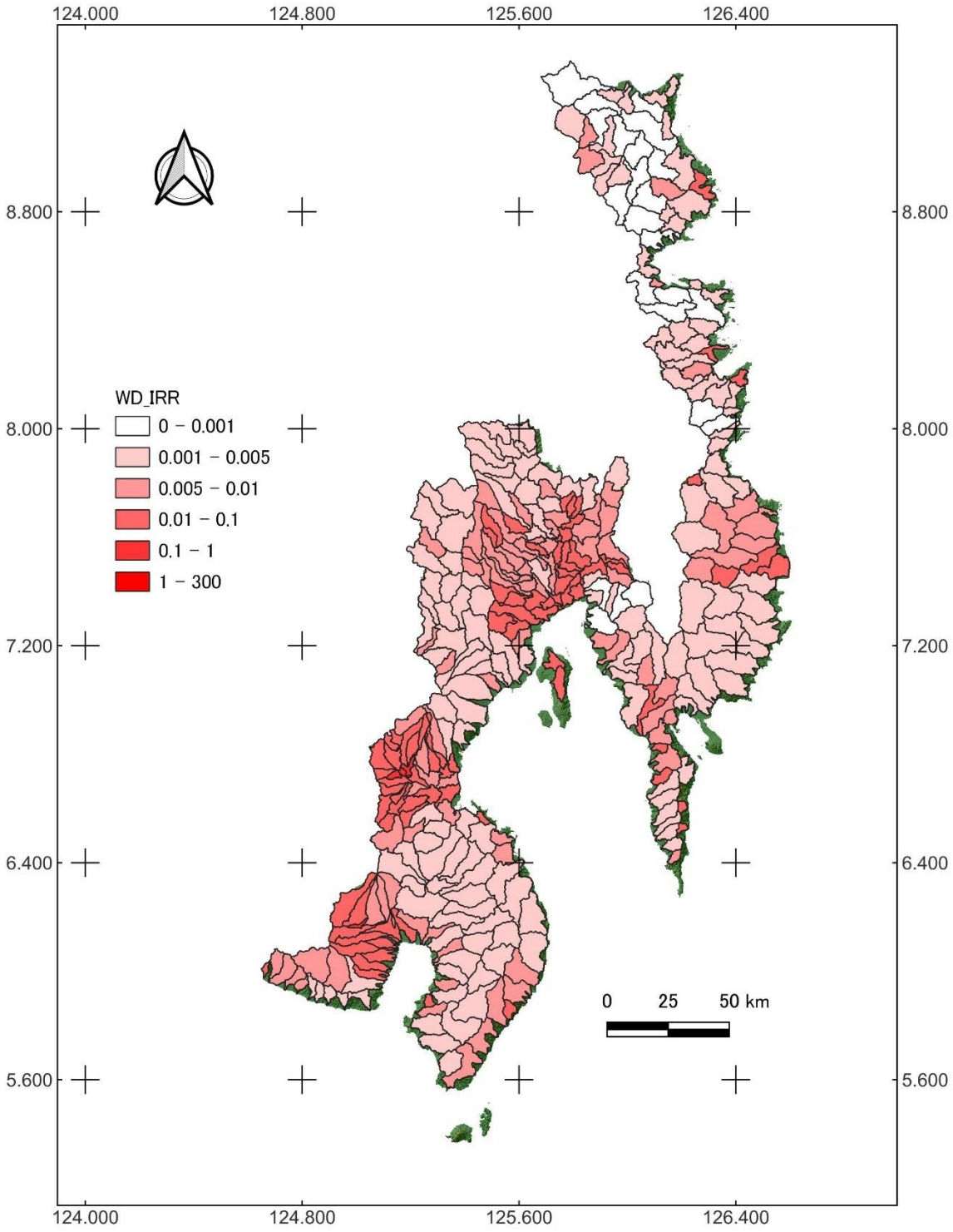
"Other water demand" is estimated by multiplying the construction water demand by Sub-Basin by the ratio of construction water demand and other water demand of NWRB water rights in each province.

(Sub-Basin-wise Other WD) = (Sub-Basin-wise MIWD) x (Ratio of water rights of MIWWD and Other WD)

In the water balance calculation of this study, the water demand for power generation was assumed to be so small that the water consumption could be ignored.

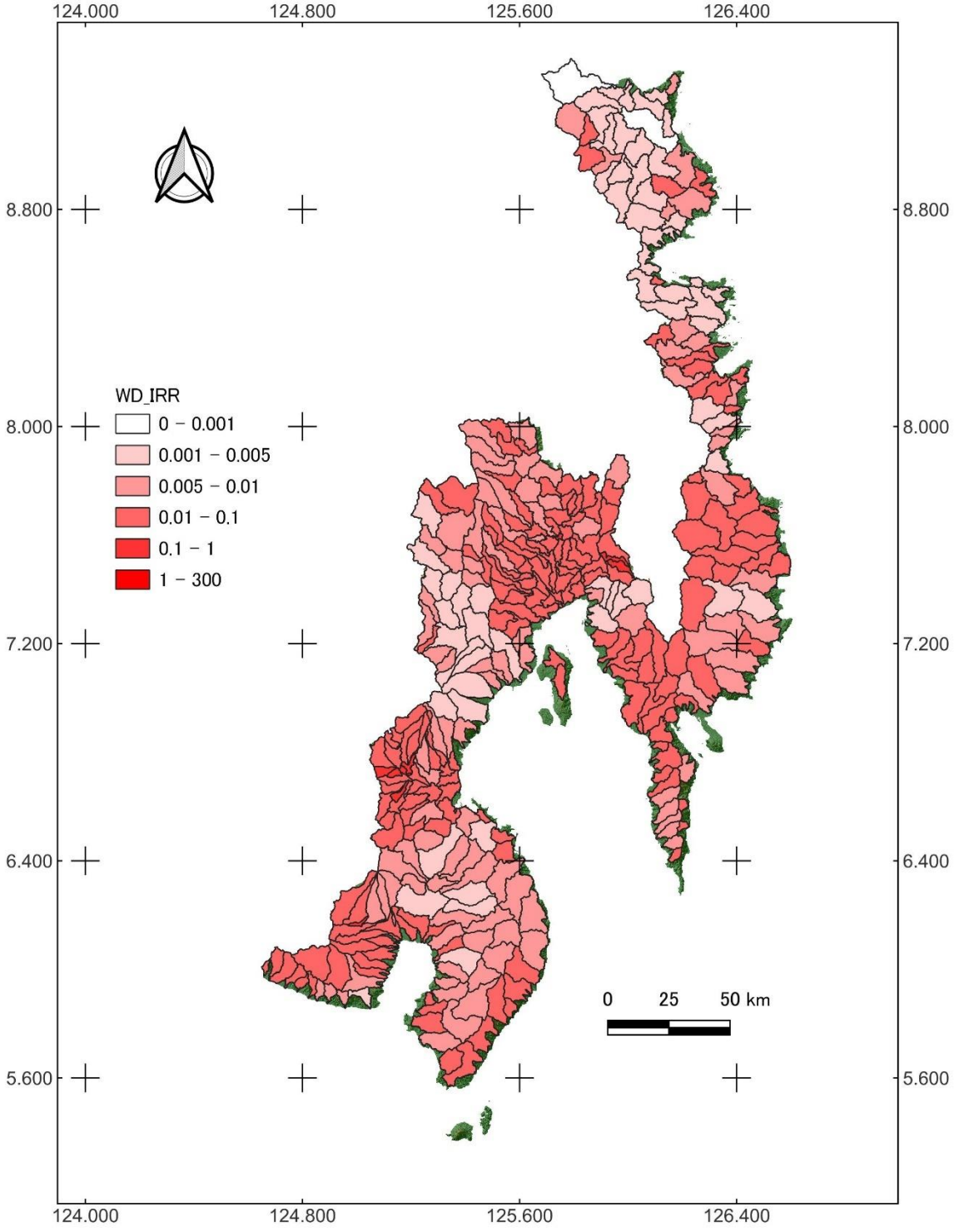
(2) Maps of Results of Sub-Basin wise Water Demand

1) Irrigation Water Demand (SW&GW)



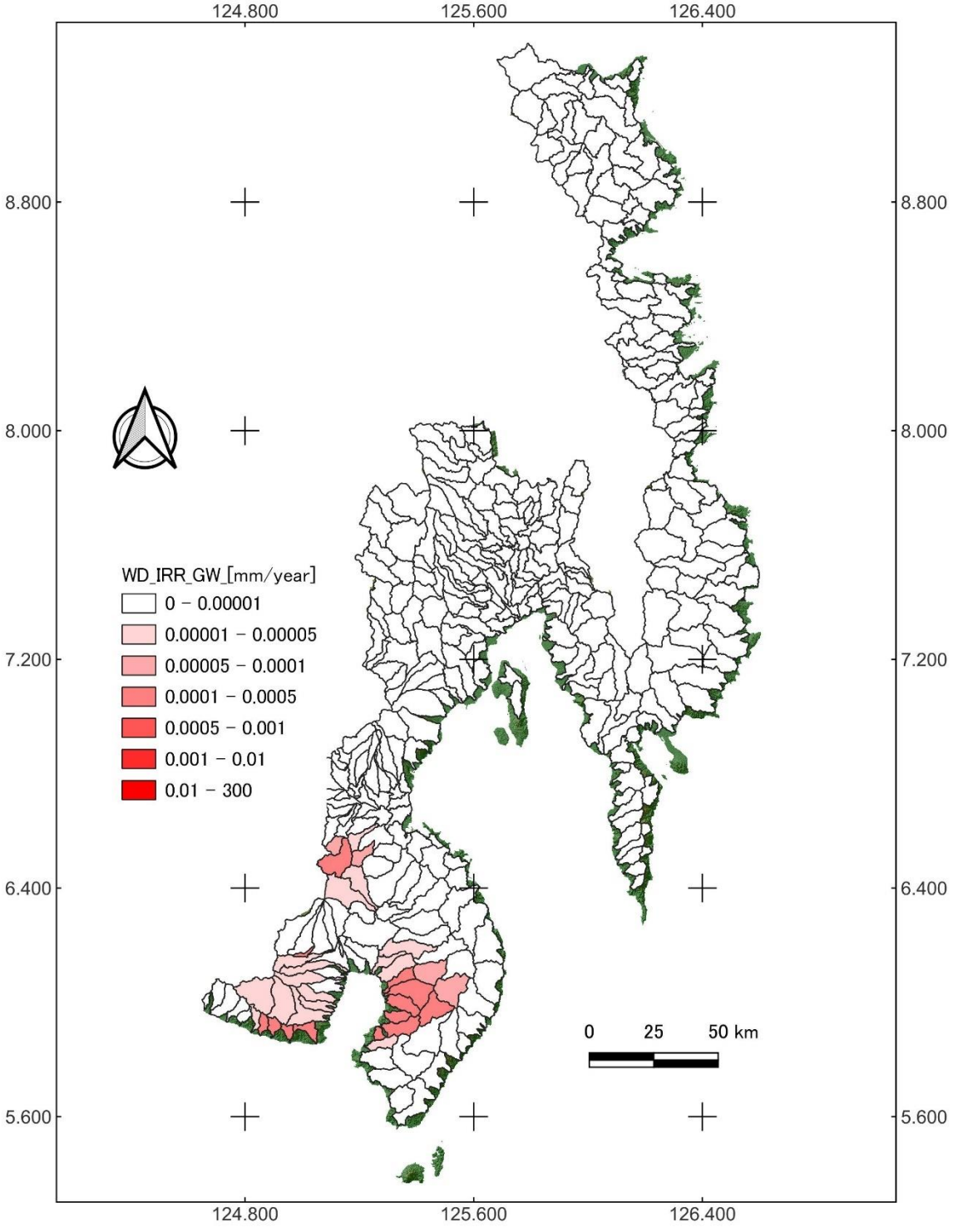
Source: JICA Survey Team

Figure D-352 Irrigation Water Demand of Surface Water in WRR-XI (2020)



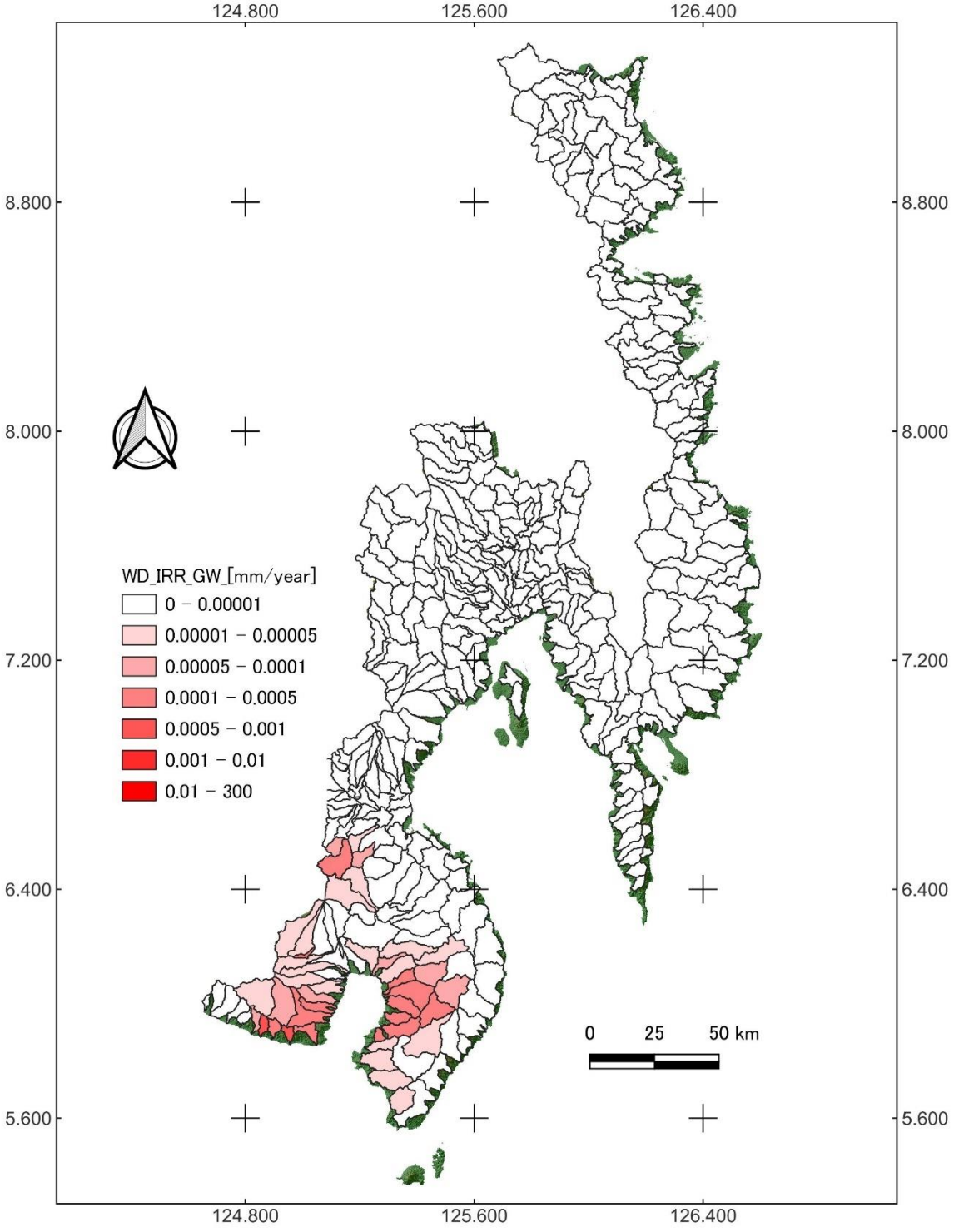
Source: JICA Survey Team

Figure D-353 Irrigation Water Demand of Surface Water in WRR-XI (2025)



Source: JICA Survey Team

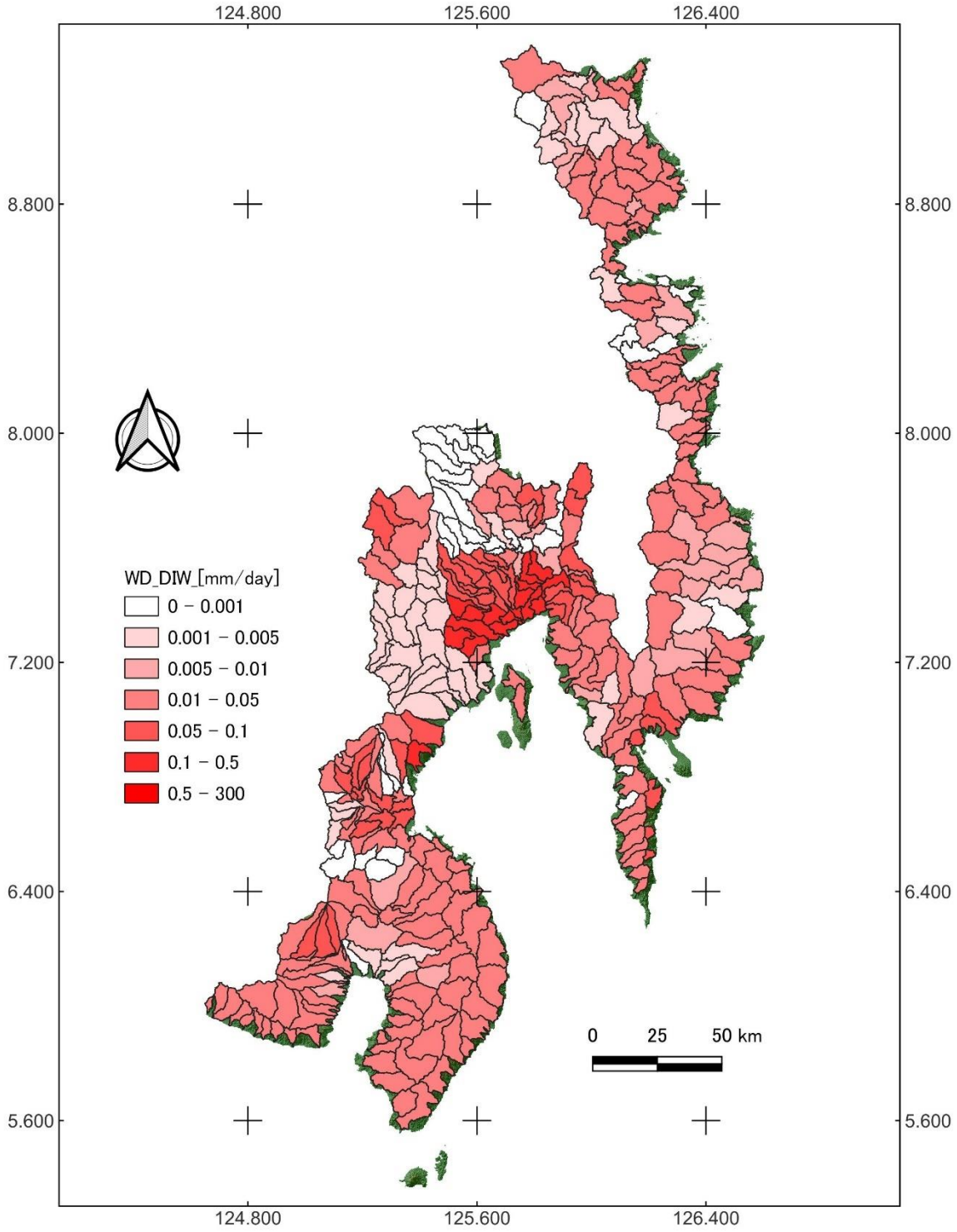
Figure D-354 Irrigation Water Demand of Groundwater in WRR-XI (2020)



Source: JICA Survey Team

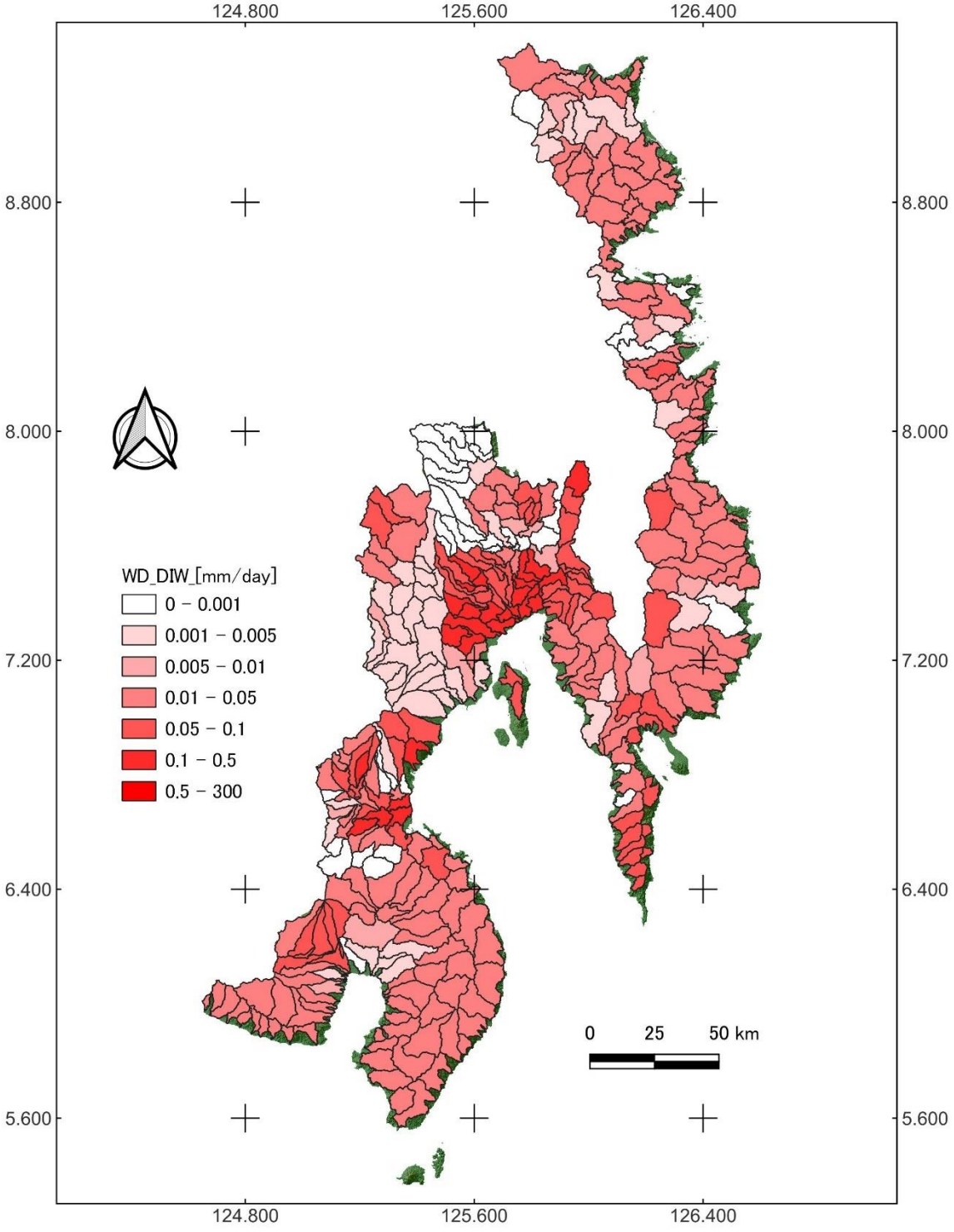
Figure D-355 Irrigation Water Demand of Groundwater in WRR-XI (2025)

2) Municipal and Industrial Water Demand (SW&GW)



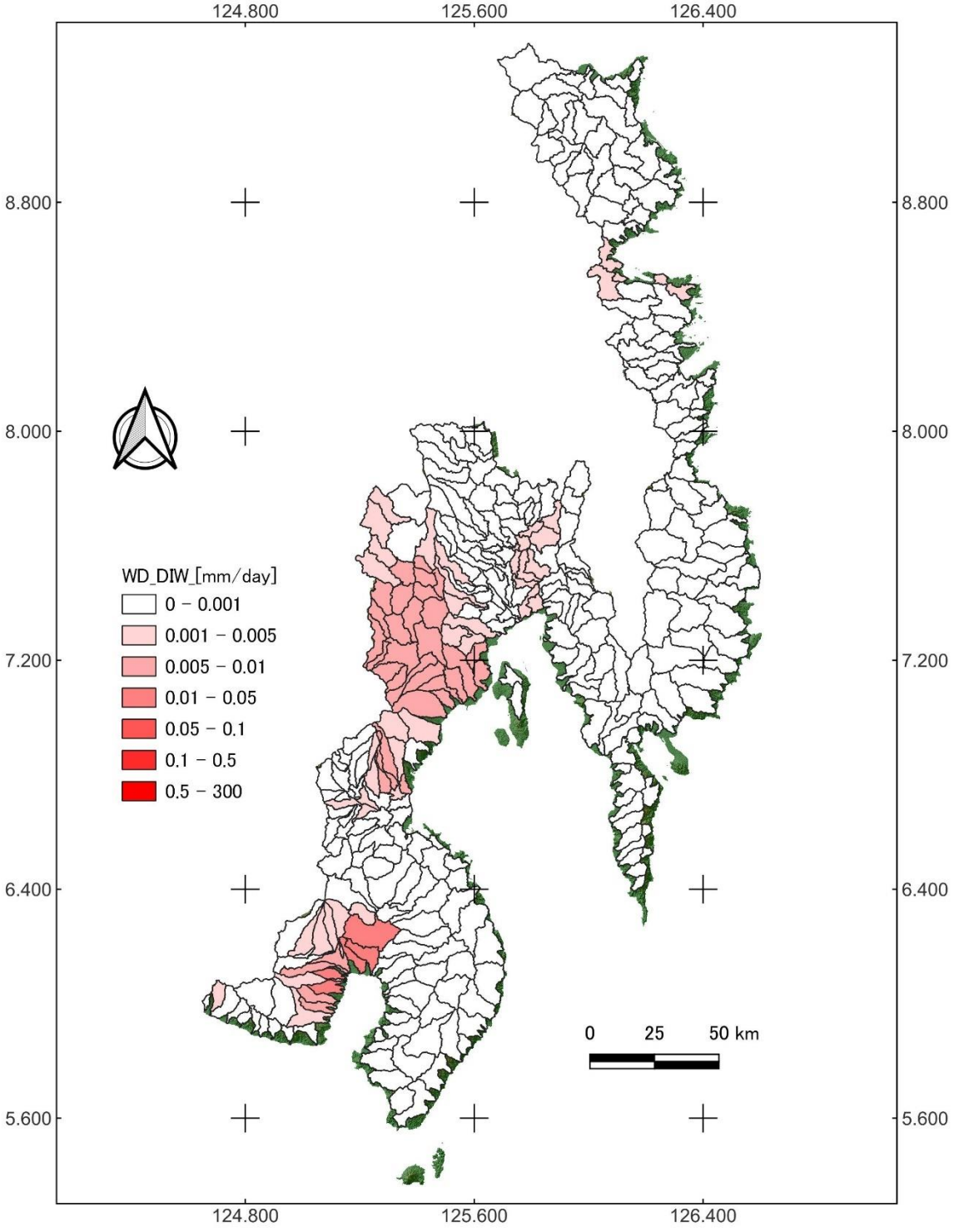
Source: JICA Survey Team

Figure D-356 Municipal and Industrial Water Demand of Surface Water in WRR-XI (2020)



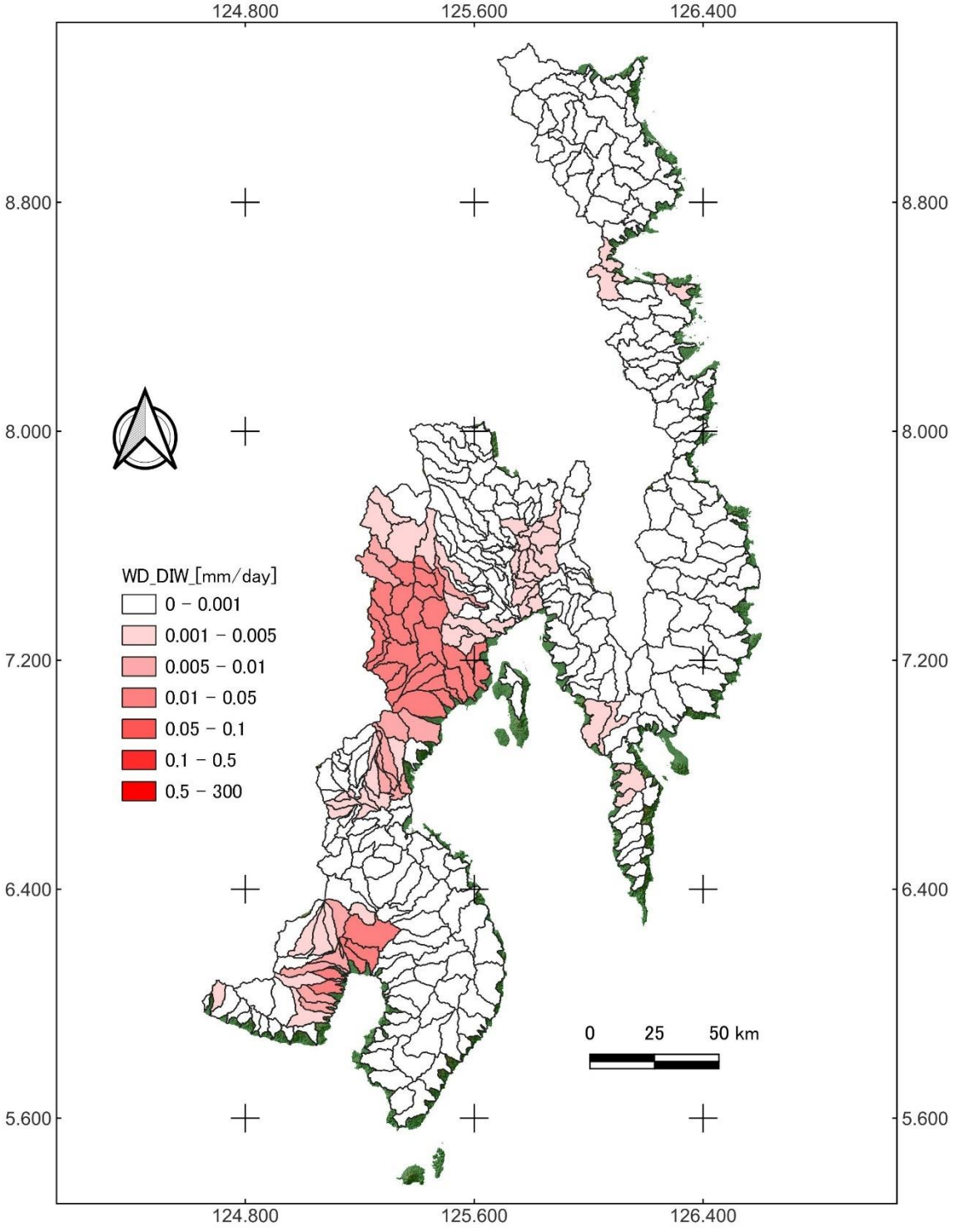
Source: JICA Survey Team

Figure D-357 Municipal and Industrial Water Demand of Surface Water in WRR-XI (2020)



Source: JICA Survey Team

Figure D-358 Municipal and Industrial Water Demand of Groundwater in WRR-XI (2050)



Source: JICA Survey Team

Figure D-359 Municipal and Industrial Water Demand of Groundwater in WRR-XI (2050)

11.2.3 WRR-V

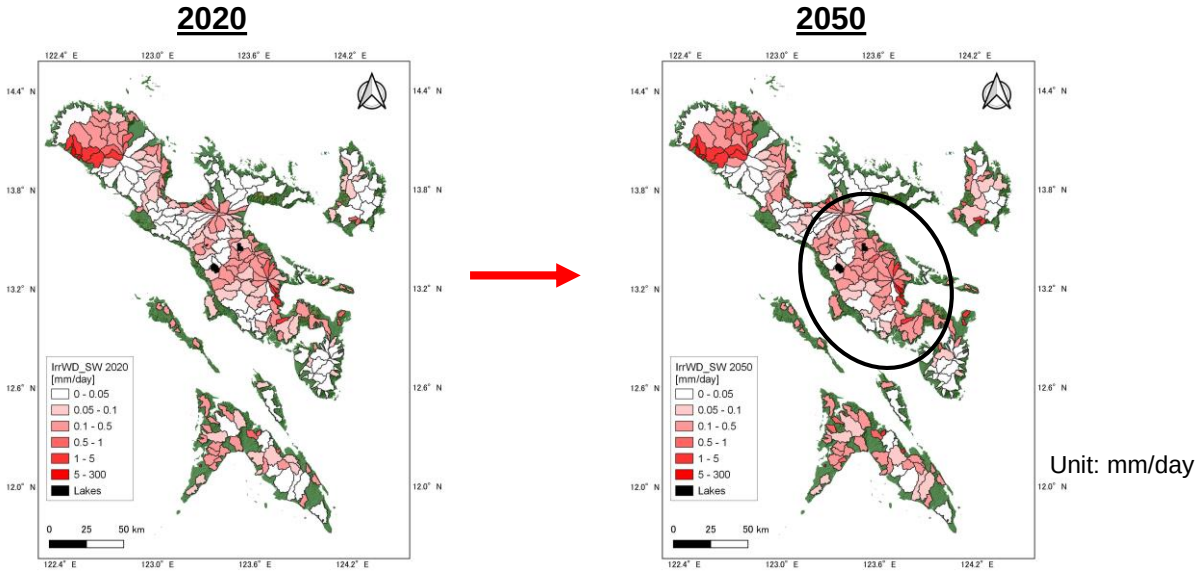
(1) Sub-Basin wise Water Demand

1) Irrigation Water Demand (SW&GW)

Provincial-wise irrigation water demands were estimated by Section 3.2.6-(2). The water demand of each sub-basin in SHER Model and for water balance was calculated by multiplying the area of each province by the area ratio of each municipality included in each sub-basin as follows.

(Sub-Basin-wise Irrigation WD) = (Provincial-wise Irrigation WD) x (Area Ratio of Municipality in Province) x (Area Ratio of Sub-basin in Municipality)

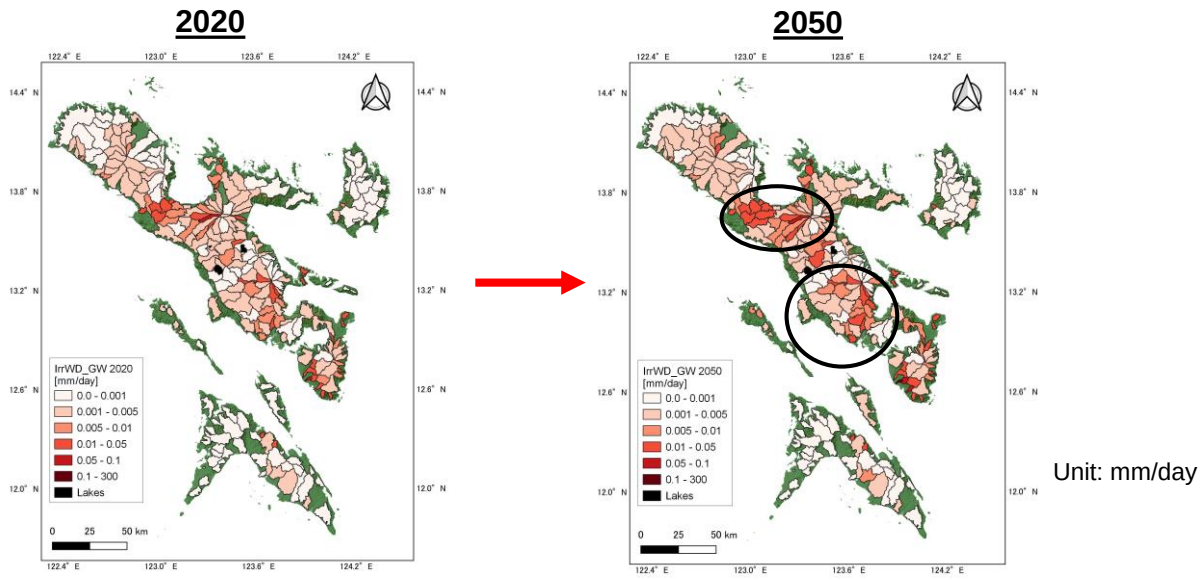
Irrigation water demand of surface water at present and future in WRR-XI were estimated by each sub-basin as shown in Figure below. Irrigation water demand of surface water in 2050 will be increased especially in Eastern Part of WRR-V.



Source: JICA Survey Team

Figure D-360 Irrigation Water Demand of Surface Water in WRR-V

Irrigation water demand of groundwater at present and future in WRR-XI were estimated by each sub-basin as shown in Figure below. Irrigation water demand of groundwater of 2050 will be not so changed in future in the WRR-V.



Source: JICA Survey Team

Figure D-361 Irrigation Water Demand of Groundwater in WRR-V

2) Livestock Water Demand (SW&GW)

Provincial-wise livestock water demands were estimated by Section 3.2.6-(2). The water demand of each sub-basin in SHER Model and for water balance was calculated by multiplying the area of each province by the area ratio of each municipality included in each sub-basin as follows.

(Sub-Basin-wise Livestock WD) = (Provincial-wise Livestock WD) x (Area Ratio of Municipality in Province) x (Area Ratio of Sub-basin in Municipality)

3) Fishpond Water Demand (SW&GW)

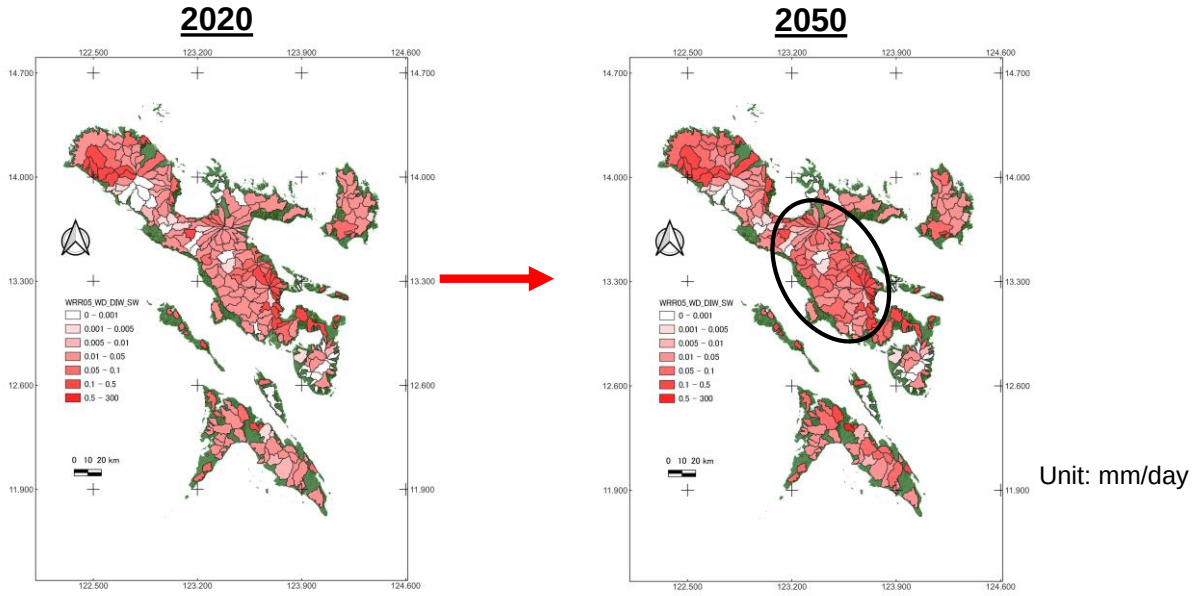
Provincial-wise fishpond water demands were estimated by Section 3.2.6-(2). However, in this water balance study, the fishpond water demands are not considered in SHER Model and for water balance. This is because the fishpond water demand is considered to be almost equal to the amount of water intake and the amount of return, and the water consumption in the fishpond is considered to be negligible small.

4) Municipal and Industrial Water Demand (SW&GW)

Provincial-wise and municipality-wise Municipal and industrial water demands were estimated by Section 3.2.6-(3). The water demand of each sub-basin in SHER Model and for water balance was calculated by multiplying the area ratio of each municipality included in each sub-basin as follows.

(Sub-Basin-wise MIWD) = (Municipality-wise MIWD) x (Area Ratio of Sub-basin in Municipality)

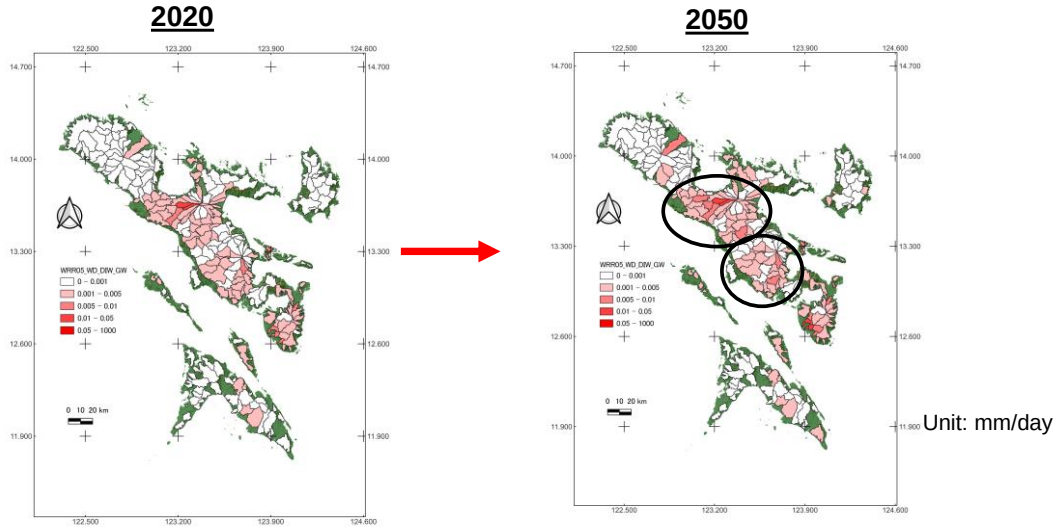
Municipal and industrial water demand of surface water at present and future in WRR-XI were estimated by each sub-basin as shown in Figure below. Municipal and industrial water demand of surface water of 2050 will be not so changed in future in the WRR-XI.



Source: JICA Survey Team

Figure D-362 Municipal and Industrial Water Demand of Surface Water in WRR-V

Municipal and industrial water demand of groundwater at present and future in WRR-XI were estimated by each sub-basin as shown in Figure below. Municipal and industrial water demand of groundwater of 2050 will be increased in near Metro Davao City and Metro General Santos areas.



Source: JICA Survey Team

Figure D-363 Municipal and Industrial Water Demand of Groundwater in WRR-V

5) Other Water Demand (SW&GW)

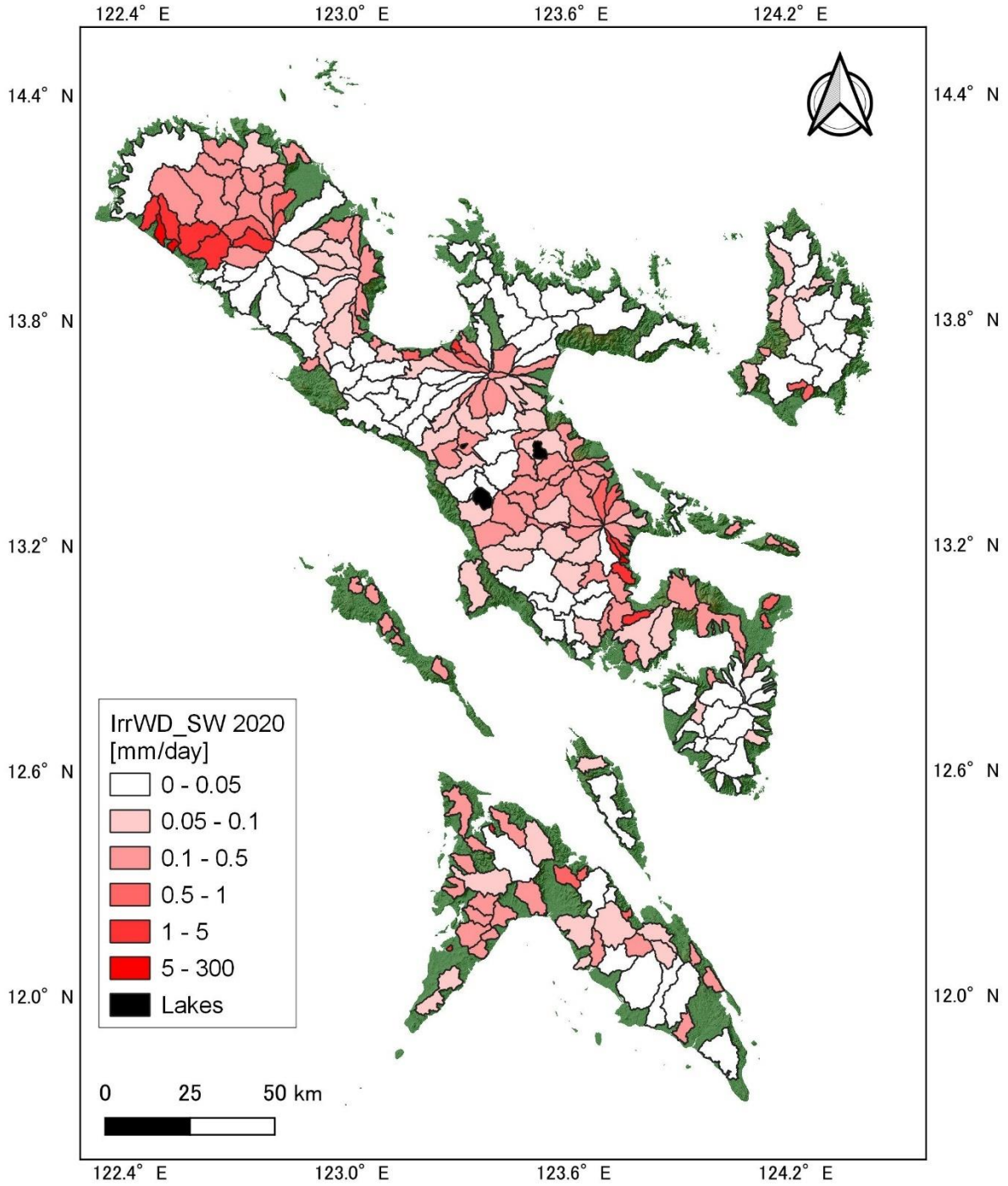
"Other water demand" is estimated by multiplying the construction water demand by Sub-Basin by the ratio of construction water demand and other water demand of NWRB water rights in each province.

(Sub-Basin-wise Other WD) = (Sub-Basin-wise MIWD) x (Ratio of water rights of MIWWD and Other WD)

In the water balance calculation of this study, the water demand for power generation was assumed to be so small that the water consumption could be ignored.

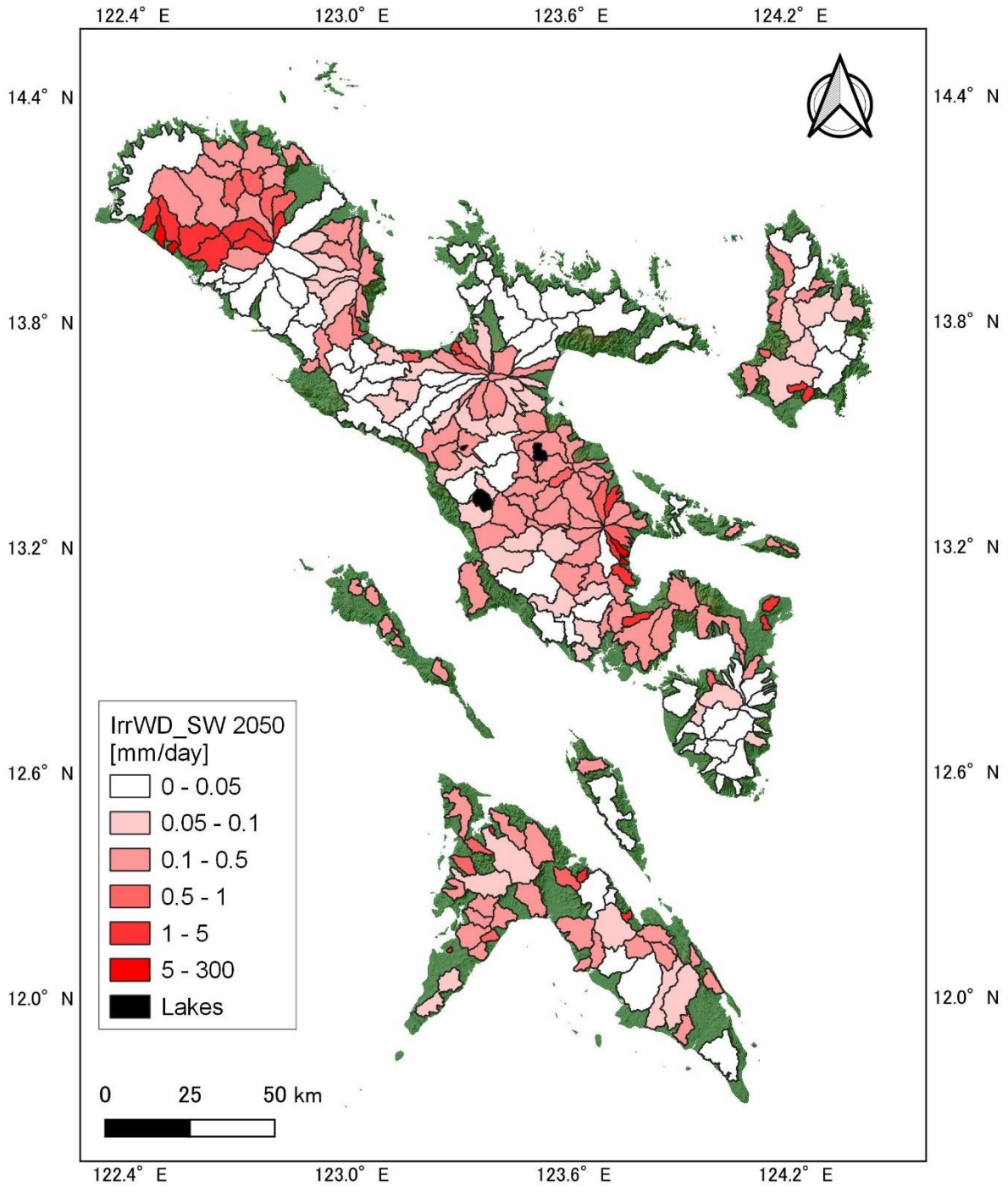
(2) Maps of Results of Sub-Basin wise Water Demand

1) Irrigation Water Demand (SW&GW)



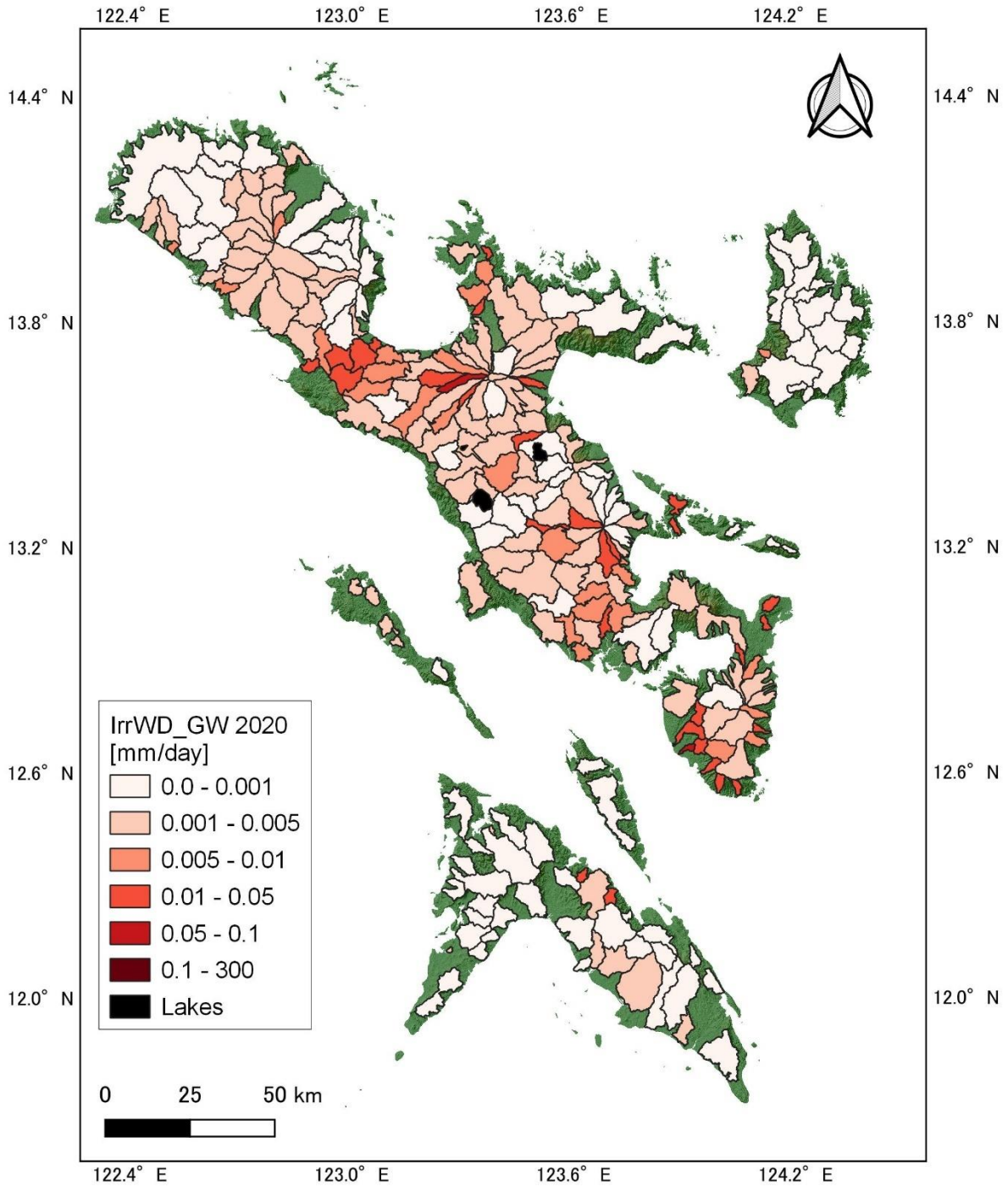
Source: JICA Survey Team

Figure D-364 Irrigation Water Demand of Surface Water in WRR-V (2020)



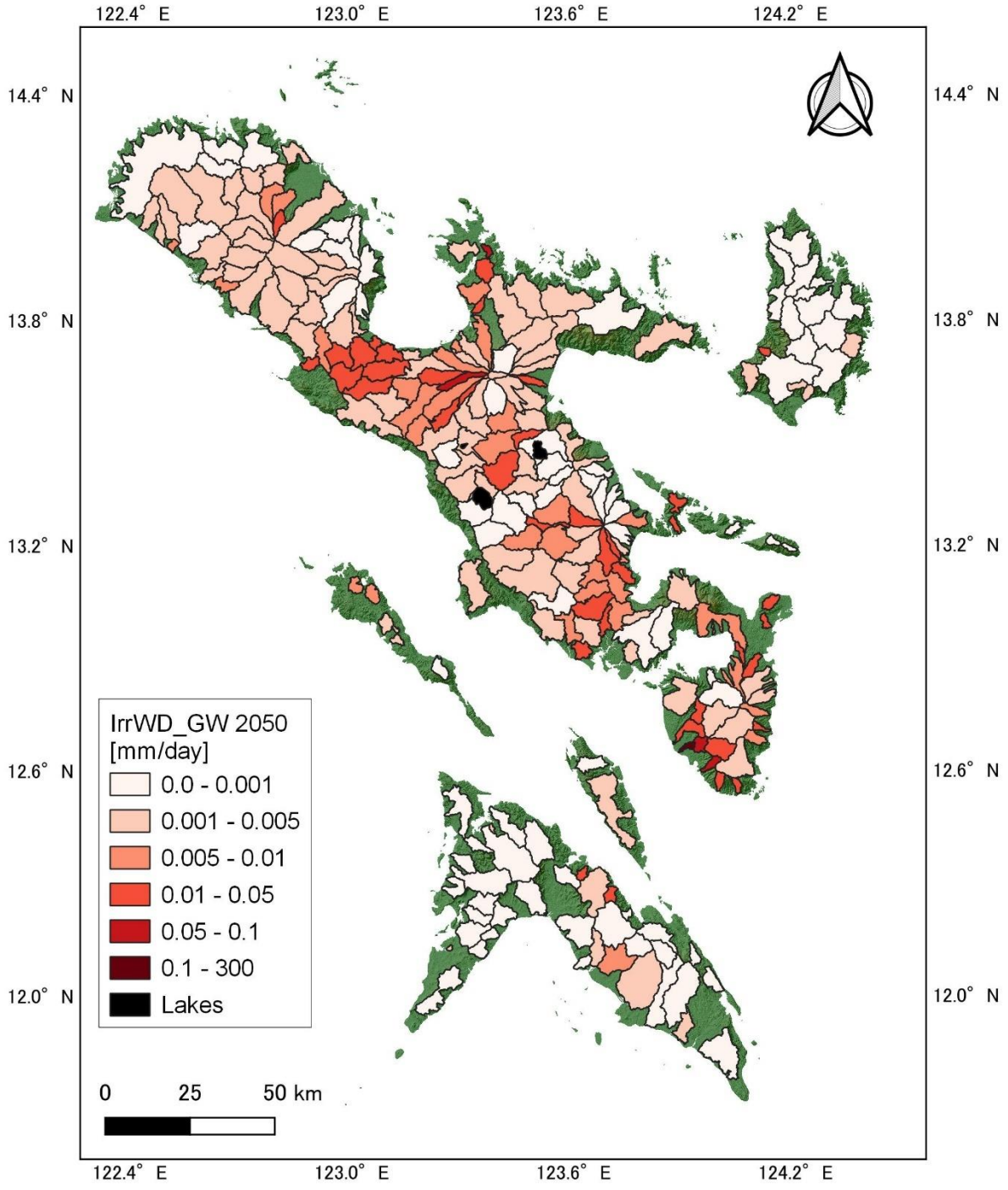
Source: JICA Survey Team

Figure D-365 Irrigation Water Demand of Surface Water in WRR-V (2025)



Source: JICA Survey Team

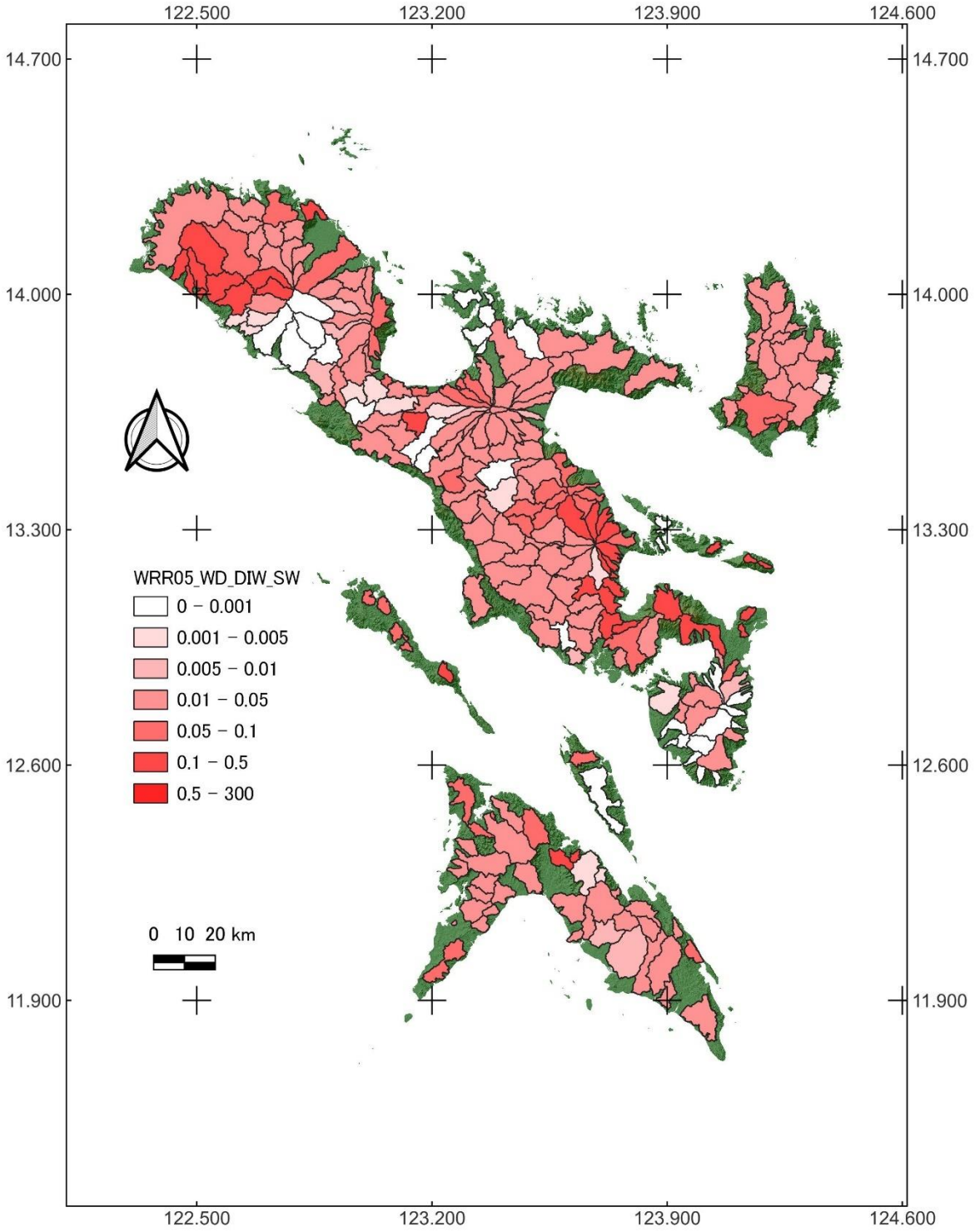
Figure D-366 Irrigation Water Demand of Groundwater in WRR-V (2020)



Source: JICA Survey Team

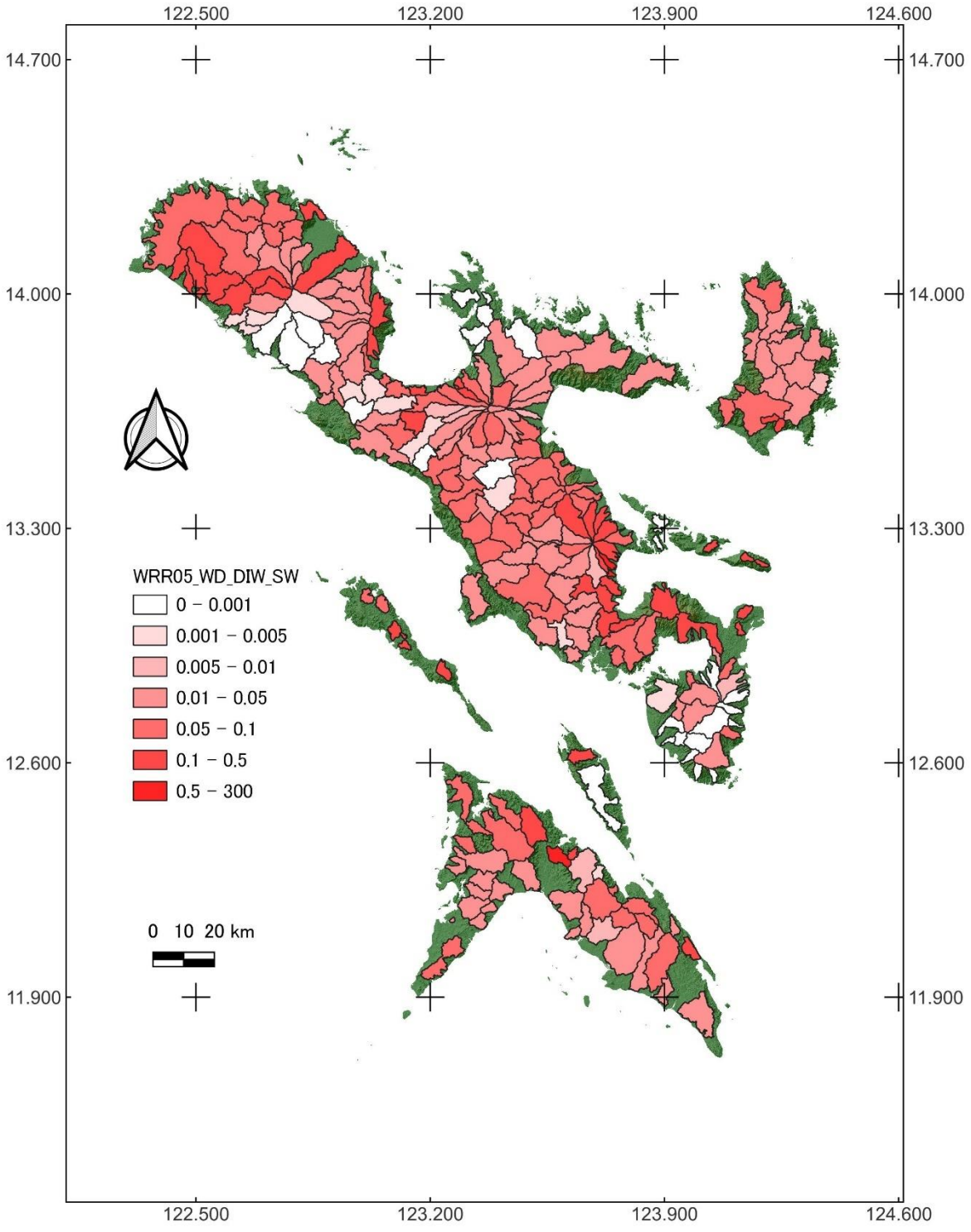
Figure D-367 Irrigation Water Demand of Groundwater in WRR-V (2025)

2) Municipal and Industrial Water Demand (SW&GW)



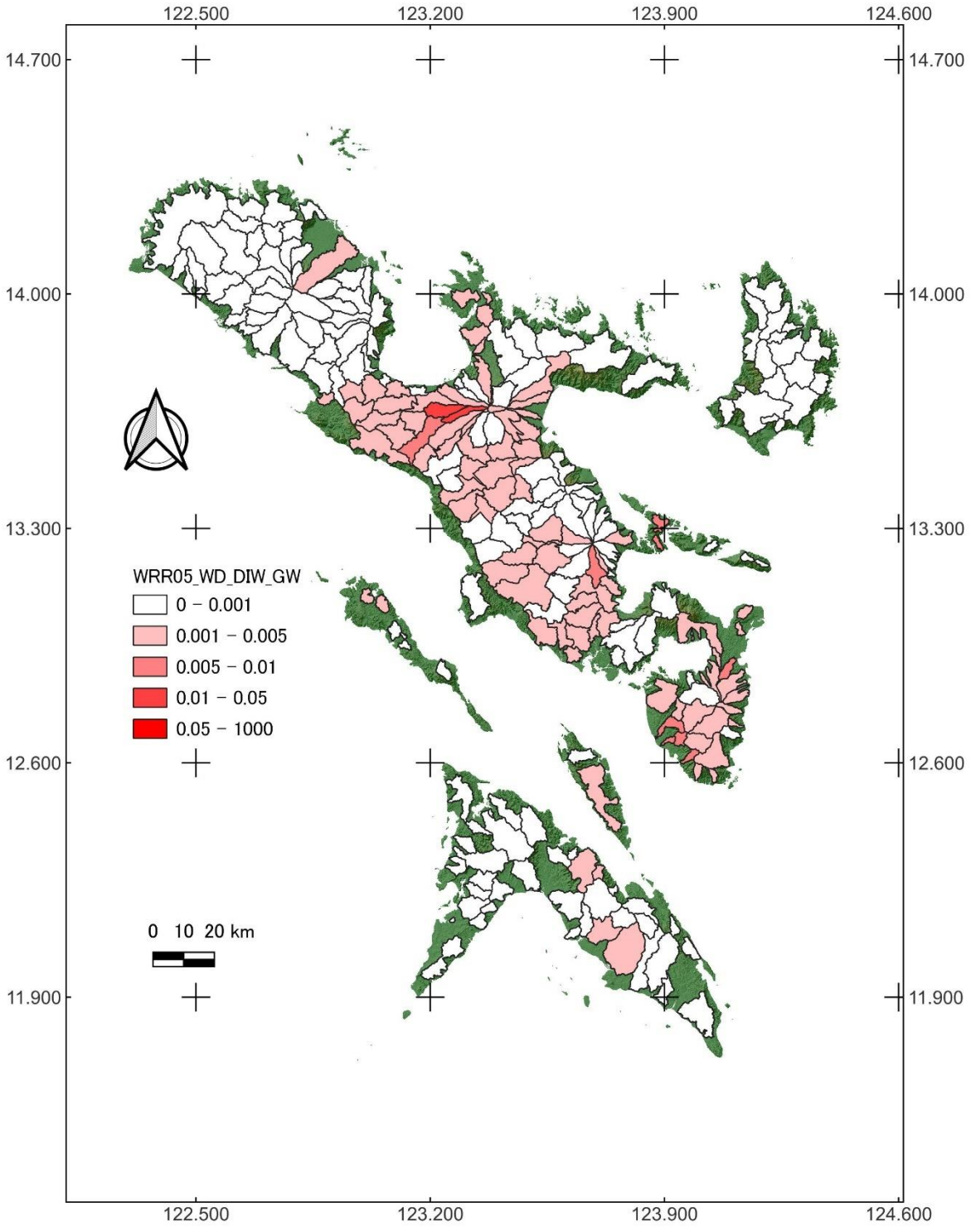
Source: JICA Survey Team

Figure D-368 Municipal and Industrial Water Demand of Surface Water in WRR-V (2020)



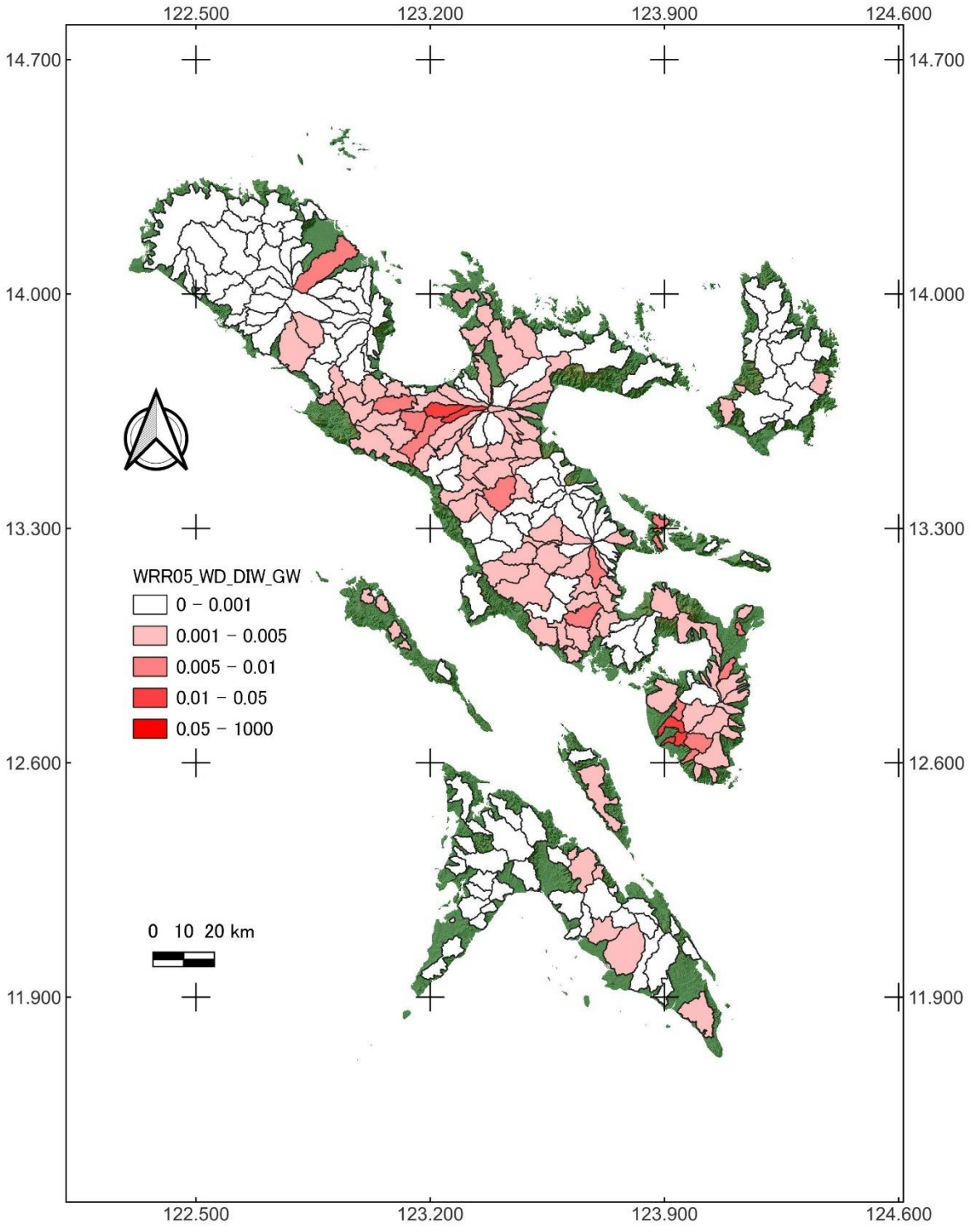
Source: JICA Survey Team

Figure D-369 Municipal and Industrial Water Demand of Surface Water in WRR-V (2020)



Source: JICA Survey Team

Figure D-370 Municipal and Industrial Water Demand of Groundwater in WRR-V (2050)



Source: JICA Survey Team

Figure D-371 Municipal and Industrial Water Demand of Groundwater in WRR-V (2050)

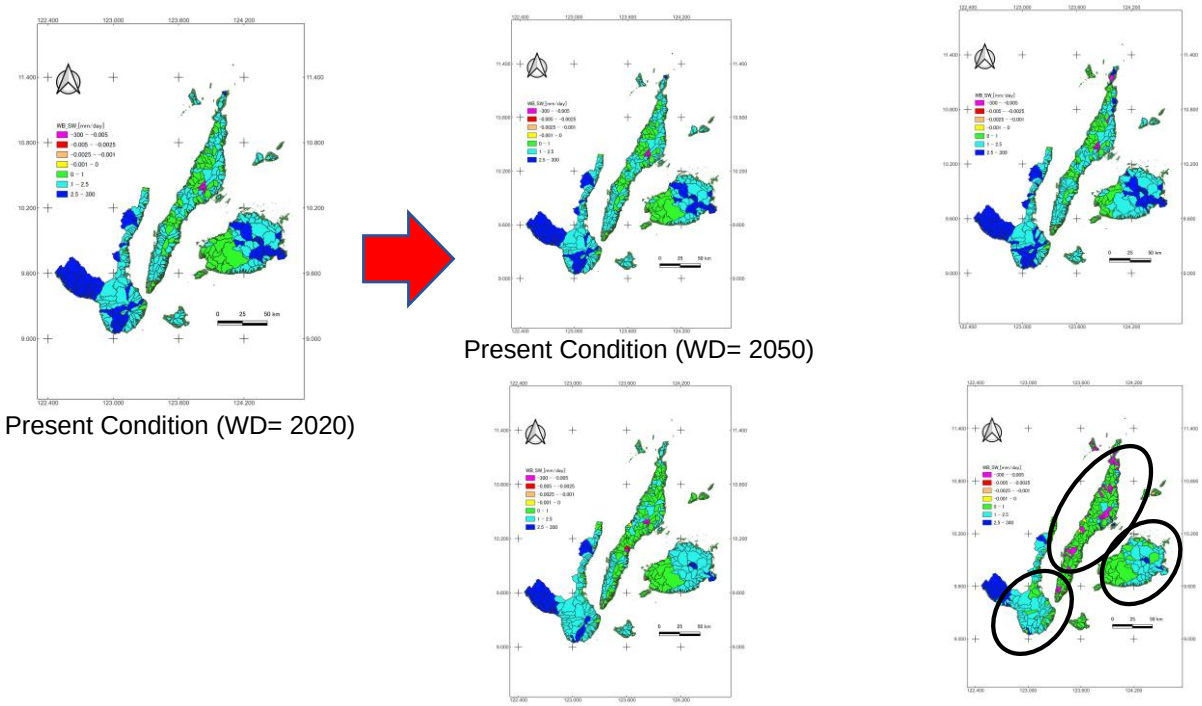
11.3 Results of Detailed Water Balance Analysis in Priority WRRs

11.3.1 WRR-VII

(1) Sub-Basin wise Surface Water Balance

Sub-basin wise surface water balance at present condition, future (2050) and climate change condition is shown Figure below.

In terms of future water demand (2050), in the RCP8.5-Low case of climate change, the surface water balance of the entire Cebu Island and the entire Bohol Island is on a declining trend, and it is expected that the water balance will be especially tight in the Metro Cebu area.



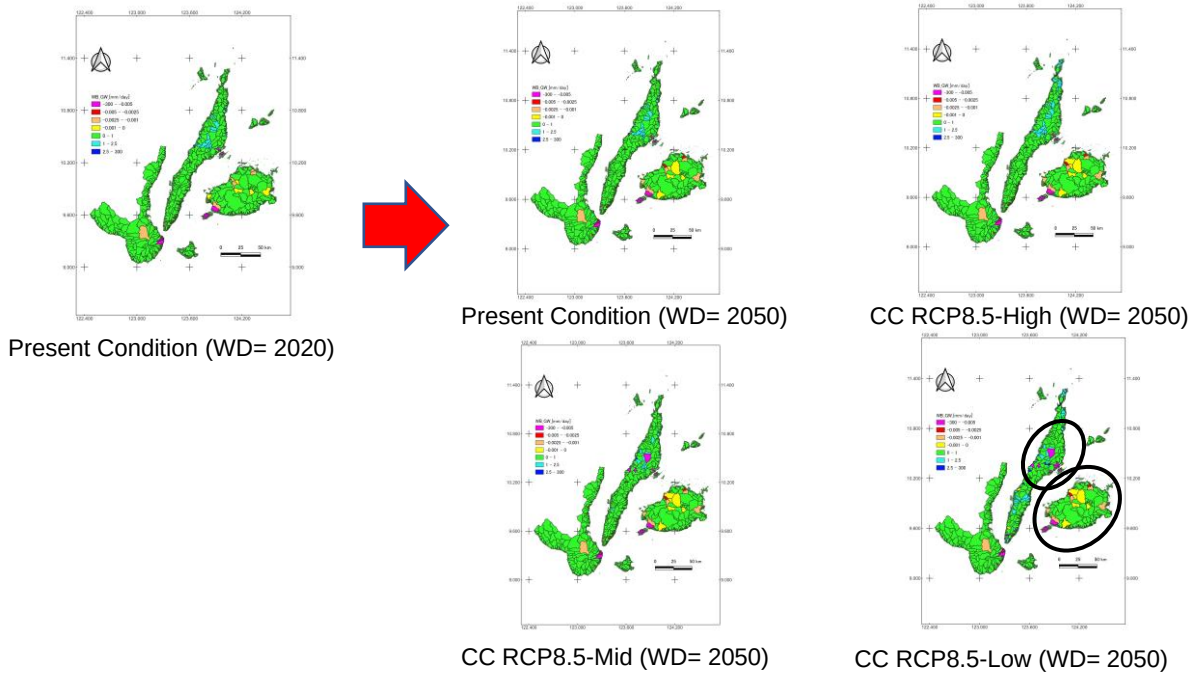
Source: JICA Survey Team

Figure D-372 Estimated Sub-Basin wise Surface Water Balance in WRR-VII

(2) Sub-Basin wise Groundwater Balance

Sub-basin wise Groundwater balance at present condition, future (2050) and climate change condition is shown Figure below.

In terms of future water demand (2050), in the RCP8.5-Low case of climate change for the groundwater balance of the Metro Cebu areas will be on a declining trend. In terms of future water demand (2050), in the RCP8.5-High case of climate change for the groundwater balance of entire Bohol Island will be on a declining trend.



Source: JICA Survey Team

Figure D-373 Estimated Sub-Basin wise Groundwater Balance in WRR-VII

(3) Provincial-wise Water Balance

Provincial-wise surface and ground water balance in 1/5-dry year at present weather condition and water demand of 2050 are shown in Tables below.

Table D-106 Surface and Groundwater Balance of Cebu Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Cebu Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,743 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	245.6	329.9	355.8	102.8	690.6	757.3	758.0	567.0	488.7	576.8	339.9	326.3	5,538.8	
Surface Water Potential	**165.4**	**148.2**	**148.3**	**87.8**	**125.3**	**160.1**	**164.1**	**165.7**	**131.7**	**162.6**	**104.5**	**108.6**	**1,672.4**	
Irrigation Water Demand (SW)	23.4	10.1	0.0	0.0	4.0	20.9	15.9	20.3	8.5	3.0	21.2	19.1	146.3	
Livestock Water Deamnd (SW)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	6.7	
Municipal and Industrial Water Demand (SW)	10.2	9.3	10.2	9.9	10.2	9.9	10.2	10.2	9.9	10.2	9.9	10.2	120.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	34.2	19.9	10.8	10.5	14.8	31.4	26.7	31.1	19.0	13.8	31.7	29.9	273.6	
SW Water Balance	**131.2**	**128.4**	**137.5**	**77.4**	**110.5**	**128.7**	**137.4**	**134.7**	**112.7**	**148.9**	**72.8**	**78.7**	**1,398.8**	**0.0**
Groundwater Potential	**77.0**	**72.2**	**76.5**	**73.7**	**75.7**	**73.2**	**75.1**	**75.1**	**72.6**	**75.3**	**73.2**	**75.3**	**895.0**	
Safety Groundwater Availability (70% of GWP)	**53.9**	**50.5**	**53.6**	**51.6**	**53.0**	**51.2**	**52.6**	**52.6**	**50.9**	**52.7**	**51.3**	**52.7**	**626.5**	
Irrigation Water Demand (GW)	3.2	1.4	0.0	0.0	0.7	3.5	2.5	3.4	1.2	0.5	2.8	2.7	21.7	
Livestock Water Deamnd (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.4	
Municipal and Industrial Water Demand (GW)	47.0	42.4	47.0	45.5	47.0	45.5	47.0	47.0	45.5	47.0	45.5	47.0	553.3	
Other Water Demand (GW)	22.3	20.2	22.3	21.6	22.3	21.6	22.3	22.3	21.6	22.3	21.6	22.3	263.0	
Total Water Demand (GW)	73.0	64.5	69.9	67.6	70.6	71.1	72.4	73.2	68.9	70.4	70.4	72.5	844.4	
GW Water Balance	**-19.1**	**-14.0**	**-16.3**	**-16.1**	**-17.6**	**-19.9**	**-19.8**	**-20.7**	**-18.0**	**-17.7**	**-19.2**	**-19.8**	**-217.9**	**-218.0**
Total Water Potential (SW+GW)	**219.3**	**198.7**	**201.9**	**139.4**	**178.3**	**211.3**	**216.7**	**218.3**	**182.5**	**215.3**	**155.7**	**161.2**	**2,298.9**	
Irrigation Water Demand (Total)	26.6	11.5	0.0	0.0	4.7	24.4	18.4	23.6	9.8	3.5	24.0	21.8	168.0	
Livestock Water Deamnd (Total)	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	13.1	
Municipal and Industrial Water Demand (Total)	57.2	51.7	57.2	55.4	57.2	55.4	57.2	57.2	55.4	57.2	55.4	57.2	673.9	
Other Water Demand (Total)	22.3	20.2	22.3	21.6	22.3	21.6	22.3	22.3	21.6	22.3	21.6	22.3	263.0	
Total Water Demand (SW+GW)	107.2	84.3	80.7	78.1	85.4	102.5	99.1	104.3	87.9	84.2	102.1	102.4	1,118.0	
Total Water Balance (SW+GW)	**112.1**	**114.4**	**121.2**	**61.3**	**93.0**	**108.8**	**117.6**	**114.0**	**94.7**	**131.2**	**53.7**	**58.8**	**1,180.9**	**-218.0**

Source: JICA Survey Team

Table D-107 Surface and Groundwater Balance of Bohol Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Bohol Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,402 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	477.0	401.1	853.5	82.2	271.4	731.8	590.7	774.5	503.6	464.0	180.1	166.5	5,496.3	
Surface Water Potential	**252.4**	**284.7**	**371.1**	**136.2**	**99.7**	**241.2**	**275.6**	**369.3**	**329.8**	**225.4**	**143.7**	**135.8**	**2,865.0**	
Irrigation Water Demand (SW)	71.3	38.5	17.7	0.0	10.3	29.8	76.8	73.2	40.3	21.7	75.0	98.4	559.6	
Livestock Water Deamnd (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.8	
Municipal and Industrial Water Demand (SW)	2.9	2.6	2.9	2.8	2.9	2.8	2.9	2.9	2.8	2.9	2.8	2.9	33.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	74.6	41.5	20.9	3.2	13.5	33.0	80.0	76.5	43.4	25.0	78.1	101.6	598.0	
SW Water Balance	**177.8**	**243.2**	**350.1**	**133.1**	**86.2**	**208.2**	**195.6**	**292.8**	**286.4**	**200.4**	**65.6**	**34.1**	**2,267.0**	**0.0**
Groundwater Potential	**1.4**	**1.2**	**0.9**	**0.7**	**0.8**	**1.0**	**0.9**	**0.8**	**0.8**	**0.9**	**1.2**	**1.2**	**11.9**	
Safety Groundwater Availability (70% of GWP)	**1.0**	**0.8**	**0.6**	**0.5**	**0.6**	**0.7**	**0.6**	**0.6**	**0.6**	**0.7**	**0.9**	**0.8**	**8.3**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.1	
Municipal and Industrial Water Demand (GW)	6.7	6.0	6.7	6.5	6.7	6.5	6.7	6.7	6.5	6.7	6.5	6.7	78.7	
Other Water Demand (GW)	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.6	
Total Water Demand (GW)	7.2	6.5	7.2	6.9	7.2	6.9	7.2	7.2	6.9	7.2	6.9	7.2	84.4	
GW Water Balance	**-6.2**	**-5.6**	**-6.5**	**-6.4**	**-6.6**	**-6.2**	**-6.6**	**-6.6**	**-6.4**	**-6.5**	**-6.1**	**-6.4**	**-76.0**	**-76.0**
Total Water Potential (SW+GW)	**253.7**	**285.9**	**372.0**	**137.0**	**100.6**	**242.2**	**276.5**	**370.1**	**330.7**	**226.3**	**145.0**	**136.9**	**2,876.9**	
Irrigation Water Demand (Total)	71.3	38.5	17.7	0.0	10.3	29.8	76.8	73.2	40.3	21.7	75.0	98.4	553.0	
Livestock Water Deamnd (Total)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.9	
Municipal and Industrial Water Demand (Total)	9.5	8.6	9.5	9.2	9.5	9.2	9.5	9.5	9.2	9.5	9.2	9.5	112.3	
Other Water Demand (Total)	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.6	
Total Water Demand (SW+GW)	81.7	47.9	28.1	10.1	20.7	39.9	87.2	83.7	50.4	32.2	85.1	108.8	675.7	
Total Water Balance (SW+GW)	**172.0**	**237.9**	**343.9**	**126.9**	**79.9**	**202.3**	**189.3**	**286.5**	**280.3**	**194.2**	**59.9**	**28.1**	**2,201.2**	**-76.0**

Source: JICA Survey Team

Table D-108 Surface and Groundwater Balance of Negros Oriental Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Bohol Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,402 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	477.0	401.1	853.5	82.2	271.4	731.8	590.7	774.5	503.6	464.0	180.1	166.5	5,496.3	
Surface Water Potential	**252.4**	**284.7**	**371.1**	**136.2**	**99.7**	**241.2**	**275.6**	**369.3**	**329.8**	**225.4**	**143.7**	**135.8**	**2,865.0**	
Irrigation Water Demand (SW)	23.4	10.1	0.0	0.0	4.0	20.9	15.9	20.3	8.5	3.0	21.2	19.1	146.3	
Livestock Water Deamnd (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.8	
Municipal and Industrial Water Demand (SW)	3.5	3.2	3.5	3.4	3.5	3.4	3.5	3.5	3.4	3.5	3.4	3.5	41.8	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	27.4	13.7	4.0	3.8	7.9	24.7	19.8	24.2	12.3	6.9	25.0	23.1	192.9	
SW Water Balance	**225.0**	**271.0**	**367.1**	**132.4**	**91.8**	**216.5**	**255.8**	**345.1**	**317.5**	**218.4**	**118.7**	**112.7**	**2,672.1**	**0.0**
Groundwater Potential	**1.4**	**1.2**	**0.9**	**0.7**	**0.8**	**1.0**	**0.9**	**0.8**	**0.8**	**0.9**	**1.2**	**1.2**	**11.9**	
Safety Groundwater Availability (70% of GWP)	**1.0**	**0.8**	**0.6**	**0.5**	**0.6**	**0.7**	**0.6**	**0.6**	**0.6**	**0.7**	**0.9**	**0.8**	**8.3**	
Irrigation Water Demand (GW)	3.2	1.4	0.0	0.0	0.7	3.5	2.5	3.4	1.2	0.5	2.8	2.7	21.7	
Livestock Water Deamnd (GW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.1	
Municipal and Industrial Water Demand (GW)	8.7	7.8	8.7	8.4	8.7	8.4	8.7	8.7	8.4	8.7	8.4	8.7	102.0	
Other Water Demand (GW)	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.6	
Total Water Demand (GW)	12.3	9.6	9.1	8.9	9.9	12.3	11.6	12.5	10.1	9.7	11.6	11.8	129.4	
GW Water Balance	**-11.3**	**-8.8**	**-8.5**	**-8.3**	**-9.3**	**-11.6**	**-11.0**	**-11.9**	**-9.5**	**-9.0**	**-10.8**	**-11.0**	**-121.0**	**-121.1**
Total Water Potential (SW+GW)	**253.3**	**285.5**	**371.7**	**136.8**	**100.3**	**241.9**	**276.3**	**369.9**	**330.4**	**226.0**	**144.6**	**136.6**	**2,873.3**	
Irrigation Water Demand (Total)	26.6	11.5	0.0	0.0	4.7	24.4	18.4	23.6	9.8	3.5	24.0	21.8	168.0	
Livestock Water Deamnd (Total)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.9	
Municipal and Industrial Water Demand (Total)	12.2	11.0	12.2	11.8	12.2	11.8	12.2	12.2	11.8	12.2	11.8	12.2	143.8	
Other Water Demand (Total)	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.6	
Total Water Demand (SW+GW)	39.7	23.3	13.1	12.7	17.8	37.1	31.5	36.7	22.4	16.6	36.7	34.9	322.3	
Total Water Balance (SW+GW)	**213.7**	**262.2**	**358.6**	**124.1**	**82.5**	**204.9**	**244.8**	**333.1**	**308.0**	**209.4**	**107.9**	**101.7**	**2,551.1**	**-121.1**

Source: JICA Survey Team

Table D-109 Surface and Groundwater Balance of Siquijor Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Siquijor Target Year= 2050
Weather Condition: Present Total Area [km2]= 163 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	23.8	6.7	4.6	2.5	7.8	35.9	25.5	12.9	16.1	17.4	29.4	20.4	202.9	
Surface Water Potential	**8.9**	**7.7**	**8.1**	**6.8**	**6.4**	**6.1**	**7.7**	**9.4**	**9.0**	**9.1**	**9.0**	**10.7**	**98.7**	
Irrigation Water Demand (SW)	23.4	10.1	0.0	0.0	4.0	20.9	15.9	20.3	8.5	3.0	21.2	19.1	146.3	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (SW)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	24.7	11.3	1.3	1.3	5.3	22.2	17.2	21.6	9.8	4.3	22.5	20.4	161.7	
SW Water Balance	**-15.8**	**-3.6**	**6.8**	**5.5**	**1.1**	**-16.1**	**-9.5**	**-12.2**	**-0.8**	**4.8**	**-13.4**	**-9.7**	**-62.9**	**-81.1**
Groundwater Potential	**0.4**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**4.5**	
Safety Groundwater Availability (70% of GWP)	**0.3**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**3.1**	
Irrigation Water Demand (GW)	3.2	1.4	0.0	0.0	0.7	3.5	2.5	3.4	1.2	0.5	2.8	2.7	21.7	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.0	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	3.8	2.0	0.7	0.7	1.4	4.1	3.2	4.1	1.9	1.2	3.5	3.3	29.7	
GW Water Balance	**-3.6**	**-1.7**	**-0.4**	**-0.4**	**-1.1**	**-3.9**	**-2.9**	**-3.8**	**-1.6**	**-0.9**	**-3.2**	**-3.1**	**-26.5**	**-26.7**
Total Water Potential (SW+GW)	**9.2**	**7.9**	**8.3**	**7.0**	**6.6**	**6.3**	**8.0**	**9.6**	**9.3**	**9.4**	**9.3**	**10.9**	**101.9**	
Irrigation Water Demand (Total)	26.6	11.5	0.0	0.0	4.7	24.4	18.4	23.6	9.8	3.5	24.0	21.8	168.0	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (Total)	1.9	1.7	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	22.6	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	28.5	13.3	2.0	1.9	6.7	26.3	20.4	25.6	11.7	5.5	25.9	23.7	191.3	
Total Water Balance (SW+GW)	**-19.4**	**-5.3**	**6.3**	**5.1**	**-0.0**	**-20.0**	**-12.4**	**-16.0**	**-2.4**	**3.9**	**-16.6**	**-12.8**	**-89.5**	**-107.8**

Source: JICA Survey Team

Summary of water balance and deficit estimation of provincial-wise surface and ground water balance at each climate change condition and water demand of 2020 and 2050 are shown in Tables below. In Cebu Island, Bohol Island and Siquijor Island, negative values of annual water and deficit of groundwater will be increased in future.

Table D-11.3110 Summary of Annual Water Balance and Deficit of Cebu Province at Each Climate Change Condition

Total Area [km^2]= 3,742.7

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	2,519.8	-43.4	2,476.4	0.0	-43.4	-43.4
2	Present	2020	1/5-Dry Year	1,428.6	-69.0	1,359.6	0.0	-69.0	-69.0
3	Present	2020	1/10-Dry Year	616.7	-124.4	492.3	0.0	-124.4	-124.4
4	Present	2050	Average Year	2,489.9	-192.2	2,297.7	0.0	-192.4	-192.4
5	Present	2050	1/5-Dry Year	1,398.8	-217.9	1,180.9	0.0	-218.0	-218.0
6	Present	2050	1/10-Dry Year	586.9	-273.3	313.6	0.0	-273.4	-273.4
7	CC RCP8.5-High	2050	Average Year	3,071.5	-39.7	3,031.8	0.0	-39.9	-39.9
8	CC RCP8.5-High	2050	1/5-Dry Year	1,559.5	-72.2	1,487.2	0.0	-72.3	-72.3
9	CC RCP8.5-High	2050	1/10-Dry Year	520.2	-150.3	370.0	0.0	-150.4	-150.4
10	CC RCP8.5-Mid.	2050	Average Year	2,254.1	-148.4	2,105.7	0.0	-148.5	-148.5
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,063.8	-199.5	864.3	0.0	-199.6	-199.6
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	442.9	-252.9	190.0	0.0	-253.0	-253.0
13	CC RCP8.5-Low	2050	Average Year	1,657.7	-229.2	1,428.4	0.0	-229.4	-229.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	874.7	-294.2	580.5	0.0	-294.3	-294.3
15	CC RCP8.5-Low	2050	1/10-Dry Year	167.4	-337.4	-170.0	-0.8	-337.5	-338.3

Source: JICA Survey Team

Table D-111 Summary of Annual Water Balance and Deficit of Bohol Province at Each Climate Change Condition

Total Area [km^2]= 3,401.6

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	3,870.1	-62.2	3,807.9	0.0	-62.2	-62.2
2	Present	2020	1/5-Dry Year	2,513.8	-63.0	2,450.8	0.0	-63.0	-63.0
3	Present	2020	1/10-Dry Year	2,817.6	-54.0	2,763.6	0.0	-54.0	-54.0
4	Present	2050	Average Year	4,028.4	-120.2	3,908.2	0.0	-120.3	-120.3
5	Present	2050	1/5-Dry Year	2,672.1	-121.0	2,551.1	0.0	-121.1	-121.1
6	Present	2050	1/10-Dry Year	2,975.9	-112.0	2,863.9	0.0	-112.1	-112.1
7	CC RCP8.5-High	2050	Average Year	4,338.4	-120.2	4,218.2	0.0	-120.3	-120.3
8	CC RCP8.5-High	2050	1/5-Dry Year	2,794.8	-121.0	2,673.8	0.0	-121.1	-121.1
9	CC RCP8.5-High	2050	1/10-Dry Year	3,187.7	-112.0	3,075.8	0.0	-112.1	-112.1
10	CC RCP8.5-Mid.	2050	Average Year	3,309.3	-120.2	3,189.1	0.0	-120.3	-120.3
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	2,338.7	-121.0	2,217.7	0.0	-121.2	-121.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2,612.6	-112.0	2,500.6	0.0	-112.1	-112.1
13	CC RCP8.5-Low	2050	Average Year	2,382.5	-120.3	2,262.2	0.0	-120.4	-120.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,771.6	-121.1	1,650.5	0.0	-121.2	-121.2
15	CC RCP8.5-Low	2050	1/10-Dry Year	1,978.0	-112.1	1,865.9	0.0	-112.2	-112.2

Source: JICA Survey Team

Table D-112 Summary of Annual Water Balance and Deficit of Negros Oriental Province at Each Climate Change Condition

Total Area [km^2]= 3,540.7

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	4,305.0	32.4	4,337.4	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	2,906.5	29.9	2,936.4	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	3,032.5	39.5	3,072.0	0.0	0.0	0.0
4	Present	2050	Average Year	4,384.7	3.0	4,387.7	0.0	-4.2	-4.2
5	Present	2050	1/5-Dry Year	2,986.2	0.5	2,986.7	0.0	-5.5	-5.5
6	Present	2050	1/10-Dry Year	3,112.2	10.1	3,122.3	0.0	-3.2	-3.2
7	CC RCP8.5-High	2050	Average Year	4,615.2	3.1	4,618.3	0.0	-4.2	-4.2
8	CC RCP8.5-High	2050	1/5-Dry Year	3,139.4	0.6	3,140.0	0.0	-5.4	-5.4
9	CC RCP8.5-High	2050	1/10-Dry Year	3,210.2	10.2	3,220.4	0.0	-3.2	-3.2
10	CC RCP8.5-Mid.	2050	Average Year	3,666.4	2.8	3,669.3	0.0	-4.2	-4.2
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	2,512.4	0.1	2,512.5	0.0	-5.7	-5.7
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2,587.3	9.9	2,597.2	0.0	-3.2	-3.2
13	CC RCP8.5-Low	2050	Average Year	2,551.9	2.4	2,554.3	0.0	-4.4	-4.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,638.8	-1.4	1,637.4	0.0	-6.6	-6.6
15	CC RCP8.5-Low	2050	1/10-Dry Year	1,682.9	9.3	1,692.2	0.0	-3.5	-3.5

Source: JICA Survey Team

Table D-113 Summary of Annual Water Balance and Deficit of Siquijor Province at Each Climate Change Condition

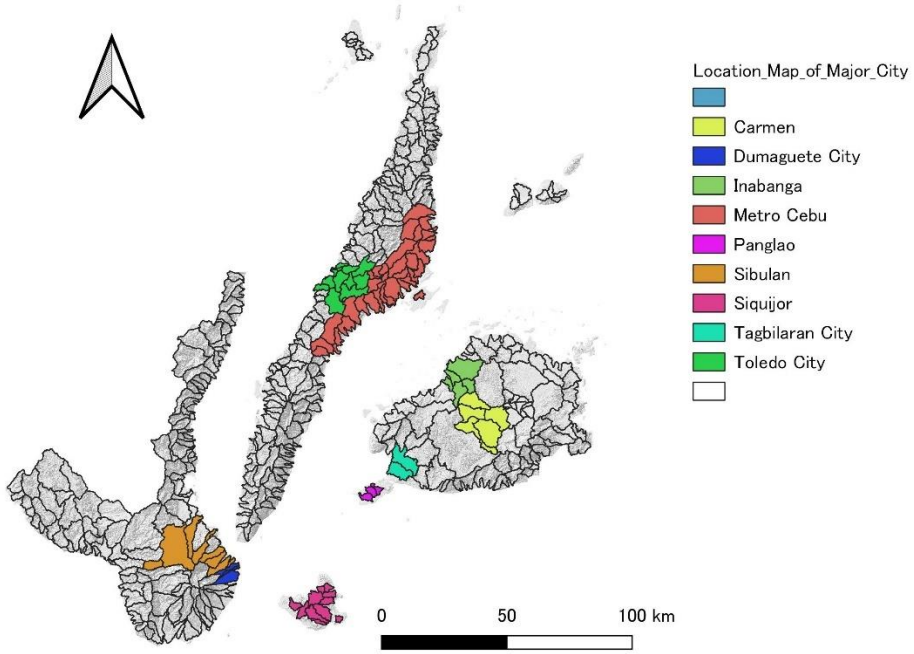
Total Area [km^2]= 163.1

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	83.5	-1.0	82.5	0.0	-1.0	-1.0
2	Present	2020	1/5-Dry Year	83.5	-1.0	82.5	0.0	-1.0	-1.0
3	Present	2020	1/10-Dry Year	83.5	-1.0	82.4	0.0	-1.0	-1.0
4	Present	2050	Average Year	-62.9	-26.5	-89.5	-81.1	-26.7	-107.8
5	Present	2050	1/5-Dry Year	-62.9	-26.5	-89.5	-81.1	-26.7	-107.8
6	Present	2050	1/10-Dry Year	-63.0	-26.5	-89.5	-81.1	-26.7	-107.8
7	CC RCP8.5-High	2050	Average Year	-58.0	-26.5	-84.6	-78.0	-26.7	-104.6
8	CC RCP8.5-High	2050	1/5-Dry Year	-58.0	-26.5	-84.6	-78.0	-26.7	-104.6
9	CC RCP8.5-High	2050	1/10-Dry Year	-58.0	-26.5	-84.6	-78.0	-26.7	-104.6
10	CC RCP8.5-Mid.	2050	Average Year	-74.5	-26.6	-101.0	-88.1	-26.7	-114.8
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	-74.5	-26.6	-101.0	-88.1	-26.7	-114.8
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	-74.5	-26.6	-101.0	-88.1	-26.7	-114.8
13	CC RCP8.5-Low	2050	Average Year	-103.1	-26.6	-129.7	-110.2	-26.8	-137.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	-103.1	-26.6	-129.7	-110.2	-26.8	-137.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	-103.1	-26.6	-129.7	-110.2	-26.8	-137.0

Source: JICA Survey Team

(4) Major City/Town-wise Water Balance

Location map of major cities in WRR-VII is shown in Figure below.



Source: JICA Survey Team

Figure D-374 Location Map of Major Cities in WRR-VII

The surface and ground water balance in 1/5-dry year in the major cities at present weather condition and water demand of 2050 are shown in Tables below. In most cities, the groundwater balance is projected to be negative against the water demand in 2050, and the negative groundwater balance is particularly large in the Metro Cebu area. All cities will be surplus of surface water balance in future. However, these annual SW potentials are included flood discharge. Thus, SW reservoirs might be needed.

Table D-114 Surface and Groundwater Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Metro Cebu Target Year= 2050
Weather Condition: Present Total Area [km2]= 829 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	45.3	66.1	68.3	21.9	144.7	162.0	171.4	135.2	110.4	127.3	62.6	62.6	1,177.9	
Surface Water Potential	**35.6**	**32.3**	**32.3**	**19.6**	**29.1**	**31.5**	**31.5**	**33.7**	**27.6**	**35.2**	**22.3**	**22.2**	**352.9**	
Irrigation Water Demand (SW)	4.5	1.9	0.0	0.0	0.8	4.0	3.1	3.9	1.6	0.6	4.1	3.7	28.2	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	2.3	2.1	2.3	2.2	2.3	2.2	2.3	2.3	2.2	2.3	2.2	2.3	27.3	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	6.8	4.0	2.3	2.3	3.1	6.3	5.4	6.2	3.9	2.9	6.3	6.0	55.6	
SW Water Balance	**28.8**	**28.2**	**30.0**	**17.3**	**26.0**	**25.2**	**26.2**	**27.5**	**23.7**	**32.3**	**15.9**	**16.2**	**297.3**	**0.0**
Groundwater Potential	**23.3**	**21.9**	**23.3**	**22.4**	**22.8**	**21.8**	**22.3**	**22.3**	**21.6**	**22.4**	**21.7**	**22.2**	**268.1**	
Safety Groundwater Availability (70% of GWP)	**16.3**	**15.3**	**16.3**	**15.7**	**16.0**	**15.3**	**15.6**	**15.6**	**15.1**	**15.7**	**15.2**	**15.5**	**187.6**	
Irrigation Water Demand (GW)	2.2	0.9	0.0	0.0	0.5	2.4	1.7	2.3	0.9	0.4	1.9	1.8	14.9	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (GW)	19.4	17.5	19.4	18.8	19.4	18.8	19.4	19.4	18.8	19.4	18.8	19.4	228.8	
Other Water Demand (GW)	17.4	15.7	17.4	16.9	17.4	16.9	17.4	17.4	16.9	17.4	16.9	17.4	205.0	
Total Water Demand (GW)	39.0	34.2	36.9	35.7	37.4	38.1	38.6	39.2	36.5	37.2	37.6	38.7	449.1	
GW Water Balance	**-22.7**	**-18.9**	**-20.6**	**-20.0**	**-21.4**	**-22.8**	**-23.0**	**-23.5**	**-21.4**	**-21.6**	**-22.4**	**-23.1**	**-261.5**	**-261.5**
Total Water Potential (SW+GW)	**52.0**	**47.6**	**48.6**	**35.2**	**45.0**	**46.7**	**47.2**	**49.4**	**42.7**	**50.9**	**37.4**	**37.7**	**540.5**	
Irrigation Water Demand (Total)	6.7	2.9	0.0	0.0	1.2	6.4	4.8	6.2	2.5	0.9	6.0	5.5	43.1	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Municipal and Industrial Water Demand (Total)	21.7	19.6	21.7	21.0	21.7	21.0	21.7	21.7	21.0	21.7	21.0	21.7	256.1	
Other Water Demand (Total)	17.4	15.7	17.4	16.9	17.4	16.9	17.4	17.4	16.9	17.4	16.9	17.4	205.0	
Total Water Demand (SW+GW)	45.9	38.3	39.2	37.9	40.4	44.4	44.0	45.4	40.4	40.1	43.9	44.7	504.7	
Total Water Balance (SW+GW)	**6.1**	**9.3**	**9.4**	**-2.7**	**4.6**	**2.4**	**3.2**	**3.9**	**2.3**	**10.8**	**-6.5**	**-7.0**	**35.8**	**-261.5**

Source: JICA Survey Team

Table D-115 Surface and Groundwater Balance of Toledo City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Toledo City Target Year= 2050
Weather Condition: Present Total Area [km2]= 272 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	11.6	19.4	19.9	7.4	52.5	60.6	65.5	48.2	37.9	40.4	21.7	22.2	407.4	
Surface Water Potential	**14.2**	**12.6**	**11.2**	**7.2**	**9.5**	**11.0**	**12.0**	**12.7**	**10.6**	**12.5**	**8.3**	**8.4**	**130.1**	
Irrigation Water Demand (SW)	1.6	0.7	0.0	0.0	0.3	1.4	1.1	1.4	0.6	0.2	1.5	1.3	10.1	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.3	0.2	0.3	0.2	0.3	3.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.9	0.9	0.3	0.2	0.5	1.7	1.4	1.7	0.8	0.5	1.7	1.6	13.1	
SW Water Balance	**12.3**	**11.7**	**10.9**	**7.0**	**9.0**	**9.3**	**10.7**	**11.0**	**9.7**	**12.0**	**6.6**	**6.8**	**117.0**	**0.0**
Groundwater Potential	**7.5**	**7.0**	**7.5**	**7.3**	**7.5**	**7.2**	**7.5**	**7.5**	**7.2**	**7.5**	**7.2**	**7.5**	**88.5**	
Safety Groundwater Availability (70% of GWP)	**5.3**	**4.9**	**5.3**	**5.1**	**5.2**	**5.1**	**5.2**	**5.2**	**5.1**	**5.2**	**5.1**	**5.2**	**61.9**	
Irrigation Water Demand (GW)	0.2	0.1	0.0	0.0	0.0	0.2	0.1	0.2	0.1	0.0	0.2	0.1	1.2	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	2.1	1.9	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	25.1	
Other Water Demand (GW)	3.5	3.2	3.5	3.4	3.5	3.4	3.5	3.5	3.4	3.5	3.4	3.5	41.1	
Total Water Demand (GW)	5.8	5.2	5.6	5.4	5.7	5.6	5.8	5.8	5.5	5.7	5.6	5.8	67.4	
GW Water Balance	**-0.5**	**-0.2**	**-0.4**	**-0.3**	**-0.4**	**-0.6**	**-0.5**	**-0.6**	**-0.5**	**-0.4**	**-0.5**	**-0.5**	**-5.5**	**-5.5**
Total Water Potential (SW+GW)	**19.4**	**17.5**	**16.5**	**12.3**	**14.8**	**16.0**	**17.3**	**17.9**	**15.6**	**17.7**	**13.3**	**13.6**	**192.0**	
Irrigation Water Demand (Total)	1.8	0.8	0.0	0.0	0.3	1.6	1.2	1.6	0.7	0.2	1.6	1.5	11.3	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	2.4	2.2	2.4	2.3	2.4	2.3	2.4	2.4	2.3	2.4	2.3	2.4	28.1	
Other Water Demand (Total)	3.5	3.2	3.5	3.4	3.5	3.4	3.5	3.5	3.4	3.5	3.4	3.5	41.1	
Total Water Demand (SW+GW)	7.7	6.1	5.9	5.7	6.2	7.3	7.1	7.5	6.3	6.1	7.3	7.3	80.5	
Total Water Balance (SW+GW)	**11.8**	**11.4**	**10.6**	**6.7**	**8.6**	**8.7**	**10.1**	**10.4**	**9.3**	**11.6**	**6.0**	**6.2**	**111.4**	**-5.5**

Source: JICA Survey Team

Table D-116 Surface and Groundwater Balance of Tagbilaran City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Tagbilaran City Target Year= 2050
Weather Condition: Present Total Area [km2]= 105 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	9.1	8.7	25.2	4.1	8.5	16.9	15.6	17.0	11.2	14.3	8.9	6.8	146.3	
Surface Water Potential	**1.7**	**1.7**	**6.5**	**0.8**	**0.5**	**2.6**	**2.7**	**3.0**	**2.2**	**2.8**	**1.2**	**1.2**	**27.0**	
Irrigation Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.1	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.4	
SW Water Balance	**1.4**	**1.5**	**6.2**	**0.6**	**0.2**	**2.4**	**2.4**	**2.7**	**1.9**	**2.6**	**0.9**	**0.9**	**23.6**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.6	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (GW)	1.3	1.1	1.3	1.2	1.3	1.2	1.3	1.3	1.2	1.3	1.2	1.3	14.8	
GW Water Balance	**-1.2**	**-1.1**	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-1.2**	**-14.7**	**-14.7**
Total Water Potential (SW+GW)	**1.7**	**1.8**	**6.5**	**0.8**	**0.5**	**2.6**	**2.7**	**3.0**	**2.2**	**2.9**	**1.2**	**1.2**	**27.0**	
Irrigation Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	1.5	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	17.7	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (SW+GW)	1.6	1.4	1.5	1.5	1.5	1.5	1.6	1.6	1.5	1.5	1.5	1.6	18.1	
Total Water Balance (SW+GW)	**0.2**	**0.4**	**5.0**	**-0.6**	**-1.1**	**1.1**	**1.1**	**1.4**	**0.7**	**1.3**	**-0.3**	**-0.4**	**8.9**	**-14.7**

Source: JICA Survey Team

Table D-117 Surface and Groundwater Balance of Panglao City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Panglao Target Year= 2050
Weather Condition: Present Total Area [km2]= 32 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	2.6	2.3	7.7	1.3	2.4	5.3	3.7	4.2	2.7	4.1	2.4	1.2	40.0	
Surface Water Potential	**0.2**	**0.3**	**2.0**	**0.1**	**0.0**	**0.4**	**0.3**	**0.4**	**0.2**	**0.5**	**0.1**	**0.0**	**4.5**	
Irrigation Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SW Water Balance	**0.2**	**0.3**	**2.0**	**0.1**	**0.0**	**0.4**	**0.3**	**0.4**	**0.2**	**0.5**	**0.1**	**0.0**	**4.5**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.8	0.7	0.8	0.7	0.8	8.9	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Total Water Demand (GW)	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.3	
GW Water Balance	**-0.8**	**-0.7**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-9.3**	**-9.3**
Total Water Potential (SW+GW)	**0.2**	**0.3**	**2.0**	**0.1**	**0.0**	**0.4**	**0.3**	**0.4**	**0.2**	**0.5**	**0.1**	**0.0**	**4.5**	
Irrigation Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.8	0.7	0.8	0.7	0.8	8.9	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Total Water Demand (SW+GW)	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.3	
Total Water Balance (SW+GW)	**-0.6**	**-0.5**	**1.2**	**-0.7**	**-0.8**	**-0.4**	**-0.5**	**-0.4**	**-0.5**	**-0.3**	**-0.6**	**-0.7**	**-4.8**	**-9.3**

Source: JICA Survey Team

Table D-118 Surface and Groundwater Balance of Carmen City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Weather Condition: Present Total Area [km2]= 299 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	38.5	35.7	85.4	6.0	24.8	71.8	59.6	71.4	45.6	38.5	16.2	12.4	505.8	
Surface Water Potential	**15.1**	**15.9**	**32.4**	**11.3**	**6.6**	**18.0**	**22.0**	**27.2**	**24.2**	**17.1**	**7.7**	**6.5**	**204.0**	
Irrigation Water Demand (SW)	1.0	0.6	0.3	0.0	0.2	0.4	1.1	1.1	0.6	0.3	1.1	1.4	8.1	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Municipal and Industrial Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.2	0.7	0.4	0.1	0.3	0.6	1.3	1.2	0.7	0.5	1.2	1.6	9.7	
SW Water Balance	**13.9**	**15.2**	**32.0**	**11.1**	**6.3**	**17.4**	**20.7**	**26.0**	**23.5**	**16.7**	**6.5**	**5.0**	**194.3**	**0.0**
Groundwater Potential	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.6**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (GW)	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.1	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.3	
GW Water Balance	**-0.2**	**-0.2**	**-0.3**	**-0.3**	**-0.3**	**-0.2**	**-0.3**	**-0.3**	**-0.2**	**-0.3**	**-0.2**	**-0.2**	**-2.9**	**-2.9**
Total Water Potential (SW+GW)	**15.2**	**15.9**	**32.4**	**11.3**	**6.6**	**18.0**	**22.0**	**27.2**	**24.2**	**17.2**	**7.8**	**6.6**	**204.4**	
Irrigation Water Demand (Total)	1.0	0.6	0.3	0.0	0.2	0.4	1.1	1.1	0.6	0.3	1.1	1.4	8.1	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (Total)	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.4	0.3	0.4	0.3	0.4	4.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	1.5	0.9	0.7	0.4	0.6	0.8	1.5	1.5	1.0	0.7	1.5	1.9	13.1	
Total Water Balance (SW+GW)	**13.7**	**15.0**	**31.7**	**10.9**	**6.1**	**17.2**	**20.5**	**25.7**	**23.2**	**16.4**	**6.2**	**4.7**	**191.3**	**-2.9**

Source: JICA Survey Team

Table D-119 Surface and Groundwater Balance of Inabanga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Inabanga Target Year= 2050
Weather Condition: Present Total Area [km2]= 171 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	18.9	18.2	43.6	3.5	13.1	41.9	30.2	38.4	26.8	21.3	7.2	7.4	270.3	
Surface Water Potential	**10.3**	**11.7**	**17.9**	**7.0**	**3.9**	**10.3**	**12.4**	**17.3**	**16.2**	**11.0**	**5.0**	**4.5**	**127.4**	
Irrigation Water Demand (SW)	0.1	0.1	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.1	0.2	1.1	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.2	0.1	0.1	0.0	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	1.6	
SW Water Balance	**10.1**	**11.6**	**17.8**	**6.9**	**3.9**	**10.2**	**12.2**	**17.1**	**16.1**	**10.9**	**4.8**	**4.3**	**125.8**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.8	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.8	
GW Water Balance	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-3.7**	**-3.7**
Total Water Potential (SW+GW)	**10.3**	**11.7**	**17.9**	**7.0**	**3.9**	**10.3**	**12.4**	**17.3**	**16.2**	**11.0**	**5.0**	**4.5**	**127.5**	
Irrigation Water Demand (Total)	0.1	0.1	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.0	0.1	0.2	1.1	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.4	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.5	0.6	5.5	
Total Water Balance (SW+GW)	**9.8**	**11.3**	**17.5**	**6.6**	**3.5**	**9.9**	**11.9**	**16.8**	**15.8**	**10.6**	**4.5**	**4.0**	**122.1**	**-3.7**

Source: JICA Survey Team

Table D-120 Surface and Groundwater Balance of Dumaguete City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Dumaguete City Target Year= 2050
Weather Condition: Present Total Area [km2]= 52 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	1.6	1.0	3.0	0.9	2.9	5.7	10.1	6.6	5.5	5.5	5.5	11.4	59.5	
Surface Water Potential	**1.7**	**1.3**	**1.5**	**1.1**	**1.1**	**1.3**	**2.0**	**2.1**	**2.1**	**2.0**	**2.1**	**3.1**	**21.5**	
Irrigation Water Demand (SW)	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.5	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.4	0.3	0.4	0.3	0.4	4.1	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.4	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	4.7	
SW Water Balance	**1.3**	**1.0**	**1.1**	**0.8**	**0.7**	**0.9**	**1.6**	**1.7**	**1.8**	**1.6**	**1.7**	**2.8**	**16.9**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.6	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (GW)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.9	
GW Water Balance	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-9.8**	**-9.8**
Total Water Potential (SW+GW)	**1.7**	**1.3**	**1.5**	**1.1**	**1.1**	**1.3**	**2.0**	**2.1**	**2.1**	**2.0**	**2.1**	**3.2**	**21.6**	
Irrigation Water Demand (Total)	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.5	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	1.2	1.1	1.2	1.1	1.2	1.1	1.2	1.2	1.1	1.2	1.1	1.2	13.7	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (SW+GW)	1.3	1.1	1.2	1.2	1.3	1.2	1.3	1.2	1.2	1.2	1.2	1.2	14.6	
Total Water Balance (SW+GW)	**0.5**	**0.2**	**0.3**	**-0.0**	**-0.1**	**0.1**	**0.7**	**0.9**	**0.9**	**0.8**	**0.9**	**1.9**	**7.0**	**-9.8**

Source: JICA Survey Team

Table D-121 Surface and Groundwater Balance of Sibulan City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Sibulan Target Year= 2050
Weather Condition: Present Total Area [km2]= 360 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	14.4	6.3	21.3	8.8	23.5	48.2	94.1	66.6	45.1	53.6	37.7	99.9	519.5	
Surface Water Potential	**20.4**	**15.5**	**15.8**	**13.1**	**12.5**	**12.3**	**24.6**	**34.8**	**27.8**	**25.7**	**26.5**	**42.2**	**271.1**	
Irrigation Water Demand (SW)	1.8	0.6	0.0	0.0	1.8	1.4	1.2	1.1	0.0	0.9	1.4	0.9	11.3	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.5	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	2.1	0.9	0.3	0.3	2.1	1.7	1.5	1.4	0.3	1.2	1.7	1.2	14.8	
SW Water Balance	**18.2**	**14.7**	**15.5**	**12.8**	**10.4**	**10.5**	**23.1**	**33.4**	**27.5**	**24.5**	**24.8**	**41.0**	**256.3**	**0.0**
Groundwater Potential	**0.9**	**0.8**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**10.9**	
Safety Groundwater Availability (70% of GWP)	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.7**	**7.6**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	6.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	6.8	
GW Water Balance	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.8**	**0.0**
Total Water Potential (SW+GW)	**21.0**	**16.1**	**16.4**	**13.7**	**13.2**	**12.9**	**25.2**	**35.4**	**28.4**	**26.4**	**27.1**	**42.9**	**278.7**	
Irrigation Water Demand (Total)	1.8	0.6	0.0	0.0	1.8	1.4	1.2	1.1	0.0	0.9	1.4	0.9	11.3	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.9	0.8	0.9	0.8	0.9	0.8	0.9	0.9	0.8	0.9	0.8	0.9	10.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	2.7	1.4	0.9	0.8	2.7	2.3	2.1	2.0	0.9	1.8	2.3	1.8	21.5	
Total Water Balance (SW+GW)	**18.3**	**14.7**	**15.5**	**12.9**	**10.5**	**10.6**	**23.1**	**33.4**	**27.5**	**24.6**	**24.9**	**41.1**	**257.2**	**0.0**

Source: JICA Survey Team

Table D-122 Surface and Groundwater Balance of Siquijor Island in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Siquijor Target Year= 2050
Weather Condition: Present Total Area [km2]= 163 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	23.8	6.7	4.6	2.5	7.8	35.9	25.5	12.9	16.1	17.4	29.4	20.4	202.9	
Surface Water Potential	**8.9**	**7.7**	**8.1**	**6.8**	**6.4**	**6.1**	**7.7**	**9.4**	**9.0**	**9.1**	**9.0**	**10.7**	**98.7**	
Irrigation Water Demand (SW)	1.1	0.7	0.0	0.0	0.7	2.4	2.0	2.9	1.2	0.3	1.0	1.1	13.4	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (SW)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.3	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.8	1.3	0.7	0.7	1.4	3.1	2.7	3.6	1.9	1.0	1.6	1.7	21.3	
SW Water Balance	**7.1**	**6.4**	**7.3**	**6.1**	**5.0**	**3.0**	**5.0**	**5.8**	**7.1**	**8.1**	**7.4**	**8.9**	**77.4**	**0.0**
Groundwater Potential	**0.4**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**4.5**	
Safety Groundwater Availability (70% of GWP)	**0.3**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**3.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	4.0	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	4.0	
GW Water Balance	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.9**	**-0.9**
Total Water Potential (SW+GW)	**9.2**	**7.9**	**8.3**	**7.0**	**6.6**	**6.3**	**8.0**	**9.6**	**9.3**	**9.4**	**9.3**	**10.9**	**101.9**	
Irrigation Water Demand (Total)	1.1	0.7	0.0	0.0	0.7	2.4	2.0	2.9	1.2	0.3	1.0	1.1	13.4	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (Total)	1.0	0.9	1.0	0.9	1.0	0.9	1.0	1.0	0.9	1.0	0.9	1.0	11.3	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	2.1	1.6	1.0	1.0	1.7	3.4	3.0	3.9	2.2	1.3	1.9	2.1	25.3	
Total Water Balance (SW+GW)	**7.1**	**6.3**	**7.3**	**6.0**	**4.9**	**2.9**	**5.0**	**5.7**	**7.1**	**8.1**	**7.3**	**8.9**	**76.5**	**-0.9**

Source: JICA Survey Team

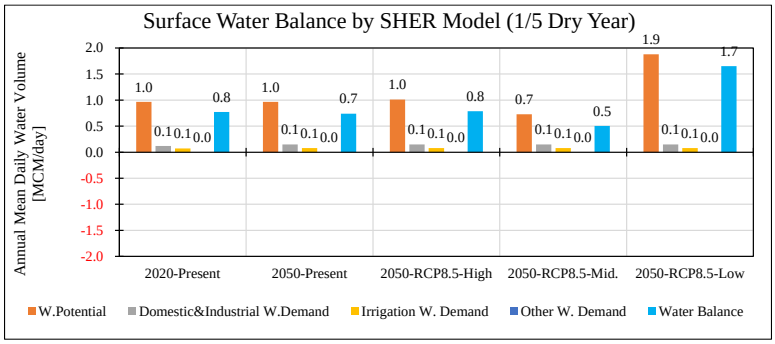
Summary of water balance and deficit estimation of surface and ground water balance at each climate change condition and water demand of 2020 and 2050 in Metro Cebu areas are shown in Tables below. In Metro Cebu, negative values of annual water and deficit of groundwater will be increased in future.

Table D-123 Summary of Annual Water Balance and Deficit of Metro Cebu Area at Each Climate Change Condition

Total Area [km^2]= 829.3

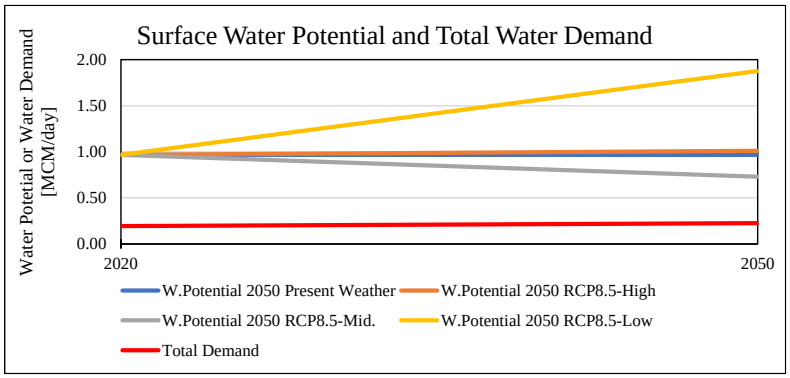
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	562.2	-331.4	230.8	0.0	-331.4	-331.4
2	Present	2020	1/5-Dry Year	282.0	-352.3	-70.4	0.0	-352.3	-352.3
3	Present	2020	1/10-Dry Year	88.0	-378.7	-290.6	0.0	-378.7	-378.7
4	Present	2050	Average Year	550.4	-448.4	101.9	0.0	-448.4	-448.4
5	Present	2050	1/5-Dry Year	270.1	-469.3	-199.2	0.0	-469.3	-469.3
6	Present	2050	1/10-Dry Year	76.2	-495.7	-419.5	0.0	-495.7	-495.7
7	CC RCP8.5-High	2050	Average Year	637.0	-445.6	191.4	0.0	-445.6	-445.6
8	CC RCP8.5-High	2050	1/5-Dry Year	286.7	-468.4	-181.7	0.0	-468.4	-468.4
9	CC RCP8.5-High	2050	1/10-Dry Year	77.6	-495.2	-417.6	0.0	-495.2	-495.2
10	CC RCP8.5-Mid.	2050	Average Year	468.2	-460.3	7.9	0.0	-460.3	-460.3
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	183.5	-487.3	-303.9	0.0	-487.3	-487.3
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	43.1	-512.7	-469.6	-0.1	-512.7	-512.8
13	CC RCP8.5-Low	2050	Average Year	477.6	-496.4	-18.9	0.0	-496.4	-496.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	602.8	-517.4	85.4	0.0	-517.4	-517.4
15	CC RCP8.5-Low	2050	1/10-Dry Year	99.4	-538.2	-438.8	0.0	-538.2	-538.2

Source: JICA Survey Team



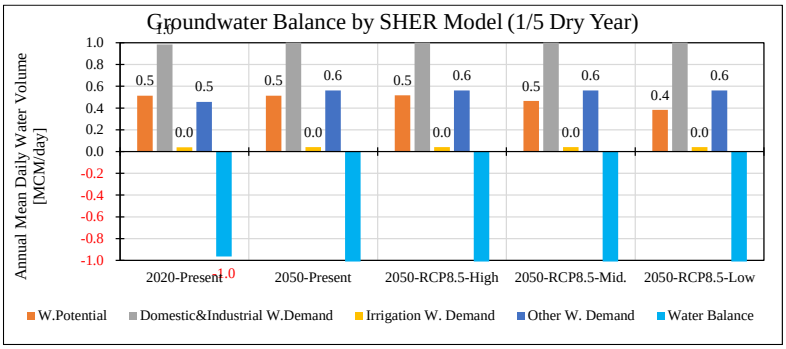
Source: JICA Survey Team

Figure D-375 Surface Water Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



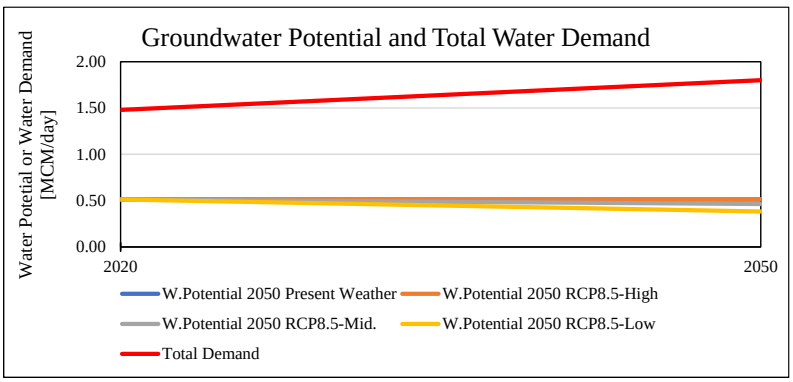
Source: JICA Survey Team

Figure D-376 Surface Water Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



Source: JICA Survey Team

Figure D-377 Groundwater Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

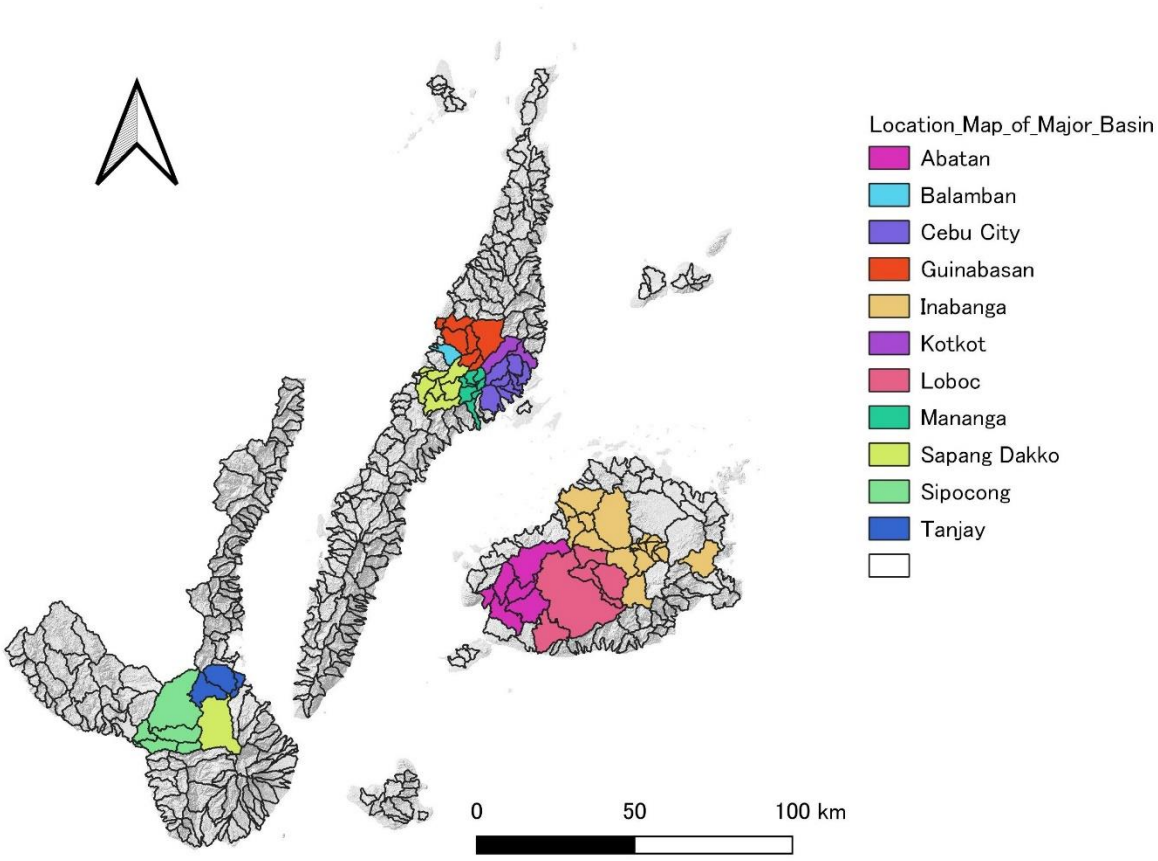


Source: JICA Survey Team

Figure D-378 Groundwater Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

(5) Major River Basin-wise Water Balance

Location map of major river basins in WRR-VII is shown in Figure below.



Source: JICA Survey Team

Figure D-379 Location Map of Major River Basins in WRR-VII

The surface and ground water balance in 1/5-dry year in the major river basins at present weather condition and water demand of 2050 are shown in Tables below. The Mananga river basin near the Cebu city area will be negative water balance of groundwater in 2050.

Table D-124 Surface and Groundwater Balance of Guinabasan River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Guinabasan Target Year= 2050
Weather Condition: Present Total Area [km2]= 236 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	14.0	18.5	21.5	6.4	43.4	47.1	47.1	34.5	32.1	37.1	22.1	18.4	342.1	
Surface Water Potential	**10.2**	**8.7**	**8.5**	**5.6**	**5.8**	**6.6**	**7.1**	**7.5**	**6.4**	**8.1**	**5.2**	**5.3**	**85.0**	
Irrigation Water Demand (SW)	2.8	1.2	0.0	0.0	0.5	2.5	1.9	2.4	1.0	0.4	2.5	2.3	17.4	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.7	
Municipal and Industrial Water Demand (SW)	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	3.7	2.1	1.0	0.9	1.4	3.4	2.9	3.4	1.9	1.3	3.5	3.2	28.7	
SW Water Balance	**6.5**	**6.7**	**7.5**	**4.7**	**4.4**	**3.2**	**4.2**	**4.1**	**4.5**	**6.8**	**1.7**	**2.1**	**56.2**	**0.0**
Groundwater Potential	**7.6**	**7.1**	**7.5**	**7.3**	**7.5**	**7.2**	**7.4**	**7.4**	**7.1**	**7.4**	**7.2**	**7.3**	**87.9**	
Safety Groundwater Availability (70% of GWP)	**5.3**	**4.9**	**5.3**	**5.1**	**5.2**	**5.0**	**5.2**	**5.2**	**5.0**	**5.2**	**5.0**	**5.1**	**61.5**	
Irrigation Water Demand (GW)	0.3	0.1	0.0	0.0	0.1	0.4	0.3	0.4	0.1	0.1	0.3	0.3	2.3	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (GW)	1.5	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	17.8	
Other Water Demand (GW)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.8	
Total Water Demand (GW)	2.8	2.4	2.4	2.4	2.5	2.7	2.7	2.8	2.5	2.5	2.7	2.7	31.1	
GW Water Balance	**2.5**	**2.6**	**2.8**	**2.7**	**2.7**	**2.3**	**2.5**	**2.4**	**2.5**	**2.7**	**2.4**	**2.4**	**30.5**	**0.0**
Total Water Potential (SW+GW)	**15.5**	**13.7**	**13.8**	**10.7**	**11.0**	**11.7**	**12.2**	**12.6**	**11.4**	**13.3**	**10.2**	**10.4**	**146.5**	
Irrigation Water Demand (Total)	3.1	1.3	0.0	0.0	0.5	2.9	2.2	2.8	1.1	0.4	2.8	2.6	19.7	
Livestock Water Deamnd (Total)	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.8	
Municipal and Industrial Water Demand (Total)	2.3	2.1	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	27.5	
Other Water Demand (Total)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.8	
Total Water Demand (SW+GW)	6.5	4.4	3.4	3.3	4.0	6.2	5.6	6.2	4.4	3.8	6.1	6.0	59.8	
Total Water Balance (SW+GW)	**9.0**	**9.3**	**10.4**	**7.4**	**7.1**	**5.5**	**6.7**	**6.5**	**7.0**	**9.4**	**4.1**	**4.5**	**86.7**	**0.0**

Source: JICA Survey Team

Table D-125 Surface and Groundwater Balance of Balamban River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Balamban Target Year= 2050
Weather Condition: Present Total Area [km2]= 33 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	1.7	2.5	2.8	0.9	6.3	7.6	6.9	5.1	4.5	5.1	2.9	2.7	49.1	
Surface Water Potential	**1.8**	**1.4**	**1.2**	**0.6**	**0.6**	**0.7**	**0.7**	**0.9**	**0.8**	**1.1**	**0.7**	**0.7**	**11.4**	
Irrigation Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8	
SW Water Balance	**1.7**	**1.4**	**1.1**	**0.5**	**0.5**	**0.7**	**0.7**	**0.9**	**0.7**	**1.1**	**0.7**	**0.7**	**10.6**	**0.0**
Groundwater Potential	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**13.6**	
Safety Groundwater Availability (70% of GWP)	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**9.5**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
GW Water Balance	**0.8**	**0.7**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**9.3**	**0.0**
Total Water Potential (SW+GW)	**2.6**	**2.2**	**2.0**	**1.4**	**1.4**	**1.5**	**1.5**	**1.7**	**1.6**	**1.9**	**1.5**	**1.5**	**20.9**	
Irrigation Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.9	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.9	
Total Water Balance (SW+GW)	**2.5**	**2.1**	**1.9**	**1.3**	**1.3**	**1.4**	**1.5**	**1.7**	**1.5**	**1.9**	**1.5**	**1.4**	**19.9**	**0.0**

Source: JICA Survey Team

Table D-126 Surface and Groundwater Balance of Sapang Dakko River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Sapang Dakko Target Year= 2050
Weather Condition: Present Total Area [km2]= 352 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	15.4	23.0	26.1	10.0	62.8	77.0	88.1	65.7	49.1	53.2	28.4	36.7	535.6	
Surface Water Potential	**16.5**	**13.7**	**12.2**	**7.9**	**9.0**	**10.5**	**16.5**	**21.0**	**14.4**	**15.5**	**12.2**	**17.1**	**166.5**	
Irrigation Water Demand (SW)	2.0	0.8	0.0	0.0	0.9	1.7	1.3	1.5	0.5	0.5	1.7	1.4	12.2	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	2.4	1.2	0.4	0.4	1.3	2.1	1.7	1.9	0.9	0.9	2.1	1.8	17.1	
SW Water Balance	**14.2**	**12.6**	**11.8**	**7.4**	**7.7**	**8.5**	**14.7**	**19.1**	**13.5**	**14.6**	**10.1**	**15.3**	**149.4**	**0.0**
Groundwater Potential	**10.2**	**9.5**	**10.2**	**9.8**	**10.1**	**9.7**	**10.0**	**10.1**	**9.7**	**10.1**	**9.7**	**10.0**	**119.2**	
Safety Groundwater Availability (70% of GWP)	**7.1**	**6.7**	**7.1**	**6.9**	**7.1**	**6.8**	**7.0**	**7.0**	**6.8**	**7.0**	**6.8**	**7.0**	**83.4**	
Irrigation Water Demand (GW)	0.1	0.1	0.0	0.0	0.0	0.2	0.1	0.2	0.1	0.0	0.1	0.1	1.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	3.2	2.9	3.2	3.1	3.2	3.1	3.2	3.2	3.1	3.2	3.1	3.2	37.4	
Other Water Demand (GW)	2.6	2.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	31.0	
Total Water Demand (GW)	6.0	5.3	5.8	5.6	5.8	5.8	5.9	6.0	5.7	5.8	5.8	5.9	69.4	
GW Water Balance	**1.2**	**1.3**	**1.3**	**1.2**	**1.2**	**1.0**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**	**1.1**	**14.0**	**0.0**
Total Water Potential (SW+GW)	**23.7**	**20.4**	**19.3**	**14.7**	**16.1**	**17.4**	**23.5**	**28.1**	**21.2**	**22.6**	**19.0**	**24.1**	**250.0**	
Irrigation Water Demand (Total)	2.1	0.8	0.0	0.0	0.9	1.8	1.4	1.7	0.5	0.5	1.8	1.5	13.1	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	3.6	3.2	3.6	3.5	3.6	3.5	3.6	3.6	3.5	3.6	3.5	3.6	42.3	
Other Water Demand (Total)	2.6	2.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	31.0	
Total Water Demand (SW+GW)	8.3	6.5	6.2	6.0	7.2	7.9	7.7	7.9	6.6	6.8	7.8	7.7	86.6	
Total Water Balance (SW+GW)	**15.3**	**13.9**	**13.1**	**8.7**	**8.9**	**9.5**	**15.8**	**20.2**	**14.6**	**15.8**	**11.2**	**16.4**	**163.4**	**0.0**

Source: JICA Survey Team

Table D-127 Surface and Groundwater Balance of Mananga River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Mananga Target Year= 2050
Weather Condition: Present Total Area [km2]= 85 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	4.0	5.9	6.6	2.1	15.1	18.7	19.4	15.8	11.4	12.9	5.4	5.7	123.0	
Surface Water Potential	**2.8**	**2.4**	**2.5**	**2.1**	**2.3**	**2.3**	**2.5**	**2.7**	**2.4**	**2.7**	**2.1**	**2.1**	**29.0**	
Irrigation Water Demand (SW)	1.7	0.7	0.0	0.0	0.3	1.5	1.1	1.5	0.6	0.2	1.5	1.4	10.6	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1	1.0	1.1	12.5	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	2.7	1.7	1.1	1.0	1.3	2.5	2.2	2.5	1.6	1.3	2.6	2.4	23.0	
SW Water Balance	**0.0**	**0.7**	**1.4**	**1.1**	**0.9**	**-0.2**	**0.3**	**0.2**	**0.8**	**1.4**	**-0.4**	**-0.3**	**5.9**	**-1.0**
Groundwater Potential	**3.8**	**3.5**	**3.8**	**3.6**	**3.6**	**3.4**	**3.4**	**3.4**	**3.3**	**3.4**	**3.3**	**3.3**	**41.7**	
Safety Groundwater Availability (70% of GWP)	**2.6**	**2.5**	**2.6**	**2.5**	**2.5**	**2.4**	**2.4**	**2.4**	**2.3**	**2.4**	**2.3**	**2.3**	**29.2**	
Irrigation Water Demand (GW)	0.9	0.4	0.0	0.0	0.2	1.0	0.7	1.0	0.4	0.1	0.8	0.8	6.3	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	4.5	4.1	4.5	4.4	4.5	4.4	4.5	4.5	4.4	4.5	4.4	4.5	53.3	
Other Water Demand (GW)	2.9	2.7	2.9	2.8	2.9	2.8	2.9	2.9	2.8	2.9	2.8	2.9	34.6	
Total Water Demand (GW)	8.4	7.1	7.5	7.2	7.7	8.2	8.2	8.4	7.6	7.6	8.0	8.2	94.3	
GW Water Balance	**-5.7**	**-4.7**	**-4.8**	**-4.7**	**-5.2**	**-5.9**	**-5.8**	**-6.1**	**-5.3**	**-5.2**	**-5.7**	**-5.9**	**-65.1**	**-65.1**
Total Water Potential (SW+GW)	**5.4**	**4.9**	**5.1**	**4.6**	**4.8**	**4.7**	**4.9**	**5.1**	**4.7**	**5.1**	**4.4**	**4.4**	**58.2**	
Irrigation Water Demand (Total)	2.6	1.1	0.0	0.0	0.5	2.5	1.9	2.4	1.0	0.4	2.3	2.1	16.8	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	5.6	5.0	5.6	5.4	5.6	5.4	5.6	5.6	5.4	5.6	5.4	5.6	65.8	
Other Water Demand (Total)	2.9	2.7	2.9	2.8	2.9	2.8	2.9	2.9	2.8	2.9	2.8	2.9	34.6	
Total Water Demand (SW+GW)	11.1	8.8	8.5	8.3	9.0	10.8	10.4	11.0	9.2	8.9	10.6	10.7	117.3	
Total Water Balance (SW+GW)	**-5.7**	**-3.9**	**-3.4**	**-3.6**	**-4.3**	**-6.1**	**-5.5**	**-5.8**	**-4.5**	**-3.8**	**-6.2**	**-6.2**	**-59.1**	**-66.0**

Source: JICA Survey Team

Table D-128 Surface and Groundwater Balance of Cebu City Area Small River Basins in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Cebu City Target Year= 2050
Weather Condition: Present Total Area [km2]= 182 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	10.6	13.9	13.9	4.3	26.6	31.9	34.0	26.7	24.0	27.6	13.4	12.1	239.1	
Surface Water Potential	**8.4**	**7.6**	**7.7**	**3.4**	**8.2**	**9.5**	**9.6**	**9.4**	**7.6**	**10.2**	**5.1**	**4.9**	**91.5**	
Irrigation Water Demand (SW)	1.3	0.6	0.0	0.0	0.2	1.2	0.9	1.2	0.5	0.2	1.2	1.1	8.4	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	2.5	2.3	2.5	2.4	2.5	2.4	2.5	2.5	2.4	2.5	2.4	2.5	29.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	3.9	2.9	2.5	2.4	2.7	3.6	3.4	3.7	2.9	2.7	3.7	3.6	38.0	
SW Water Balance	**4.5**	**4.8**	**5.2**	**0.9**	**5.4**	**5.9**	**6.2**	**5.7**	**4.6**	**7.5**	**1.5**	**1.3**	**53.5**	**0.0**
Groundwater Potential	**3.5**	**3.3**	**3.5**	**3.4**	**3.5**	**3.3**	**3.4**	**3.4**	**3.3**	**3.4**	**3.3**	**3.4**	**40.8**	
Safety Groundwater Availability (70% of GWP)	**2.4**	**2.3**	**2.4**	**2.3**	**2.4**	**2.3**	**2.4**	**2.4**	**2.3**	**2.4**	**2.3**	**2.4**	**28.6**	
Irrigation Water Demand (GW)	0.8	0.3	0.0	0.0	0.2	0.9	0.6	0.8	0.3	0.1	0.7	0.7	5.4	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	12.5	11.3	12.5	12.1	12.5	12.1	12.5	12.5	12.1	12.5	12.1	12.5	147.7	
Other Water Demand (GW)	5.0	4.5	5.0	4.8	5.0	4.8	5.0	5.0	4.8	5.0	4.8	5.0	59.0	
Total Water Demand (GW)	18.3	16.2	17.6	17.0	17.7	17.9	18.2	18.4	17.3	17.7	17.7	18.2	212.2	
GW Water Balance	**-15.9**	**-13.9**	**-15.1**	**-14.6**	**-15.3**	**-15.5**	**-15.8**	**-16.0**	**-15.0**	**-15.3**	**-15.3**	**-15.8**	**-183.6**	**-183.6**
Total Water Potential (SW+GW)	**10.8**	**9.9**	**10.1**	**5.7**	**10.6**	**11.9**	**12.0**	**11.8**	**9.9**	**12.6**	**7.4**	**7.3**	**120.1**	
Irrigation Water Demand (Total)	2.1	0.9	0.0	0.0	0.4	2.1	1.5	2.0	0.8	0.3	1.9	1.7	13.8	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (Total)	15.1	13.6	15.1	14.6	15.1	14.6	15.1	15.1	14.6	15.1	14.6	15.1	177.3	
Other Water Demand (Total)	5.0	4.5	5.0	4.8	5.0	4.8	5.0	5.0	4.8	5.0	4.8	5.0	59.0	
Total Water Demand (SW+GW)	22.2	19.1	20.1	19.4	20.5	21.5	21.6	22.1	20.2	20.4	21.3	21.8	250.2	
Total Water Balance (SW+GW)	**-11.4**	**-9.1**	**-10.0**	**-13.7**	**-9.9**	**-9.6**	**-9.6**	**-10.3**	**-10.3**	**-7.8**	**-13.9**	**-14.5**	**-130.1**	**-183.6**

Source: JICA Survey Team

Table D-129 Surface and Groundwater Balance of Kotkot River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Kotkot Target Year= 2050
Weather Condition: Present Total Area [km2]= 84 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	5.8	7.4	8.0	2.4	14.4	14.5	16.3	12.2	11.7	13.7	7.4	6.6	120.5	
Surface Water Potential	**5.0**	**4.6**	**4.7**	**2.6**	**3.7**	**3.8**	**3.8**	**4.3**	**3.1**	**4.4**	**2.5**	**2.8**	**45.4**	
Irrigation Water Demand (SW)	0.3	0.1	0.0	0.0	0.1	0.3	0.2	0.3	0.1	0.0	0.3	0.3	1.9	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.3	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.9	0.7	0.6	0.6	0.7	0.9	0.8	0.9	0.7	0.7	0.9	0.9	9.3	
SW Water Balance	**4.1**	**3.9**	**4.1**	**2.0**	**3.0**	**2.9**	**3.0**	**3.4**	**2.4**	**3.7**	**1.6**	**1.9**	**36.1**	**0.0**
Groundwater Potential	**1.4**	**1.3**	**1.4**	**1.3**	**1.4**	**1.3**	**1.4**	**1.4**	**1.3**	**1.4**	**1.3**	**1.4**	**16.2**	
Safety Groundwater Availability (70% of GWP)	**1.0**	**0.9**	**1.0**	**0.9**	**1.0**	**0.9**	**1.0**	**1.0**	**0.9**	**1.0**	**0.9**	**1.0**	**11.4**	
Irrigation Water Demand (GW)	0.2	0.1	0.0	0.0	0.0	0.2	0.2	0.2	0.1	0.0	0.2	0.2	1.3	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	3.0	2.7	3.0	2.9	3.0	2.9	3.0	3.0	2.9	3.0	2.9	3.0	35.0	
Other Water Demand (GW)	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	12.8	
Total Water Demand (GW)	4.3	3.8	4.1	3.9	4.1	4.2	4.2	4.3	4.0	4.1	4.1	4.2	49.3	
GW Water Balance	**-3.3**	**-2.9**	**-3.1**	**-3.0**	**-3.2**	**-3.2**	**-3.3**	**-3.3**	**-3.1**	**-3.1**	**-3.2**	**-3.3**	**-37.9**	**-37.9**
Total Water Potential (SW+GW)	**6.0**	**5.5**	**5.7**	**3.5**	**4.6**	**4.8**	**4.8**	**5.3**	**4.1**	**5.4**	**3.4**	**3.8**	**56.8**	
Irrigation Water Demand (Total)	0.5	0.2	0.0	0.0	0.1	0.5	0.4	0.5	0.2	0.1	0.5	0.4	3.3	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	3.6	3.3	3.6	3.5	3.6	3.5	3.6	3.6	3.5	3.6	3.5	3.6	42.4	
Other Water Demand (Total)	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	12.8	
Total Water Demand (SW+GW)	5.2	4.5	4.7	4.5	4.8	5.0	5.1	5.2	4.7	4.8	5.0	5.1	58.5	
Total Water Balance (SW+GW)	**0.8**	**1.1**	**1.0**	**-1.0**	**-0.2**	**-0.3**	**-0.3**	**0.1**	**-0.7**	**0.6**	**-1.6**	**-1.3**	**-1.7**	**-37.9**

Source: JICA Survey Team

Table D-130 Surface and Groundwater Balance of Sipocong River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Sipocong Target Year= 2050
Weather Condition: Present Total Area [km2]= 370 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	17.6	5.9	12.2	11.2	27.4	51.5	137.7	94.5	69.0	75.9	34.9	119.9	657.6	
Surface Water Potential	**25.8**	**17.2**	**15.7**	**12.1**	**11.8**	**10.9**	**25.7**	**38.5**	**33.3**	**35.2**	**28.7**	**49.9**	**304.9**	
Irrigation Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.0	
SW Water Balance	**25.2**	**16.7**	**15.1**	**11.5**	**11.2**	**10.3**	**25.1**	**37.9**	**32.7**	**34.6**	**28.1**	**49.3**	**297.8**	**0.0**
Groundwater Potential	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**8.5**	
Safety Groundwater Availability (70% of GWP)	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**6.0**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.2	
GW Water Balance	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**4.8**	**0.0**
Total Water Potential (SW+GW)	**26.3**	**17.7**	**16.2**	**12.5**	**12.3**	**11.4**	**26.2**	**39.0**	**33.8**	**35.8**	**29.2**	**50.4**	**310.9**	
Irrigation Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.2	
Total Water Balance (SW+GW)	**25.6**	**17.0**	**15.5**	**11.9**	**11.6**	**10.7**	**25.5**	**38.3**	**33.1**	**35.1**	**28.5**	**49.7**	**302.6**	**0.0**

Source: JICA Survey Team

Table D-131 Surface and Groundwater Balance of Tanjay River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Tanjay Target Year= 2050
Weather Condition: Present Total Area [km2]= 145 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	5.9	2.6	9.5	6.2	9.9	19.0	36.7	24.7	20.2	26.6	17.5	43.5	222.2	
Surface Water Potential	**7.9**	**5.4**	**5.3**	**3.8**	**3.9**	**3.6**	**6.3**	**6.8**	**6.1**	**6.7**	**7.5**	**12.2**	**75.5**	
Irrigation Water Demand (SW)	1.0	0.3	0.0	0.0	1.0	0.8	0.7	0.6	0.0	0.5	0.8	0.5	6.4	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.3	0.6	0.3	0.3	1.3	1.1	0.9	0.9	0.3	0.8	1.1	0.8	9.4	
SW Water Balance	**6.6**	**4.8**	**5.0**	**3.6**	**2.7**	**2.5**	**5.3**	**5.9**	**5.8**	**5.9**	**6.5**	**11.4**	**66.1**	**0.0**
Groundwater Potential	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**2.7**	
Safety Groundwater Availability (70% of GWP)	**0.2**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**1.9**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.5	
GW Water Balance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	**0.0**
Total Water Potential (SW+GW)	**8.1**	**5.5**	**5.5**	**4.0**	**4.1**	**3.7**	**6.4**	**7.0**	**6.3**	**6.8**	**7.7**	**12.3**	**77.4**	
Irrigation Water Demand (Total)	1.0	0.3	0.0	0.0	1.0	0.8	0.7	0.6	0.0	0.5	0.8	0.5	6.4	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.3	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (SW+GW)	1.4	0.7	0.4	0.4	1.4	1.2	1.1	1.0	0.4	0.9	1.2	0.9	10.9	
Total Water Balance (SW+GW)	**6.6**	**4.8**	**5.1**	**3.6**	**2.7**	**2.5**	**5.3**	**6.0**	**5.9**	**5.9**	**6.5**	**11.4**	**66.5**	**0.0**

Source: JICA Survey Team

Table D-132 Surface and Groundwater Balance of Abatan River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Abatan Target Year= 2050
Weather Condition: Present Total Area [km2]= 385 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	34.0	34.9	95.4	13.6	31.8	75.4	61.3	71.7	46.0	54.3	31.9	28.8	579.1	
Surface Water Potential	**6.2**	**7.2**	**26.4**	**4.4**	**2.4**	**11.2**	**11.8**	**13.8**	**10.1**	**11.9**	**4.4**	**5.3**	**115.1**	
Irrigation Water Demand (SW)	0.7	0.4	0.2	0.0	0.1	0.3	0.8	0.8	0.4	0.2	0.8	1.0	5.7	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.2	0.8	0.6	0.4	0.5	0.7	1.2	1.2	0.8	0.7	1.2	1.5	10.8	
SW Water Balance	**5.0**	**6.4**	**25.8**	**4.0**	**1.9**	**10.4**	**10.6**	**12.6**	**9.2**	**11.3**	**3.2**	**3.8**	**104.2**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.5**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Total Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.3	
GW Water Balance	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-6.0**	**-6.0**
Total Water Potential (SW+GW)	**6.2**	**7.3**	**26.4**	**4.5**	**2.5**	**11.2**	**11.8**	**13.8**	**10.1**	**11.9**	**4.4**	**5.3**	**115.4**	
Irrigation Water Demand (Total)	0.7	0.4	0.2	0.0	0.1	0.3	0.8	0.8	0.4	0.2	0.8	1.0	5.7	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	11.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Total Water Demand (SW+GW)	1.7	1.3	1.2	0.9	1.1	1.2	1.8	1.7	1.4	1.2	1.7	2.0	17.2	
Total Water Balance (SW+GW)	**4.5**	**6.0**	**25.3**	**3.5**	**1.4**	**9.9**	**10.1**	**12.1**	**8.7**	**10.7**	**2.7**	**3.3**	**98.2**	**-6.0**

Source: JICA Survey Team

Table D-133 Surface and Groundwater Balance of Loboc River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Loboc Target Year= 2050
Weather Condition: Present Total Area [km2]= 674 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	78.0	71.9	182.1	16.5	55.2	155.3	119.0	150.3	91.9	91.6	40.4	36.3	1,088.6	
Surface Water Potential	**38.9**	**38.0**	**60.0**	**24.6**	**15.9**	**35.5**	**38.6**	**48.5**	**45.4**	**37.4**	**24.1**	**21.7**	**428.7**	
Irrigation Water Demand (SW)	1.2	0.6	0.3	0.0	0.2	0.5	1.3	1.2	0.7	0.4	1.2	1.6	9.1	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Municipal and Industrial Water Demand (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.2	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.7	1.1	0.8	0.5	0.6	1.0	1.7	1.7	1.1	0.8	1.7	2.1	14.7	
SW Water Balance	**37.3**	**37.0**	**59.2**	**24.1**	**15.3**	**34.6**	**36.8**	**46.8**	**44.3**	**36.6**	**22.4**	**19.6**	**413.9**	**0.0**
Groundwater Potential	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.8**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.6**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.4	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.6	0.5	0.6	0.5	0.6	0.5	0.6	0.6	0.5	0.6	0.5	0.6	6.6	
GW Water Balance	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-6.1**	**-6.1**
Total Water Potential (SW+GW)	**39.0**	**38.1**	**60.1**	**24.6**	**16.0**	**35.6**	**38.6**	**48.5**	**45.4**	**37.5**	**24.1**	**21.7**	**429.2**	
Irrigation Water Demand (Total)	1.2	0.6	0.3	0.0	0.2	0.5	1.3	1.2	0.7	0.4	1.2	1.6	9.1	
Livestock Water Deamnd (Total)	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	
Municipal and Industrial Water Demand (Total)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	11.6	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	2.2	1.6	1.3	1.0	1.2	1.5	2.3	2.2	1.7	1.4	2.2	2.7	21.4	
Total Water Balance (SW+GW)	**36.8**	**36.5**	**58.7**	**23.6**	**14.8**	**34.1**	**36.3**	**46.3**	**43.8**	**36.1**	**21.9**	**19.1**	**407.9**	**-6.1**

Source: JICA Survey Team

Table D-134 Surface and Groundwater Balance of Inabanga River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Inabanga Target Year= 2050
Weather Condition: Present Total Area [km2]= 690 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	106.2	89.8	180.9	13.9	53.1	158.2	130.8	165.3	108.3	91.3	31.5	26.0	1,155.3	
Surface Water Potential	**85.9**	**107.6**	**131.5**	**34.1**	**26.7**	**88.7**	**108.2**	**157.3**	**131.4**	**68.0**	**45.8**	**43.2**	**1,028.5**	
Irrigation Water Demand (SW)	19.9	10.7	4.9	0.0	2.9	8.3	21.4	20.4	11.2	6.1	20.9	27.4	154.1	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.6	
Municipal and Industrial Water Demand (SW)	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.4	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	20.4	11.2	5.4	0.5	3.4	8.8	21.9	20.9	11.7	6.6	21.4	27.9	160.2	
SW Water Balance	**65.6**	**96.4**	**126.0**	**33.6**	**23.3**	**79.8**	**86.3**	**136.3**	**119.7**	**61.4**	**24.4**	**15.3**	**868.3**	**0.0**
Groundwater Potential	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.6**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	11.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	11.8	
GW Water Balance	**-1.0**	**-0.9**	**-1.0**	**-0.9**	**-1.0**	**-0.9**	**-1.0**	**-1.0**	**-0.9**	**-1.0**	**-0.9**	**-1.0**	**-11.4**	**-11.4**
Total Water Potential (SW+GW)	**86.0**	**107.7**	**131.5**	**34.2**	**26.7**	**88.7**	**108.3**	**157.3**	**131.5**	**68.0**	**45.8**	**43.3**	**1,028.9**	
Irrigation Water Demand (Total)	19.9	10.7	4.9	0.0	2.9	8.3	21.4	20.4	11.2	6.1	20.9	27.4	154.1	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.7	
Municipal and Industrial Water Demand (Total)	1.4	1.2	1.4	1.3	1.4	1.3	1.4	1.4	1.3	1.4	1.3	1.4	16.1	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	21.4	12.1	6.4	1.5	4.4	9.8	22.9	21.9	12.7	7.6	22.4	28.9	172.0	
Total Water Balance (SW+GW)	**64.6**	**95.6**	**125.1**	**32.7**	**22.3**	**78.9**	**85.4**	**135.4**	**118.8**	**60.5**	**23.5**	**14.3**	**856.9**	**-11.4**

Source: JICA Survey Team

Summary of water balance and deficit estimation of surface and ground water balance at each climate change condition and water demand of 2020 and 2050 in the Mananga river basin areas are shown in Tables below. In the Mananga river basin, negative values of annual water and deficit of both of surface water and groundwater will be increased in future.

Table D-135 Summary of Annual Water Balance and Deficit of Mananga River Basin at Each Climate Change Condition

Total Area [km^2]= 85.2

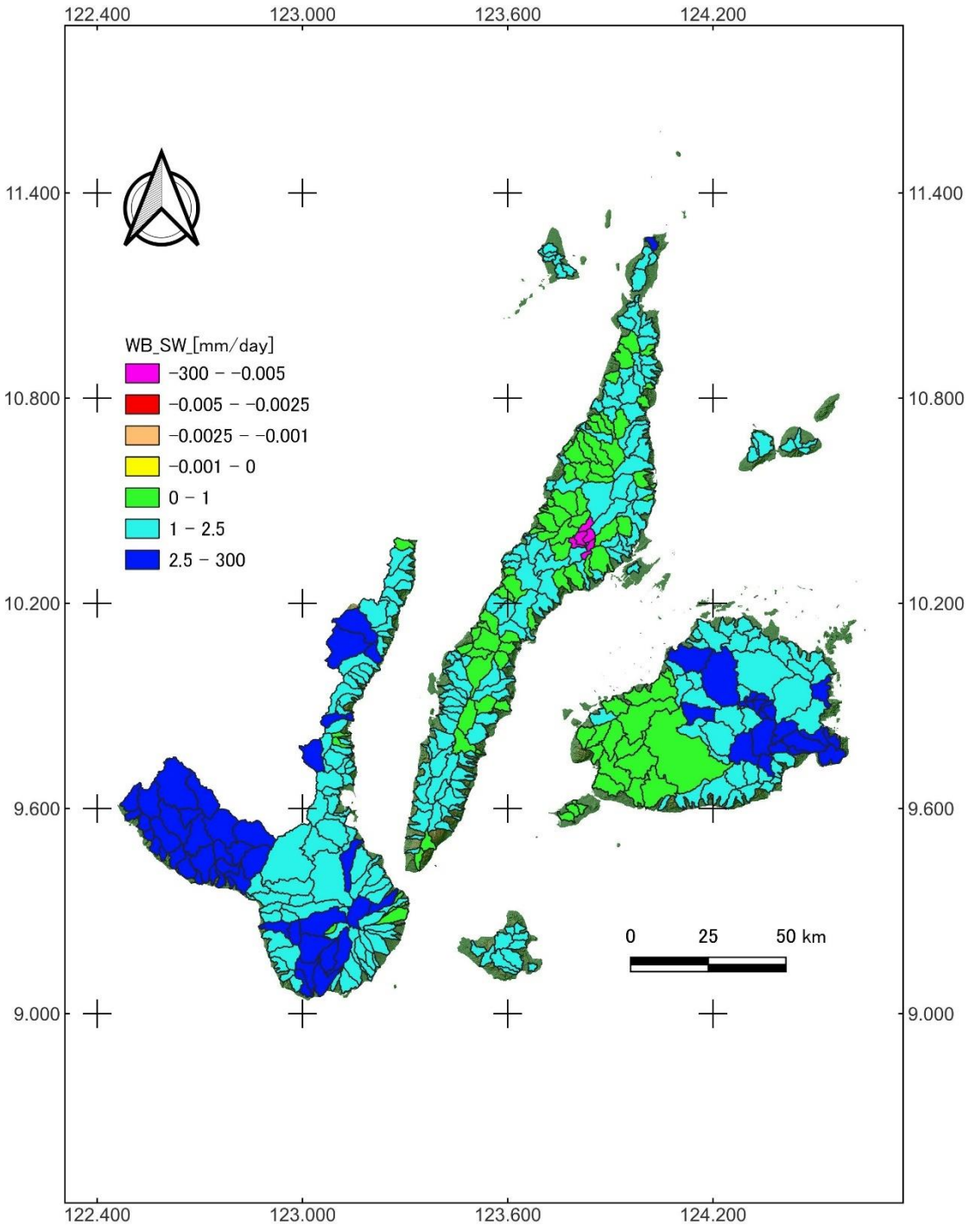
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	27.4	-25.0	2.4	0.0	-25.0	-25.0
2	Present	2020	1/5-Dry Year	12.6	-32.7	-20.1	0.0	-32.7	-32.7
3	Present	2020	1/10-Dry Year	1.6	-39.9	-38.3	-2.5	-39.9	-42.4
4	Present	2050	Average Year	25.2	-38.3	-13.1	0.0	-38.3	-38.3
5	Present	2050	1/5-Dry Year	10.4	-46.0	-35.6	-0.1	-46.0	-46.1
6	Present	2050	1/10-Dry Year	-0.6	-53.2	-53.9	-3.9	-53.2	-57.2
7	CC RCP8.5-High	2050	Average Year	31.2	-37.2	-6.0	0.0	-37.2	-37.2
8	CC RCP8.5-High	2050	1/5-Dry Year	10.9	-45.7	-34.8	-0.1	-45.7	-45.7
9	CC RCP8.5-High	2050	1/10-Dry Year	-0.6	-52.9	-53.5	-4.0	-52.9	-56.9
10	CC RCP8.5-Mid.	2050	Average Year	17.0	-42.5	-25.5	0.0	-42.5	-42.5
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	4.0	-51.4	-47.3	-1.6	-51.4	-53.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	-5.0	-57.3	-62.3	-6.5	-57.3	-63.8
13	CC RCP8.5-Low	2050	Average Year	80.6	-48.4	32.2	0.0	-48.4	-48.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	23.9	-53.8	-29.9	0.0	-53.8	-53.8
15	CC RCP8.5-Low	2050	1/10-Dry Year	-0.0	-58.5	-58.5	-3.6	-58.5	-62.1

Source: JICA Survey Team

(6) Conclusion

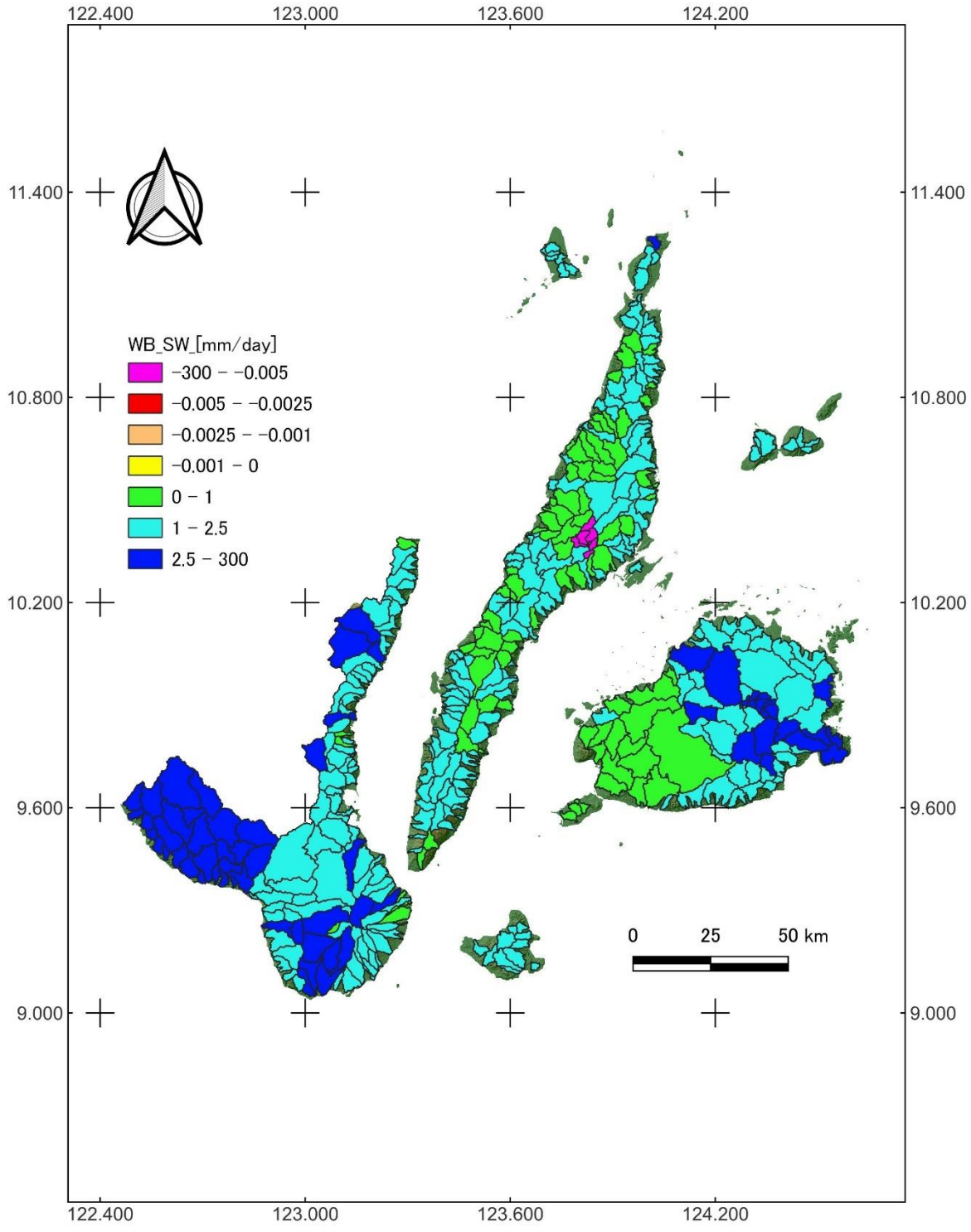
As described in above, in the Metro Cebu area, negative values of annual water and deficit of and groundwater will be increased in future.

(7) Maps of Results of Surface Water Balance



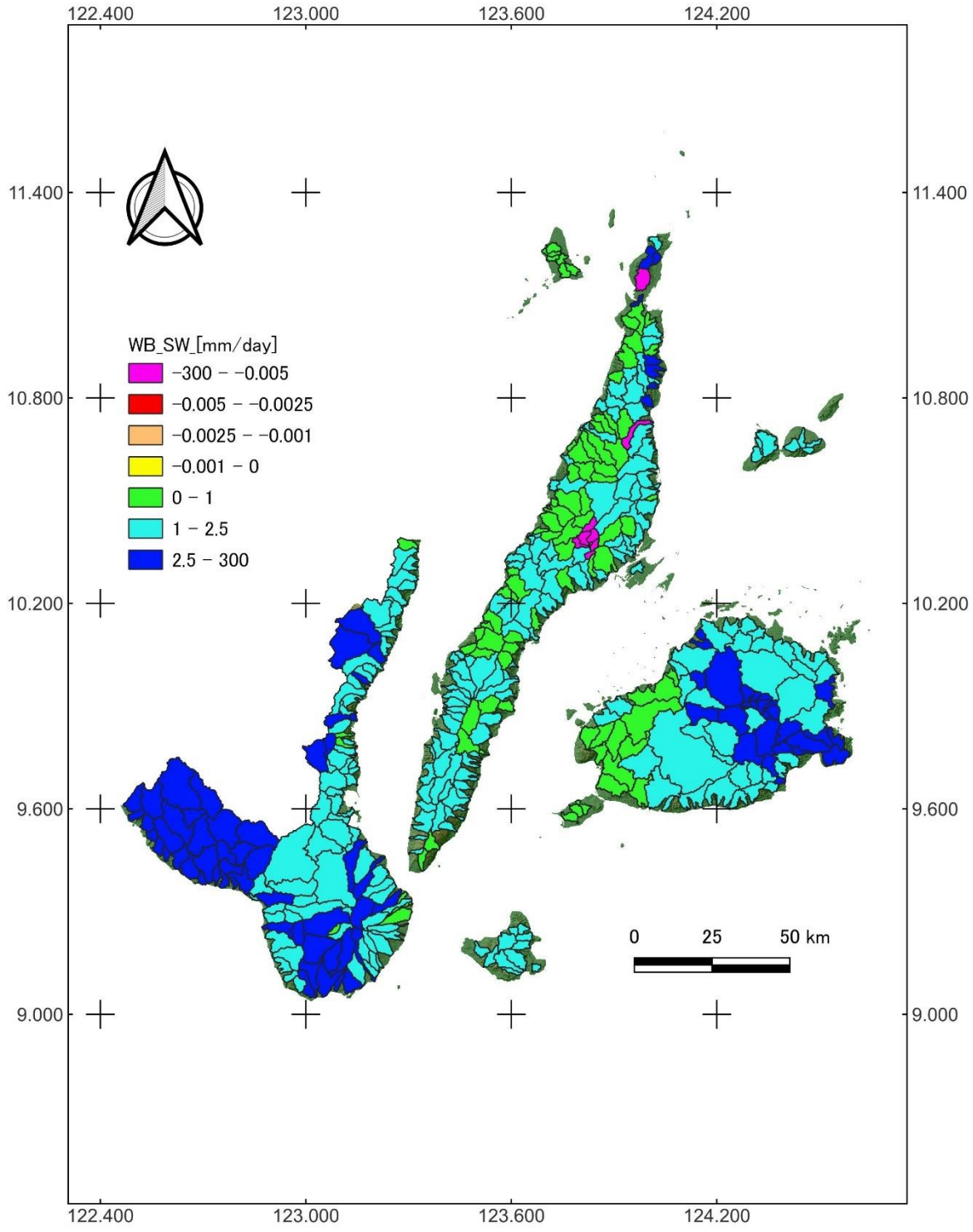
Source: JICA Survey Team

Figure D-380 Sub-Basin wise Surface Water Balance in WRR-VII (2020, Present Weather Condition)



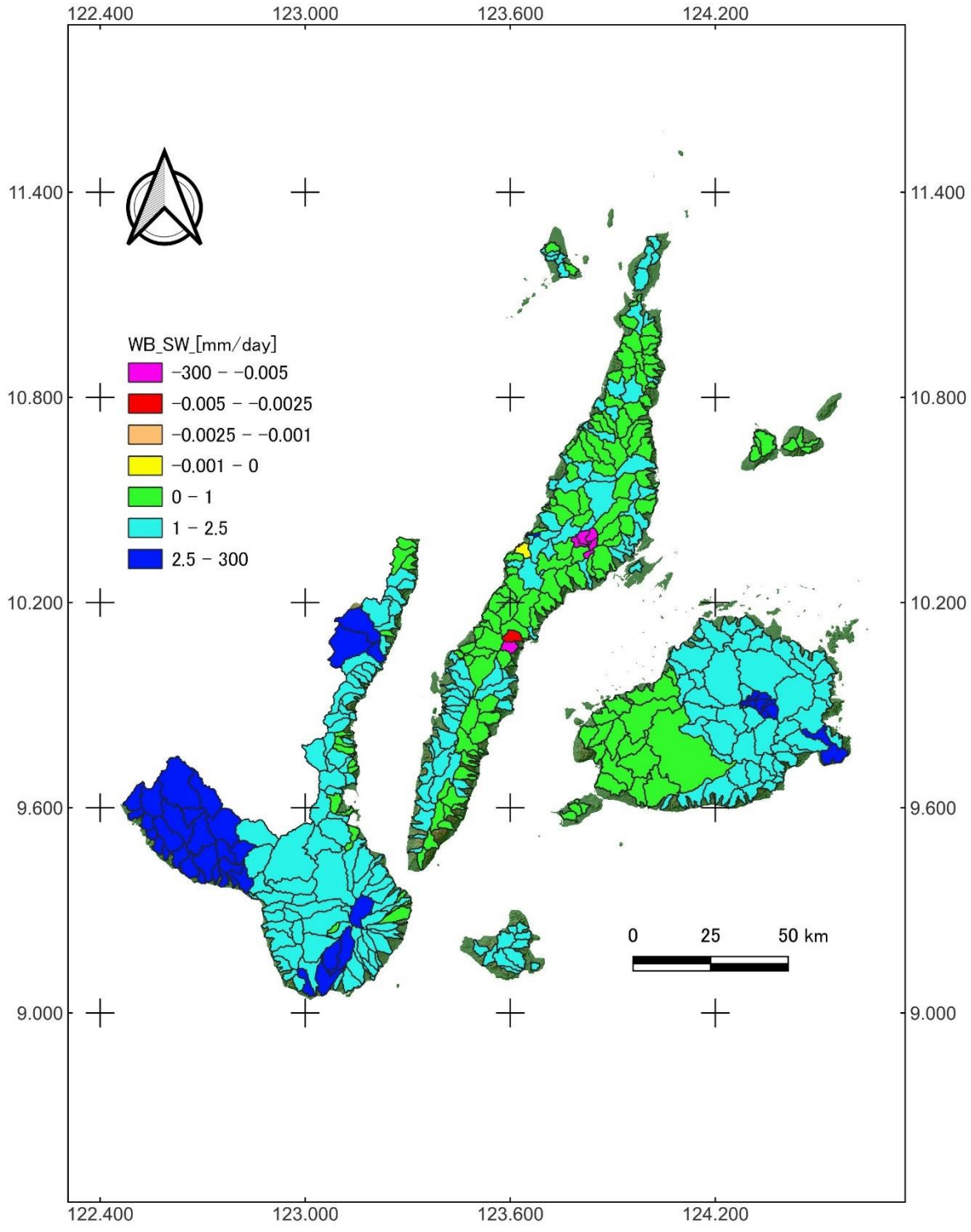
Source: JICA Survey Team

Figure D-381 Sub-Basin wise Surface Water Balance in WRR-VII (2050, Present Weather Condition)



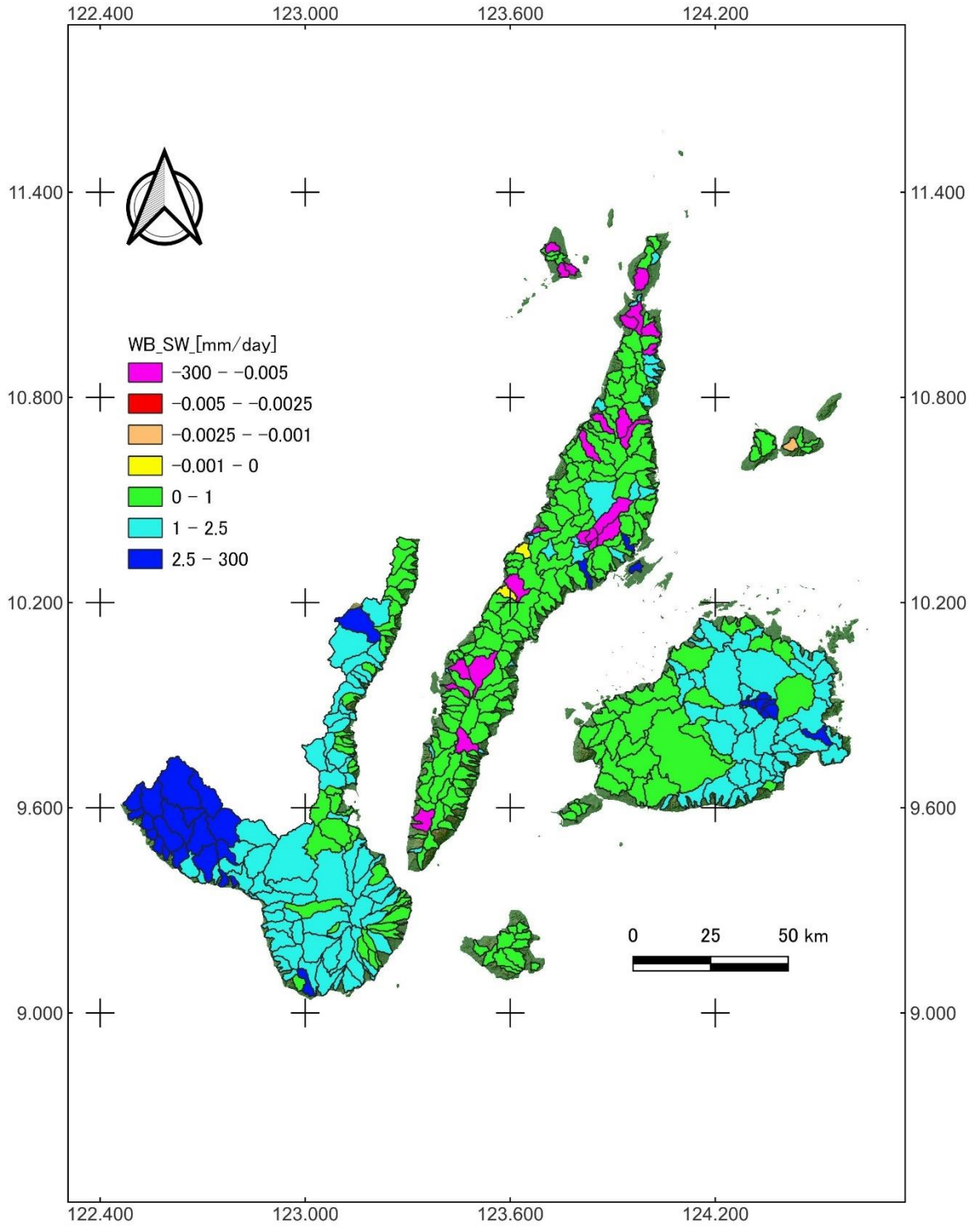
Source: JICA Survey Team

Figure D-382 Sub-Basin wise Surface Water Balance in WRR-VII (2050, Climate Change Weather Condition: RCP8.5-High)



Source: JICA Survey Team

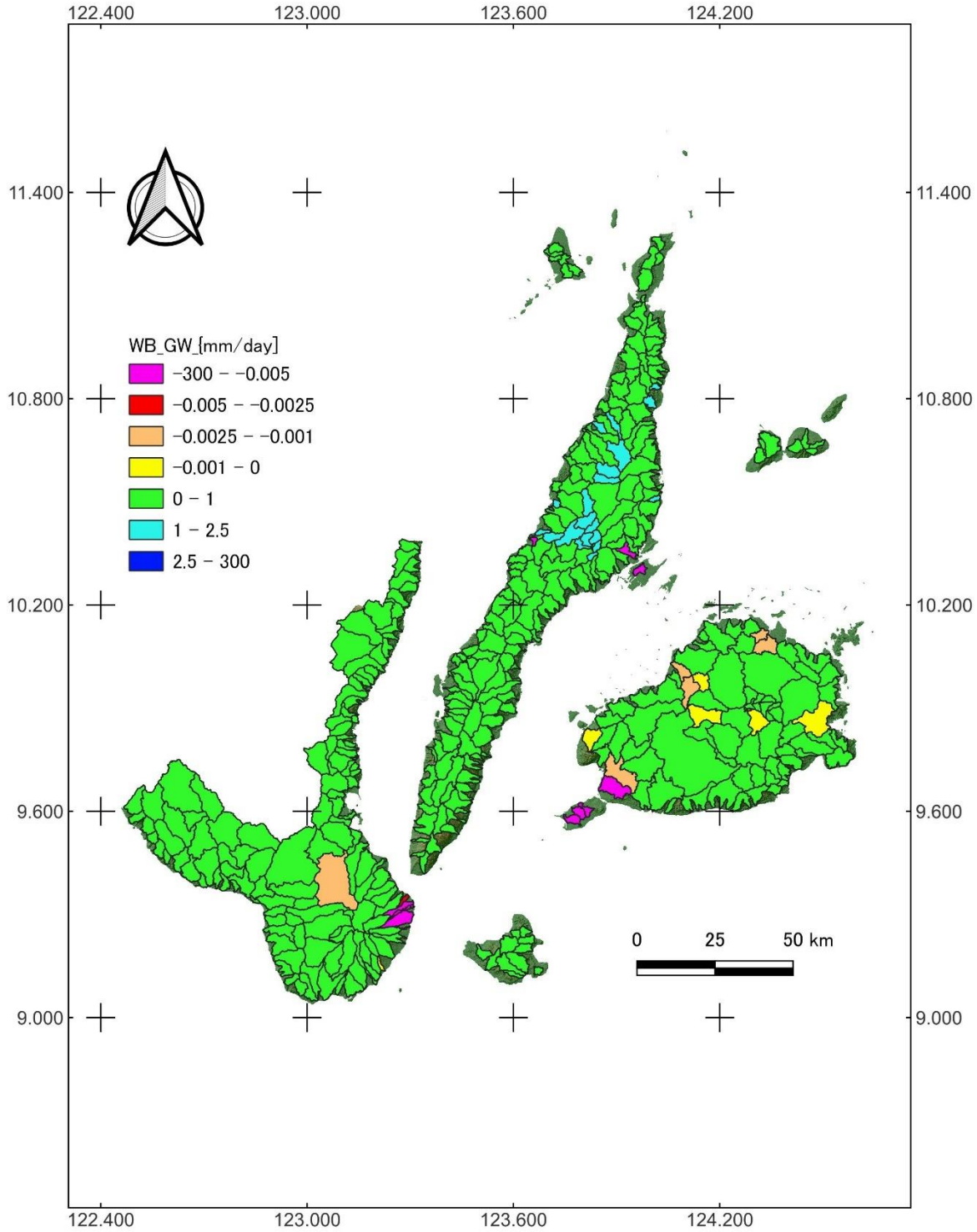
Figure D-383 Sub-Basin wise Surface Water Balance in WRR-VII (2050, Climate Change Weather Condition: RCP8.5-Mid.)



Source: JICA Survey Team

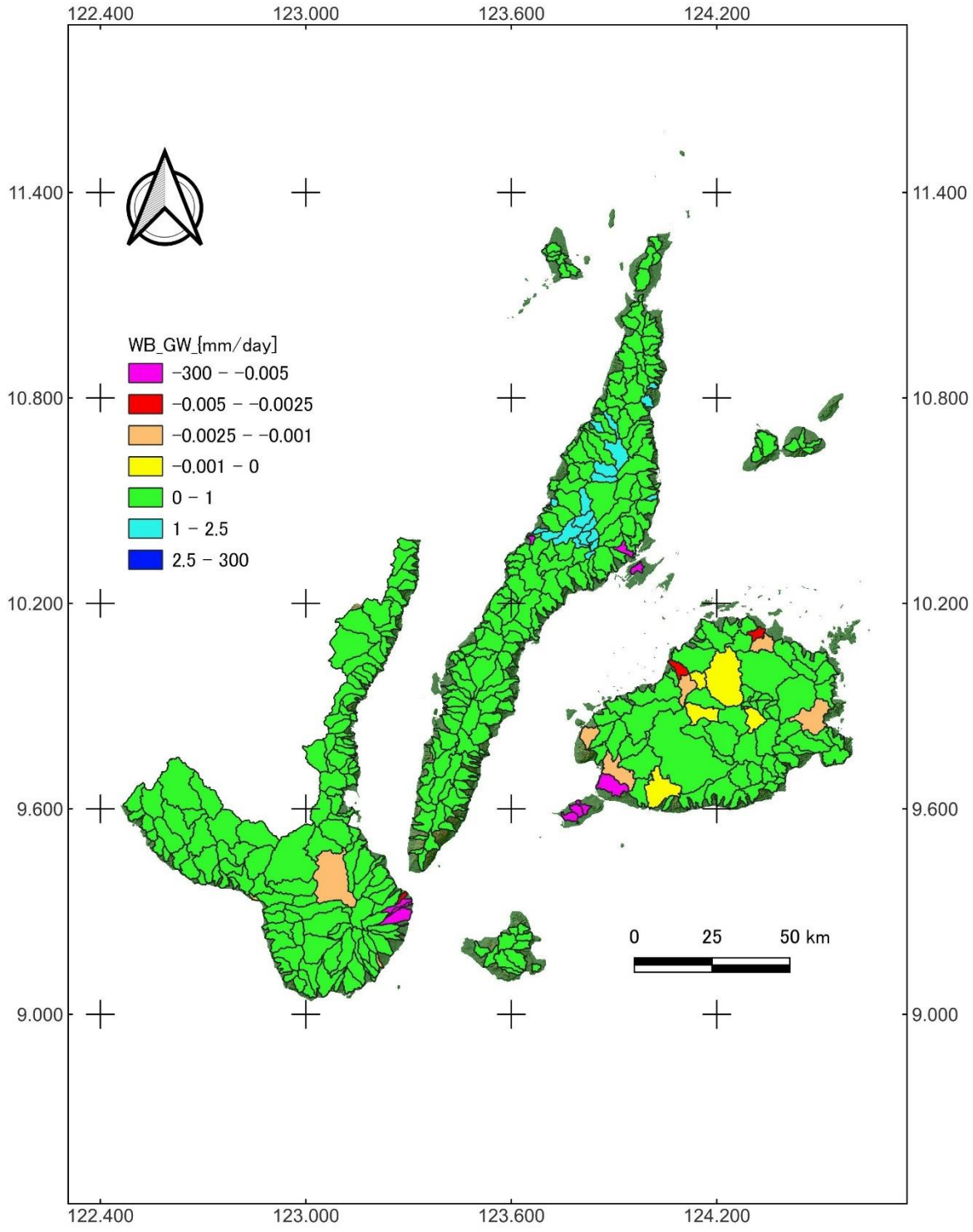
Figure D-384 Sub-Basin wise Surface Water Balance in WRR-VII (2050, Climate Change Weather Condition: RCP8.5-Low)

(8) Maps of Results of Groundwater Balance



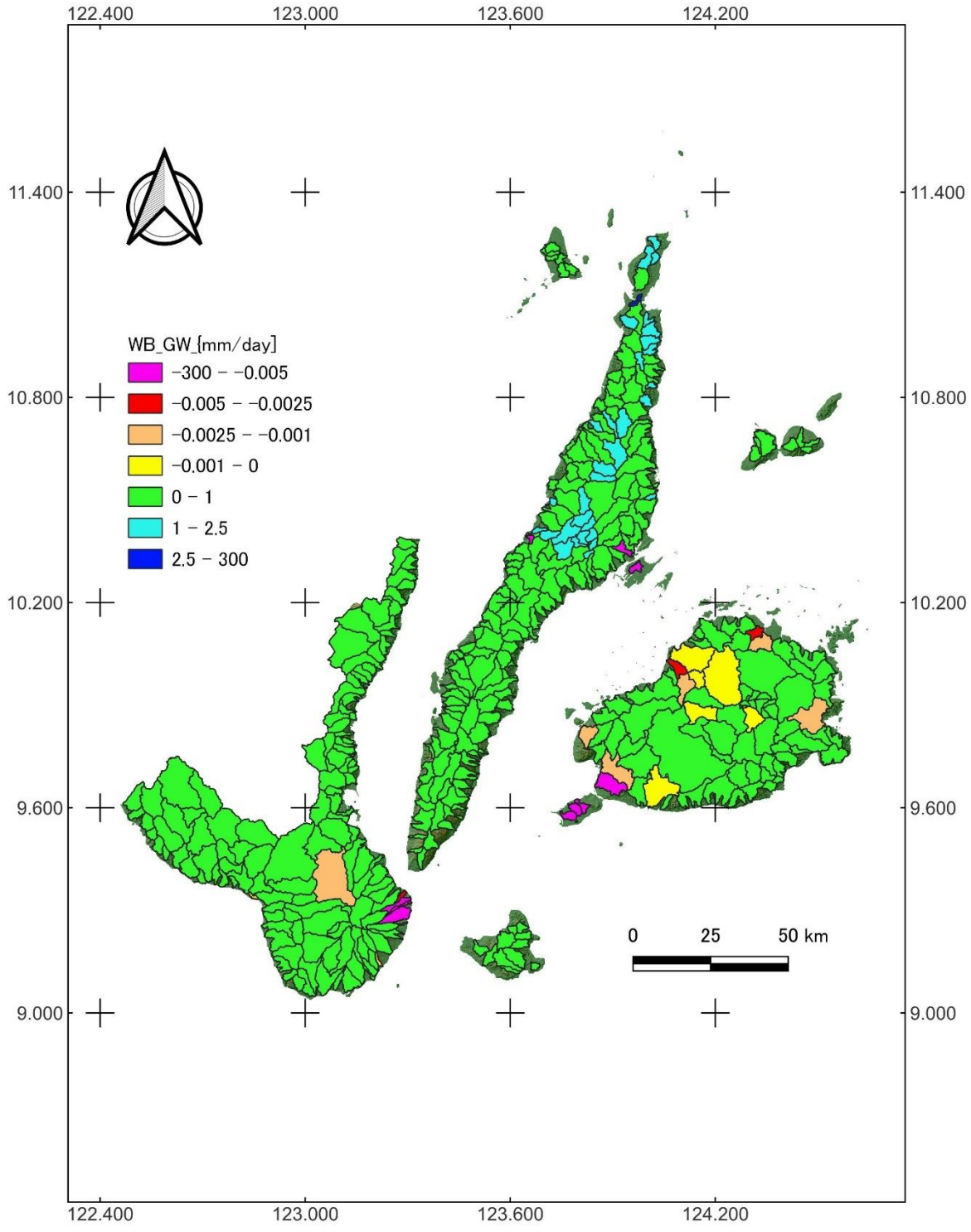
Source: JICA Survey Team

Figure D-385 Sub-Basin wise Groundwater Balance in WRR-VII (2020, Present Weather Condition)



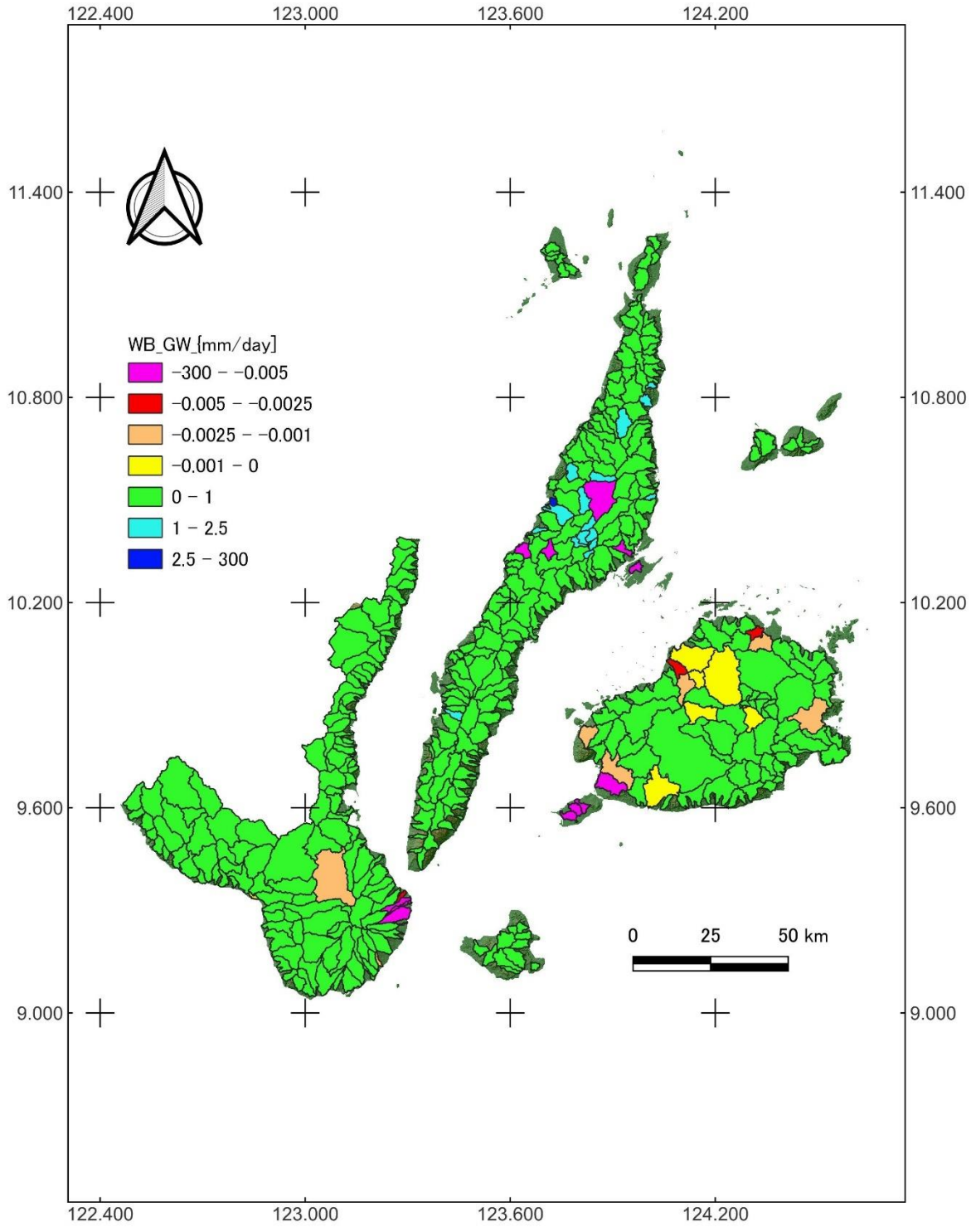
Source: JICA Survey Team

Figure D-386 Sub-Basin wise Groundwater Balance in WRR-VII (2050, Present Weather Condition)



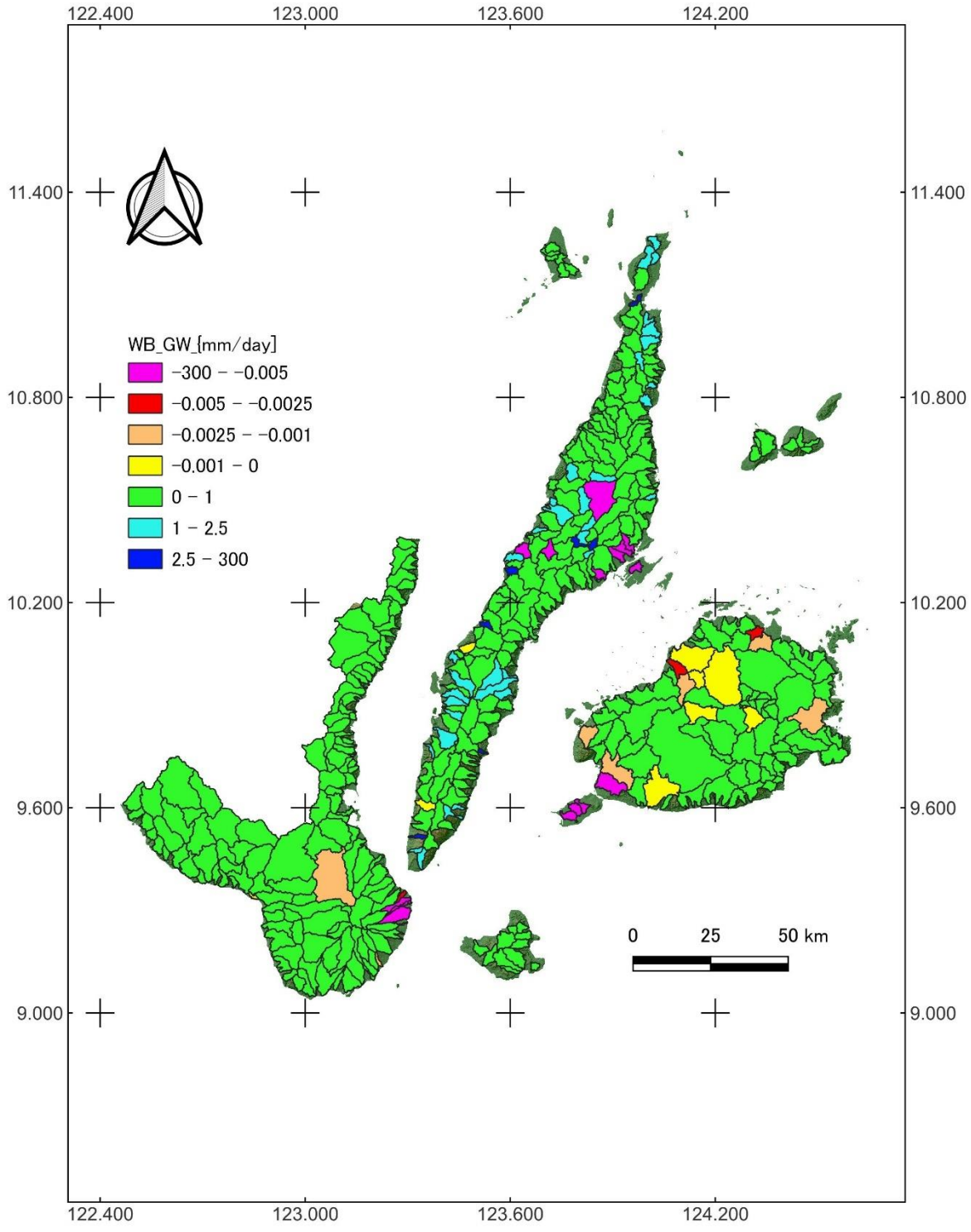
Source: JICA Survey Team

Figure D-387 Sub-Basin wise Groundwater Balance in WRR-VII (2050, Climate Change Weather Condition: RCP8.5-High)



Source: JICA Survey Team

Figure D-388 Sub-Basin wise Groundwater Balance in WRR-VII (2050, Climate Change Weather Condition: RCP8.5-Mid.)



Source: JICA Survey Team

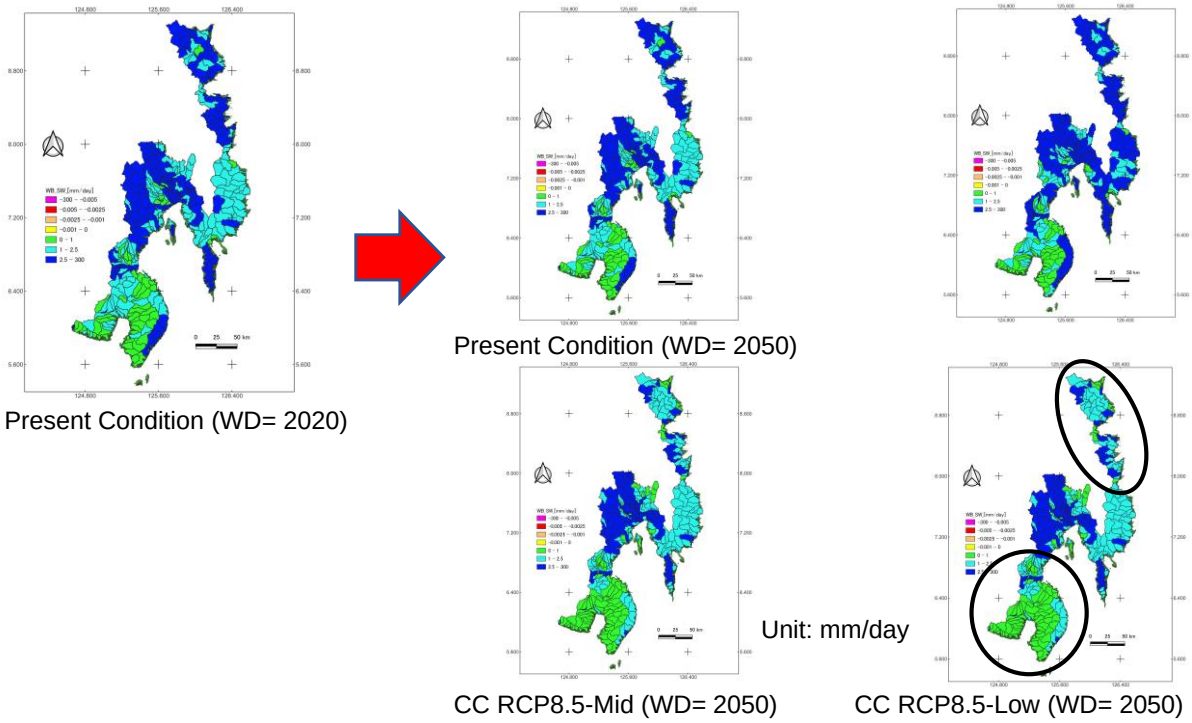
Figure D-389 Sub-Basin wise Groundwater Balance in WRR-VII (2050, Climate Change Weather Condition: RCP8.5-Low)

11.3.2 WRR-XI

(1) Sub-Basin wise Surface Water Balance

Sub-basin wise surface water balance at present condition, future (2050) and climate change condition is shown Figure below.

In terms of future water demand (2050), in the RCP8.5-Low case of climate change, the surface water balance of Northern Part of WRR11 and near the Metro General Santos City Areas are on a declining trend.

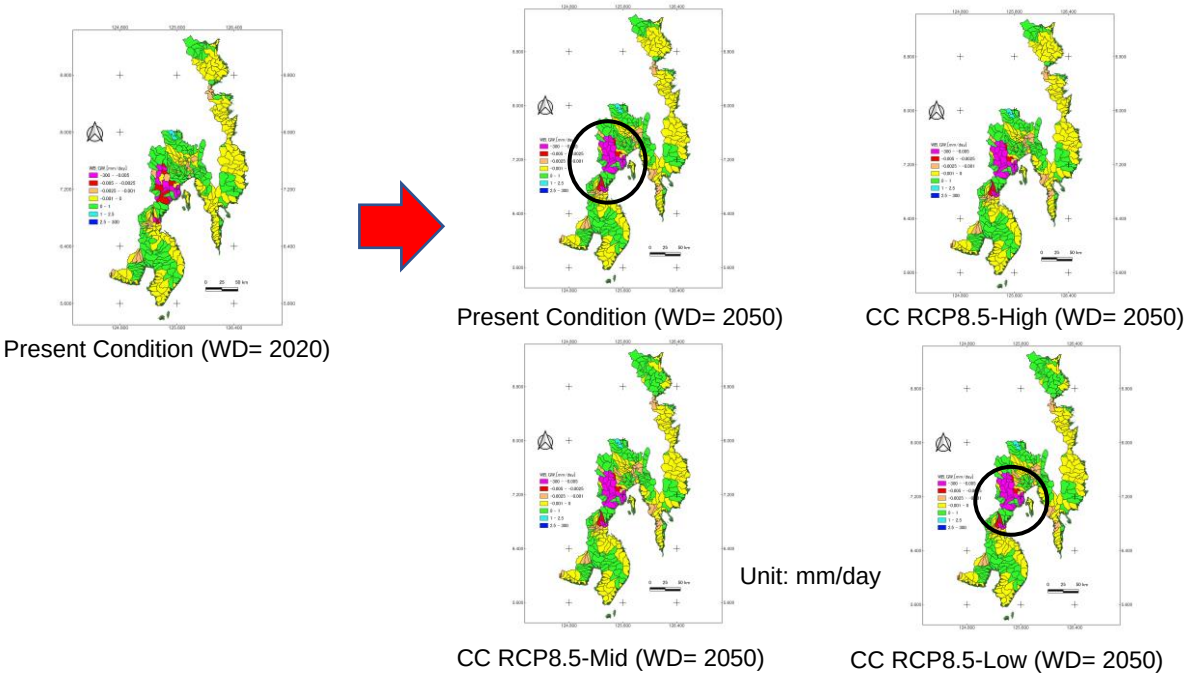


Source: JICA Survey Team

Figure D-390 Estimated Sub-Basin wise Surface Water Balance in WRR-XI

(2) Sub-Basin wise Groundwater Balance

Sub-basin wise Groundwater balance at present condition, future (2050) and climate change condition are shown Figure below. In terms of future water demand (2050) of GW, in the RCP8.5-Low case of climate change for the groundwater balance of near the Metro Davao City areas of WRR-XI will be on a declining trend.



Source: JICA Survey Team

Figure D-391 Estimated Sub-Basin wise Groundwater Balance in WRR-XI

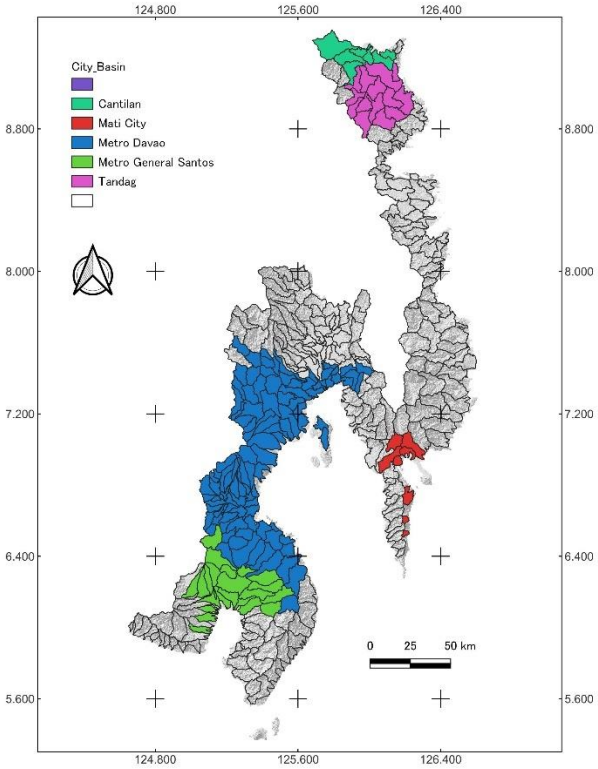
(3) Provincial-wise Water Balance

Provincial-wise surface and ground water balance in 1/5-dry year at present weather condition and water demand of 2050 are shown in **Annex-D: Hydrology 11.4**. The water balance of groundwater in 2050 in Davao del Sur, North Cotabato, South Cotabato, Sultan Kudara and Surigao del Sur provinces will be negative in future.

Summary of water balance and deficit estimation of provincial-wise surface and ground water balance at each climate change condition and water demand of 2020 and 2050 are shown in **Annex-D: Hydrology 11.4**. In Bukidnon, Davao del Sur, North Cotabato, Sarangani, South Cotabato, Sultan Kudarat and Surigao del Sur provinces, negative values of annual water and deficit of groundwater will be increased in future.

(4) Major City/Town-wise Water Balance

Location map of major cities in WRR-XI is shown in Figure below.



Source: JICA Survey Team

Figure D-392 Location Map of Major Cities in WRR-XI

The surface and ground water balance in 1/5-dry year in the major cities at present weather condition and water demand of 2050 are shown in **Annex-D: Hydrology 11.5**. In most cities, the groundwater balance is projected to be negative against the water demand in 2050, and the negative groundwater balance is particularly large in the Metro Davao and Metro General Santos areas. All cities will be surplus of surface water balance in future. However, these annual SW potentials are included flood discharge. Thus, SW reservoirs might be needed.

Table D-136 Surface and Groundwater Balance of Metro Davao in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Metro Davao Target Year= 2050
Weather Condition: Present Total Area [km2]= 5,896 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	754.3	698.4	560.1	350.2	1,244.3	1,747.3	699.4	1,142.8	1,400.9	1,017.5	710.9	471.2	10,797.1	
Surface Water Potential	**773.5**	**478.8**	**398.2**	**257.8**	**409.8**	**736.5**	**453.7**	**557.5**	**811.7**	**629.9**	**525.0**	**374.2**	**6,406.6**	
Irrigation Water Demand (SW)	137.7	96.2	79.5	52.5	44.1	132.0	112.8	125.1	71.0	21.2	112.9	154.0	1,139.1	
Livestock Water Deamnd (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.1	
Municipal and Industrial Water Demand (SW)	10.4	9.4	10.4	10.0	10.4	10.0	10.4	10.4	10.0	10.4	10.0	10.4	122.2	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	148.5	106.0	90.4	62.9	54.9	142.5	123.6	135.9	81.5	32.1	123.3	164.9	1,266.4	
SW Water Balance	**625.0**	**372.9**	**307.8**	**194.8**	**354.9**	**594.1**	**330.1**	**421.6**	**730.2**	**597.8**	**401.7**	**209.3**	**5,140.2**	**0.0**
Groundwater Potential	**6.6**	**6.0**	**4.7**	**4.1**	**4.3**	**5.1**	**4.6**	**4.5**	**4.3**	**4.8**	**6.0**	**5.8**	**60.9**	
Safety Groundwater Availability (70% of GWP)	**4.6**	**4.2**	**3.3**	**2.8**	**3.0**	**3.6**	**3.2**	**3.1**	**3.0**	**3.4**	**4.2**	**4.0**	**42.6**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	43.2	39.0	43.2	41.8	43.2	41.8	43.2	43.2	41.8	43.2	41.8	43.2	508.5	
Other Water Demand (GW)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.9	
Total Water Demand (GW)	44.1	39.9	44.1	42.7	44.1	42.7	44.1	44.1	42.7	44.1	42.7	44.1	519.6	
GW Water Balance	**-39.5**	**-35.7**	**-40.8**	**-39.9**	**-41.1**	**-39.1**	**-40.9**	**-41.0**	**-39.7**	**-40.7**	**-38.5**	**-40.1**	**-477.0**	**-477.0**
Total Water Potential (SW+GW)	**778.1**	**483.0**	**401.5**	**260.6**	**412.9**	**740.1**	**456.9**	**560.7**	**814.7**	**633.3**	**529.2**	**378.2**	**6,449.2**	
Irrigation Water Demand (Total)	137.7	96.2	79.6	52.5	44.1	132.0	112.8	125.1	71.0	21.2	112.9	154.1	1,139.2	
Livestock Water Deamnd (Total)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.3	
Municipal and Industrial Water Demand (Total)	53.6	48.4	53.6	51.8	53.6	51.8	53.6	53.6	51.8	53.6	51.8	53.6	630.7	
Other Water Demand (Total)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.9	
Total Water Demand (SW+GW)	192.7	145.8	134.5	105.7	99.1	185.2	167.7	180.0	124.2	76.2	166.0	209.0	1,786.0	
Total Water Balance (SW+GW)	**585.5**	**337.2**	**267.0**	**155.0**	**313.8**	**554.9**	**289.2**	**380.7**	**690.5**	**557.1**	**363.2**	**169.2**	**4,663.2**	**-477.0**

Source: JICA Survey Team

Summary of water balance and deficit estimation of surface and ground water balance at each climate change condition and water demand of 2020 and 2050 in Metro Davao and Metro General Santos areas are shown in **Annex-D: Hydrology 11.5**. In Metro Davao, negative values of annual water and deficit of groundwater will be increased in future.

Table D-137 Summary of Annual Water Balance and Deficit of Metro Davao at Each Climate Change Condition

Total Area [km^2]= 5,896

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	7,745.5	-281.8	7,463.6	0.0	-281.8	-281.8
2	Present	2020	1/5-Dry Year	5,677.5	-281.9	5,395.6	0.0	-281.9	-281.9
3	Present	2020	1/10-Dry Year	4,862.8	-282.0	4,580.8	0.0	-282.0	-282.0
4	Present	2050	Average Year	7,208.1	-476.9	6,731.2	0.0	-476.9	-476.9
5	Present	2050	1/5-Dry Year	5,140.2	-477.0	4,663.2	0.0	-477.0	-477.0
6	Present	2050	1/10-Dry Year	4,325.4	-477.1	3,848.3	0.0	-477.1	-477.1
7	CC RCP8.5-High	2050	Average Year	6,878.6	-476.9	6,401.7	0.0	-476.9	-476.9
8	CC RCP8.5-High	2050	1/5-Dry Year	5,236.5	-476.9	4,759.6	0.0	-476.9	-476.9
9	CC RCP8.5-High	2050	1/10-Dry Year	4,584.9	-477.0	4,107.9	0.0	-477.0	-477.0
10	CC RCP8.5-Mid.	2050	Average Year	6,553.1	-491.1	6,062.1	0.0	-491.1	-491.1
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	5,037.1	-491.2	4,545.9	0.0	-491.2	-491.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	4,660.8	-491.0	4,169.7	0.0	-491.0	-491.0
13	CC RCP8.5-Low	2050	Average Year	7,253.5	-495.8	6,757.7	0.0	-495.8	-495.8
14	CC RCP8.5-Low	2050	1/5-Dry Year	5,121.9	-495.9	4,626.0	0.0	-495.9	-495.9
15	CC RCP8.5-Low	2050	1/10-Dry Year	4,843.7	-495.6	4,348.0	0.0	-495.6	-495.6

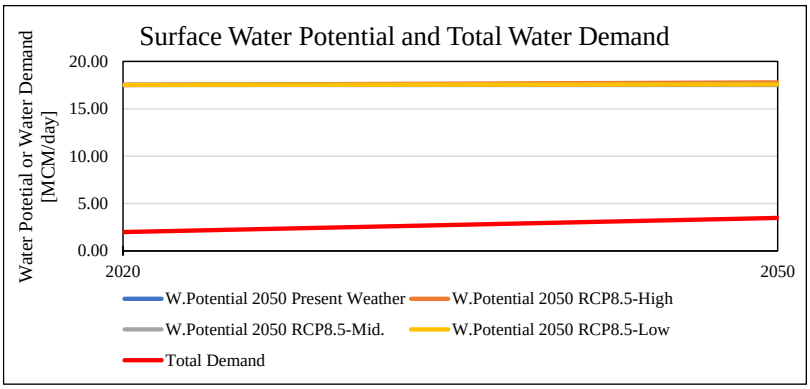
Source: JICA Survey Team

Table D-138 Summary of Annual Water Balance and Deficit of Metro General Santos at Each Climate Change Condition

Total Area [km^2]= 1,737

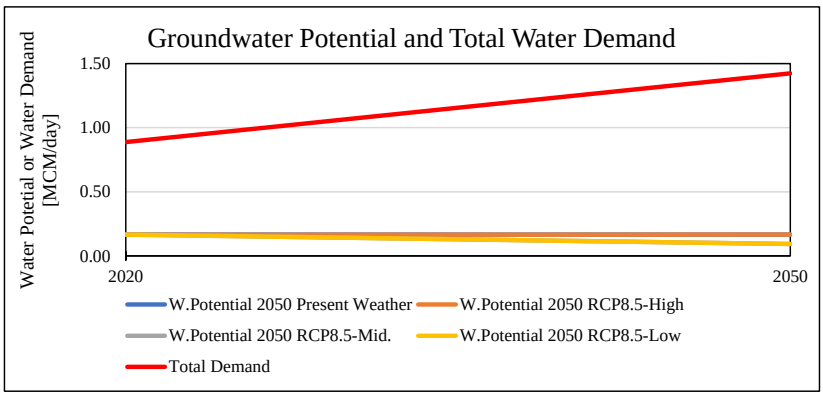
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	2,817.0	-90.0	2,727.1	0.0	-90.0	-90.0
2	Present	2020	1/5-Dry Year	2,576.7	-90.1	2,486.6	0.0	-90.1	-90.1
3	Present	2020	1/10-Dry Year	2,485.3	-90.1	2,395.2	0.0	-90.1	-90.1
4	Present	2050	Average Year	2,745.1	-115.0	2,630.0	0.0	-115.0	-115.0
5	Present	2050	1/5-Dry Year	2,504.7	-115.2	2,389.6	0.0	-115.2	-115.2
6	Present	2050	1/10-Dry Year	2,413.4	-115.1	2,298.2	0.0	-115.1	-115.1
7	CC RCP8.5-High	2050	Average Year	2,646.6	-115.0	2,531.6	0.0	-115.0	-115.0
8	CC RCP8.5-High	2050	1/5-Dry Year	2,401.3	-115.1	2,286.1	0.0	-115.1	-115.1
9	CC RCP8.5-High	2050	1/10-Dry Year	2,400.3	-115.1	2,285.1	0.0	-115.1	-115.1
10	CC RCP8.5-Mid.	2050	Average Year	1,505.9	-125.1	1,380.9	0.0	-125.1	-125.1
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,198.6	-125.2	1,073.5	0.0	-125.2	-125.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,195.4	-125.1	1,070.2	0.0	-125.1	-125.1
13	CC RCP8.5-Low	2050	Average Year	2,819.8	-130.7	2,689.1	0.0	-130.7	-130.7
14	CC RCP8.5-Low	2050	1/5-Dry Year	2,645.2	-130.8	2,514.4	0.0	-130.8	-130.8
15	CC RCP8.5-Low	2050	1/10-Dry Year	2,483.8	-130.8	2,353.0	0.0	-130.8	-130.8

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-393 Surface Water Balance of Metro Davao in 1/5-Dry Year at Each Climate Change Condition

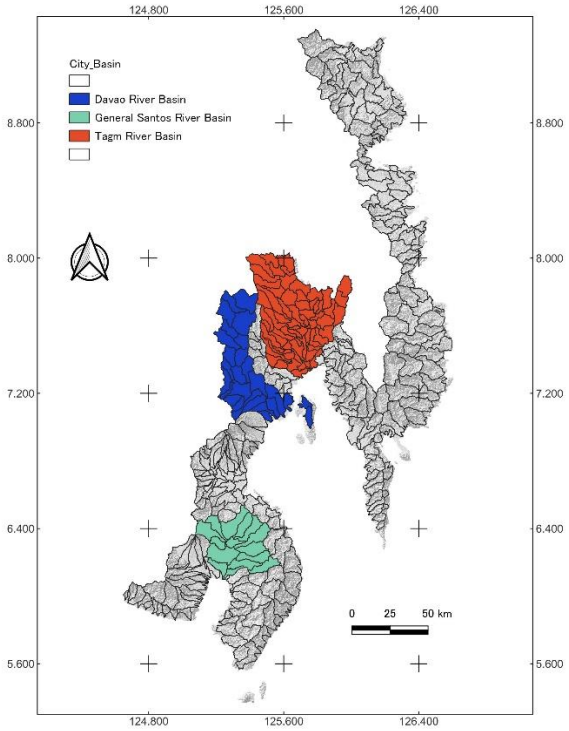


Source: JICA Survey Team

Figure D-394 Groundwater Balance of Metro Davao in 1/5-Dry Year at Each Climate Change Condition

(5) Major River Basin-wise Water Balance

Location map of major river basins in WRR-XI is shown in Figure below.



Source: JICA Survey Team

Figure D-395 Location Map of Major River Basins in WRR-XI

The surface and ground water balance in 1/5-dry year in the major river basins at present weather condition and water demand of 2050 are shown in **Annex-D: Hydrology 11.6**. The Davao River basin near the Davao city area will be negative water balance of groundwater in 2050.

Table D-139 Surface and Groundwater Balance of Davao River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Davao River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 2,144 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	305.8	293.8	266.7	152.1	596.4	757.0	301.7	550.4	673.6	415.8	320.6	183.0	4,816.7	
Surface Water Potential	**280.9**	**176.1**	**180.6**	**145.0**	**226.3**	**321.1**	**198.5**	**259.5**	**355.5**	**262.0**	**210.7**	**146.5**	**2,762.7**	
Irrigation Water Demand (SW)	21.6	20.3	13.6	0.0	0.1	19.0	16.6	21.9	10.8	0.0	12.8	16.0	152.7	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	
Municipal and Industrial Water Demand (SW)	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	17.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	23.1	21.7	15.1	1.4	1.6	20.5	18.1	23.4	12.2	1.5	14.2	17.5	170.3	
SW Water Balance	**257.7**	**154.4**	**165.5**	**143.6**	**224.8**	**300.6**	**180.3**	**236.2**	**343.3**	**260.5**	**196.5**	**129.0**	**2,592.4**	**0.0**
Groundwater Potential	**1.4**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.4**	**1.3**	**1.4**	**16.0**	
Safety Groundwater Availability (70% of GWP)	**1.0**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**1.0**	**11.2**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	28.2	25.5	28.2	27.3	28.2	27.3	28.2	28.2	27.3	28.2	27.3	28.2	332.2	
Other Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.2	
Total Water Demand (GW)	28.7	26.0	28.7	27.8	28.7	27.8	28.7	28.7	27.8	28.7	27.8	28.7	338.4	
GW Water Balance	**-27.8**	**-25.1**	**-27.8**	**-26.9**	**-27.8**	**-26.9**	**-27.8**	**-27.8**	**-26.9**	**-27.8**	**-26.9**	**-27.8**	**-327.2**	**-327.2**
Total Water Potential (SW+GW)	**281.8**	**177.0**	**181.5**	**145.9**	**227.3**	**322.0**	**199.4**	**260.5**	**356.4**	**262.9**	**211.6**	**147.5**	**2,773.8**	
Irrigation Water Demand (Total)	21.6	20.3	13.6	0.0	0.1	19.0	16.6	21.9	10.8	0.0	12.8	16.0	152.7	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	
Municipal and Industrial Water Demand (Total)	29.7	26.8	29.7	28.7	29.7	28.7	29.7	29.7	28.7	29.7	28.7	29.7	349.2	
Other Water Demand (Total)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.2	
Total Water Demand (SW+GW)	51.9	47.6	43.8	29.3	30.3	48.3	46.9	52.1	40.0	30.2	42.0	46.2	508.6	
Total Water Balance (SW+GW)	**230.0**	**129.4**	**137.7**	**116.7**	**197.0**	**273.7**	**152.5**	**208.4**	**316.4**	**232.7**	**169.6**	**101.2**	**2,265.2**	**-327.2**

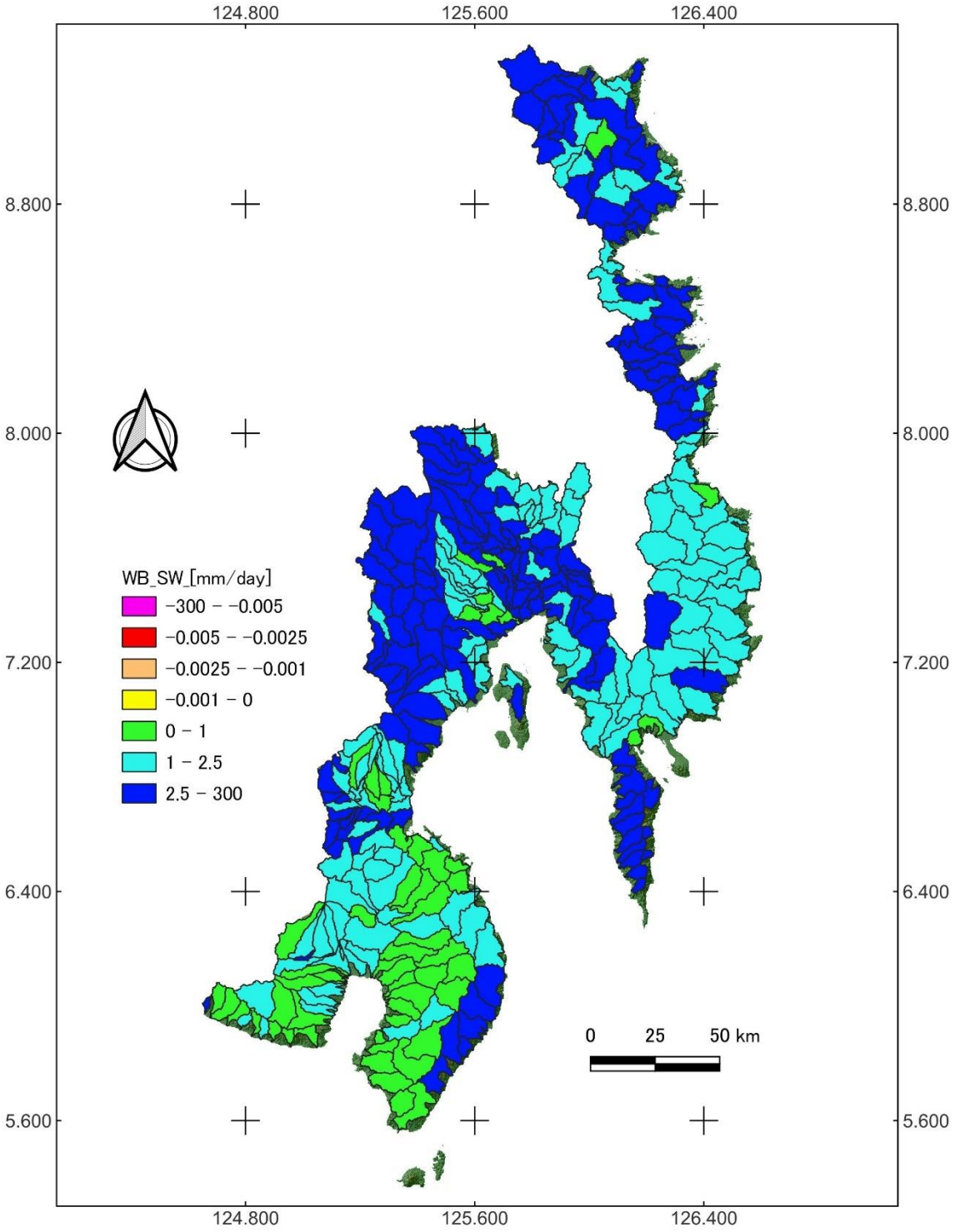
Source: JICA Survey Team

Summary of water balance and deficit estimation of surface and ground water balance at each climate change condition and water demand of 2020 and 2050 in the Davao River basin areas are shown in **Annex-D: Hydrology 11.6**. In the Davao River basin, negative values of annual water and deficit of groundwater will be increased in future.

(6) Conclusion

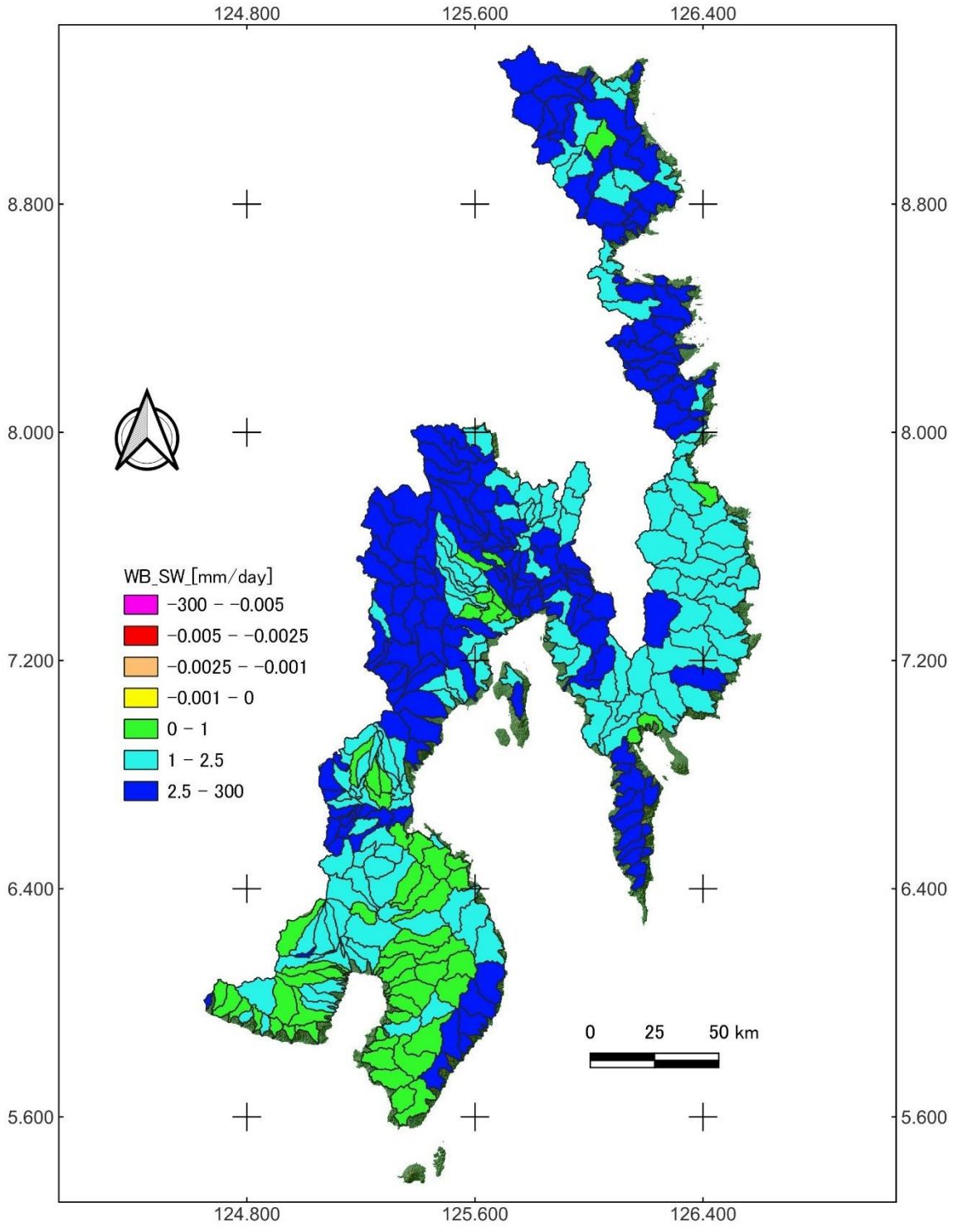
As described in above, in the Metro Davao area, negative values of annual water and deficit of and groundwater will be increased in future.

(7) Maps of Results of Surface Water Balance



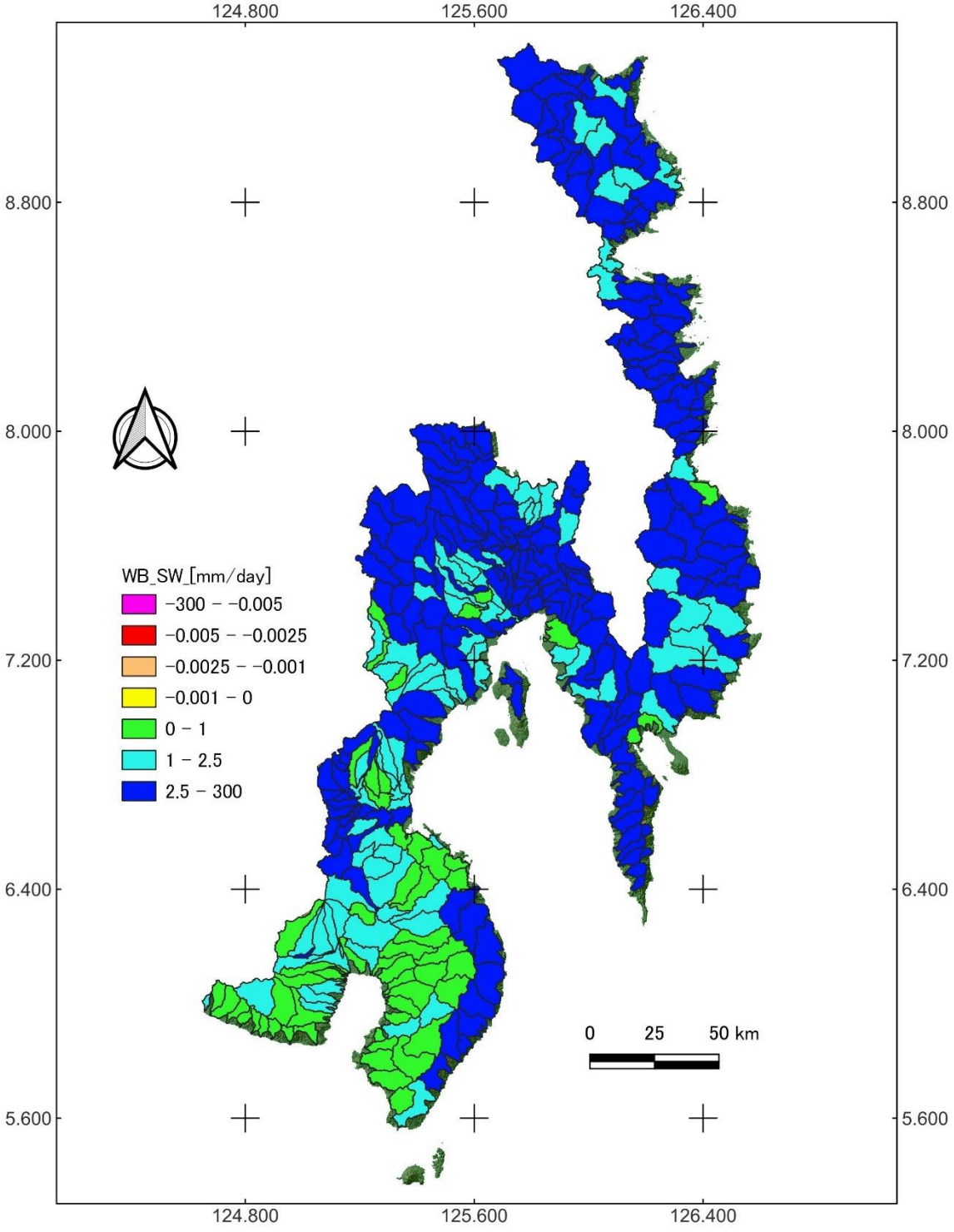
Source: JICA Survey Team

Figure D-396 Sub-Basin wise Surface Water Balance in WRR-XI (2020, Present Weather Condition)



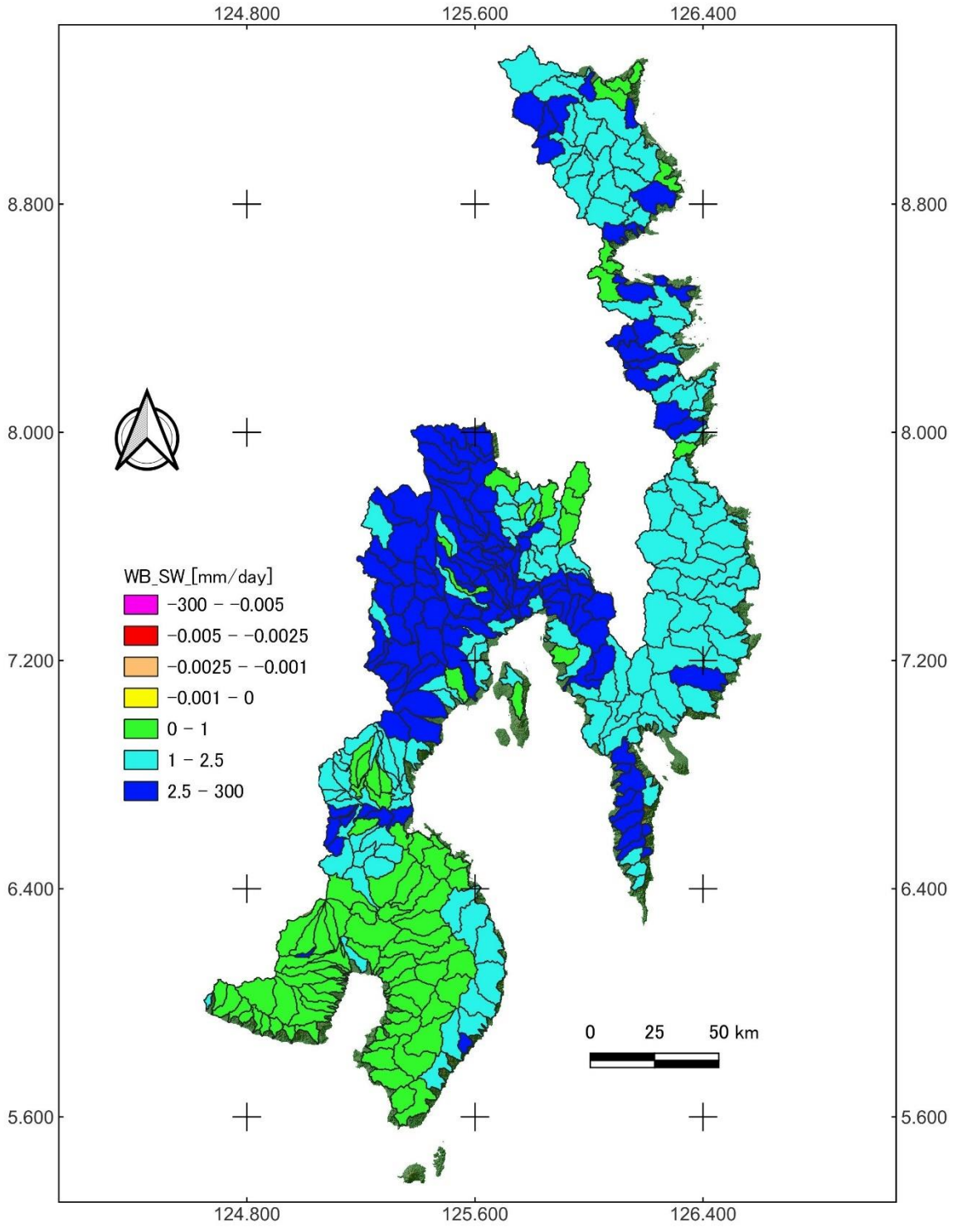
Source: JICA Survey Team

Figure D-397 Sub-Basin wise Surface Water Balance in WRR-XI (2050, Present Weather Condition)



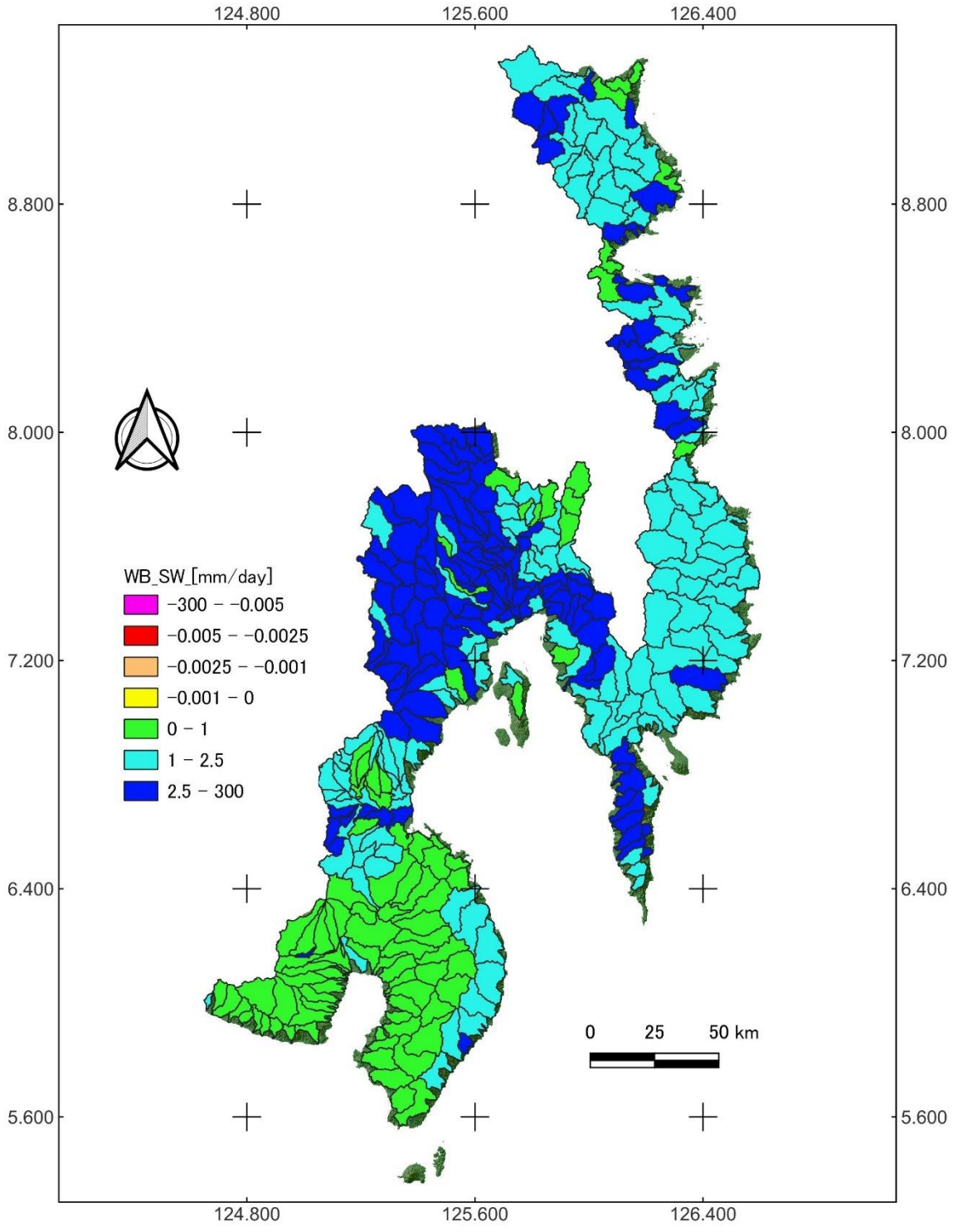
Source: JICA Survey Team

Figure D-398 Sub-Basin wise Surface Water Balance in WRR-XI (2050, Climate Change Weather Condition: RCP8.5-High)



Source: JICA Survey Team

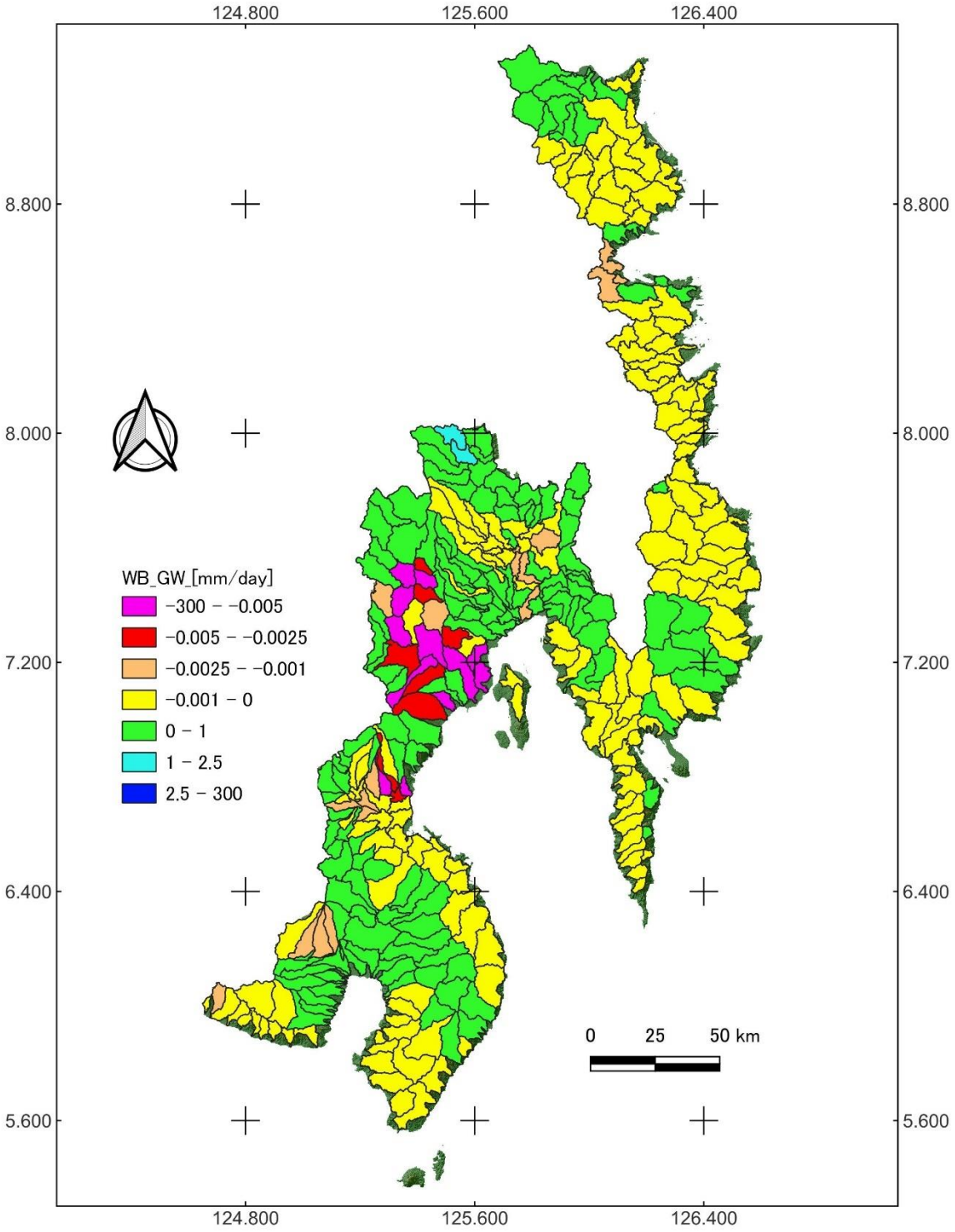
Figure D-399 Sub-Basin wise Surface Water Balance in WRR-XI (2050, Climate Change Weather Condition: RCP8.5-Mid.)



Source: JICA Survey Team

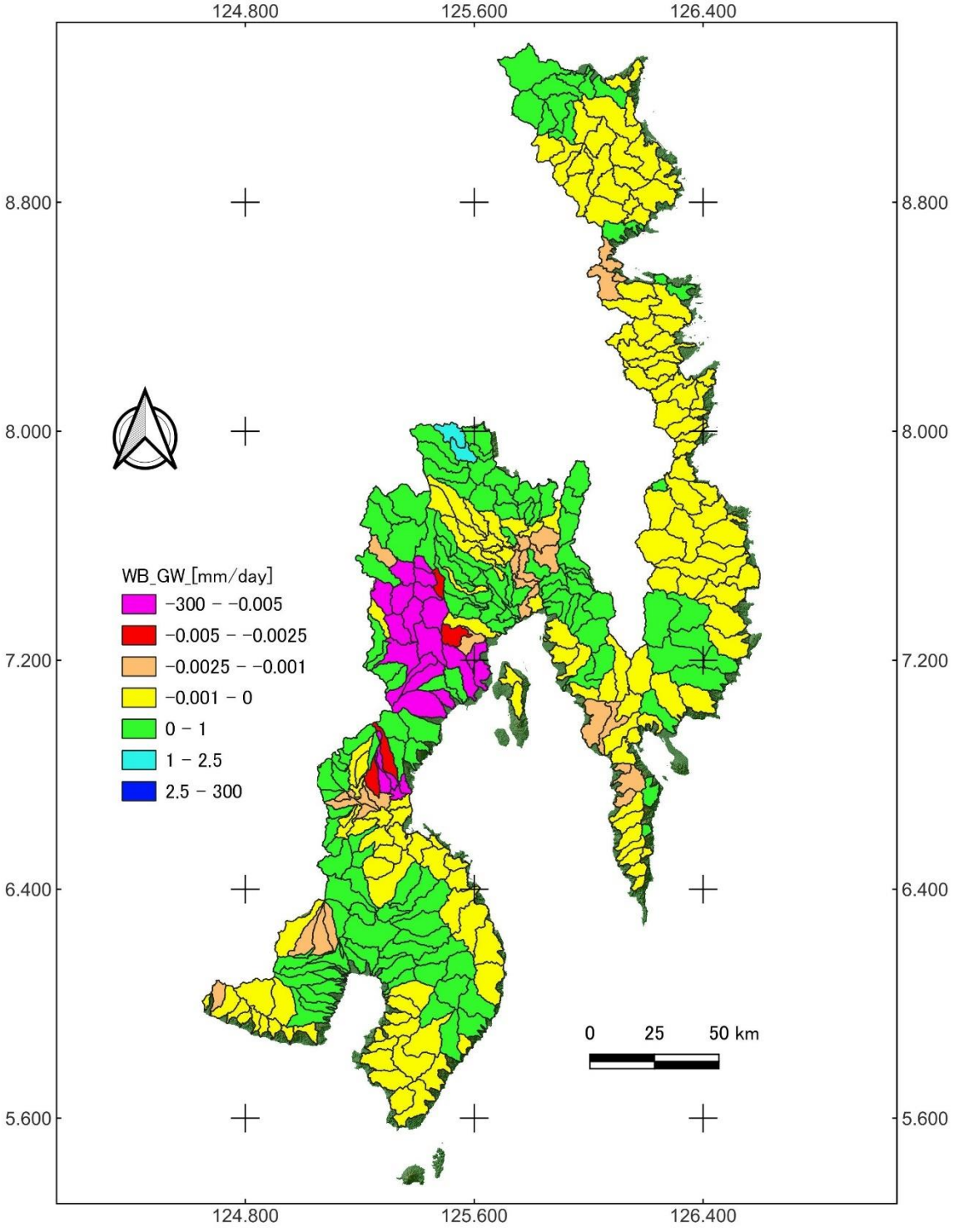
Figure D-400 Sub-Basin wise Surface Water Balance in WRR-XI (2050, Climate Change Weather Condition: RCP8.5-Low)

(8) Maps of Results of Groundwater Balance



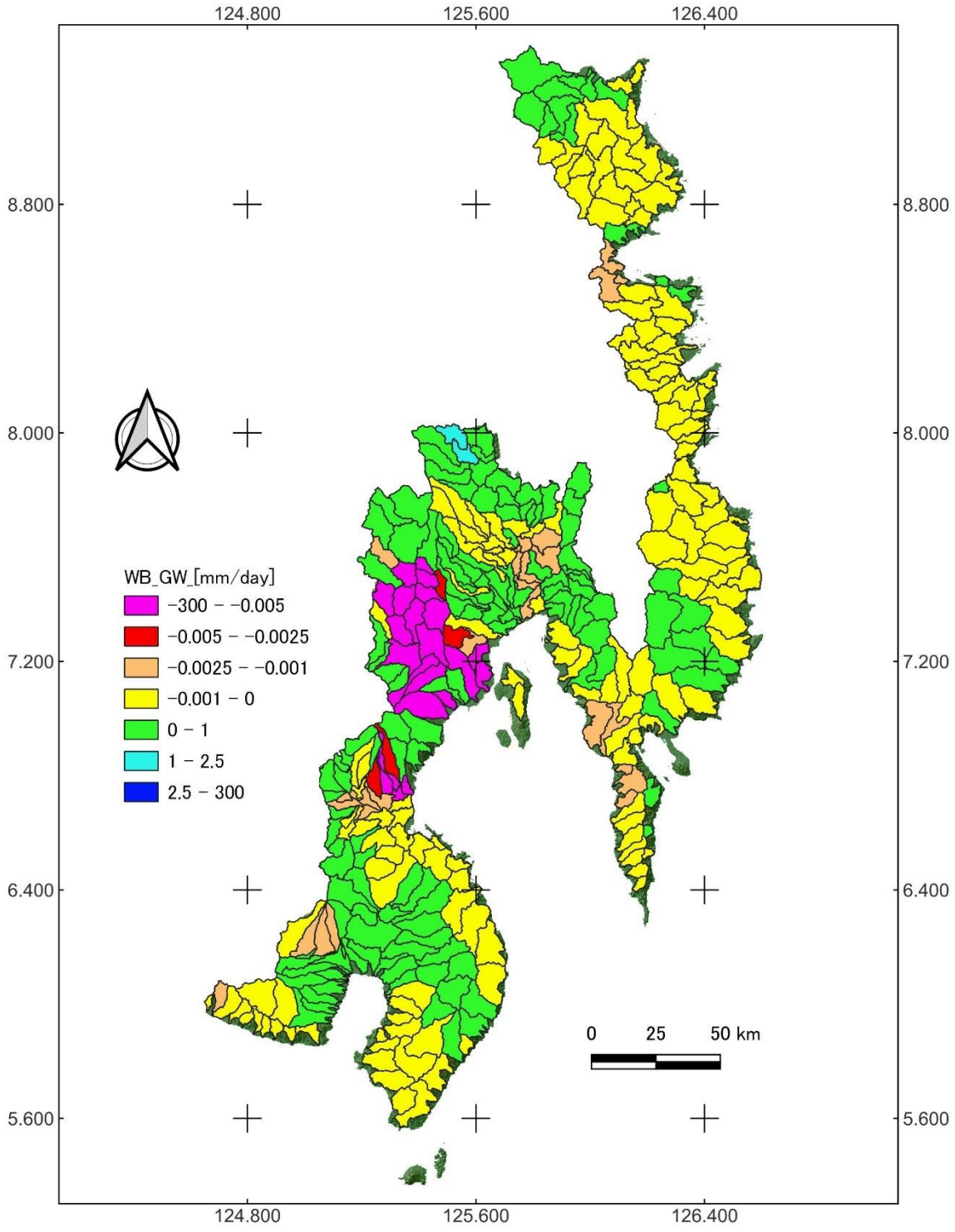
Source: JICA Survey Team

Figure D-401 Sub-Basin wise Groundwater Balance in WRR-XI (2020, Present Weather Condition)



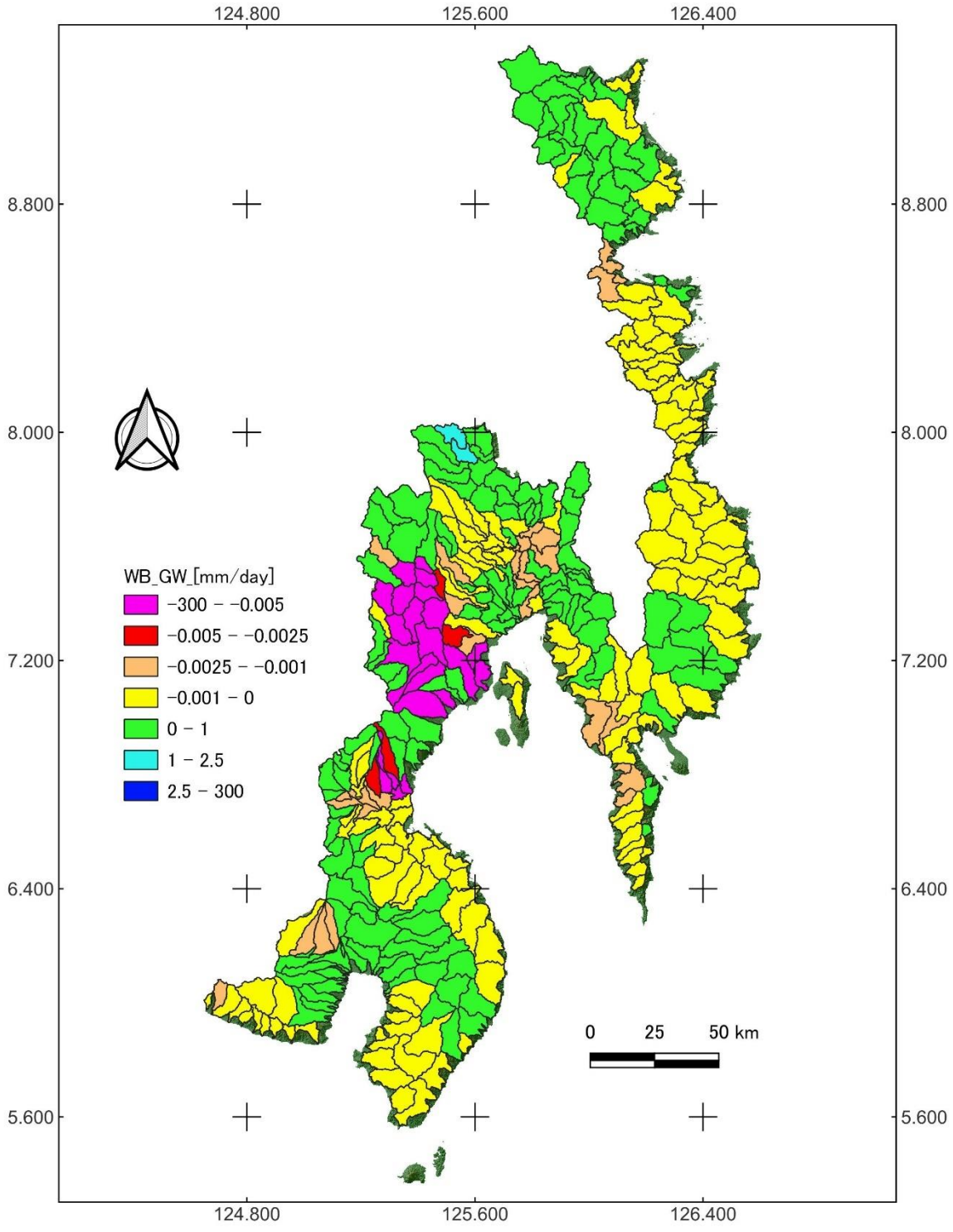
Source: JICA Survey Team

Figure D-402 Sub-Basin wise Groundwater Balance in WRR-XI (2050, Present Weather Condition)



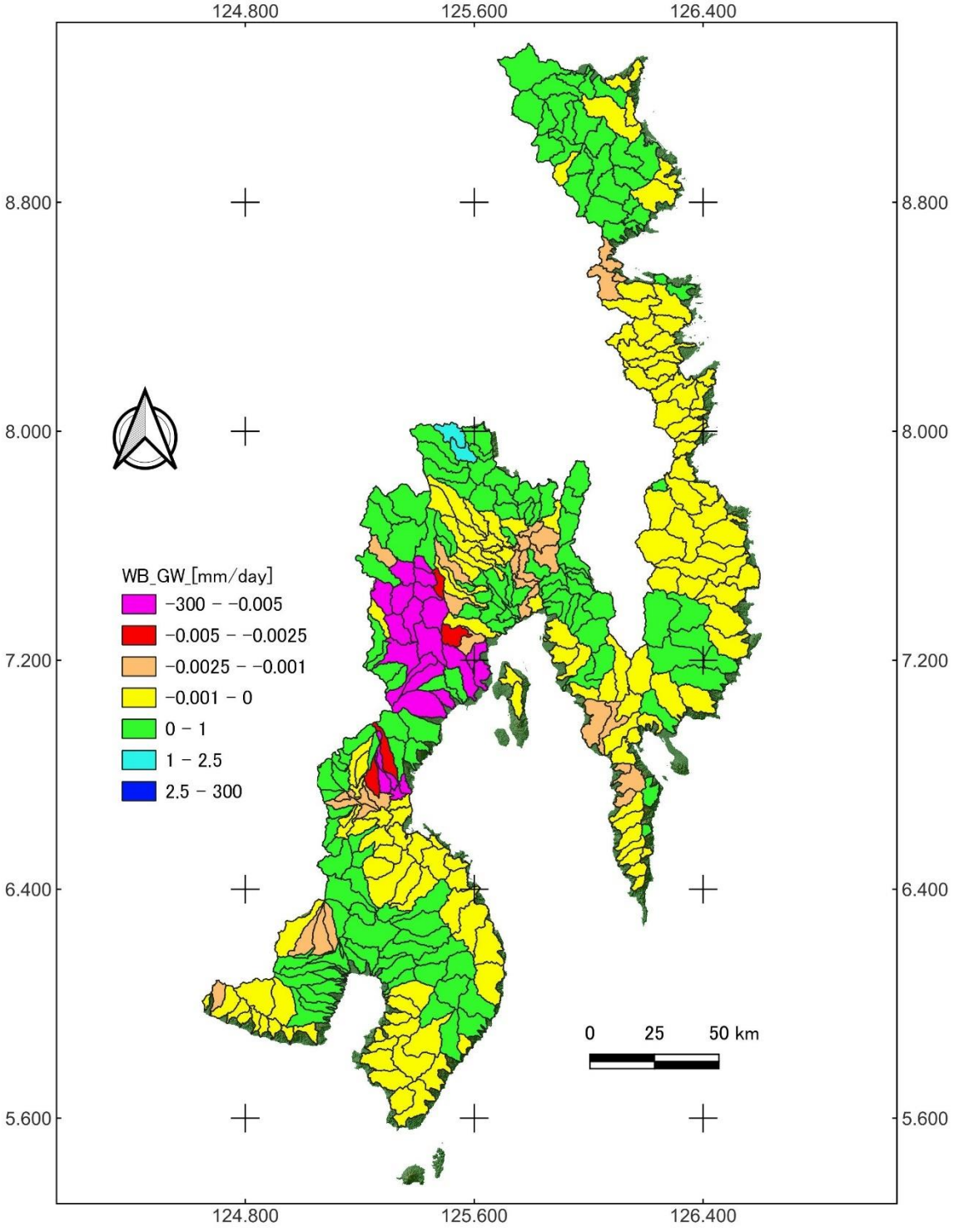
Source: JICA Survey Team

Figure D-403 Sub-Basin wise Groundwater Balance in WRR-XI (2050, Climate Change Weather Condition: RCP8.5-High)



Source: JICA Survey Team

Figure D-404 Sub-Basin wise Groundwater Balance in WRR-XI (2050, Climate Change Weather Condition: RCP8.5-Mid.)



Source: JICA Survey Team

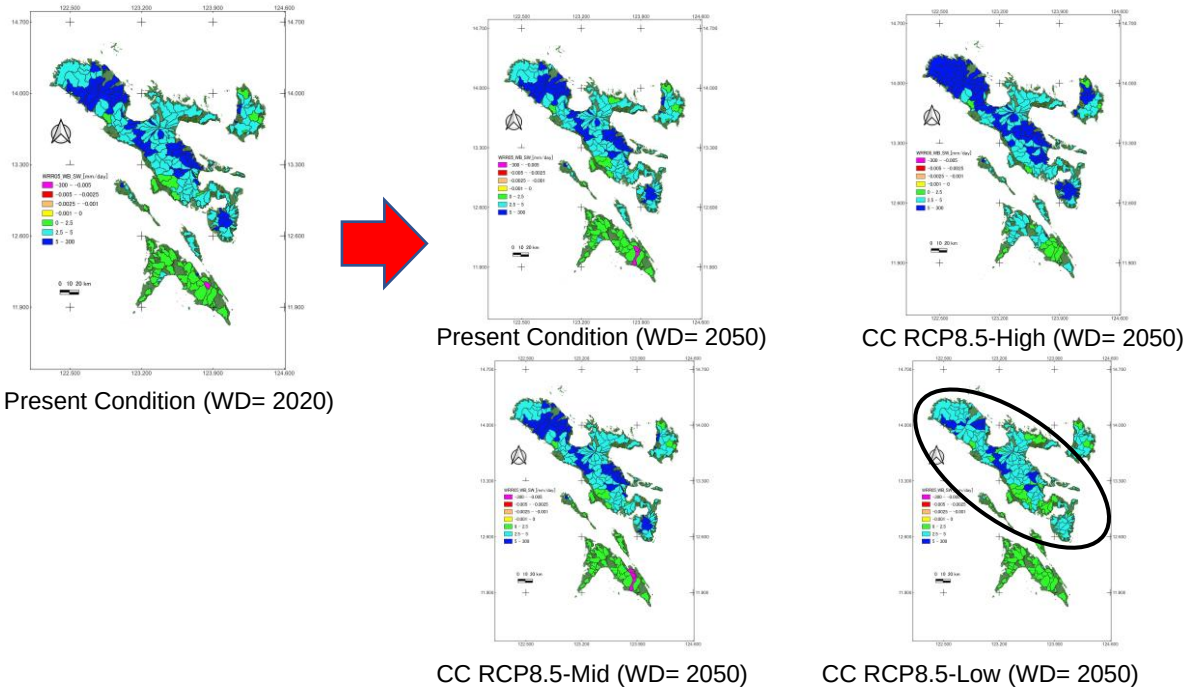
Figure D-405 Sub-Basin wise Groundwater Balance in WRR-XI (2050, Climate Change Weather Condition: RCP8.5-Low)

11.3.3 WRR-V

(1) Sub-Basin wise Surface Water Balance

Sub-basin wise surface water balance at present condition, future (2050) and climate change condition are shown Figure below.

In terms of future water demand (2050), in the RCP8.5-Low case of climate change, the surface water balance of the Northern, Central and Southern Part of WRR-V is on a declining trend.



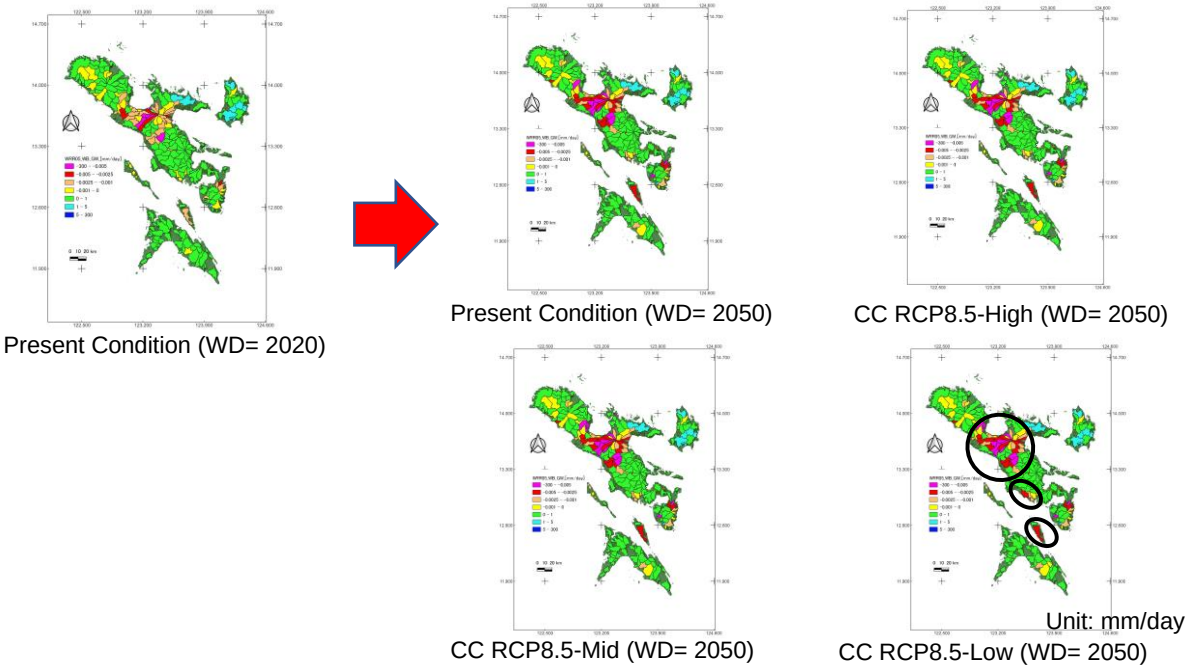
Source: JICA Survey Team

Figure D-406 Estimated Sub-Basin wise Surface Water Balance in WRR-V

(2) Sub-Basin wise Groundwater Balance

Sub-basin wise Groundwater balance at present condition, future (2050) and climate change condition are shown Figure below.

In terms of future water demand (2050), in the RCP8.5-Low case of climate change for the groundwater balance of Central Part of WRR-V, Donsol City and Ticao Island will be on a declining trend especially in the Naga City area.



Source: JICA Survey Team

Figure D-407 Estimated Sub-Basin wise Groundwater Balance in WRR-V

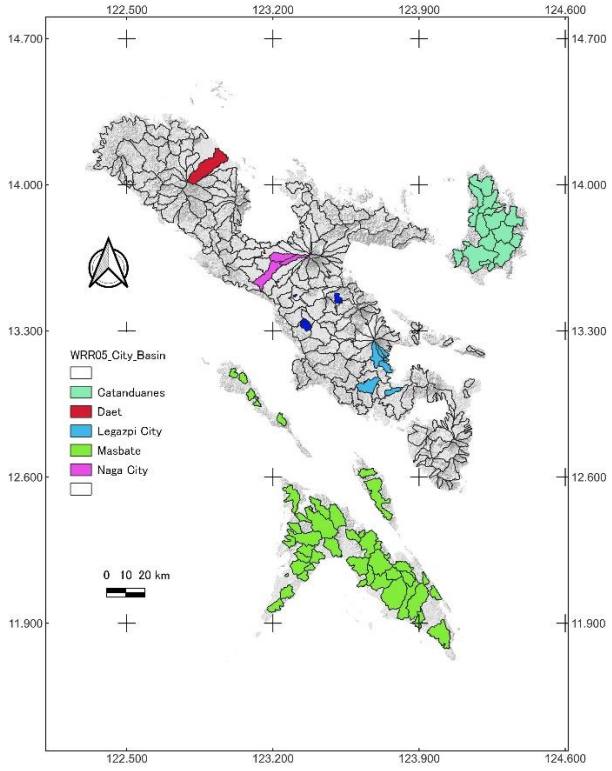
(3) Provincial-wise Water Balance

Provincial-wise surface and ground water balance in 1/5-dry year at present weather condition and water demand of 2050 are shown in **Annex-D: Hydrology**.

Summary of water balance and deficit estimation of provincial-wise surface and ground water balance at each climate change condition and water demand of 2020 and 2050 are shown in **Annex-D: Hydrology**. In Albay, Camarines Norte, Camarines Sur and Masbate provinces, negative values of annual water and deficit of groundwater will be increased in future.

(4) Major City/Town-wise Water Balance

Location map of major cities in WRR-V is shown in Figure below.



Source: JICA Survey Team

Figure D-408 Location Map of Major Cities in WRR-V

The surface and ground water balance in 1/5-dry year in the major cities at present weather condition and water demand of 2050 are shown in **Annex-D: Hydrology**. In most cities, the groundwater balance is projected to be negative against the water demand in 2050, and the negative groundwater balance is particularly large in the Naga and Legazpi cities.

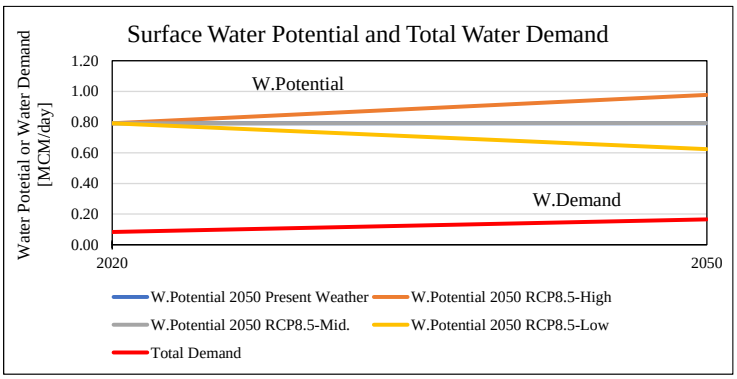
Table D-140 Surface and Groundwater Balance of Naga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Town/City: Naga City Target Year= 2050
Weather Condition: Present Total Area [km2]= 148 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	16.8	9.6	10.9	7.0	18.1	14.6	41.5	43.4	50.2	35.1	54.4	35.5	337.1	
Surface Water Potential	**60.1**	**40.9**	**32.9**	**30.2**	**20.0**	**16.3**	**39.1**	**14.4**	**22.7**	**25.7**	**45.5**	**33.8**	**381.6**	
Irrigation Water Demand (SW)	19.5	20.9	29.3	3.8	19.4	21.1	15.0	16.1	0.0	0.0	0.0	10.5	155.7	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	19.6	21.0	29.3	3.9	19.5	21.1	15.1	16.1	0.0	0.1	0.0	10.6	156.3	
SW Water Balance	**40.5**	**20.0**	**3.6**	**26.3**	**0.5**	**-4.8**	**24.0**	**-1.7**	**22.7**	**25.7**	**45.4**	**23.3**	**225.3**	**-6.5**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	
Irrigation Water Demand (GW)	0.4	0.5	0.6	0.1	0.5	0.5	0.4	0.4	0.0	0.0	0.0	0.2	3.6	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (GW)	4.6	4.1	4.6	4.4	4.6	4.4	4.6	4.6	4.4	4.6	4.4	4.6	53.6	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	5.0	4.6	5.2	4.5	5.1	4.9	4.9	5.0	4.4	4.6	4.4	4.8	57.5	
GW Water Balance	**-5.0**	**-4.6**	**-5.2**	**-4.5**	**-5.0**	**-4.9**	**-4.9**	**-5.0**	**-4.4**	**-4.6**	**-4.4**	**-4.8**	**-57.4**	**-57.4**
Total Water Potential (SW+GW)	**60.1**	**40.9**	**32.9**	**30.2**	**20.0**	**16.3**	**39.1**	**14.4**	**22.7**	**25.7**	**45.5**	**33.8**	**381.7**	
Irrigation Water Demand (Total)	20.0	21.4	29.9	3.9	19.9	21.6	15.4	16.5	0.0	0.0	0.0	10.7	159.3	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Municipal and Industrial Water Demand (Total)	4.6	4.1	4.6	4.4	4.6	4.4	4.6	4.6	4.4	4.6	4.4	4.6	53.9	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	24.6	25.6	34.5	8.4	24.5	26.1	20.0	21.1	4.5	4.6	4.5	15.4	213.8	
Total Water Balance (SW+GW)	**35.5**	**15.4**	**-1.6**	**21.8**	**-4.6**	**-9.7**	**19.1**	**-6.7**	**18.3**	**21.1**	**41.0**	**18.5**	**167.9**	**-64.0**

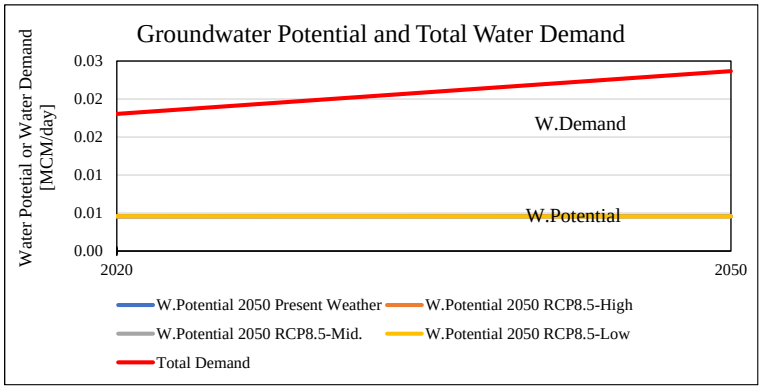
Source: JICA Survey Team

Summary of water balance and deficit estimation of surface and ground water balance at each climate change condition and water demand of 2020 and 2050 in Legazpi, Daet and Naga cities are shown in **Annex-D: Hydrology**. In Naga, Daet and Legazpi cities, negative values of annual water and deficit of groundwater will be increased in future. All cities will be surplus of surface water balance in future. However, these annual SW potentials are included flood discharge. Thus, SW reservoirs might be needed.



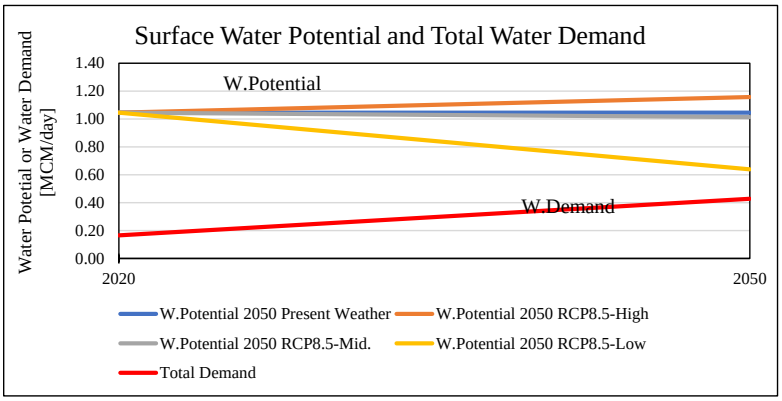
Source: JICA Survey Team

Figure D-409 Surface Water Balance of Legazpi City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



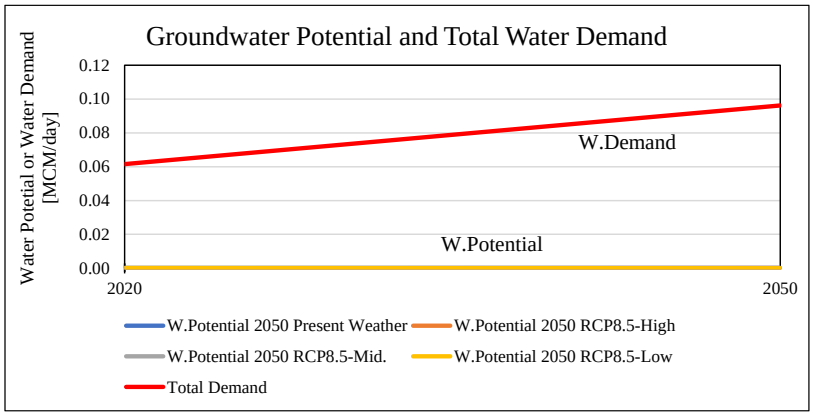
Source: JICA Survey Team

Figure D-410 Groundwater Balance of Legazpi City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



Source: JICA Survey Team

Figure D-411 Surface Water Balance of Naga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

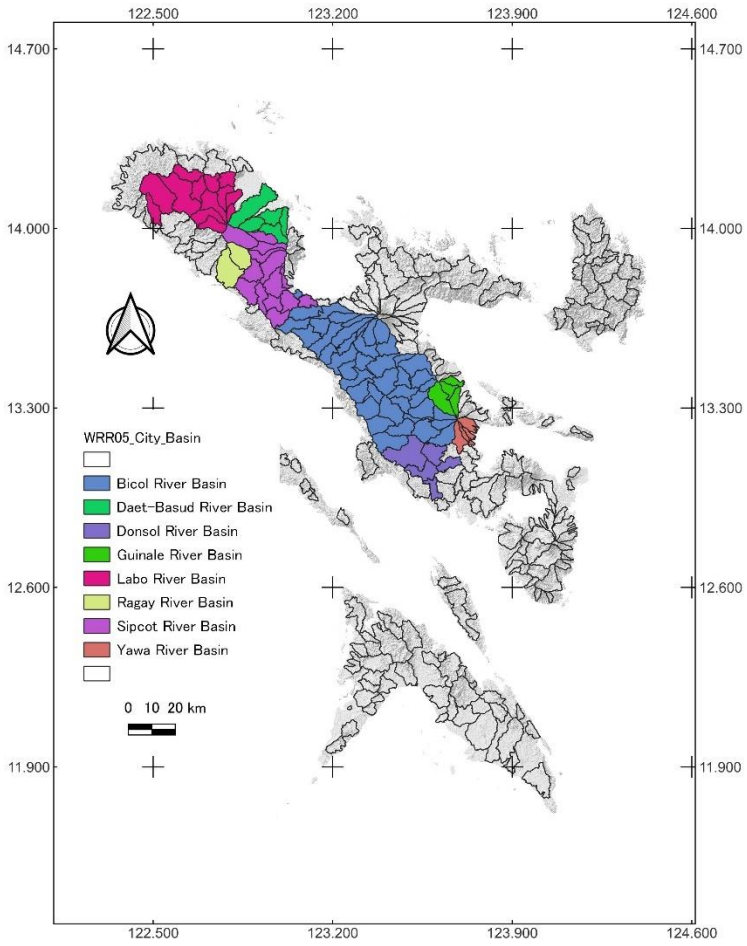


Source: JICA Survey Team

Figure D-412 Groundwater Balance of Naga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

(5) Major River Basin-wise Water Balance

Location map of major river basins in WRR-V is shown in Figure below.



Source: JICA Survey Team

Figure D-413 Location Map of Major River Basins in WRR-VII

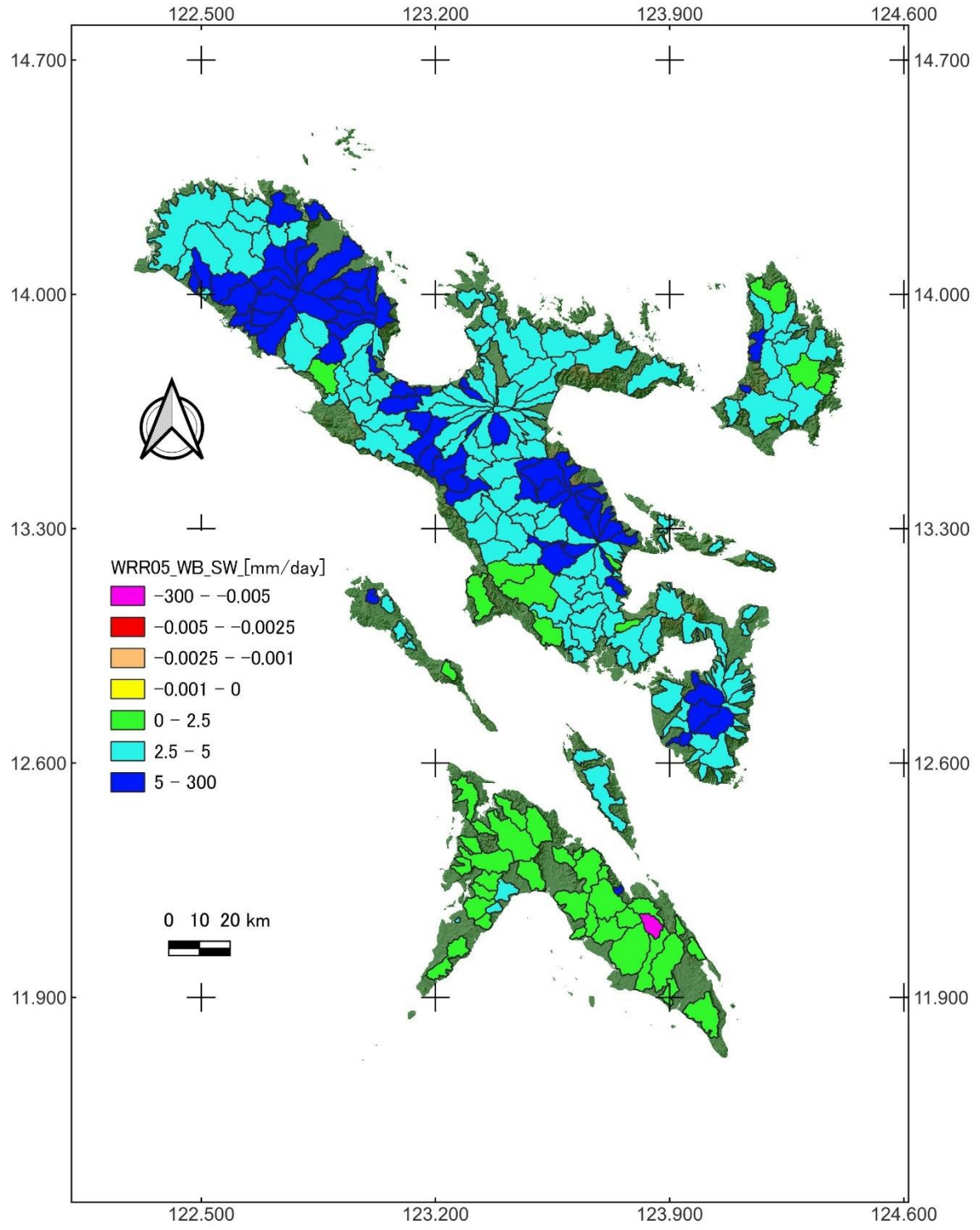
The surface and ground water balance in 1/5-dry year in the major river basins at present weather condition and water demand of 2050 are shown in **Annex-D: Hydrology**. The Bicol and Sipcot river basins will be negative water balance of groundwater in 2050.

Summary of water balance and deficit estimation of surface and ground water balance at each climate change condition and water demand of 2020 and 2050 in the Mananga river basin areas are shown in **Annex-D: Hydrology**. In the Bicol and Sipcot river basins, negative values of annual water and deficit of groundwater will be increased in future.

(6) Conclusion

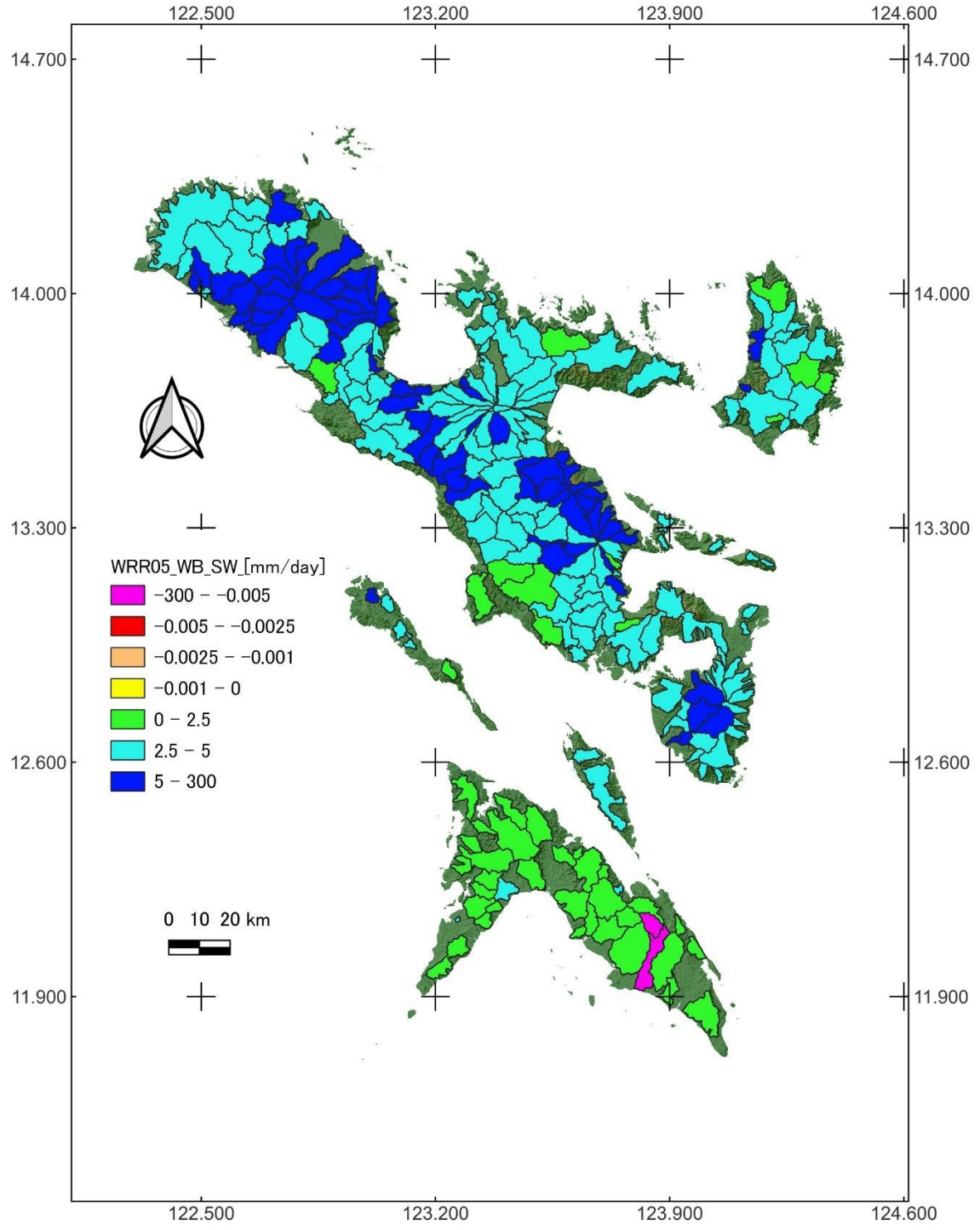
As described in above, in the Legazpi, Naga and Daet cities, negative values of annual water and deficit of and groundwater will be increased in future.

(7) Maps of Results of Surface Water Balance



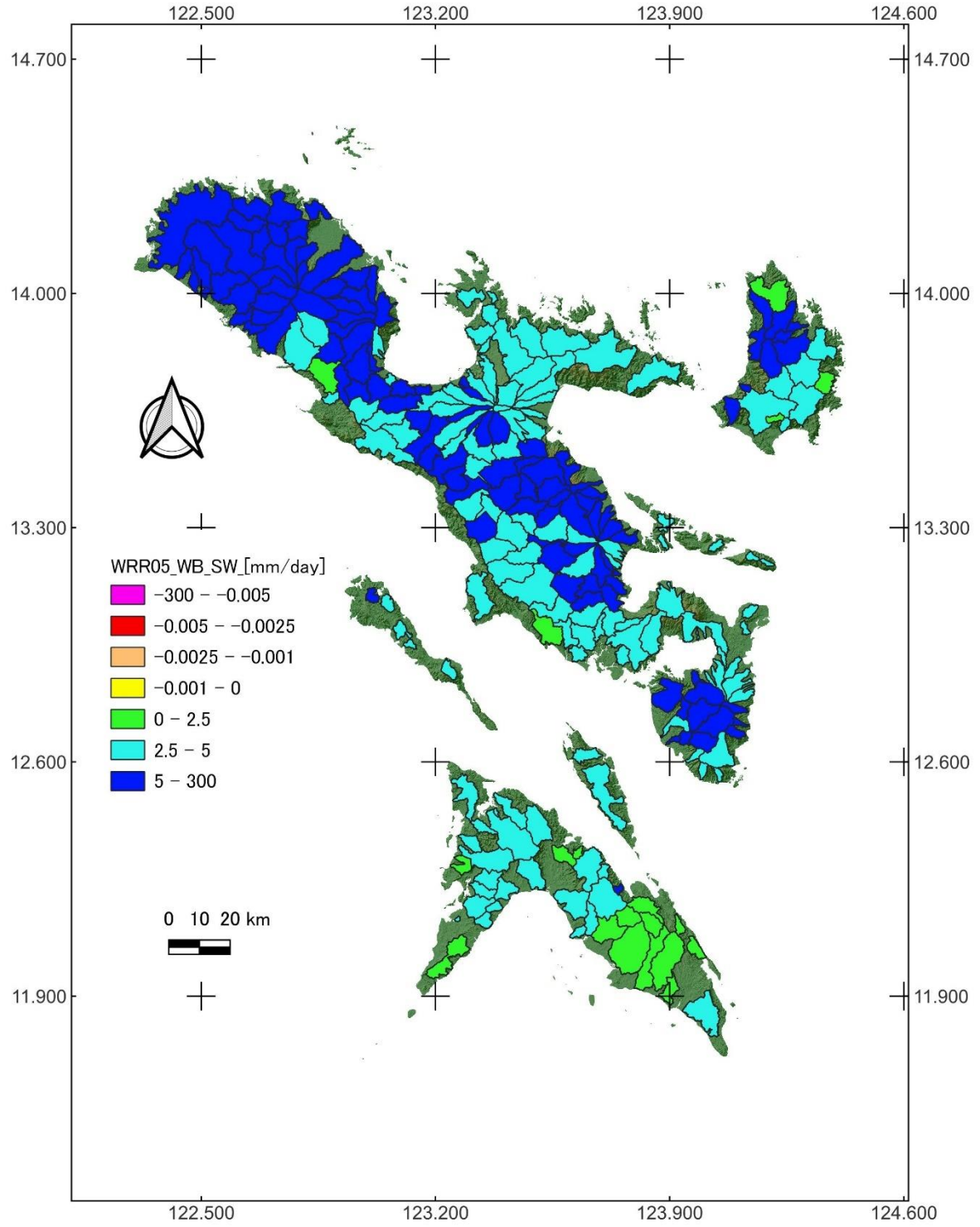
Source: JICA Survey Team

Figure D-414 Sub-Basin wise Surface Water Balance in WRR-V (2020, Present Weather Condition)



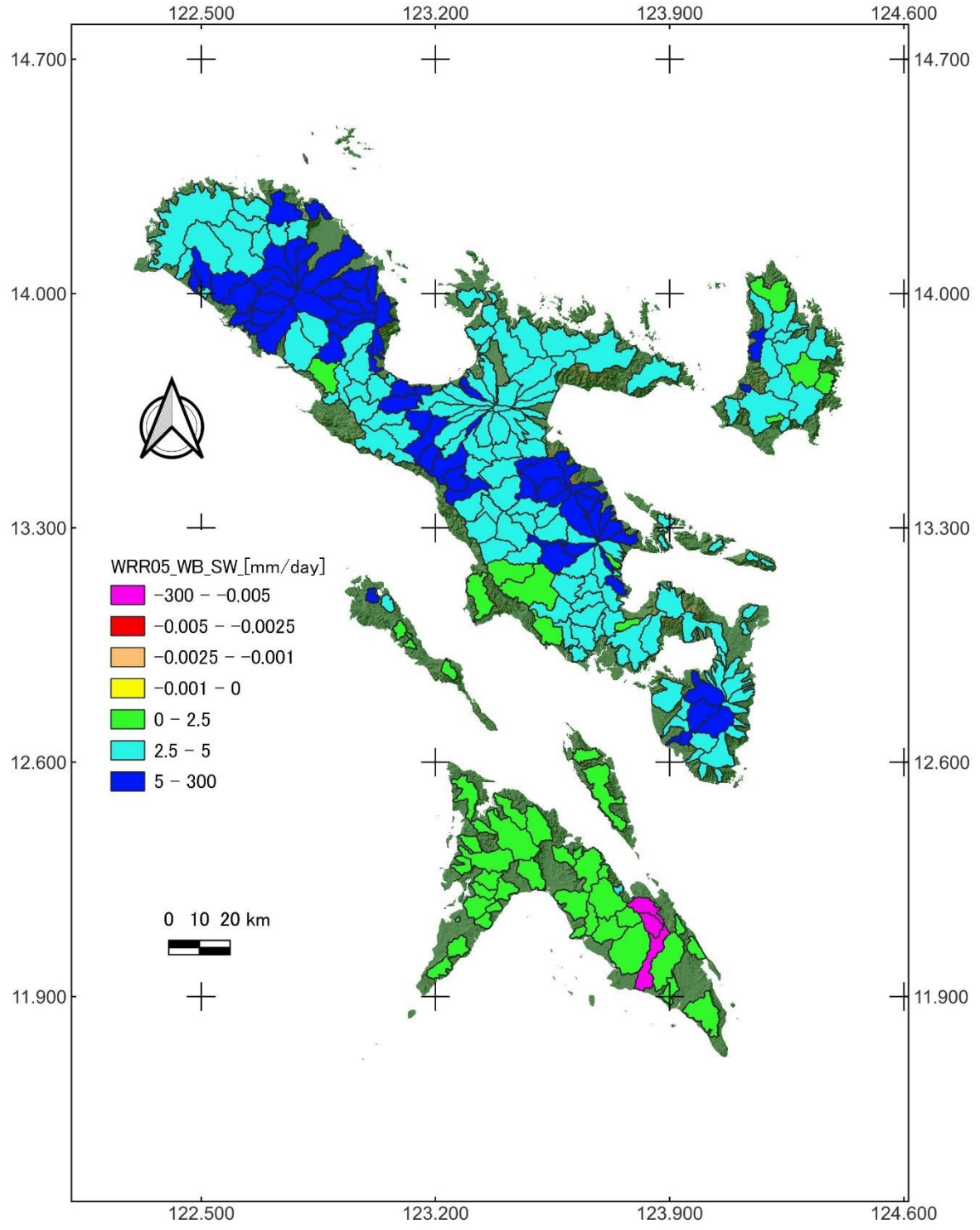
Source: JICA Survey Team

Figure D-415 Sub-Basin wise Surface Water Balance in WRR-V (2050, Present Weather Condition)



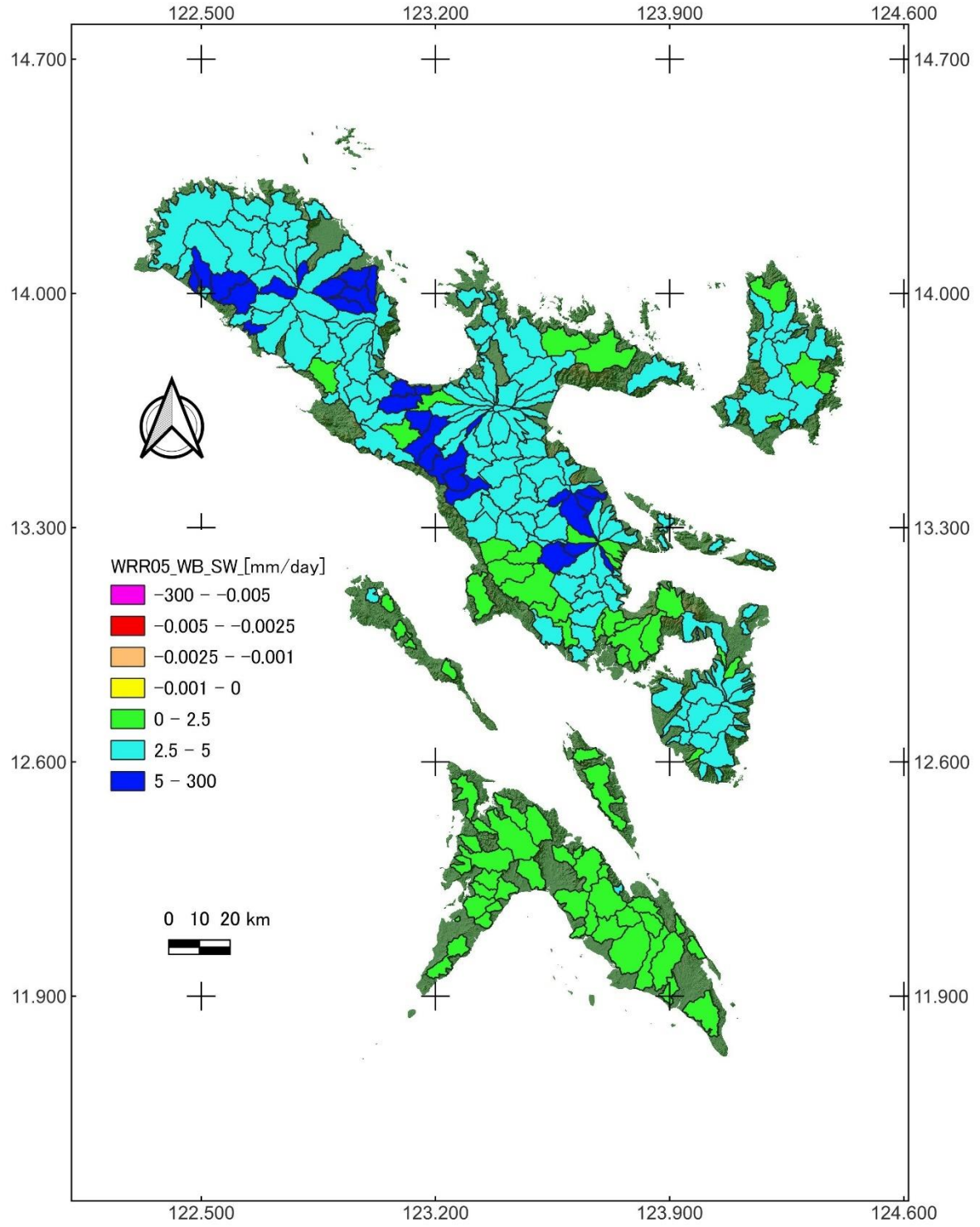
Source: JICA Survey Team

Figure D-416 Sub-Basin wise Surface Water Balance in WRR-V (2050, Climate Change Weather Condition: RCP8.5-High)



Source: JICA Survey Team

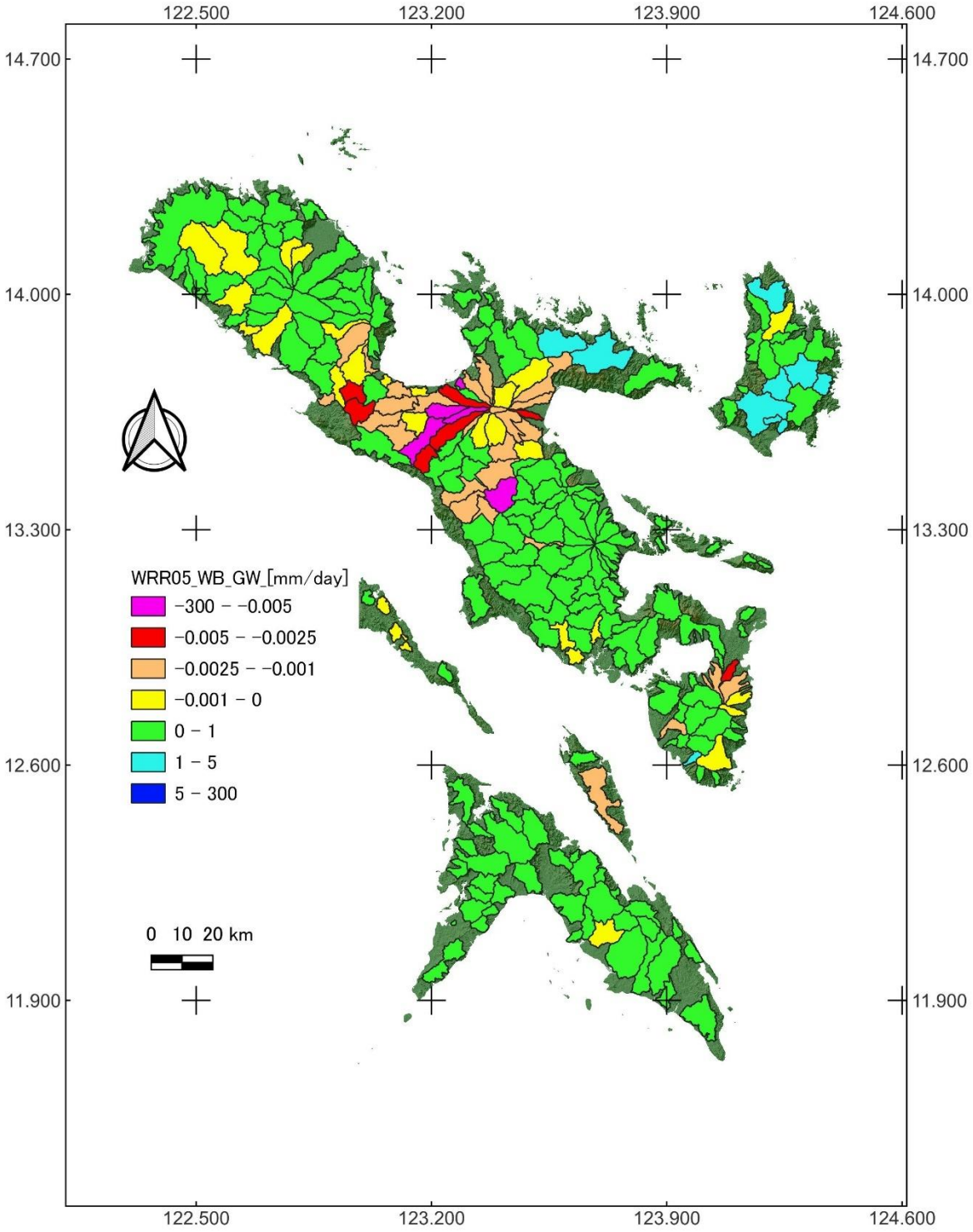
Figure D-417 Sub-Basin wise Surface Water Balance in WRR-V (2050, Climate Change Weather Condition: RCP8.5-Mid.)



Source: JICA Survey Team

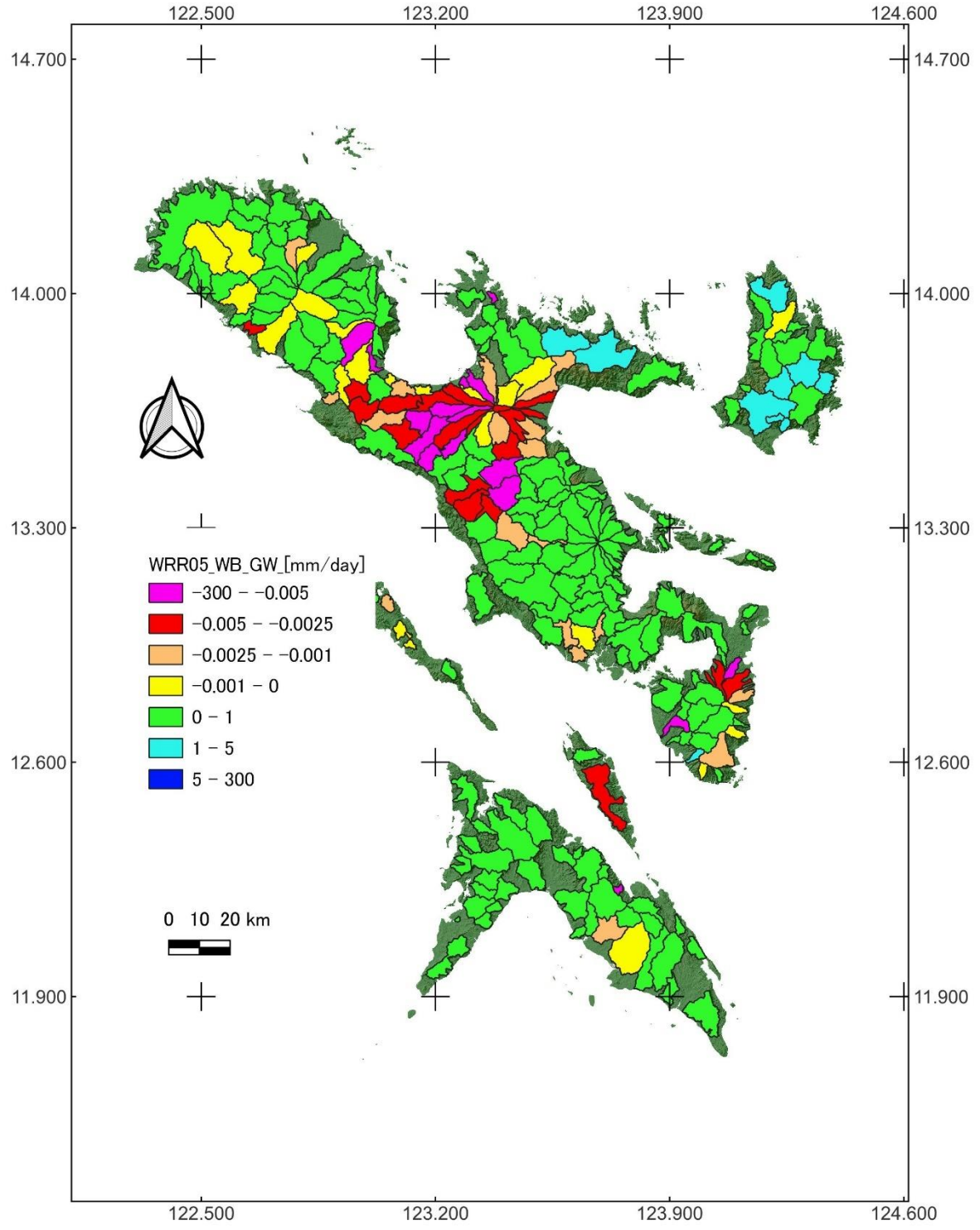
Figure D-418 Sub-Basin wise Surface Water Balance in WRR-V (2050, Climate Change Weather Condition: RCP8.5-Low)

(8) Maps of Results of Groundwater Balance



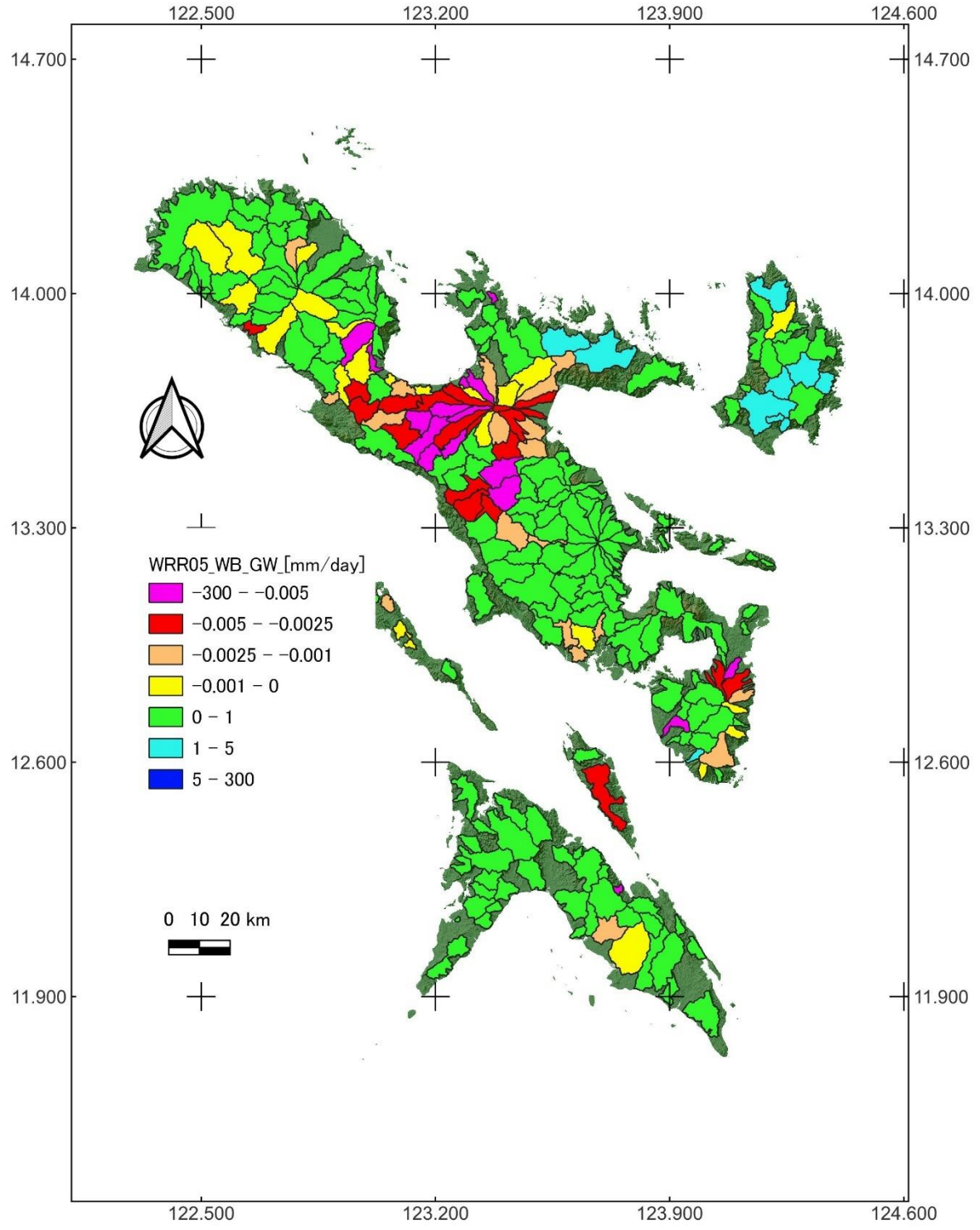
Source: JICA Survey Team

Figure D-419 Sub-Basin wise Groundwater Balance in WRR-V (2020, Present Weather Condition)



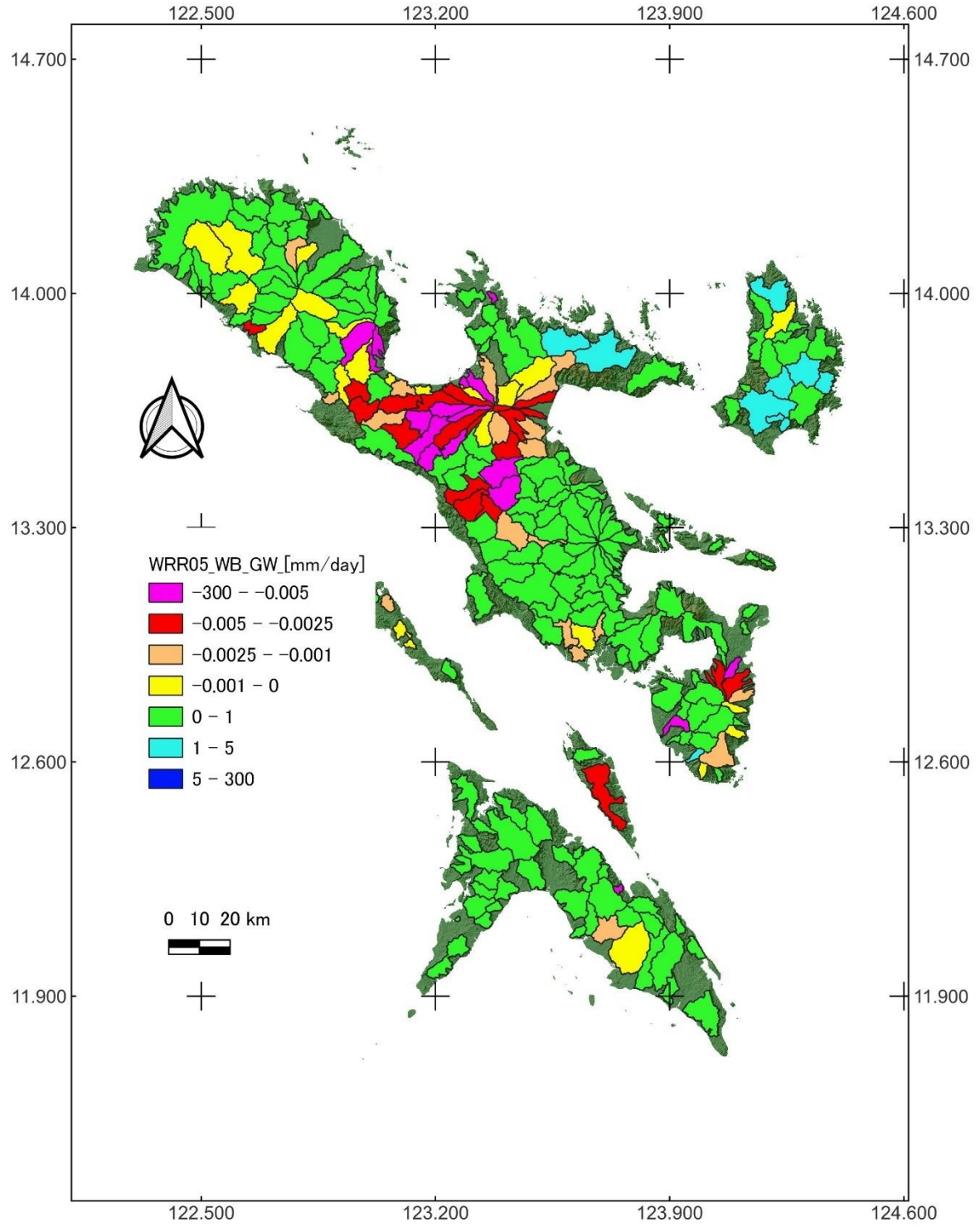
Source: JICA Survey Team

Figure D-420 Sub-Basin wise Groundwater Balance in WRR-V (2050, Present Weather Condition)



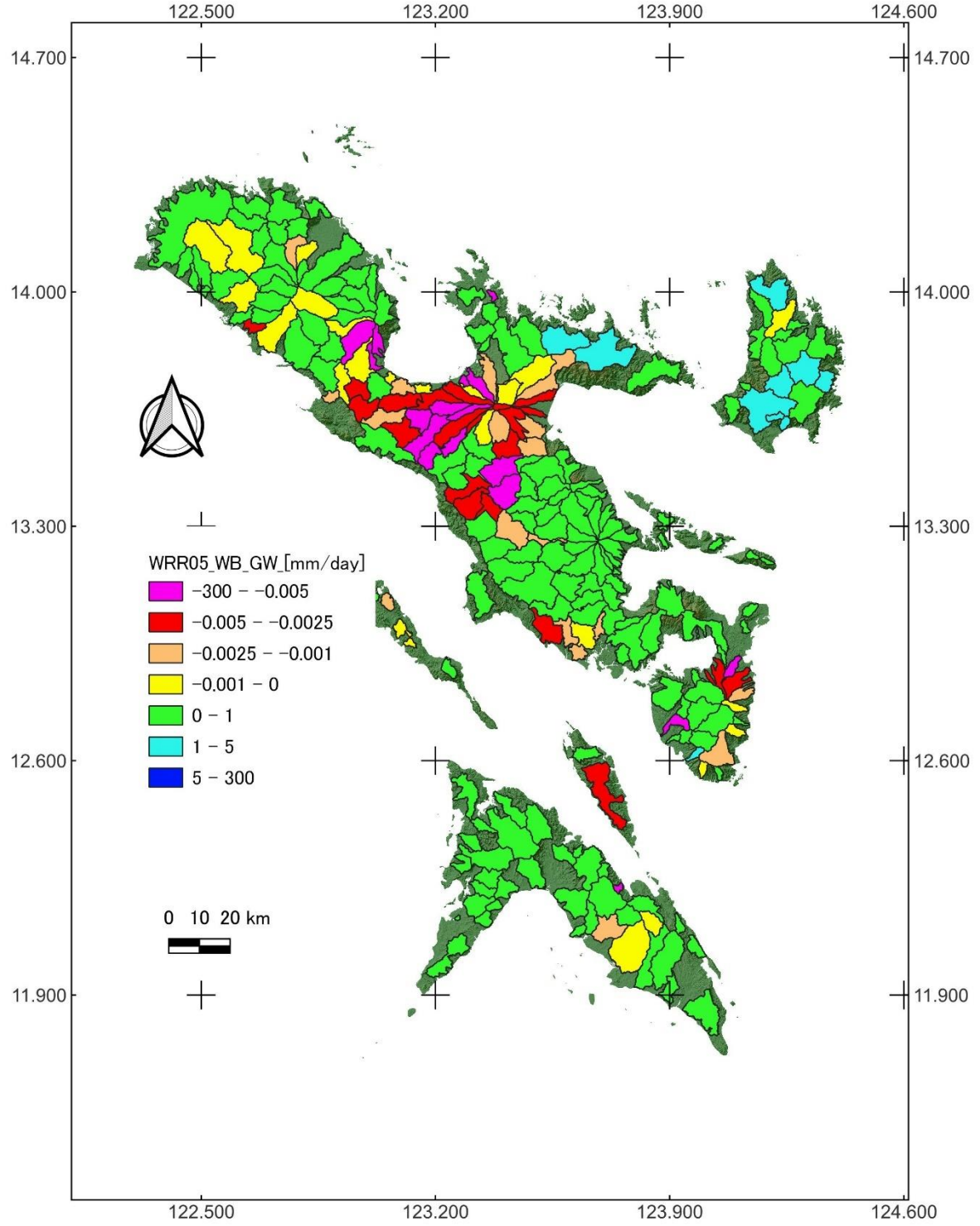
Source: JICA Survey Team

Figure D-421 Sub-Basin wise Groundwater Balance in WRR-V (2050, Climate Change Weather Condition: RCP8.5-High)



Source: JICA Survey Team

Figure D-422 Sub-Basin wise Groundwater Balance in WRR-V (2050, Climate Change Weather Condition: RCP8.5-Mid.)



Source: JICA Survey Team

Figure D-423 Sub-Basin wise Groundwater Balance in WRR-V (2050, Climate Change Weather Condition: RCP8.5-Low)

11.4 Data and Results of Provincial-wise Water Balance

11.4.1 WRR-VII

Table D-141 Surface and Groundwater Balance of Cebu Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Cebu Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,743 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	245.6	329.9	355.8	102.8	690.6	757.3	758.0	567.0	488.7	576.8	339.9	326.3	5,538.8	
Surface Water Potential	**165.4**	**148.2**	**148.3**	**87.8**	**125.3**	**160.1**	**164.1**	**165.7**	**131.7**	**162.6**	**104.5**	**108.6**	**1,672.4**	
Irrigation Water Demand (SW)	23.4	10.1	0.0	0.0	4.0	20.9	15.9	20.3	8.5	3.0	21.2	19.1	146.3	
Livestock Water Deamnd (SW)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	6.7	
Municipal and Industrial Water Demand (SW)	10.2	9.3	10.2	9.9	10.2	9.9	10.2	10.2	9.9	10.2	9.9	10.2	120.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	34.2	19.9	10.8	10.5	14.8	31.4	26.7	31.1	19.0	13.8	31.7	29.9	273.6	
SW Water Balance	**131.2**	**128.4**	**137.5**	**77.4**	**110.5**	**128.7**	**137.4**	**134.7**	**112.7**	**148.9**	**72.8**	**78.7**	**1,398.8**	**0.0**
Groundwater Potential	**77.0**	**72.2**	**76.5**	**73.7**	**75.7**	**73.2**	**75.1**	**75.1**	**72.6**	**75.3**	**73.2**	**75.3**	**895.0**	
Safety Groundwater Availability (70% of GWP)	**53.9**	**50.5**	**53.6**	**51.6**	**53.0**	**51.2**	**52.6**	**52.6**	**50.9**	**52.7**	**51.3**	**52.7**	**626.5**	
Irrigation Water Demand (GW)	3.2	1.4	0.0	0.0	0.7	3.5	2.5	3.4	1.2	0.5	2.8	2.7	21.7	
Livestock Water Deamnd (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.4	
Municipal and Industrial Water Demand (GW)	47.0	42.4	47.0	45.5	47.0	45.5	47.0	47.0	45.5	47.0	45.5	47.0	553.3	
Other Water Demand (GW)	22.3	20.2	22.3	21.6	22.3	21.6	22.3	22.3	21.6	22.3	21.6	22.3	263.0	
Total Water Demand (GW)	73.0	64.5	69.9	67.6	70.6	71.1	72.4	73.2	68.9	70.4	70.4	72.5	844.4	
GW Water Balance	**-19.1**	**-14.0**	**-16.3**	**-16.1**	**-17.6**	**-19.9**	**-19.8**	**-20.7**	**-18.0**	**-17.7**	**-19.2**	**-19.8**	**-217.9**	**-218.0**
Total Water Potential (SW+GW)	**219.3**	**198.7**	**201.9**	**139.4**	**178.3**	**211.3**	**216.7**	**218.3**	**182.5**	**215.3**	**155.7**	**161.2**	**2,298.9**	
Irrigation Water Demand (Total)	26.6	11.5	0.0	0.0	4.7	24.4	18.4	23.6	9.8	3.5	24.0	21.8	168.0	
Livestock Water Deamnd (Total)	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	13.1	
Municipal and Industrial Water Demand (Total)	57.2	51.7	57.2	55.4	57.2	55.4	57.2	57.2	55.4	57.2	55.4	57.2	673.9	
Other Water Demand (Total)	22.3	20.2	22.3	21.6	22.3	21.6	22.3	22.3	21.6	22.3	21.6	22.3	263.0	
Total Water Demand (SW+GW)	107.2	84.3	80.7	78.1	85.4	102.5	99.1	104.3	87.9	84.2	102.1	102.4	1,118.0	
Total Water Balance (SW+GW)	**112.1**	**114.4**	**121.2**	**61.3**	**93.0**	**108.8**	**117.6**	**114.0**	**94.7**	**131.2**	**53.7**	**58.8**	**1,180.9**	**-218.0**

Source: JICA Survey Team

Table D-142 Surface and Groundwater Balance of Bohol Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Bohol Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,402 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	477.0	401.1	853.5	82.2	271.4	731.8	590.7	774.5	503.6	464.0	180.1	166.5	5,496.3	
Surface Water Potential	**252.4**	**284.7**	**371.1**	**136.2**	**99.7**	**241.2**	**275.6**	**369.3**	**329.8**	**225.4**	**143.7**	**135.8**	**2,865.0**	
Irrigation Water Demand (SW)	23.4	10.1	0.0	0.0	4.0	20.9	15.9	20.3	8.5	3.0	21.2	19.1	146.3	
Livestock Water Deamnd (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.8	
Municipal and Industrial Water Demand (SW)	3.5	3.2	3.5	3.4	3.5	3.4	3.5	3.5	3.4	3.5	3.4	3.5	41.8	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	27.4	13.7	4.0	3.8	7.9	24.7	19.8	24.2	12.3	6.9	25.0	23.1	192.9	
SW Water Balance	**225.0**	**271.0**	**367.1**	**132.4**	**91.8**	**216.5**	**255.8**	**345.1**	**317.5**	**218.4**	**118.7**	**112.7**	**2,672.1**	**0.0**
Groundwater Potential	**1.4**	**1.2**	**0.9**	**0.7**	**0.8**	**1.0**	**0.9**	**0.8**	**0.8**	**0.9**	**1.2**	**1.2**	**11.9**	
Safety Groundwater Availability (70% of GWP)	**1.0**	**0.8**	**0.6**	**0.5**	**0.6**	**0.7**	**0.6**	**0.6**	**0.6**	**0.7**	**0.9**	**0.8**	**8.3**	
Irrigation Water Demand (GW)	3.2	1.4	0.0	0.0	0.7	3.5	2.5	3.4	1.2	0.5	2.8	2.7	21.7	
Livestock Water Deamnd (GW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.1	
Municipal and Industrial Water Demand (GW)	8.7	7.8	8.7	8.4	8.7	8.4	8.7	8.7	8.4	8.7	8.4	8.7	102.0	
Other Water Demand (GW)	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.6	
Total Water Demand (GW)	12.3	9.6	9.1	8.9	9.9	12.3	11.6	12.5	10.1	9.7	11.6	11.8	129.4	
GW Water Balance	**-11.3**	**-8.8**	**-8.5**	**-8.3**	**-9.3**	**-11.6**	**-11.0**	**-11.9**	**-9.5**	**-9.0**	**-10.8**	**-11.0**	**-121.0**	**-121.1**
Total Water Potential (SW+GW)	**253.3**	**285.5**	**371.7**	**136.8**	**100.3**	**241.9**	**276.3**	**369.9**	**330.4**	**226.0**	**144.6**	**136.6**	**2,873.3**	
Irrigation Water Demand (Total)	26.6	11.5	0.0	0.0	4.7	24.4	18.4	23.6	9.8	3.5	24.0	21.8	168.0	
Livestock Water Deamnd (Total)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.9	
Municipal and Industrial Water Demand (Total)	12.2	11.0	12.2	11.8	12.2	11.8	12.2	12.2	11.8	12.2	11.8	12.2	143.8	
Other Water Demand (Total)	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.6	
Total Water Demand (SW+GW)	39.7	23.3	13.1	12.7	17.8	37.1	31.5	36.7	22.4	16.6	36.7	34.9	322.3	
Total Water Balance (SW+GW)	**213.7**	**262.2**	**358.6**	**124.1**	**82.5**	**204.9**	**244.8**	**333.1**	**308.0**	**209.4**	**107.9**	**101.7**	**2,551.1**	**-121.1**

Source: JICA Survey Team

Table D-143 Surface and Groundwater Balance of Negros Oriental Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Negros Oriental Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,541 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	136.3	66.5	175.9	96.0	260.8	544.4	1,024.3	811.0	628.5	733.7	412.5	1,102.3	5,992.3	
Surface Water Potential	**240.1**	**180.0**	**165.8**	**136.5**	**137.4**	**154.7**	**340.0**	**397.2**	**333.5**	**347.6**	**293.4**	**496.7**	**3,222.8**	
Irrigation Water Demand (SW)	23.4	10.1	0.0	0.0	4.0	20.9	15.9	20.3	8.5	3.0	21.2	19.1	146.3	
Livestock Water Deamnd (SW)	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.1	
Municipal and Industrial Water Demand (SW)	7.4	6.7	7.4	7.2	7.4	7.2	7.4	7.4	7.2	7.4	7.2	7.4	87.2	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	31.1	17.0	7.7	7.4	11.6	28.3	23.6	27.9	15.9	10.6	28.6	26.8	236.6	
SW Water Balance	**209.0**	**163.0**	**158.1**	**129.1**	**125.8**	**126.4**	**316.4**	**369.3**	**317.5**	**337.0**	**264.8**	**469.9**	**2,986.2**	**0.0**
Groundwater Potential	**12.0**	**10.7**	**10.1**	**9.2**	**9.6**	**10.1**	**9.8**	**9.8**	**9.5**	**10.2**	**11.2**	**11.2**	**123.5**	
Safety Groundwater Availability (70% of GWP)	**8.4**	**7.5**	**7.0**	**6.4**	**6.7**	**7.1**	**6.9**	**6.9**	**6.7**	**7.1**	**7.9**	**7.8**	**86.5**	
Irrigation Water Demand (GW)	3.2	1.4	0.0	0.0	0.7	3.5	2.5	3.4	1.2	0.5	2.8	2.7	21.7	
Livestock Water Deamnd (GW)	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.1	
Municipal and Industrial Water Demand (GW)	5.0	4.6	5.0	4.9	5.0	4.9	5.0	5.0	4.9	5.0	4.9	5.0	59.4	
Other Water Demand (GW)	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.8	
Total Water Demand (GW)	8.6	6.3	5.5	5.3	6.2	8.8	8.0	8.8	6.5	6.0	8.1	8.1	86.0	
GW Water Balance	**-0.2**	**1.2**	**1.6**	**1.2**	**0.6**	**-1.7**	**-1.1**	**-2.0**	**0.1**	**1.2**	**-0.2**	**-0.3**	**0.5**	**-5.5**
Total Water Potential (SW+GW)	**248.5**	**187.5**	**172.9**	**142.9**	**144.1**	**161.8**	**346.9**	**404.1**	**340.1**	**354.8**	**301.3**	**504.5**	**3,309.3**	
Irrigation Water Demand (Total)	26.6	11.5	0.0	0.0	4.7	24.4	18.4	23.6	9.8	3.5	24.0	21.8	168.0	
Livestock Water Deamnd (Total)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.1	
Municipal and Industrial Water Demand (Total)	12.5	11.2	12.5	12.1	12.5	12.1	12.5	12.5	12.1	12.5	12.1	12.5	146.6	
Other Water Demand (Total)	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.8	
Total Water Demand (SW+GW)	39.7	23.3	13.1	12.7	17.8	37.1	31.5	36.8	22.5	16.6	36.7	34.9	322.6	
Total Water Balance (SW+GW)	**208.8**	**164.2**	**159.7**	**130.2**	**126.3**	**124.7**	**315.3**	**367.3**	**317.6**	**338.2**	**264.6**	**469.6**	**2,986.7**	**-5.5**

Source: JICA Survey Team

Table D-144 Surface and Groundwater Balance of Siquijor Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Siquijor Target Year= 2050
Weather Condition: Present Total Area [km2]= 163 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	23.8	6.7	4.6	2.5	7.8	35.9	25.5	12.9	16.1	17.4	29.4	20.4	202.9	
Surface Water Potential	**8.9**	**7.7**	**8.1**	**6.8**	**6.4**	**6.1**	**7.7**	**9.4**	**9.0**	**9.1**	**9.0**	**10.7**	**98.7**	
Irrigation Water Demand (SW)	23.4	10.1	0.0	0.0	4.0	20.9	15.9	20.3	8.5	3.0	21.2	19.1	146.3	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (SW)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	24.7	11.3	1.3	1.3	5.3	22.2	17.2	21.6	9.8	4.3	22.5	20.4	161.7	
SW Water Balance	**-15.8**	**-3.6**	**6.8**	**5.5**	**1.1**	**-16.1**	**-9.5**	**-12.2**	**-0.8**	**4.8**	**-13.4**	**-9.7**	**-62.9**	**-81.1**
Groundwater Potential	**0.4**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**4.5**	
Safety Groundwater Availability (70% of GWP)	**0.3**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**3.1**	
Irrigation Water Demand (GW)	3.2	1.4	0.0	0.0	0.7	3.5	2.5	3.4	1.2	0.5	2.8	2.7	21.7	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.0	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	3.8	2.0	0.7	0.7	1.4	4.1	3.2	4.1	1.9	1.2	3.5	3.3	29.7	
GW Water Balance	**-3.6**	**-1.7**	**-0.4**	**-0.4**	**-1.1**	**-3.9**	**-2.9**	**-3.8**	**-1.6**	**-0.9**	**-3.2**	**-3.1**	**-26.5**	**-26.7**
Total Water Potential (SW+GW)	**9.2**	**7.9**	**8.3**	**7.0**	**6.6**	**6.3**	**8.0**	**9.6**	**9.3**	**9.4**	**9.3**	**10.9**	**101.9**	
Irrigation Water Demand (Total)	26.6	11.5	0.0	0.0	4.7	24.4	18.4	23.6	9.8	3.5	24.0	21.8	168.0	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (Total)	1.9	1.7	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	22.6	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	28.5	13.3	2.0	1.9	6.7	26.3	20.4	25.6	11.7	5.5	25.9	23.7	191.3	
Total Water Balance (SW+GW)	**-19.4**	**-5.3**	**6.3**	**5.1**	**-0.0**	**-20.0**	**-12.4**	**-16.0**	**-2.4**	**3.9**	**-16.6**	**-12.8**	**-89.5**	**-107.8**

Source: JICA Survey Team

Table D-145 Summary of Annual Water Balance and Deficit of Cebu Province at Each Climate Change Condition

Total Area [km^2]= 3,742.7

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	2,519.8	-43.4	2,476.4	0.0	-43.4	-43.4
2	Present	2020	1/5-Dry Year	1,428.6	-69.0	1,359.6	0.0	-69.0	-69.0
3	Present	2020	1/10-Dry Year	616.7	-124.4	492.3	0.0	-124.4	-124.4
4	Present	2050	Average Year	2,489.9	-192.2	2,297.7	0.0	-192.4	-192.4
5	Present	2050	1/5-Dry Year	1,398.8	-217.9	1,180.9	0.0	-218.0	-218.0
6	Present	2050	1/10-Dry Year	586.9	-273.3	313.6	0.0	-273.4	-273.4
7	CC RCP8.5-High	2050	Average Year	3,071.5	-39.7	3,031.8	0.0	-39.9	-39.9
8	CC RCP8.5-High	2050	1/5-Dry Year	1,559.5	-72.2	1,487.2	0.0	-72.3	-72.3
9	CC RCP8.5-High	2050	1/10-Dry Year	520.2	-150.3	370.0	0.0	-150.4	-150.4
10	CC RCP8.5-Mid.	2050	Average Year	2,254.1	-148.4	2,105.7	0.0	-148.5	-148.5
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,063.8	-199.5	864.3	0.0	-199.6	-199.6
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	442.9	-252.9	190.0	0.0	-253.0	-253.0
13	CC RCP8.5-Low	2050	Average Year	1,657.7	-229.2	1,428.4	0.0	-229.4	-229.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	874.7	-294.2	580.5	0.0	-294.3	-294.3
15	CC RCP8.5-Low	2050	1/10-Dry Year	167.4	-337.4	-170.0	-0.8	-337.5	-338.3

Source: JICA Survey Team

Table D-146 Summary of Annual Water Balance and Deficit of Bohol Province at Each Climate Change Condition

Total Area [km^2]= 3,401.6

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	3,870.1	-62.2	3,807.9	0.0	-62.2	-62.2
2	Present	2020	1/5-Dry Year	2,513.8	-63.0	2,450.8	0.0	-63.0	-63.0
3	Present	2020	1/10-Dry Year	2,817.6	-54.0	2,763.6	0.0	-54.0	-54.0
4	Present	2050	Average Year	4,028.4	-120.2	3,908.2	0.0	-120.3	-120.3
5	Present	2050	1/5-Dry Year	2,672.1	-121.0	2,551.1	0.0	-121.1	-121.1
6	Present	2050	1/10-Dry Year	2,975.9	-112.0	2,863.9	0.0	-112.1	-112.1
7	CC RCP8.5-High	2050	Average Year	4,338.4	-120.2	4,218.2	0.0	-120.3	-120.3
8	CC RCP8.5-High	2050	1/5-Dry Year	2,794.8	-121.0	2,673.8	0.0	-121.1	-121.1
9	CC RCP8.5-High	2050	1/10-Dry Year	3,187.7	-112.0	3,075.8	0.0	-112.1	-112.1
10	CC RCP8.5-Mid.	2050	Average Year	3,309.3	-120.2	3,189.1	0.0	-120.3	-120.3
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	2,338.7	-121.0	2,217.7	0.0	-121.2	-121.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2,612.6	-112.0	2,500.6	0.0	-112.1	-112.1
13	CC RCP8.5-Low	2050	Average Year	2,382.5	-120.3	2,262.2	0.0	-120.4	-120.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,771.6	-121.1	1,650.5	0.0	-121.2	-121.2
15	CC RCP8.5-Low	2050	1/10-Dry Year	1,978.0	-112.1	1,865.9	0.0	-112.2	-112.2

Source: JICA Survey Team

Table D-147 Summary of Annual Water Balance and Deficit of Negros Oriental Province at Each Climate Change Condition

Total Area [km^2]= 3,540.7

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	4,305.0	32.4	4,337.4	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	2,906.5	29.9	2,936.4	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	3,032.5	39.5	3,072.0	0.0	0.0	0.0
4	Present	2050	Average Year	4,384.7	3.0	4,387.7	0.0	-4.2	-4.2
5	Present	2050	1/5-Dry Year	2,986.2	0.5	2,986.7	0.0	-5.5	-5.5
6	Present	2050	1/10-Dry Year	3,112.2	10.1	3,122.3	0.0	-3.2	-3.2
7	CC RCP8.5-High	2050	Average Year	4,615.2	3.1	4,618.3	0.0	-4.2	-4.2
8	CC RCP8.5-High	2050	1/5-Dry Year	3,139.4	0.6	3,140.0	0.0	-5.4	-5.4
9	CC RCP8.5-High	2050	1/10-Dry Year	3,210.2	10.2	3,220.4	0.0	-3.2	-3.2
10	CC RCP8.5-Mid.	2050	Average Year	3,666.4	2.8	3,669.3	0.0	-4.2	-4.2
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	2,512.4	0.1	2,512.5	0.0	-5.7	-5.7
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2,587.3	9.9	2,597.2	0.0	-3.2	-3.2
13	CC RCP8.5-Low	2050	Average Year	2,551.9	2.4	2,554.3	0.0	-4.4	-4.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,638.8	-1.4	1,637.4	0.0	-6.6	-6.6
15	CC RCP8.5-Low	2050	1/10-Dry Year	1,682.9	9.3	1,692.2	0.0	-3.5	-3.5

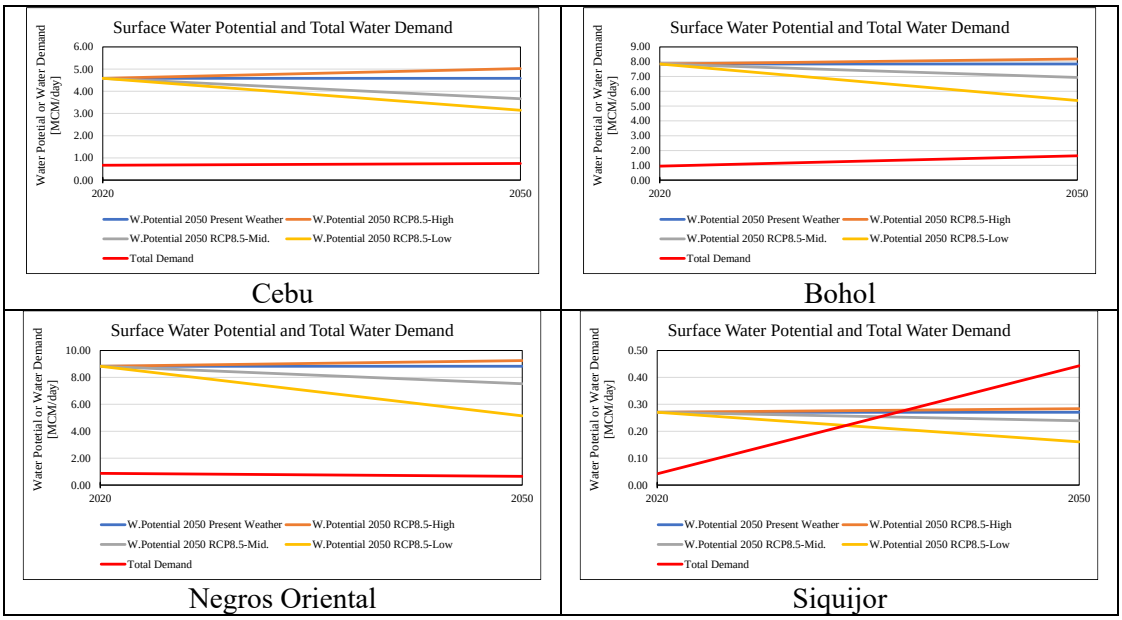
Source: JICA Survey Team

Table D-148 Summary of Annual Water Balance and Deficit of Siquijor Province at Each Climate Change Condition

Total Area [km^2]= 163.1

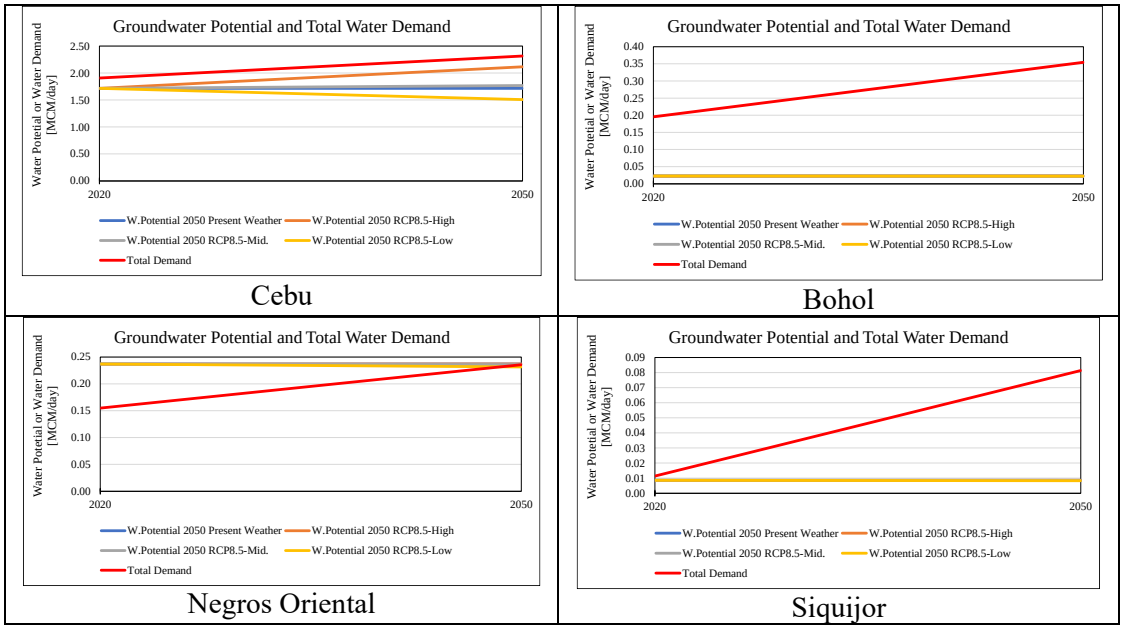
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	83.5	-1.0	82.5	0.0	-1.0	-1.0
2	Present	2020	1/5-Dry Year	83.5	-1.0	82.5	0.0	-1.0	-1.0
3	Present	2020	1/10-Dry Year	83.5	-1.0	82.4	0.0	-1.0	-1.0
4	Present	2050	Average Year	-62.9	-26.5	-89.5	-81.1	-26.7	-107.8
5	Present	2050	1/5-Dry Year	-62.9	-26.5	-89.5	-81.1	-26.7	-107.8
6	Present	2050	1/10-Dry Year	-63.0	-26.5	-89.5	-81.1	-26.7	-107.8
7	CC RCP8.5-High	2050	Average Year	-58.0	-26.5	-84.6	-78.0	-26.7	-104.6
8	CC RCP8.5-High	2050	1/5-Dry Year	-58.0	-26.5	-84.6	-78.0	-26.7	-104.6
9	CC RCP8.5-High	2050	1/10-Dry Year	-58.0	-26.5	-84.6	-78.0	-26.7	-104.6
10	CC RCP8.5-Mid.	2050	Average Year	-74.5	-26.6	-101.0	-88.1	-26.7	-114.8
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	-74.5	-26.6	-101.0	-88.1	-26.7	-114.8
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	-74.5	-26.6	-101.0	-88.1	-26.7	-114.8
13	CC RCP8.5-Low	2050	Average Year	-103.1	-26.6	-129.7	-110.2	-26.8	-137.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	-103.1	-26.6	-129.7	-110.2	-26.8	-137.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	-103.1	-26.6	-129.7	-110.2	-26.8	-137.0

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-424 Surface Water Balance by Province in WRR-VII at Each Climate Change Condition



Source: JICA Survey Team

Figure D-425 Groundwater Balance by Province in WRR-VII at Each Climate Change Condition

11.4.2 WRR-XI

Table D-149 Surface and Groundwater Balance of Agusan del Sur Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Agusan del Sur Target Year= 2050
Weather Condition: Present Total Area [km2]= 930 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	652.9	156.1	153.5	136.8	112.0	323.5	125.7	237.6	350.0	143.8	260.1	271.2	2,923.2	
Surface Water Potential	**469.9**	**165.5**	**109.1**	**95.9**	**84.3**	**119.1**	**79.5**	**105.8**	**172.0**	**94.3**	**106.7**	**134.4**	**1,736.4**	
Irrigation Water Demand (SW)	23.7	17.5	9.2	0.0	0.0	13.5	6.2	9.1	3.8	0.0	5.6	4.9	97.5	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	24.0	17.7	9.5	0.2	0.2	13.7	6.5	9.4	4.0	0.2	5.8	5.1	100.2	
SW Water Balance	**445.9**	**147.8**	**99.6**	**95.6**	**84.0**	**105.4**	**73.1**	**96.4**	**168.0**	**94.0**	**100.9**	**129.4**	**1,636.2**	**0.0**
Groundwater Potential	**8.0**	**7.0**	**7.1**	**6.4**	**6.4**	**6.4**	**7.3**	**7.7**	**7.7**	**7.9**	**7.4**	**7.2**	**86.5**	
Safety Groundwater Availability (70% of GWP)	**5.6**	**4.9**	**5.0**	**4.5**	**4.5**	**4.5**	**5.1**	**5.4**	**5.4**	**5.5**	**5.2**	**5.1**	**60.6**	
Irrigation Water Demand (GW)	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.5	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	1.1	
GW Water Balance	**5.5**	**4.8**	**4.9**	**4.4**	**4.4**	**4.3**	**5.0**	**5.3**	**5.3**	**5.5**	**5.1**	**5.0**	**59.5**	**0.0**
Total Water Potential (SW+GW)	**475.5**	**170.4**	**114.1**	**100.3**	**88.7**	**123.6**	**84.6**	**111.2**	**177.4**	**99.8**	**111.9**	**139.5**	**1,797.0**	
Irrigation Water Demand (Total)	23.8	17.6	9.3	0.0	0.0	13.6	6.3	9.2	3.8	0.0	5.6	4.9	97.9	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.3	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	24.1	17.8	9.6	0.3	0.3	13.8	6.6	9.5	4.1	0.3	5.8	5.2	101.3	
Total Water Balance (SW+GW)	**451.4**	**152.6**	**104.5**	**100.0**	**88.4**	**109.7**	**78.0**	**101.7**	**173.3**	**99.5**	**106.0**	**134.3**	**1,695.7**	**0.0**

Source: JICA Survey Team

Table D-150 Surface and Groundwater Balance of Bukidnon Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Bukidnon Target Year= 2050
Weather Condition: Present Total Area [km2]= 353 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	82.3	32.1	45.2	33.7	85.9	133.0	93.6	117.6	175.8	60.3	54.5	45.5	959.8	
Surface Water Potential	**68.2**	**44.9**	**33.1**	**28.4**	**41.2**	**56.7**	**40.2**	**69.1**	**89.8**	**47.7**	**45.5**	**40.7**	**605.4**	
Irrigation Water Demand (SW)	11.4	7.6	1.2	0.4	0.4	2.7	2.1	5.9	1.2	0.0	1.9	6.1	41.9	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (SW)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.4	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	12.3	8.4	2.1	1.3	1.3	3.6	3.0	6.9	2.1	0.9	2.8	7.0	52.7	
SW Water Balance	**55.9**	**36.5**	**31.0**	**27.1**	**39.9**	**53.1**	**37.2**	**62.2**	**87.6**	**46.8**	**42.7**	**33.7**	**552.7**	**0.0**
Groundwater Potential	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**1.1**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.8**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.0	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.0	
GW Water Balance	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-5.2**	**-5.2**
Total Water Potential (SW+GW)	**68.3**	**44.9**	**33.1**	**28.4**	**41.3**	**56.7**	**40.3**	**69.2**	**89.8**	**47.8**	**45.5**	**40.8**	**606.2**	
Irrigation Water Demand (Total)	11.4	7.6	1.2	0.4	0.4	2.7	2.1	5.9	1.2	0.0	1.9	6.1	41.9	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (Total)	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	16.4	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	12.8	8.9	2.6	1.8	1.8	4.0	3.5	7.4	2.6	1.4	3.3	7.5	58.7	
Total Water Balance (SW+GW)	**55.5**	**36.1**	**30.5**	**26.7**	**39.5**	**52.7**	**36.8**	**61.8**	**87.2**	**46.4**	**42.2**	**33.3**	**547.5**	**-5.2**

Source: JICA Survey Team

Table D-151 Surface and Groundwater Balance of Davao de Oro (Compostela Valley) Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Davao de Oro Target Year= 2050
Weather Condition: Present Total Area [km2]= 2,172 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	829.7	205.3	286.2	225.9	346.5	666.3	336.0	411.0	680.6	267.2	321.4	291.8	4,868.1	
Surface Water Potential	**487.8**	**122.7**	**107.2**	**98.9**	**130.8**	**176.3**	**109.6**	**157.4**	**287.7**	**178.3**	**97.0**	**113.4**	**2,067.0**	
Irrigation Water Demand (SW)	116.3	62.4	14.7	0.0	1.0	124.7	62.3	92.0	79.0	0.0	45.1	91.8	689.3	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1	
Municipal and Industrial Water Demand (SW)	3.6	3.3	3.6	3.5	3.6	3.5	3.6	3.6	3.5	3.6	3.5	3.6	42.9	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	120.1	65.7	18.4	3.6	4.7	128.3	66.1	95.8	82.6	3.7	48.7	95.5	733.3	
SW Water Balance	**367.8**	**57.0**	**88.8**	**95.3**	**126.0**	**48.0**	**43.5**	**61.6**	**205.1**	**174.5**	**48.3**	**17.9**	**1,333.8**	**0.0**
Groundwater Potential	**2.4**	**2.1**	**2.4**	**2.3**	**2.4**	**2.3**	**2.4**	**2.4**	**2.3**	**2.4**	**2.3**	**2.4**	**27.9**	
Safety Groundwater Availability (70% of GWP)	**1.7**	**1.5**	**1.7**	**1.6**	**1.7**	**1.6**	**1.7**	**1.7**	**1.6**	**1.7**	**1.6**	**1.7**	**19.5**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.3	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.3	
GW Water Balance	**1.2**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**14.2**	**0.0**
Total Water Potential (SW+GW)	**489.5**	**124.2**	**108.9**	**100.5**	**132.4**	**177.9**	**111.2**	**159.1**	**289.3**	**179.9**	**98.6**	**115.0**	**2,086.6**	
Irrigation Water Demand (Total)	116.3	62.4	14.7	0.0	1.0	124.7	62.3	92.0	79.0	0.0	45.1	91.8	689.3	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1	
Municipal and Industrial Water Demand (Total)	4.1	3.7	4.1	4.0	4.1	4.0	4.1	4.1	4.0	4.1	4.0	4.1	48.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	120.5	66.2	18.9	4.1	5.2	128.8	66.5	96.2	83.0	4.2	49.1	95.9	738.6	
Total Water Balance (SW+GW)	**369.0**	**58.1**	**90.0**	**96.5**	**127.2**	**49.1**	**44.7**	**62.9**	**206.3**	**175.7**	**49.5**	**19.1**	**1,348.0**	**0.0**

Source: JICA Survey Team

Table D-152 Surface and Groundwater Balance of Davao del Norte Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Davao del Norte Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,485 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	756.2	745.9	562.7	332.3	872.6	1,163.9	443.3	904.8	1,177.9	725.9	511.5	320.1	8,516.9	
Surface Water Potential	**735.3**	**365.4**	**300.1**	**197.8**	**297.0**	**519.0**	**265.8**	**461.7**	**799.8**	**511.2**	**297.8**	**187.0**	**4,937.9**	
Irrigation Water Demand (SW)	38.9	56.1	46.9	0.0	0.0	37.7	55.0	69.8	21.1	0.0	24.1	55.3	425.0	
Livestock Water Deamnd (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.1	
Municipal and Industrial Water Demand (SW)	7.5	6.8	7.5	7.3	7.5	7.3	7.5	7.5	7.3	7.5	7.3	7.5	88.8	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	46.9	63.3	54.9	7.7	8.0	45.4	63.0	77.8	28.8	8.0	31.8	63.3	518.9	
SW Water Balance	**688.4**	**302.1**	**245.2**	**190.1**	**289.0**	**473.6**	**202.8**	**383.9**	**771.0**	**503.2**	**266.0**	**123.7**	**4,419.0**	**0.0**
Groundwater Potential	**9.5**	**8.3**	**7.2**	**6.3**	**6.3**	**7.4**	**7.2**	**7.1**	**7.1**	**7.7**	**8.8**	**8.4**	**91.3**	
Safety Groundwater Availability (70% of GWP)	**6.7**	**5.8**	**5.1**	**4.4**	**4.4**	**5.2**	**5.0**	**5.0**	**4.9**	**5.4**	**6.2**	**5.8**	**63.9**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	3.8	3.4	3.8	3.7	3.8	3.7	3.8	3.8	3.7	3.8	3.7	3.8	44.9	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Total Water Demand (GW)	3.9	3.5	3.9	3.7	3.9	3.7	3.9	3.9	3.7	3.9	3.7	3.9	45.5	
GW Water Balance	**2.8**	**2.3**	**1.2**	**0.7**	**0.5**	**1.4**	**1.2**	**1.1**	**1.2**	**1.6**	**2.4**	**2.0**	**18.4**	**0.0**
Total Water Potential (SW+GW)	**741.9**	**371.2**	**305.2**	**202.2**	**301.4**	**524.2**	**270.9**	**466.7**	**804.8**	**516.6**	**303.9**	**192.9**	**5,001.8**	
Irrigation Water Demand (Total)	38.9	56.1	46.9	0.0	0.0	37.7	55.0	69.8	21.1	0.0	24.1	55.3	425.0	
Livestock Water Deamnd (Total)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.2	
Municipal and Industrial Water Demand (Total)	11.4	10.3	11.4	11.0	11.4	11.0	11.4	11.4	11.0	11.4	11.0	11.4	133.7	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Total Water Demand (SW+GW)	50.7	66.8	58.8	11.5	11.8	49.2	66.9	81.6	32.6	11.8	35.5	67.2	564.4	
Total Water Balance (SW+GW)	**691.2**	**304.4**	**246.4**	**190.7**	**289.5**	**475.0**	**204.0**	**385.0**	**772.2**	**504.8**	**268.4**	**125.7**	**4,437.4**	**0.0**

Source: JICA Survey Team

Table D-153 Surface and Groundwater Balance of Davao del Sur Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Davao del Sur Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,662 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	424.0	421.2	339.3	186.0	872.2	1,186.1	389.2	735.7	923.4	596.7	423.9	233.9	6,731.6	
Surface Water Potential	**401.1**	**212.9**	**198.6**	**137.6**	**259.4**	**504.7**	**241.0**	**323.3**	**511.4**	**351.3**	**274.5**	**168.3**	**3,584.1**	
Irrigation Water Demand (SW)	107.7	61.1	28.9	0.0	10.0	80.8	90.9	75.9	21.5	0.0	66.4	99.0	664.5	
Livestock Water Deamnd (SW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.6	
Municipal and Industrial Water Demand (SW)	3.8	3.5	3.8	3.7	3.8	3.7	3.8	3.8	3.7	3.8	3.7	3.8	45.1	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	111.8	64.8	33.1	4.0	14.1	84.8	95.1	80.1	25.5	4.1	70.4	103.1	713.2	
SW Water Balance	**289.3**	**148.0**	**165.5**	**133.6**	**245.3**	**419.9**	**146.0**	**243.3**	**485.9**	**347.1**	**204.1**	**65.2**	**2,870.9**	**0.0**
Groundwater Potential	**2.1**	**1.9**	**2.1**	**2.0**	**2.0**	**2.0**	**2.1**	**2.1**	**2.0**	**2.1**	**2.1**	**2.1**	**24.5**	
Safety Groundwater Availability (70% of GWP)	**1.5**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.5**	**1.4**	**1.5**	**17.2**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	41.0	37.0	41.0	39.7	41.0	39.7	41.0	41.0	39.7	41.0	39.7	41.0	482.5	
Other Water Demand (GW)	0.9	0.8	0.9	0.8	0.9	0.8	0.9	0.9	0.8	0.9	0.8	0.9	10.2	
Total Water Demand (GW)	41.8	37.8	41.8	40.5	41.8	40.5	41.8	41.8	40.5	41.8	40.5	41.8	492.7	
GW Water Balance	**-40.3**	**-36.4**	**-40.4**	**-39.1**	**-40.4**	**-39.1**	**-40.4**	**-40.4**	**-39.1**	**-40.4**	**-39.1**	**-40.4**	**-475.6**	**-475.6**
Total Water Potential (SW+GW)	**402.6**	**214.2**	**200.0**	**139.0**	**260.9**	**506.1**	**242.5**	**324.8**	**512.8**	**352.7**	**276.0**	**169.8**	**3,601.3**	
Irrigation Water Demand (Total)	107.7	61.1	28.9	0.0	10.0	80.8	90.9	75.9	21.5	0.0	66.4	99.0	664.5	
Livestock Water Deamnd (Total)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.7	
Municipal and Industrial Water Demand (Total)	44.8	40.5	44.8	43.4	44.8	43.4	44.8	44.8	43.4	44.8	43.4	44.8	527.6	
Other Water Demand (Total)	0.9	0.8	0.9	0.8	0.9	0.8	0.9	0.9	0.8	0.9	0.8	0.9	10.2	
Total Water Demand (SW+GW)	153.7	102.6	74.9	44.5	56.0	125.3	136.9	121.9	66.0	46.0	110.9	145.0	1,206.0	
Total Water Balance (SW+GW)	**249.0**	**111.6**	**125.1**	**94.5**	**204.9**	**380.9**	**105.5**	**202.9**	**446.8**	**306.7**	**165.1**	**24.8**	**2,395.4**	**-475.6**

Source: JICA Survey Team

Table D-154 Surface and Groundwater Balance of Davao Oriental Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Davao Oriental Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,844 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	58.3	179.8	276.8	128.2	702.6	1,072.0	844.4	513.0	927.0	1,720.1	1,165.8	1,213.5	8,801.6	
Surface Water Potential	**476.2**	**456.9**	**451.0**	**450.8**	**438.8**	**639.1**	**644.3**	**594.0**	**690.8**	**1,161.2**	**827.1**	**803.7**	**7,633.8**	
Irrigation Water Demand (SW)	70.2	43.9	19.6	0.0	5.8	40.8	32.3	44.9	6.2	0.0	15.4	19.3	310.1	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.6	
Municipal and Industrial Water Demand (SW)	3.6	3.3	3.6	3.5	3.6	3.5	3.6	3.6	3.5	3.6	3.5	3.6	42.5	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	74.0	47.3	23.3	3.6	9.5	44.4	36.0	48.7	9.8	3.8	19.1	23.1	354.3	
SW Water Balance	**402.2**	**409.6**	**427.7**	**447.2**	**429.3**	**594.6**	**608.3**	**545.3**	**681.0**	**1,157.5**	**808.0**	**780.7**	**7,279.6**	**0.0**
Groundwater Potential	**2.9**	**2.7**	**2.8**	**2.8**	**2.8**	**2.7**	**2.9**	**2.9**	**2.8**	**2.9**	**2.8**	**2.9**	**33.7**	
Safety Groundwater Availability (70% of GWP)	**2.0**	**1.9**	**2.0**	**1.9**	**2.0**	**1.9**	**2.0**	**2.0**	**1.9**	**2.0**	**1.9**	**2.0**	**23.6**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1	1.0	1.1	12.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1	1.0	1.1	12.7	
GW Water Balance	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**10.9**	**0.0**
Total Water Potential (SW+GW)	**478.1**	**458.7**	**453.0**	**452.7**	**440.8**	**641.0**	**646.3**	**596.0**	**692.7**	**1,163.2**	**829.0**	**805.7**	**7,657.4**	
Irrigation Water Demand (Total)	70.2	43.9	19.6	0.0	5.8	40.8	32.3	44.9	6.2	0.0	15.4	19.3	310.1	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.6	
Municipal and Industrial Water Demand (Total)	4.7	4.2	4.7	4.5	4.7	4.5	4.7	4.7	4.5	4.7	4.5	4.7	55.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	75.1	48.3	24.4	4.7	10.6	45.5	37.1	49.7	10.8	4.8	20.1	24.1	366.9	
Total Water Balance (SW+GW)	**403.1**	**410.5**	**428.6**	**448.1**	**430.2**	**595.5**	**609.2**	**546.2**	**681.9**	**1,158.4**	**808.9**	**781.6**	**7,290.5**	**0.0**

Source: JICA Survey Team

Table D-155 Surface and Groundwater Balance of Davao Occidental Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Davao Occidental Target Year= 2050
Weather Condition: Present Total Area [km2]= 1,744 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	49.9	31.8	31.0	45.4	185.1	478.7	242.7	205.4	417.2	611.7	294.6	348.6	2,942.2	
Surface Water Potential	**39.5**	**24.0**	**15.1**	**9.9**	**16.1**	**57.7**	**55.0**	**84.7**	**109.2**	**189.1**	**154.7**	**170.3**	**925.3**	
Irrigation Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	1.7	1.5	1.7	1.6	1.7	1.6	1.7	1.7	1.6	1.7	1.6	1.7	19.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.7	1.5	1.7	1.6	1.7	1.6	1.7	1.7	1.6	1.7	1.6	1.7	19.8	
SW Water Balance	**37.9**	**22.5**	**13.4**	**8.3**	**14.4**	**56.1**	**53.3**	**83.0**	**107.5**	**187.4**	**153.1**	**168.6**	**905.5**	**0.0**
Groundwater Potential	**5.0**	**4.6**	**4.9**	**4.8**	**4.9**	**4.8**	**5.0**	**5.0**	**4.8**	**5.0**	**4.9**	**5.0**	**58.6**	
Safety Groundwater Availability (70% of GWP)	**3.5**	**3.3**	**3.5**	**3.3**	**3.4**	**3.3**	**3.5**	**3.5**	**3.4**	**3.5**	**3.4**	**3.5**	**41.0**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.5	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Total Water Demand (GW)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	10.0	
GW Water Balance	**2.6**	**2.5**	**2.6**	**2.5**	**2.6**	**2.5**	**2.6**	**2.6**	**2.5**	**2.7**	**2.6**	**2.7**	**31.1**	**0.0**
Total Water Potential (SW+GW)	**43.0**	**27.3**	**18.6**	**13.3**	**19.6**	**61.0**	**58.4**	**88.1**	**112.5**	**192.6**	**158.1**	**173.8**	**966.3**	
Irrigation Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	2.5	2.2	2.5	2.4	2.5	2.4	2.5	2.5	2.4	2.5	2.4	2.5	29.3	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Total Water Demand (SW+GW)	2.5	2.3	2.5	2.4	2.5	2.4	2.5	2.5	2.4	2.5	2.4	2.5	29.8	
Total Water Balance (SW+GW)	**40.5**	**25.0**	**16.0**	**10.8**	**17.0**	**58.6**	**55.9**	**85.6**	**110.1**	**190.0**	**155.7**	**171.3**	**936.5**	**0.0**

Source: JICA Survey Team

Table D-156 Surface and Groundwater Balance of North Cotabato Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: North Cotabato Target Year= 2050
Weather Condition: Present Total Area [km2]= 282 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	32.3	37.3	33.4	27.3	45.0	86.7	50.6	151.8	27.3	48.2	34.6	29.6	604.0	
Surface Water Potential	**31.9**	**30.2**	**11.0**	**6.7**	**9.9**	**31.7**	**17.4**	**49.1**	**14.7**	**18.6**	**27.9**	**23.8**	**272.7**	
Irrigation Water Demand (SW)	6.4	0.0	8.1	23.4	14.6	8.9	1.3	0.0	4.6	9.9	13.1	14.5	105.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (SW)	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.1	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	6.7	0.3	8.4	23.7	14.9	9.1	1.6	0.3	4.9	10.2	13.4	14.8	108.3	
SW Water Balance	**25.2**	**30.0**	**2.5**	**-17.0**	**-5.1**	**22.6**	**15.8**	**48.8**	**9.7**	**8.4**	**14.4**	**9.0**	**164.4**	**-22.0**
Groundwater Potential	**0.2**	**0.2**	**0.1**	**0.0**	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.2**	**0.1**	**1.2**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.1**	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.1**	**0.9**	
Irrigation Water Demand (GW)	0.1	0.0	0.1	0.3	0.2	0.1	0.0	0.0	0.1	0.1	0.1	0.2	1.1	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	11.6	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Total Water Demand (GW)	1.1	0.9	1.1	1.2	1.2	1.1	1.0	1.0	1.0	1.1	1.1	1.2	13.0	
GW Water Balance	**-0.9**	**-0.8**	**-1.0**	**-1.2**	**-1.1**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.1**	**-1.0**	**-1.1**	**-12.1**	**-12.1**
Total Water Potential (SW+GW)	**32.0**	**30.3**	**11.0**	**6.7**	**9.9**	**31.8**	**17.5**	**49.1**	**14.7**	**18.6**	**28.0**	**23.9**	**273.6**	
Irrigation Water Demand (Total)	6.5	0.0	8.2	23.6	14.8	9.0	1.3	0.0	4.7	10.0	13.3	14.7	106.1	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (Total)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.7	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Total Water Demand (SW+GW)	7.8	1.2	9.5	24.9	16.1	10.2	2.6	1.3	5.9	11.3	14.5	16.0	121.3	
Total Water Balance (SW+GW)	**24.3**	**29.2**	**1.5**	**-18.2**	**-6.2**	**21.6**	**14.9**	**47.8**	**8.8**	**7.3**	**13.4**	**7.9**	**152.3**	**-34.1**

Source: JICA Survey Team

Table D-157 Surface and Groundwater Balance of Sarangani Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Sarangani Target Year= 2050
Weather Condition: Present Total Area [km2]= 2,507 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	254.5	485.8	225.7	202.3	264.5	301.7	444.0	171.5	239.9	299.0	312.7	330.3	3,531.9	
Surface Water Potential	**134.5**	**161.2**	**186.6**	**119.2**	**103.9**	**88.0**	**140.3**	**99.0**	**84.7**	**88.6**	**107.9**	**111.2**	**1,425.0**	
Irrigation Water Demand (SW)	5.0	0.0	10.8	20.8	19.0	15.2	0.5	1.0	3.2	13.3	11.0	10.4	110.2	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	
Municipal and Industrial Water Demand (SW)	3.6	3.3	3.6	3.5	3.6	3.5	3.6	3.6	3.5	3.6	3.5	3.6	42.9	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	8.7	3.4	14.5	24.4	22.7	18.8	4.2	4.7	6.8	17.0	14.6	14.2	154.1	
SW Water Balance	**125.7**	**157.9**	**172.1**	**94.8**	**81.2**	**69.1**	**136.1**	**94.3**	**77.9**	**71.5**	**93.2**	**97.1**	**1,270.9**	**0.0**
Groundwater Potential	**2.5**	**2.2**	**1.9**	**1.7**	**1.8**	**2.0**	**1.8**	**1.8**	**1.7**	**1.9**	**2.3**	**2.2**	**23.9**	
Safety Groundwater Availability (70% of GWP)	**1.8**	**1.6**	**1.3**	**1.2**	**1.2**	**1.4**	**1.3**	**1.3**	**1.2**	**1.4**	**1.6**	**1.6**	**16.7**	
Irrigation Water Demand (GW)	0.1	0.0	0.1	0.2	0.2	0.2	0.0	0.0	0.0	0.2	0.1	0.1	1.3	
Livestock Water Deamnd (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8	
Municipal and Industrial Water Demand (GW)	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1	1.0	1.1	12.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	1.2	1.0	1.3	1.4	1.4	1.3	1.2	1.2	1.2	1.3	1.3	1.3	14.9	
GW Water Balance	**0.5**	**0.5**	**0.0**	**-0.2**	**-0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**	**0.4**	**0.3**	**1.8**	**-0.3**
Total Water Potential (SW+GW)	**136.2**	**162.8**	**187.9**	**120.4**	**105.1**	**89.4**	**141.6**	**100.2**	**86.0**	**89.9**	**109.5**	**112.8**	**1,441.8**	
Irrigation Water Demand (Total)	5.1	0.0	10.9	21.1	19.2	15.4	0.5	1.0	3.2	13.5	11.1	10.6	111.6	
Livestock Water Deamnd (Total)	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.2	0.1	0.2	1.8	
Municipal and Industrial Water Demand (Total)	4.7	4.3	4.7	4.6	4.7	4.6	4.7	4.7	4.6	4.7	4.6	4.7	55.6	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	10.0	4.4	15.8	25.8	24.1	20.1	5.4	5.9	8.0	18.3	15.9	15.5	169.0	
Total Water Balance (SW+GW)	**126.3**	**158.4**	**172.1**	**94.6**	**81.1**	**69.2**	**136.2**	**94.4**	**78.0**	**71.6**	**93.6**	**97.3**	**1,272.7**	**-0.3**

Source: JICA Survey Team

Table D-158 Surface and Groundwater Balance of South Cotabato Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: South Cotabato Target Year= 2050
Weather Condition: Present Total Area [km2]= 1,445 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	98.9	14.3	68.3	67.4	149.8	304.9	275.4	171.2	106.1	211.1	89.2	89.2	1,645.8	
Surface Water Potential	**268.1**	**249.4**	**211.7**	**200.4**	**202.9**	**247.4**	**279.6**	**233.7**	**241.2**	**244.8**	**266.5**	**255.3**	**2,901.0**	
Irrigation Water Demand (SW)	44.0	6.1	52.0	123.8	89.2	50.2	0.0	0.0	37.5	49.5	76.6	82.5	611.5	
Livestock Water Deamnd (SW)	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.8	
Municipal and Industrial Water Demand (SW)	2.5	2.3	2.5	2.4	2.5	2.4	2.5	2.5	2.4	2.5	2.4	2.5	29.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	46.7	8.5	54.7	126.4	91.9	52.8	2.7	2.7	40.1	52.2	79.2	85.2	643.0	
SW Water Balance	**221.4**	**240.8**	**157.0**	**74.0**	**111.0**	**194.5**	**276.9**	**231.1**	**201.2**	**192.6**	**187.3**	**170.1**	**2,257.9**	**0.0**
Groundwater Potential	**5.7**	**4.9**	**1.3**	**0.0**	**0.4**	**2.4**	**1.0**	**0.7**	**0.7**	**1.5**	**4.6**	**3.7**	**26.8**	
Safety Groundwater Availability (70% of GWP)	**4.0**	**3.4**	**0.9**	**0.0**	**0.3**	**1.7**	**0.7**	**0.5**	**0.5**	**1.1**	**3.2**	**2.6**	**18.8**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Livestock Water Deamnd (GW)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.0	
Municipal and Industrial Water Demand (GW)	13.9	12.5	13.9	13.4	13.9	13.4	13.9	13.9	13.4	13.9	13.4	13.9	163.3	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	14.1	12.7	14.1	13.6	14.1	13.6	14.0	14.0	13.6	14.1	13.6	14.1	165.6	
GW Water Balance	**-10.1**	**-9.2**	**-13.2**	**-13.6**	**-13.8**	**-11.9**	**-13.4**	**-13.6**	**-13.1**	**-13.0**	**-10.4**	**-11.5**	**-146.8**	**-146.8**
Total Water Potential (SW+GW)	**272.0**	**252.8**	**212.6**	**200.4**	**203.2**	**249.0**	**280.3**	**234.2**	**241.7**	**245.9**	**269.7**	**257.9**	**2,919.7**	
Irrigation Water Demand (Total)	44.0	6.1	52.0	123.8	89.3	50.3	0.0	0.0	37.5	49.6	76.6	82.5	611.7	
Livestock Water Deamnd (Total)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.8	
Municipal and Industrial Water Demand (Total)	16.4	14.8	16.4	15.9	16.4	15.9	16.4	16.4	15.9	16.4	15.9	16.4	193.0	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	60.7	21.2	68.7	140.0	106.0	66.4	16.7	16.7	53.7	66.3	92.8	99.2	808.6	
Total Water Balance (SW+GW)	**211.3**	**231.6**	**143.9**	**60.4**	**97.2**	**182.6**	**263.6**	**217.5**	**188.0**	**179.6**	**176.8**	**158.6**	**2,111.1**	**-146.8**

Source: JICA Survey Team

Table D-159 Surface and Groundwater Balance of Sultan Kudarat Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Sultan Kudarat Target Year= 2050
Weather Condition: Present Total Area [km2]= 244 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	28.8	40.1	26.4	22.7	30.8	30.8	46.8	19.0	42.3	29.2	18.2	19.3	354.4	
Surface Water Potential	**42.3**	**49.1**	**32.5**	**9.4**	**9.8**	**20.0**	**39.7**	**11.0**	**25.6**	**27.4**	**37.3**	**27.0**	**331.0**	
Irrigation Water Demand (SW)	2.0	0.0	4.9	8.6	7.6	3.8	0.0	0.4	0.4	3.8	4.3	5.2	41.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Municipal and Industrial Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	2.1	0.1	5.0	8.7	7.7	3.9	0.1	0.6	0.5	4.0	4.5	5.3	42.5	
SW Water Balance	**40.2**	**49.0**	**27.4**	**0.7**	**2.1**	**16.1**	**39.6**	**10.4**	**25.1**	**23.4**	**32.9**	**21.6**	**288.5**	**0.0**
Groundwater Potential	**0.1**	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.6**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	
Irrigation Water Demand (GW)	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.5	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.3	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	1.8	
GW Water Balance	**-0.1**	**-0.1**	**-0.1**	**-0.2**	**-0.2**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-0.1**	**-1.3**	**-1.3**
Total Water Potential (SW+GW)	**42.3**	**49.1**	**32.5**	**9.5**	**9.8**	**20.0**	**39.7**	**11.0**	**25.6**	**27.4**	**37.4**	**27.0**	**331.5**	
Irrigation Water Demand (Total)	2.0	0.0	4.9	8.7	7.7	3.8	0.0	0.5	0.4	3.9	4.4	5.3	41.5	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Municipal and Industrial Water Demand (Total)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.3	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	2.2	0.2	5.2	8.9	7.9	4.1	0.2	0.7	0.6	4.1	4.6	5.5	44.3	
Total Water Balance (SW+GW)	**40.1**	**48.9**	**27.3**	**0.6**	**1.9**	**16.0**	**39.5**	**10.3**	**25.0**	**23.3**	**32.7**	**21.5**	**287.2**	**-1.3**

Source: JICA Survey Team

Table D-160 Surface and Groundwater Balance of Surigao del Sur Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Surigao del Sur Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,269 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	1,002.7	490.1	981.4	927.7	1,025.2	941.3	821.2	493.1	630.9	817.0	1,302.2	790.9	10,223.7	
Surface Water Potential	**432.4**	**228.6**	**339.5**	**283.0**	**503.1**	**282.6**	**374.7**	**222.8**	**150.0**	**303.4**	**617.9**	**344.0**	**4,082.2**	
Irrigation Water Demand (SW)	50.8	43.0	27.0	0.0	0.0	81.9	62.6	81.4	70.0	0.0	77.8	64.3	558.7	
Livestock Water Deamnd (SW)	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.6	
Municipal and Industrial Water Demand (SW)	2.4	2.2	2.4	2.3	2.4	2.3	2.4	2.4	2.3	2.4	2.3	2.4	28.5	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	53.3	45.2	29.4	2.4	2.5	84.3	65.1	83.9	72.4	2.5	80.2	66.8	587.8	
SW Water Balance	**379.2**	**183.4**	**310.1**	**280.6**	**500.7**	**198.4**	**309.6**	**138.9**	**77.7**	**300.9**	**537.7**	**277.2**	**3,494.4**	**0.0**
Groundwater Potential	**1.1**	**1.0**	**0.9**	**0.8**	**0.9**	**1.0**	**0.9**	**0.9**	**0.9**	**0.9**	**1.1**	**1.0**	**11.5**	
Safety Groundwater Availability (70% of GWP)	**0.8**	**0.7**	**0.7**	**0.6**	**0.6**	**0.7**	**0.6**	**0.6**	**0.6**	**0.7**	**0.7**	**0.7**	**8.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.4	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	1.4	1.2	1.4	1.3	1.4	1.3	1.4	1.4	1.3	1.4	1.3	1.4	16.1	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	1.4	1.2	1.4	1.3	1.4	1.4	1.5	1.5	1.4	1.4	1.3	1.4	16.5	
GW Water Balance	**-0.6**	**-0.5**	**-0.7**	**-0.7**	**-0.7**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.7**	**-0.6**	**-0.6**	**-8.5**	**-8.5**
Total Water Potential (SW+GW)	**433.2**	**229.3**	**340.2**	**283.6**	**503.8**	**283.3**	**375.3**	**223.5**	**150.6**	**304.1**	**618.6**	**344.8**	**4,090.3**	
Irrigation Water Demand (Total)	50.8	43.0	27.0	0.0	0.0	82.0	62.7	81.5	70.1	0.0	77.8	64.3	559.1	
Livestock Water Deamnd (Total)	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	
Municipal and Industrial Water Demand (Total)	3.8	3.4	3.8	3.7	3.8	3.7	3.8	3.8	3.7	3.8	3.7	3.8	44.6	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	54.6	46.4	30.8	3.7	3.8	85.7	66.5	85.4	73.8	3.8	81.5	68.2	604.3	
Total Water Balance (SW+GW)	**378.6**	**182.9**	**309.4**	**279.9**	**499.9**	**197.6**	**308.8**	**138.1**	**76.8**	**300.2**	**537.1**	**276.6**	**3,486.0**	**-8.5**

Source: JICA Survey Team

Table D-161 Summary of Annual Water Balance and Deficit of Agusan del Sur Province at Each Climate Change Condition

Total Area [km^2]= 930

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	1,822.6	62.6	1,885.2	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	1,636.9	59.9	1,696.8	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	1,094.2	51.6	1,145.8	0.0	0.0	0.0
4	Present	2050	Average Year	1,821.9	62.2	1,884.1	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	1,636.2	59.5	1,695.7	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	1,093.5	51.2	1,144.7	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	2,106.1	62.7	2,168.8	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	1,941.2	59.7	2,000.9	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	1,284.7	52.4	1,337.2	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	1,885.6	56.0	1,941.6	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,335.7	52.3	1,388.0	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,166.2	47.4	1,213.6	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	1,289.8	83.4	1,373.2	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,125.2	80.4	1,205.6	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	794.7	69.4	864.1	0.0	0.0	0.0

Source: JICA Survey Team

Table D-162 Summary of Annual Water Balance and Deficit of Bukidnon Province at Each Climate Change Condition

Total Area [km^2]= 353

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	651.5	-4.5	647.0	0.0	-4.5	-4.5
2	Present	2020	1/5-Dry Year	554.0	-4.5	549.5	0.0	-4.5	-4.5
3	Present	2020	1/10-Dry Year	415.2	-4.5	410.7	0.0	-4.5	-4.5
4	Present	2050	Average Year	650.2	-5.2	645.0	0.0	-5.2	-5.2
5	Present	2050	1/5-Dry Year	552.7	-5.2	547.5	0.0	-5.2	-5.2
6	Present	2050	1/10-Dry Year	413.9	-5.2	408.7	0.0	-5.2	-5.2
7	CC RCP8.5-High	2050	Average Year	716.5	-5.2	711.3	0.0	-5.2	-5.2
8	CC RCP8.5-High	2050	1/5-Dry Year	666.6	-5.2	661.3	0.0	-5.2	-5.2
9	CC RCP8.5-High	2050	1/10-Dry Year	393.3	-5.2	388.1	0.0	-5.2	-5.2
10	CC RCP8.5-Mid.	2050	Average Year	1,645.5	-5.4	1,640.1	0.0	-5.4	-5.4
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,390.2	-5.4	1,384.8	0.0	-5.4	-5.4
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	982.9	-5.4	977.5	0.0	-5.4	-5.4
13	CC RCP8.5-Low	2050	Average Year	553.4	-3.5	549.9	0.0	-3.5	-3.5
14	CC RCP8.5-Low	2050	1/5-Dry Year	441.3	-3.6	437.6	0.0	-3.6	-3.6
15	CC RCP8.5-Low	2050	1/10-Dry Year	314.0	-3.6	310.5	0.0	-3.6	-3.6

Source: JICA Survey Team

Table D-163 Summary of Annual Water Balance and Deficit of Davao de Oro (Compostela Valley) Province at Each Climate Change Condition

Total Area [km^2]= 2,172

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	2,519.9	15.4	2,535.2	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	1,344.9	15.3	1,360.2	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	1,221.1	15.3	1,236.4	0.0	0.0	0.0
4	Present	2050	Average Year	2,508.7	14.3	2,523.0	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	1,333.8	14.2	1,348.0	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	1,210.0	14.2	1,224.2	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	2,951.5	38.8	2,990.3	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	1,665.5	14.3	1,679.8	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	1,487.5	38.7	1,526.2	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	2,747.9	3.1	2,751.0	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,726.5	3.0	1,729.5	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,543.4	3.1	1,546.4	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	1,870.8	14.3	1,885.0	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,055.0	3.0	1,058.0	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	961.3	14.2	975.5	-7.4	0.0	-7.4

Source: JICA Survey Team

Table D-164 Summary of Annual Water Balance and Deficit of Davao del Norte Province at Each Climate Change Condition

Total Area [km^2]= 3,485

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	6,063.5	33.0	6,096.4	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	4,433.3	31.3	4,464.5	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	3,641.8	31.6	3,673.4	0.0	0.0	0.0
4	Present	2050	Average Year	6,049.2	20.1	6,069.3	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	4,419.0	18.4	4,437.4	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	3,627.5	18.7	3,646.2	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	7,108.5	20.2	7,128.7	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	5,184.5	18.6	5,203.1	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	4,213.0	19.0	4,232.0	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	5,164.5	19.5	5,184.1	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	3,655.4	17.0	3,672.4	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	3,045.8	18.8	3,064.6	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	7,201.9	20.5	7,222.4	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	5,632.5	19.0	5,651.5	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	4,452.2	19.2	4,471.5	0.0	0.0	0.0

Source: JICA Survey Team

Table D-165 Summary of Annual Water Balance and Deficit of Davao del Sur Province at Each Climate Change Condition

Total Area [km^2]= 3,662

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	4,049.4	-288.1	3,761.3	0.0	-288.1	-288.1
2	Present	2020	1/5-Dry Year	2,883.7	-288.2	2,595.6	0.0	-288.2	-288.2
3	Present	2020	1/10-Dry Year	2,355.5	-288.2	2,067.3	0.0	-288.2	-288.2
4	Present	2050	Average Year	4,036.5	-475.5	3,561.0	0.0	-475.5	-475.5
5	Present	2050	1/5-Dry Year	2,870.9	-475.6	2,395.4	0.0	-475.6	-475.6
6	Present	2050	1/10-Dry Year	2,342.7	-475.6	1,867.1	0.0	-475.6	-475.6
7	CC RCP8.5-High	2050	Average Year	3,243.7	-475.5	2,768.2	0.0	-475.5	-475.5
8	CC RCP8.5-High	2050	1/5-Dry Year	2,408.6	-475.5	1,933.1	0.0	-475.5	-475.5
9	CC RCP8.5-High	2050	1/10-Dry Year	2,187.7	-475.6	1,712.2	0.0	-475.6	-475.6
10	CC RCP8.5-Mid.	2050	Average Year	4,062.8	-478.8	3,584.0	0.0	-478.8	-478.8
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	3,147.3	-478.9	2,668.4	0.0	-478.9	-478.9
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2,961.7	-478.7	2,482.9	0.0	-478.7	-478.7
13	CC RCP8.5-Low	2050	Average Year	3,689.7	-479.1	3,210.5	0.0	-479.1	-479.1
14	CC RCP8.5-Low	2050	1/5-Dry Year	2,561.1	-479.2	2,081.9	0.0	-479.2	-479.2
15	CC RCP8.5-Low	2050	1/10-Dry Year	2,047.0	-478.9	1,568.1	0.0	-478.9	-478.9

Source: JICA Survey Team

Table D-166 Summary of Annual Water Balance and Deficit of Davao Oriental Province at Each Climate Change Condition

Total Area [km^2]= 3,844

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	7,834.1	14.0	7,848.1	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	7,290.8	14.1	7,304.8	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	6,346.4	14.0	6,360.5	0.0	0.0	0.0
4	Present	2050	Average Year	7,822.9	10.9	7,833.8	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	7,279.6	10.9	7,290.5	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	6,335.2	10.9	6,346.1	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	8,419.6	10.9	8,430.5	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	7,699.9	10.9	7,710.9	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	6,643.1	10.9	6,654.0	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	8,584.7	13.1	8,597.8	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	8,336.3	13.1	8,349.4	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	6,761.1	35.0	6,796.1	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	10,980.8	10.9	10,991.7	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	10,781.2	10.9	10,792.1	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	5,637.6	10.9	5,648.5	0.0	0.0	0.0

Source: JICA Survey Team

Table D-167 Summary of Annual Water Balance and Deficit of Davao Occidental Province at Each Climate Change Condition

Total Area [km^2]= 1,744

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	1,076.5	33.7	1,110.2	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	910.3	33.5	943.8	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	893.8	33.5	927.4	0.0	0.0	0.0
4	Present	2050	Average Year	1,071.7	31.2	1,102.9	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	905.5	31.1	936.5	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	889.1	31.0	920.1	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	1,125.2	31.3	1,156.4	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	1,086.4	31.1	1,117.5	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	1,056.2	31.1	1,087.3	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	935.2	12.5	947.7	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	973.7	12.3	986.1	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,018.4	12.4	1,030.8	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	897.0	5.7	902.6	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	578.0	5.3	583.4	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	572.8	5.4	578.2	0.0	0.0	0.0

Source: JICA Survey Team

Table D-168 Summary of Annual Water Balance and Deficit of North Cotabato Province at Each Climate Change Condition

Total Area [km^2]= 282

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	308.1	-7.0	301.1	0.0	-7.0	-7.0
2	Present	2020	1/5-Dry Year	164.7	-7.0	157.7	-1.2	-7.0	-8.2
3	Present	2020	1/10-Dry Year	130.2	-7.0	123.2	-4.2	-7.0	-11.3
4	Present	2050	Average Year	307.8	-12.1	295.7	-13.6	-12.1	-25.7
5	Present	2050	1/5-Dry Year	164.4	-12.1	152.3	-22.0	-12.1	-34.1
6	Present	2050	1/10-Dry Year	129.9	-12.1	117.8	-25.2	-12.1	-37.3
7	CC RCP8.5-High	2050	Average Year	352.9	-12.1	340.7	-13.0	-12.1	-25.2
8	CC RCP8.5-High	2050	1/5-Dry Year	345.0	-12.1	332.9	-15.5	-12.1	-27.6
9	CC RCP8.5-High	2050	1/10-Dry Year	239.9	-12.1	227.8	-21.5	-12.1	-33.6
10	CC RCP8.5-Mid.	2050	Average Year	437.7	-12.3	425.4	-14.0	-12.3	-26.3
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	319.1	-12.4	306.8	-14.5	-12.4	-26.8
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	352.3	-12.4	339.9	-23.7	-12.4	-36.1
13	CC RCP8.5-Low	2050	Average Year	274.2	-12.1	262.1	-11.2	-12.1	-23.3
14	CC RCP8.5-Low	2050	1/5-Dry Year	88.8	-12.1	76.7	-25.9	-12.1	-38.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	55.8	-12.1	43.6	-26.3	-12.1	-38.4

Source: JICA Survey Team

Table D-169 Summary of Annual Water Balance and Deficit of Sarangani Province at Each Climate Change Condition

Total Area [km^2]= 2,507

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	1,625.0	3.9	1,628.9	0.0	-0.0	-0.0
2	Present	2020	1/5-Dry Year	1,278.6	3.8	1,282.5	0.0	-0.0	-0.0
3	Present	2020	1/10-Dry Year	1,172.5	3.8	1,176.3	0.0	-0.0	-0.0
4	Present	2050	Average Year	1,617.3	1.9	1,619.1	0.0	-0.3	-0.3
5	Present	2050	1/5-Dry Year	1,270.9	1.8	1,272.7	0.0	-0.3	-0.3
6	Present	2050	1/10-Dry Year	1,164.7	1.8	1,166.6	0.0	-0.3	-0.3
7	CC RCP8.5-High	2050	Average Year	1,556.5	1.9	1,558.4	0.0	-0.3	-0.3
8	CC RCP8.5-High	2050	1/5-Dry Year	1,227.0	1.9	1,228.9	0.0	-0.3	-0.3
9	CC RCP8.5-High	2050	1/10-Dry Year	1,116.4	1.9	1,118.3	0.0	-0.3	-0.3
10	CC RCP8.5-Mid.	2050	Average Year	1,155.6	-7.1	1,148.5	0.0	-7.1	-7.1
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	859.0	-7.1	851.8	0.0	-7.1	-7.1
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	744.3	-7.1	737.2	0.0	-7.1	-7.1
13	CC RCP8.5-Low	2050	Average Year	1,086.5	-11.9	1,074.5	0.0	-11.9	-11.9
14	CC RCP8.5-Low	2050	1/5-Dry Year	911.2	-11.9	899.2	0.0	-11.9	-11.9
15	CC RCP8.5-Low	2050	1/10-Dry Year	837.4	-11.9	825.5	0.0	-11.9	-11.9

Source: JICA Survey Team

Table D-170 Summary of Annual Water Balance and Deficit of South Cotabato Province at Each Climate Change Condition

Total Area [km^2]= 1,445

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	2,523.4	-119.3	2,404.1	0.0	-119.3	-119.3
2	Present	2020	1/5-Dry Year	2,264.4	-119.4	2,144.9	0.0	-119.4	-119.4
3	Present	2020	1/10-Dry Year	2,210.1	-119.4	2,090.7	0.0	-119.4	-119.4
4	Present	2050	Average Year	2,517.0	-146.7	2,370.3	0.0	-146.7	-146.7
5	Present	2050	1/5-Dry Year	2,257.9	-146.8	2,111.1	0.0	-146.8	-146.8
6	Present	2050	1/10-Dry Year	2,203.7	-146.8	2,056.9	0.0	-146.8	-146.8
7	CC RCP8.5-High	2050	Average Year	2,347.1	-146.7	2,200.4	0.0	-146.7	-146.7
8	CC RCP8.5-High	2050	1/5-Dry Year	2,102.4	-146.8	1,955.6	0.0	-146.8	-146.8
9	CC RCP8.5-High	2050	1/10-Dry Year	2,139.9	-146.8	1,993.1	0.0	-146.8	-146.8
10	CC RCP8.5-Mid.	2050	Average Year	926.9	-146.7	780.1	-135.7	-146.7	-282.4
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	600.1	-146.8	453.3	-134.8	-146.8	-281.6
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	666.8	-146.8	520.0	-124.1	-146.8	-270.9
13	CC RCP8.5-Low	2050	Average Year	2,661.8	-146.7	2,515.1	0.0	-146.7	-146.7
14	CC RCP8.5-Low	2050	1/5-Dry Year	2,474.8	-146.8	2,328.0	0.0	-146.8	-146.8
15	CC RCP8.5-Low	2050	1/10-Dry Year	2,327.1	-146.8	2,180.3	0.0	-146.8	-146.8

Source: JICA Survey Team

Table D-171 Summary of Annual Water Balance and Deficit of Sultan Kudarat Province at Each Climate Change Condition

Total Area [km^2]= 244

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	363.7	-1.0	362.7	-2.1	-1.0	-3.1
2	Present	2020	1/5-Dry Year	288.9	-1.0	287.9	0.0	-1.0	-1.0
3	Present	2020	1/10-Dry Year	260.0	-1.0	259.0	-8.7	-1.0	-9.7
4	Present	2050	Average Year	363.3	-1.3	362.0	-4.3	-1.3	-5.6
5	Present	2050	1/5-Dry Year	288.5	-1.3	287.2	0.0	-1.3	-1.3
6	Present	2050	1/10-Dry Year	259.6	-1.3	258.3	-12.8	-1.3	-14.2
7	CC RCP8.5-High	2050	Average Year	426.8	-1.3	425.5	-4.3	-1.3	-5.6
8	CC RCP8.5-High	2050	1/5-Dry Year	348.7	-1.3	347.4	0.0	-1.3	-1.3
9	CC RCP8.5-High	2050	1/10-Dry Year	312.1	-1.3	310.8	-13.3	-1.3	-14.6
10	CC RCP8.5-Mid.	2050	Average Year	613.7	-1.2	612.5	0.0	-1.2	-1.2
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	519.7	-1.2	518.5	0.0	-1.2	-1.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	440.6	-1.2	439.4	-12.1	-1.2	-13.3
13	CC RCP8.5-Low	2050	Average Year	318.6	-1.3	317.3	-5.0	-1.3	-6.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	239.6	-1.3	238.3	-0.9	-1.3	-2.2
15	CC RCP8.5-Low	2050	1/10-Dry Year	215.3	-1.3	213.9	-12.9	-1.3	-14.3

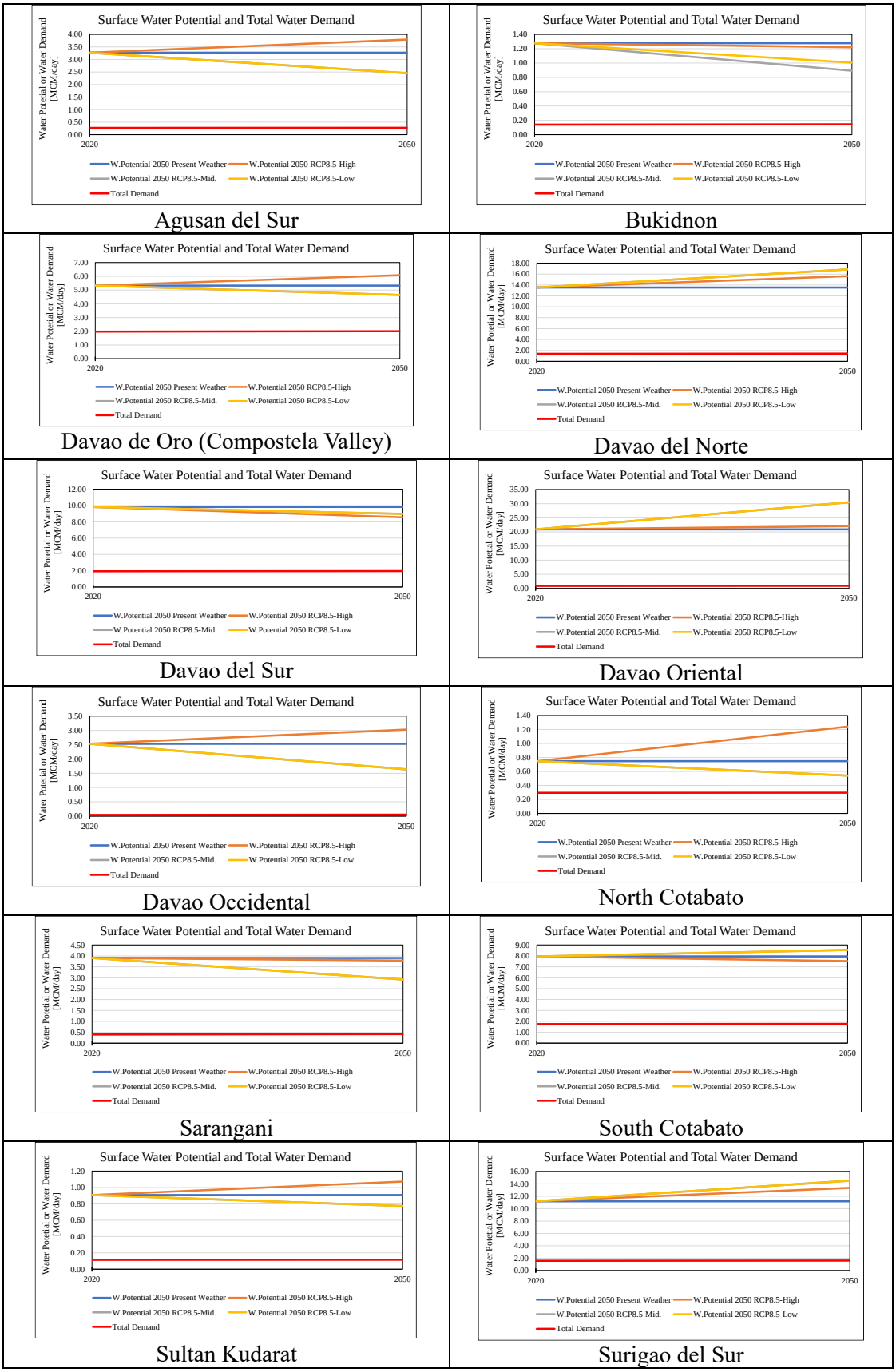
Source: JICA Survey Team

Table D-172 Summary of Annual Water Balance and Deficit of Surigao del Sur Province at Each Climate Change Condition

Total Area [km^2]= 3,269

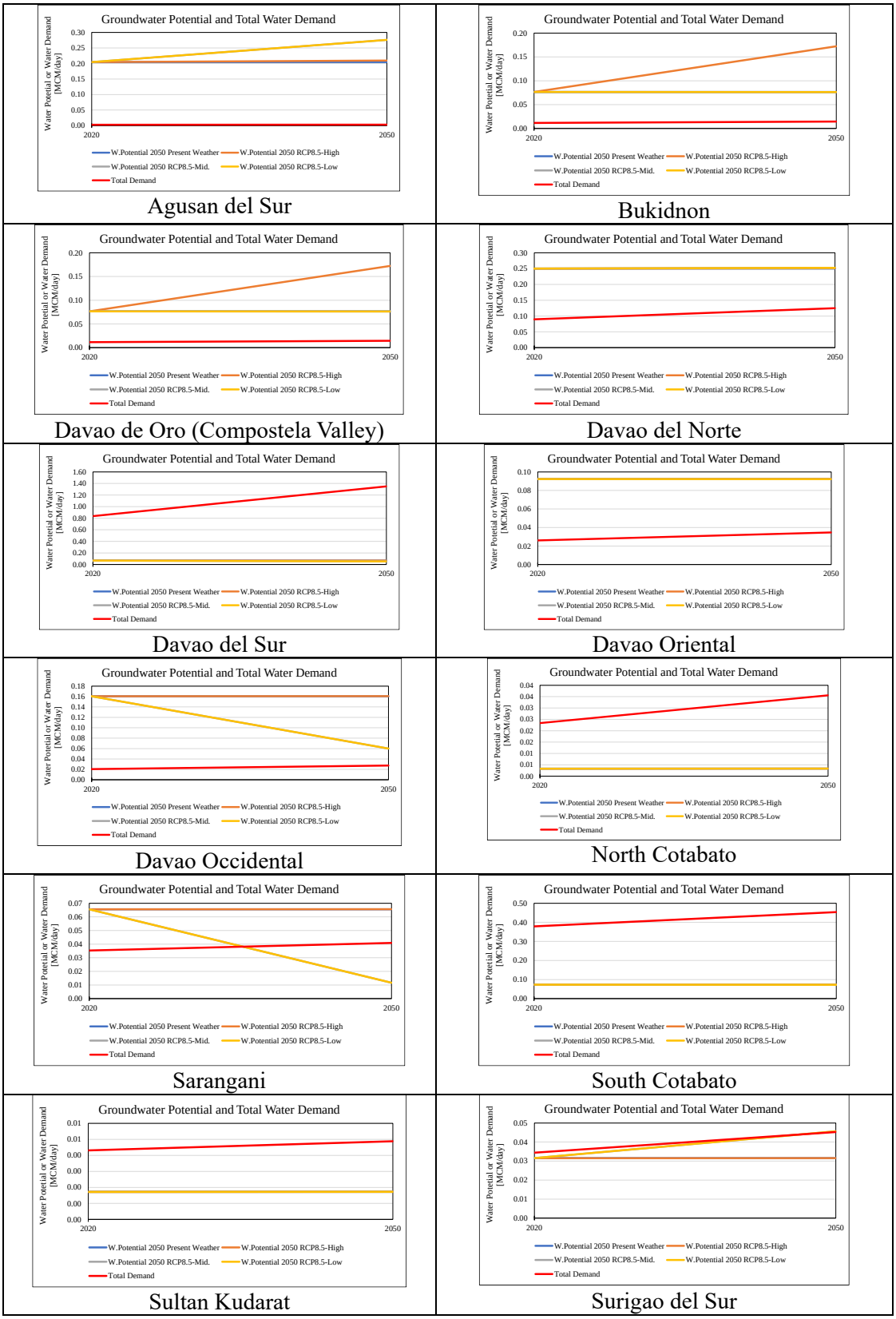
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	6,943.6	-4.2	6,939.4	0.0	-4.2	-4.2
2	Present	2020	1/5-Dry Year	3,501.4	-4.2	3,497.2	0.0	-4.2	-4.2
3	Present	2020	1/10-Dry Year	2,779.4	-4.2	2,775.1	0.0	-4.2	-4.2
4	Present	2050	Average Year	6,936.6	-8.5	6,928.2	0.0	-8.5	-8.5
5	Present	2050	1/5-Dry Year	3,494.4	-8.5	3,486.0	0.0	-8.5	-8.5
6	Present	2050	1/10-Dry Year	2,772.3	-8.5	2,763.9	-18.8	-8.5	-27.3
7	CC RCP8.5-High	2050	Average Year	8,769.0	-8.5	8,760.5	0.0	-8.5	-8.5
8	CC RCP8.5-High	2050	1/5-Dry Year	4,288.4	-8.5	4,279.9	0.0	-8.5	-8.5
9	CC RCP8.5-High	2050	1/10-Dry Year	3,003.4	-8.5	2,995.0	-9.3	-8.5	-17.7
10	CC RCP8.5-Mid.	2050	Average Year	8,616.5	-7.4	8,609.1	0.0	-7.4	-7.4
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	5,147.6	-7.3	5,140.3	0.0	-7.3	-7.3
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	3,280.3	-7.0	3,273.3	0.0	-7.0	-7.0
13	CC RCP8.5-Low	2050	Average Year	6,270.7	-4.9	6,265.8	0.0	-4.9	-4.9
14	CC RCP8.5-Low	2050	1/5-Dry Year	4,710.3	-4.9	4,705.5	0.0	-4.9	-4.9
15	CC RCP8.5-Low	2050	1/10-Dry Year	2,767.7	-8.2	2,759.4	-35.3	-8.2	-43.5

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-426 Surface Water Balance by Province in WRR-XI at Each Climate Change Condition



Source: JICA Survey Team

Figure D-427 Groundwater Balance by Province in WRR-XI at Each Climate Change Condition

11.4.3 WRR-V

Table D-173 Surface and Groundwater Balance of Albay Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Albay Target Year= 2050
Weather Condition: Present Total Area [km2]= 1,922 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	379.4	231.1	203.2	220.4	311.7	208.3	586.8	567.5	611.9	437.4	744.2	556.8	5,058.7	
Surface Water Potential	**285.0**	**185.3**	**181.8**	**177.3**	**161.0**	**137.0**	**231.5**	**325.4**	**357.7**	**262.9**	**486.9**	**380.4**	**3,172.1**	
Irrigation Water Demand (SW)	133.9	112.7	177.3	32.4	164.0	167.8	88.9	81.6	12.7	0.0	0.0	93.1	1,095.6	
Livestock Water Deamnd (SW)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.3	
Municipal and Industrial Water Demand (SW)	8.7	7.9	8.7	8.5	8.7	8.5	8.7	8.7	8.5	8.7	8.5	8.7	102.9	
Other Water Demand (SW)	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.9	
Total Water Demand (SW)	142.9	120.9	186.4	41.2	173.0	176.6	98.0	90.6	21.5	9.1	8.8	102.2	1,202.6	
SW Water Balance	**142.0**	**64.3**	**-4.6**	**136.1**	**-12.1**	**-39.6**	**133.5**	**234.7**	**336.2**	**253.8**	**478.1**	**278.2**	**1,969.6**	**-56.3**
Groundwater Potential	**3.2**	**2.9**	**3.2**	**3.1**	**3.2**	**3.1**	**3.2**	**3.2**	**3.1**	**3.2**	**3.1**	**3.2**	**37.5**	
Safety Groundwater Availability (70% of GWP)	**2.2**	**2.0**	**2.2**	**2.1**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**26.2**	
Irrigation Water Demand (GW)	2.0	1.7	2.6	0.5	2.3	2.3	1.2	1.1	0.2	0.0	0.0	1.4	15.8	
Livestock Water Deamnd (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.6	
Municipal and Industrial Water Demand (GW)	4.3	3.9	4.3	4.2	4.3	4.2	4.3	4.3	4.2	4.3	4.2	4.3	50.8	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (GW)	6.5	5.7	7.1	4.8	6.7	6.7	5.7	5.6	4.5	4.5	4.3	5.8	68.4	
GW Water Balance	**-4.2**	**-3.7**	**-4.9**	**-2.7**	**-4.5**	**-4.5**	**-3.5**	**-3.4**	**-2.4**	**-2.3**	**-2.2**	**-3.6**	**-42.2**	**-41.7**
Total Water Potential (SW+GW)	**287.2**	**187.3**	**184.0**	**179.4**	**163.2**	**139.1**	**233.7**	**327.6**	**359.9**	**265.1**	**489.1**	**382.7**	**3,198.4**	
Irrigation Water Demand (Total)	135.8	114.4	179.9	32.8	166.2	170.1	90.2	82.7	12.9	0.0	0.0	94.5	1,111.3	
Livestock Water Deamnd (Total)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.9	
Municipal and Industrial Water Demand (Total)	13.0	11.8	13.0	12.6	13.0	12.6	13.0	13.0	12.6	13.0	12.6	13.0	153.6	
Other Water Demand (Total)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.1	
Total Water Demand (SW+GW)	149.4	126.6	193.5	46.0	179.8	183.2	103.7	96.3	26.0	13.6	13.1	108.1	1,270.9	
Total Water Balance (SW+GW)	**137.8**	**60.6**	**-9.5**	**133.5**	**-16.6**	**-44.1**	**130.0**	**231.4**	**333.9**	**251.6**	**476.0**	**274.6**	**1,927.4**	**-98.0**

Source: JICA Survey Team

Table D-174 Surface and Groundwater Balance of Camarines Norte Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Camarines Norte Target Year= 2050
Weather Condition: Present Total Area [km2]= 1,633 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	323.5	308.6	366.6	74.9	369.1	368.4	277.9	327.8	183.3	838.5	1,167.8	539.7	5,146.1	
Surface Water Potential	**230.0**	**189.4**	**230.6**	**100.8**	**110.8**	**192.0**	**132.0**	**207.6**	**121.7**	**534.8**	**886.1**	**551.7**	**3,487.5**	
Irrigation Water Demand (SW)	63.9	53.8	67.8	7.9	68.4	28.3	36.3	33.3	0.0	0.0	0.0	34.9	411.8	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.8	
Municipal and Industrial Water Demand (SW)	5.5	4.9	5.5	5.3	5.5	5.3	5.5	5.5	5.3	5.5	5.3	5.5	64.4	
Other Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1	
Total Water Demand (SW)	69.6	59.0	73.5	13.5	74.1	33.9	42.0	39.0	5.5	5.7	5.5	40.6	479.0	
SW Water Balance	**160.4**	**130.4**	**157.0**	**87.4**	**36.7**	**158.1**	**90.0**	**168.6**	**116.1**	**529.1**	**880.6**	**511.2**	**3,008.5**	**0.0**
Groundwater Potential	**2.2**	**2.1**	**2.2**	**2.1**	**2.2**	**2.1**	**2.2**	**2.2**	**2.1**	**2.2**	**2.1**	**2.2**	**26.0**	
Safety Groundwater Availability (70% of GWP)	**1.6**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.6**	**18.2**	
Irrigation Water Demand (GW)	1.6	1.3	1.7	0.2	1.7	0.7	0.9	0.8	0.0	0.0	0.0	0.9	10.3	
Livestock Water Deamnd (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.5	
Municipal and Industrial Water Demand (GW)	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	16.8	
Other Water Demand (GW)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.1	
Total Water Demand (GW)	4.4	3.8	4.5	2.9	4.5	3.4	3.7	3.6	2.7	2.8	2.7	3.6	42.8	
GW Water Balance	**-2.8**	**-2.4**	**-2.9**	**-1.4**	**-2.9**	**-1.9**	**-2.1**	**-2.0**	**-1.2**	**-1.2**	**-1.2**	**-2.1**	**-24.6**	**-24.1**
Total Water Potential (SW+GW)	**231.6**	**190.9**	**232.1**	**102.3**	**112.3**	**193.5**	**133.5**	**209.1**	**123.1**	**536.3**	**887.6**	**553.3**	**3,505.7**	
Irrigation Water Demand (Total)	65.5	55.2	69.5	8.1	70.1	29.0	37.2	34.1	0.0	0.0	0.0	35.7	422.1	
Livestock Water Deamnd (Total)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.3	
Municipal and Industrial Water Demand (Total)	6.9	6.2	6.9	6.7	6.9	6.7	6.9	6.9	6.7	6.9	6.7	6.9	81.2	
Other Water Demand (Total)	1.3	1.2	1.3	1.2	1.3	1.2	1.3	1.3	1.2	1.3	1.2	1.3	15.2	
Total Water Demand (SW+GW)	73.9	62.8	78.0	16.3	78.6	37.2	45.7	42.6	8.2	8.5	8.2	44.2	521.8	
Total Water Balance (SW+GW)	**157.6**	**128.1**	**154.1**	**86.0**	**33.8**	**156.2**	**87.8**	**166.6**	**114.9**	**527.9**	**879.4**	**509.1**	**2,983.9**	**-24.1**

Source: JICA Survey Team

Table D-175 Surface and Groundwater Balance of Camarines Sur Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Camarines Sur Target Year= 2050
Weather Condition: Present Total Area [km2]= 4,055 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	643.0	347.3	408.3	249.3	577.5	407.2	1,081.4	1,225.5	1,343.8	1,082.4	1,762.4	1,251.7	10,379.9	
Surface Water Potential	**594.5**	**431.8**	**365.7**	**251.8**	**209.7**	**201.3**	**388.2**	**785.2**	**1,044.5**	**866.3**	**1,726.6**	**1,204.2**	**8,069.9**	
Irrigation Water Demand (SW)	274.0	293.8	410.6	53.4	272.8	295.9	211.0	225.6	0.0	0.0	0.0	147.5	2,261.8	
Livestock Water Deamnd (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.9	
Municipal and Industrial Water Demand (SW)	5.6	5.1	5.6	5.5	5.6	5.5	5.6	5.6	5.5	5.6	5.5	5.6	66.4	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	
Total Water Demand (SW)	280.1	299.3	416.7	59.3	278.9	301.8	217.1	231.7	5.9	6.1	5.9	153.6	2,333.7	
SW Water Balance	**314.4**	**132.5**	**-51.0**	**192.6**	**-69.2**	**-100.5**	**171.1**	**553.5**	**1,038.6**	**860.2**	**1,720.7**	**1,050.6**	**5,736.2**	**-220.8**
Groundwater Potential	**9.7**	**8.8**	**9.5**	**8.7**	**9.1**	**8.6**	**8.7**	**8.7**	**8.2**	**8.5**	**8.5**	**9.0**	**106.2**	
Safety Groundwater Availability (70% of GWP)	**6.8**	**6.2**	**6.7**	**6.1**	**6.3**	**6.0**	**6.1**	**6.1**	**5.8**	**6.0**	**6.0**	**6.3**	**74.4**	
Irrigation Water Demand (GW)	8.1	8.7	12.2	1.6	8.9	9.6	6.9	7.4	0.0	0.0	0.0	4.4	70.1	
Livestock Water Deamnd (GW)	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.8	
Municipal and Industrial Water Demand (GW)	14.2	12.9	14.2	13.8	14.2	13.8	14.2	14.2	13.8	14.2	13.8	14.2	167.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (GW)	22.9	22.0	26.9	15.9	23.6	23.9	21.6	22.1	14.3	14.7	14.3	19.1	243.6	
GW Water Balance	**-16.1**	**-15.9**	**-20.3**	**-9.7**	**-17.3**	**-17.9**	**-15.5**	**-16.0**	**-8.5**	**-8.8**	**-8.3**	**-12.8**	**-169.3**	**-167.0**
Total Water Potential (SW+GW)	**601.3**	**438.0**	**372.3**	**258.0**	**216.0**	**207.4**	**394.3**	**791.3**	**1,050.3**	**872.3**	**1,732.6**	**1,210.5**	**8,144.2**	
Irrigation Water Demand (Total)	282.1	302.5	422.8	55.0	281.7	305.6	217.9	233.0	0.0	0.0	0.0	151.9	2,331.8	
Livestock Water Deamnd (Total)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.7	
Municipal and Industrial Water Demand (Total)	19.9	18.0	19.9	19.2	19.9	19.2	19.9	19.9	19.2	19.9	19.2	19.9	234.1	
Other Water Demand (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Total Water Demand (SW+GW)	303.0	321.3	443.6	75.1	302.5	325.8	238.7	253.8	20.2	20.8	20.2	172.7	2,577.3	
Total Water Balance (SW+GW)	**298.4**	**116.7**	**-71.3**	**182.8**	**-86.5**	**-118.4**	**155.6**	**537.5**	**1,030.1**	**851.4**	**1,712.4**	**1,037.8**	**5,566.9**	**-387.8**

Source: JICA Survey Team

Table D-176 Surface and Groundwater Balance of Catanduanes Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Catanduanes Target Year= 2050
Weather Condition: Present Total Area [km2]= 943 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	129.0	54.1	51.4	63.4	43.3	145.6	289.0	206.2	221.4	212.4	681.0	615.8	2,712.6	
Surface Water Potential	**148.1**	**99.0**	**85.6**	**71.2**	**55.2**	**45.6**	**67.6**	**63.0**	**78.3**	**70.5**	**214.6**	**348.6**	**1,347.2**	
Irrigation Water Demand (SW)	10.8	7.8	12.6	2.4	11.3	11.4	6.9	9.2	1.3	0.0	0.0	5.5	82.3	
Livestock Water Deamnd (SW)	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	
Municipal and Industrial Water Demand (SW)	2.4	2.2	2.4	2.3	2.4	2.3	2.4	2.4	2.3	2.4	2.3	2.4	28.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	13.2	10.0	15.0	4.7	13.7	13.8	9.4	11.7	3.7	2.4	2.4	7.9	111.0	
SW Water Balance	**134.9**	**88.9**	**70.5**	**66.5**	**41.5**	**31.8**	**58.3**	**51.3**	**74.6**	**68.1**	**212.2**	**340.6**	**1,236.2**	**0.0**
Groundwater Potential	**40.5**	**36.5**	**39.8**	**37.5**	**37.6**	**35.2**	**35.7**	**35.2**	**34.0**	**34.8**	**34.4**	**38.0**	**439.1**	
Safety Groundwater Availability (70% of GWP)	**28.4**	**25.5**	**27.8**	**26.2**	**26.3**	**24.6**	**25.0**	**24.7**	**23.8**	**24.4**	**24.1**	**26.6**	**307.4**	
Irrigation Water Demand (GW)	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.7	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Municipal and Industrial Water Demand (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.9	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.5	0.4	0.5	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	5.0	
GW Water Balance	**27.9**	**25.1**	**27.4**	**25.9**	**25.8**	**24.2**	**24.6**	**24.2**	**23.4**	**24.0**	**23.7**	**26.2**	**302.4**	**0.0**
Total Water Potential (SW+GW)	**176.5**	**124.5**	**113.4**	**97.4**	**81.5**	**70.2**	**92.6**	**87.6**	**102.1**	**94.9**	**238.6**	**375.2**	**1,654.6**	
Irrigation Water Demand (Total)	10.9	7.9	12.7	2.4	11.3	11.5	7.0	9.3	1.3	0.0	0.0	5.5	83.0	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	
Municipal and Industrial Water Demand (Total)	2.7	2.5	2.7	2.6	2.7	2.6	2.7	2.7	2.6	2.7	2.6	2.7	31.9	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	13.7	10.4	15.5	5.1	14.2	14.3	9.8	12.1	4.1	2.8	2.7	8.4	116.0	
Total Water Balance (SW+GW)	**162.8**	**114.1**	**97.9**	**92.3**	**67.3**	**55.9**	**82.8**	**75.5**	**98.0**	**92.1**	**235.9**	**366.8**	**1,538.6**	**0.0**

Source: JICA Survey Team

Table D-177 Surface and Groundwater Balance of Masbate Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Masbate Target Year= 2050
Weather Condition: Present Total Area [km2]= 2,108 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	171.7	132.7	221.7	100.0	333.9	390.9	589.3	536.5	275.4	465.4	448.3	298.8	3,964.5	
Surface Water Potential	**93.4**	**63.3**	**76.3**	**45.2**	**47.7**	**67.9**	**195.9**	**272.7**	**197.4**	**207.1**	**269.7**	**223.0**	**1,759.6**	
Irrigation Water Demand (SW)	60.0	62.0	60.1	11.2	53.0	46.5	38.6	38.6	2.8	0.0	0.0	43.6	424.7	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	
Municipal and Industrial Water Demand (SW)	5.2	4.7	5.2	5.0	5.2	5.0	5.2	5.2	5.0	5.2	5.0	5.2	60.9	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	65.3	66.8	65.4	16.3	58.3	51.5	43.8	43.9	7.9	5.3	5.1	48.9	486.6	
SW Water Balance	**28.1**	**-3.5**	**10.9**	**29.0**	**-10.6**	**16.3**	**152.1**	**228.8**	**189.6**	**201.8**	**264.6**	**174.1**	**1,273.0**	**-14.0**
Groundwater Potential	**1.7**	**1.5**	**1.7**	**1.6**	**1.6**	**1.6**	**1.7**	**1.7**	**1.6**	**1.6**	**1.6**	**1.7**	**19.5**	
Safety Groundwater Availability (70% of GWP)	**1.2**	**1.1**	**1.2**	**1.1**	**1.1**	**1.1**	**1.2**	**1.2**	**1.1**	**1.1**	**1.1**	**1.2**	**13.6**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (GW)	1.9	1.7	1.9	1.8	1.9	1.8	1.9	1.9	1.8	1.9	1.8	1.9	21.9	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	1.9	1.7	1.9	1.8	1.9	1.8	1.9	1.9	1.8	1.9	1.8	1.9	22.1	
GW Water Balance	**-0.7**	**-0.6**	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-8.5**	**-8.5**
Total Water Potential (SW+GW)	**94.6**	**64.4**	**77.5**	**46.3**	**48.8**	**69.0**	**197.1**	**273.9**	**198.6**	**208.2**	**270.8**	**224.2**	**1,773.3**	
Irrigation Water Demand (Total)	60.0	62.0	60.1	11.2	53.0	46.5	38.6	38.6	2.8	0.0	0.0	43.6	424.7	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.3	
Municipal and Industrial Water Demand (Total)	7.0	6.4	7.0	6.8	7.0	6.8	7.0	7.0	6.8	7.0	6.8	7.0	82.8	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	67.2	68.5	67.3	18.1	60.1	53.4	45.7	45.8	9.7	7.1	6.9	50.8	508.8	
Total Water Balance (SW+GW)	**27.4**	**-4.1**	**10.2**	**28.2**	**-11.3**	**15.6**	**151.4**	**228.1**	**188.8**	**201.1**	**263.9**	**173.4**	**1,264.5**	**-22.5**

Source: JICA Survey Team

Table D-178 Surface and Groundwater Balance of Quezon Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Quezon Target Year= 2050
Weather Condition: Present Total Area [km2]= 309 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	120.6	14.7	39.9	46.5	35.2	72.1	180.8	44.6	104.6	71.2	52.3	148.0	930.5	
Surface Water Potential	**161.9**	**29.0**	**21.3**	**16.5**	**25.1**	**39.8**	**151.7**	**47.3**	**86.7**	**69.5**	**45.3**	**141.4**	**835.5**	
Irrigation Water Demand (SW)	3.0	3.0	1.1	0.0	2.7	2.4	1.6	3.2	0.0	0.0	1.6	1.5	21.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Municipal and Industrial Water Demand (SW)	3.0	2.7	3.0	2.9	3.0	2.9	3.0	3.0	2.9	3.0	2.9	3.0	34.8	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	6.0	5.7	4.1	2.9	5.7	5.3	4.6	6.2	2.9	3.0	4.5	4.5	56.2	
SW Water Balance	**155.9**	**23.3**	**17.3**	**13.6**	**19.4**	**34.4**	**147.1**	**41.1**	**83.8**	**66.5**	**40.8**	**136.8**	**779.3**	**0.0**
Groundwater Potential	**1.7**	**1.6**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**20.4**	
Safety Groundwater Availability (70% of GWP)	**1.2**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**14.3**	
Irrigation Water Demand (GW)	0.2	0.2	0.1	0.0	0.2	0.1	0.1	0.2	0.0	0.0	0.1	0.1	1.3	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.9	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.3	0.3	0.2	0.1	0.3	0.2	0.2	0.3	0.1	0.1	0.2	0.2	2.4	
GW Water Balance	**0.9**	**0.8**	**1.0**	**1.1**	**1.0**	**0.9**	**1.0**	**0.9**	**1.1**	**1.1**	**1.0**	**1.0**	**11.9**	**0.0**
Total Water Potential (SW+GW)	**163.2**	**30.1**	**22.5**	**17.7**	**26.3**	**40.9**	**152.9**	**48.5**	**87.9**	**70.7**	**46.4**	**142.6**	**849.8**	
Irrigation Water Demand (Total)	3.2	3.2	1.1	0.0	2.9	2.6	1.7	3.4	0.0	0.0	1.7	1.6	22.3	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (Total)	3.0	2.7	3.0	2.9	3.0	2.9	3.0	3.0	2.9	3.0	2.9	3.0	35.7	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	6.3	6.0	4.2	3.0	6.0	5.5	4.8	6.5	3.0	3.1	4.7	4.7	58.7	
Total Water Balance (SW+GW)	**156.8**	**24.1**	**18.3**	**14.7**	**20.4**	**35.4**	**148.1**	**42.0**	**84.9**	**67.7**	**41.8**	**137.9**	**791.1**	**0.0**

Source: JICA Survey Team

Table D-179 Surface and Groundwater Balance of Sorsogon Province in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Province: Sorsogon Target Year= 2050
Weather Condition: Present Total Area [km2]= 1,220 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	238.9	156.3	126.0	115.7	110.7	106.7	361.2	300.2	308.6	253.6	434.7	440.2	2,952.8	
Surface Water Potential	**182.8**	**103.6**	**85.4**	**61.4**	**48.2**	**37.3**	**96.9**	**184.7**	**190.1**	**151.7**	**335.2**	**299.5**	**1,776.7**	
Irrigation Water Demand (SW)	37.1	41.1	49.7	8.2	34.9	30.7	25.0	26.7	0.5	0.0	0.0	36.0	294.9	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.6	
Municipal and Industrial Water Demand (SW)	3.3	3.0	3.3	3.2	3.3	3.2	3.3	3.3	3.2	3.3	3.2	3.3	39.3	
Other Water Demand (SW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	4.0	
Total Water Demand (SW)	40.9	44.5	53.5	11.9	38.8	34.4	28.8	30.5	4.2	3.8	3.7	39.8	339.8	
SW Water Balance	**141.9**	**59.1**	**31.9**	**49.5**	**9.4**	**2.9**	**68.1**	**154.2**	**185.9**	**147.9**	**331.5**	**259.7**	**1,436.9**	**0.0**
Groundwater Potential	**5.9**	**5.3**	**5.8**	**5.6**	**5.8**	**5.6**	**5.8**	**5.8**	**5.6**	**5.8**	**5.7**	**5.8**	**68.5**	
Safety Groundwater Availability (70% of GWP)	**4.1**	**3.7**	**4.1**	**3.9**	**4.1**	**3.9**	**4.1**	**4.1**	**3.9**	**4.1**	**4.0**	**4.1**	**47.9**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Municipal and Industrial Water Demand (GW)	4.8	4.3	4.8	4.6	4.8	4.6	4.8	4.8	4.6	4.8	4.6	4.8	56.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (GW)	4.8	4.4	4.8	4.7	4.8	4.7	4.8	4.8	4.7	4.8	4.7	4.8	56.8	
GW Water Balance	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.7**	**-0.8**	**-0.7**	**-0.7**	**-8.8**	**-8.8**
Total Water Potential (SW+GW)	**186.9**	**107.3**	**89.4**	**65.4**	**52.2**	**41.2**	**100.9**	**188.8**	**194.0**	**155.8**	**339.1**	**303.6**	**1,824.6**	
Irrigation Water Demand (Total)	37.1	41.1	49.7	8.2	34.9	30.7	25.0	26.7	0.5	0.0	0.0	36.0	294.9	
Livestock Water Deamnd (Total)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.1	
Municipal and Industrial Water Demand (Total)	8.1	7.3	8.1	7.8	8.1	7.8	8.1	8.1	7.8	8.1	7.8	8.1	95.4	
Other Water Demand (Total)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	4.0	
Total Water Demand (SW+GW)	45.7	48.9	58.3	16.6	43.6	39.0	33.6	35.3	8.9	8.6	8.4	44.6	396.6	
Total Water Balance (SW+GW)	**141.2**	**58.4**	**31.1**	**48.8**	**8.6**	**2.2**	**67.3**	**153.5**	**185.2**	**147.1**	**330.8**	**259.0**	**1,428.0**	**-8.8**

Source: JICA Survey Team

Table D-180 Summary of Annual Water Balance and Deficit of Albay Province at Each Climate Change Condition

Total Area [km^2]= 1,922

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	2,545.3	-22.6	2,522.7	-1.7	-22.4	-24.0
2	Present	2020	1/5-Dry Year	2,557.7	-22.5	2,535.3	0.0	-22.2	-22.2
3	Present	2020	1/10-Dry Year	2,053.4	-22.6	2,030.8	0.0	-22.3	-22.3
4	Present	2050	Average Year	1,957.1	-42.3	1,914.9	-258.9	-41.8	-300.7
5	Present	2050	1/5-Dry Year	1,969.6	-42.2	1,927.4	-56.3	-41.7	-98.0
6	Present	2050	1/10-Dry Year	1,465.2	-42.2	1,423.0	-226.9	-41.8	-268.7
7	CC RCP8.5-High	2050	Average Year	2,501.4	-42.2	2,459.2	-155.9	-41.7	-197.6
8	CC RCP8.5-High	2050	1/5-Dry Year	2,718.0	-42.1	2,675.9	-13.9	-41.6	-55.5
9	CC RCP8.5-High	2050	1/10-Dry Year	2,026.2	-42.2	1,984.0	-183.2	-41.7	-224.9
10	CC RCP8.5-Mid.	2050	Average Year	1,995.8	-42.3	1,953.6	-261.8	-41.8	-303.6
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,972.2	-42.2	1,930.0	-61.4	-41.7	-103.1
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,462.5	-42.2	1,420.2	-229.3	-41.8	-271.1
13	CC RCP8.5-Low	2050	Average Year	1,252.5	-42.4	1,210.1	-384.0	-41.9	-425.9
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,372.7	-42.2	1,330.5	-147.7	-41.8	-189.4
15	CC RCP8.5-Low	2050	1/10-Dry Year	1,020.8	-42.3	978.5	-277.8	-41.8	-319.6

Source: JICA Survey Team

Table D-181 Summary of Annual Water Balance and Deficit of Camarines Norte Province at Each Climate Change Condition

Total Area [km^2]= 1,633

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	4,192.2	-9.0	4,183.2	0.0	-8.9	-8.9
2	Present	2020	1/5-Dry Year	3,299.8	-9.0	3,290.8	0.0	-8.8	-8.8
3	Present	2020	1/10-Dry Year	2,947.1	-9.1	2,938.0	0.0	-8.9	-8.9
4	Present	2050	Average Year	3,900.9	-24.6	3,876.3	-6.2	-24.2	-30.4
5	Present	2050	1/5-Dry Year	3,008.5	-24.6	2,983.9	0.0	-24.1	-24.1
6	Present	2050	1/10-Dry Year	2,655.8	-24.7	2,631.1	-21.0	-24.2	-45.3
7	CC RCP8.5-High	2050	Average Year	4,701.5	-24.6	4,676.9	0.0	-24.2	-24.2
8	CC RCP8.5-High	2050	1/5-Dry Year	3,802.8	-24.5	3,778.3	0.0	-24.1	-24.1
9	CC RCP8.5-High	2050	1/10-Dry Year	3,183.2	-24.6	3,158.6	-18.4	-24.2	-42.6
10	CC RCP8.5-Mid.	2050	Average Year	3,999.2	-24.6	3,974.6	-6.9	-24.2	-31.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	3,076.4	-24.6	3,051.8	0.0	-24.1	-24.1
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2,687.8	-24.7	2,663.1	-22.6	-24.2	-46.8
13	CC RCP8.5-Low	2050	Average Year	3,304.3	-24.6	3,279.7	-14.2	-24.2	-38.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	2,291.2	-24.6	2,266.6	0.0	-24.2	-24.2
15	CC RCP8.5-Low	2050	1/10-Dry Year	2,069.9	-24.7	2,045.2	-31.0	-24.3	-55.2

Source: JICA Survey Team

Table D-182 Summary of Annual Water Balance and Deficit of Camarines Sur Province at Each Climate Change Condition

Total Area [km^2]= 4,055

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	9,169.2	-75.6	9,093.6	0.0	-74.6	-74.6
2	Present	2020	1/5-Dry Year	7,139.9	-76.4	7,063.5	0.0	-75.4	-75.4
3	Present	2020	1/10-Dry Year	6,365.4	-76.0	6,289.4	0.0	-75.0	-75.0
4	Present	2050	Average Year	7,765.5	-168.5	7,597.0	0.0	-166.2	-166.2
5	Present	2050	1/5-Dry Year	5,736.2	-169.3	5,566.9	-220.8	-167.0	-387.8
6	Present	2050	1/10-Dry Year	4,961.8	-169.0	4,792.8	-250.4	-166.7	-417.0
7	CC RCP8.5-High	2050	Average Year	9,146.1	-163.7	8,982.4	0.0	-161.4	-161.4
8	CC RCP8.5-High	2050	1/5-Dry Year	6,672.4	-165.0	6,507.4	-118.5	-162.7	-281.3
9	CC RCP8.5-High	2050	1/10-Dry Year	6,151.9	-164.9	5,987.0	-180.6	-162.6	-343.2
10	CC RCP8.5-Mid.	2050	Average Year	7,763.1	-178.9	7,584.2	0.0	-176.6	-176.6
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	5,593.1	-179.6	5,413.6	-205.9	-177.3	-383.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	5,135.9	-179.2	4,956.7	-251.8	-176.9	-428.7
13	CC RCP8.5-Low	2050	Average Year	5,397.1	-180.2	5,216.9	-83.1	-177.9	-261.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	3,469.2	-180.7	3,288.5	-370.2	-178.4	-548.6
15	CC RCP8.5-Low	2050	1/10-Dry Year	3,075.6	-180.3	2,895.3	-441.9	-178.0	-619.9

Source: JICA Survey Team

Table D-183 Summary of Annual Water Balance and Deficit of Catanduanes Province at Each Climate Change Condition

Total Area [km^2]= 943

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	1,830.7	318.3	2,149.0	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	1,280.1	304.1	1,584.2	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	1,167.6	308.4	1,476.0	0.0	0.0	0.0
4	Present	2050	Average Year	1,786.8	316.6	2,103.4	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	1,236.2	302.4	1,538.6	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	1,123.7	306.7	1,430.4	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	2,220.0	322.9	2,542.9	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	1,447.5	306.8	1,754.4	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	1,395.5	314.3	1,709.8	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	1,803.1	316.8	2,119.9	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,213.4	300.9	1,514.3	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,118.1	306.4	1,424.5	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	1,567.7	314.6	1,882.3	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,039.2	301.1	1,340.3	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	1,065.2	305.0	1,370.1	0.0	0.0	0.0

Source: JICA Survey Team

Table D-184 Summary of Annual Water Balance and Deficit of Masbate Province at Each Climate Change Condition

Total Area [km^2]= 2,108

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	3,142.0	-4.0	3,138.0	0.0	-4.0	-4.0
2	Present	2020	1/5-Dry Year	1,621.4	-3.7	1,617.7	0.0	-3.7	-3.7
3	Present	2020	1/10-Dry Year	1,914.2	-4.4	1,909.8	0.0	-4.4	-4.4
4	Present	2050	Average Year	2,793.6	-8.8	2,784.8	0.0	-8.8	-8.8
5	Present	2050	1/5-Dry Year	1,273.0	-8.5	1,264.5	-14.0	-8.5	-22.5
6	Present	2050	1/10-Dry Year	1,565.8	-9.2	1,556.6	-14.1	-9.2	-23.2
7	CC RCP8.5-High	2050	Average Year	3,376.9	-8.2	3,368.7	0.0	-8.2	-8.2
8	CC RCP8.5-High	2050	1/5-Dry Year	1,617.7	-8.4	1,609.4	-3.2	-8.4	-11.5
9	CC RCP8.5-High	2050	1/10-Dry Year	1,854.3	-8.3	1,846.0	-10.5	-8.3	-18.9
10	CC RCP8.5-Mid.	2050	Average Year	2,834.4	-9.0	2,825.4	0.0	-9.0	-9.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,069.1	-8.6	1,060.5	-16.3	-8.6	-24.8
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,428.6	-9.2	1,419.4	-16.1	-9.2	-25.3
13	CC RCP8.5-Low	2050	Average Year	2,060.9	-9.0	2,051.9	0.0	-9.0	-9.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	718.8	-9.4	709.4	-18.5	-9.4	-27.9
15	CC RCP8.5-Low	2050	1/10-Dry Year	907.7	-9.4	898.3	-25.1	-9.4	-34.5

Source: JICA Survey Team

Table D-185 Summary of Annual Water Balance and Deficit of Quezon Province at Each Climate Change Condition

Total Area [km^2]= 309

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	924.3	12.7	937.0	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	793.3	12.7	806.0	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	660.9	12.7	673.6	0.0	0.0	0.0
4	Present	2050	Average Year	910.2	11.9	922.1	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	779.3	11.9	791.1	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	646.8	11.9	658.7	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	1,197.6	11.9	1,209.5	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	1,047.0	11.9	1,058.9	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	879.3	11.9	891.2	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	944.9	11.9	956.8	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	793.0	11.9	804.9	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	651.6	11.8	663.5	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	756.2	11.9	768.1	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	576.0	11.8	587.9	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	473.5	11.8	485.3	0.0	0.0	0.0

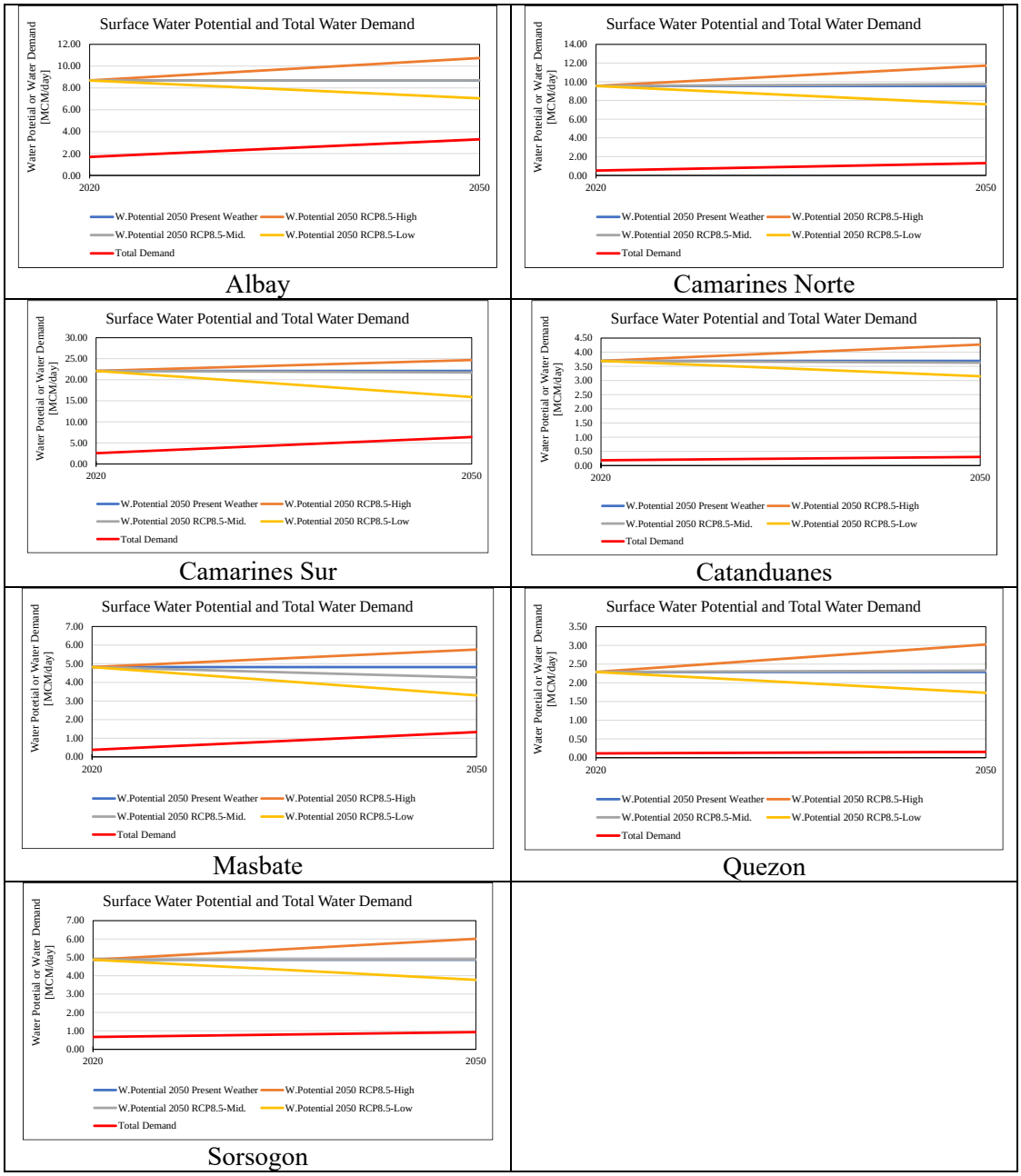
Source: JICA Survey Team

Table D-186 Summary of Annual Water Balance and Deficit of Sorsogon Province at Each Climate Change Condition

Total Area [km^2]= 1,220

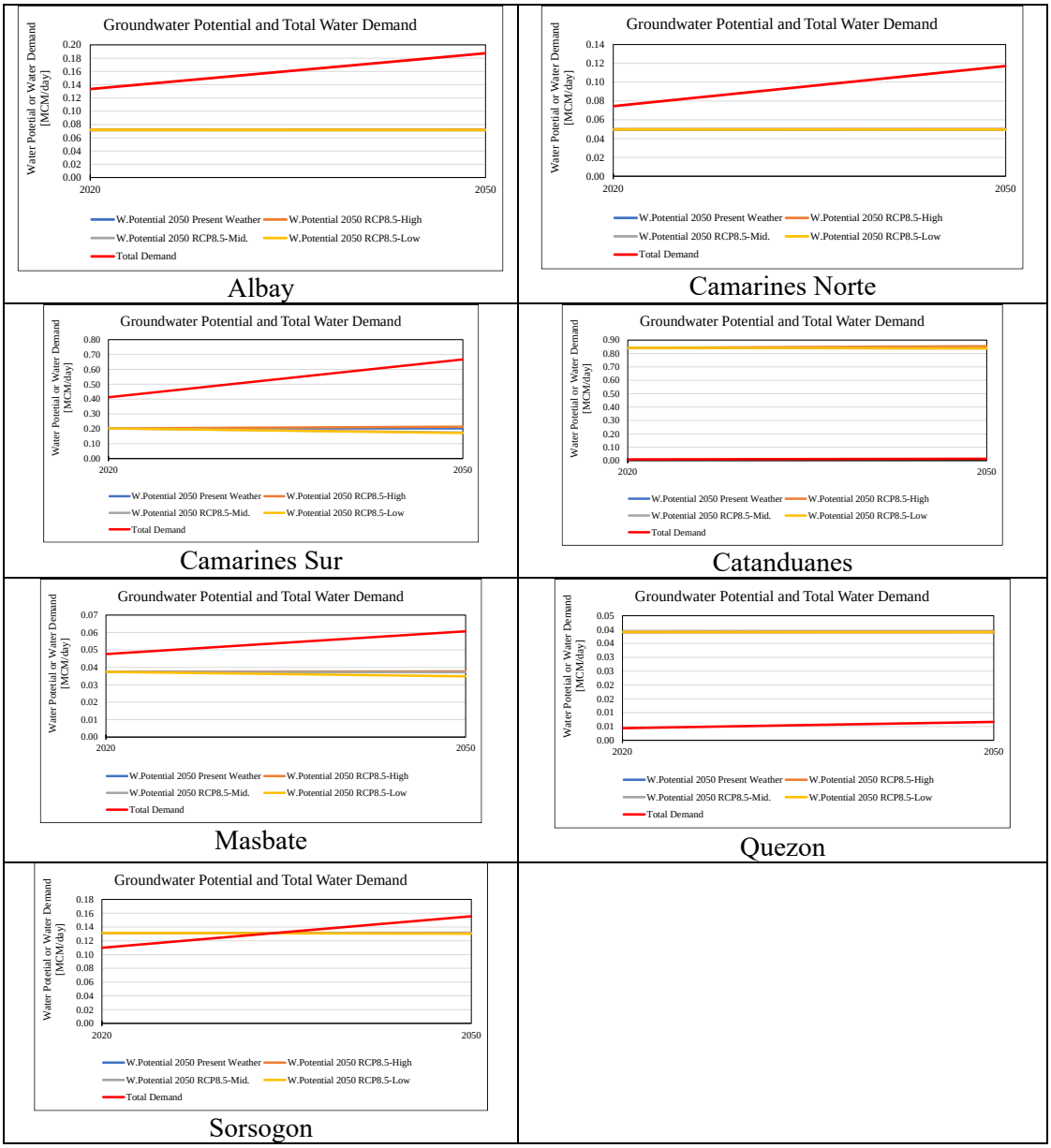
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	2,059.4	7.6	2,067.0	-0.8	0.0	-0.8
2	Present	2020	1/5-Dry Year	1,532.8	7.8	1,540.6	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	1,468.3	7.3	1,475.5	-7.0	0.0	-7.0
4	Present	2050	Average Year	1,963.5	-9.0	1,954.5	-16.7	-9.0	-25.7
5	Present	2050	1/5-Dry Year	1,436.9	-8.8	1,428.0	0.0	-8.8	-8.8
6	Present	2050	1/10-Dry Year	1,372.4	-9.4	1,363.0	-42.7	-9.4	-52.1
7	CC RCP8.5-High	2050	Average Year	2,203.9	-8.9	2,195.0	-3.8	-8.9	-12.6
8	CC RCP8.5-High	2050	1/5-Dry Year	1,852.3	-8.7	1,843.6	0.0	-8.7	-8.7
9	CC RCP8.5-High	2050	1/10-Dry Year	1,714.6	-9.1	1,705.4	-17.9	-9.1	-27.1
10	CC RCP8.5-Mid.	2050	Average Year	1,927.4	-9.0	1,918.4	-15.3	-9.0	-24.3
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,443.6	-8.8	1,434.8	0.0	-8.8	-8.8
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,367.8	-9.4	1,358.5	-41.5	-9.4	-50.9
13	CC RCP8.5-Low	2050	Average Year	1,591.9	-9.3	1,582.6	-23.7	-9.3	-33.1
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,039.3	-9.2	1,030.1	-1.3	-9.2	-10.5
15	CC RCP8.5-Low	2050	1/10-Dry Year	894.7	-9.9	884.7	-56.5	-9.9	-66.4

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-428 Surface Water Balance by Province in WRR-V at Each Climate Change Condition

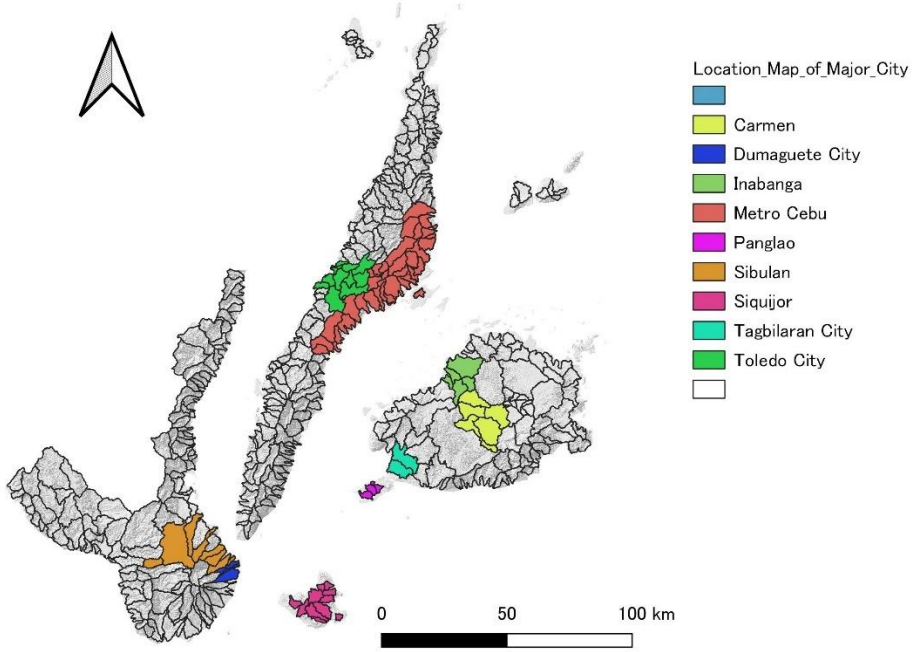


Source: JICA Survey Team

Figure D-429 Groundwater Balance by Province in WRR-V at Each Climate Change Condition

11.5 Data and Results of Major City/Town-wise Water Balance

11.5.1 WRR-VII



Source: JICA Survey Team

Figure D-430 Location Map of Major Cities in WRR-VII

Table D-187 Surface and Groundwater Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Metro Cebu Target Year= 2050
Weather Condition: Present Total Area [km2]= 829 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	45.3	66.1	68.3	21.9	144.7	162.0	171.4	135.2	110.4	127.3	62.6	62.6	1,177.9	
Surface Water Potential	**35.6**	**32.3**	**32.3**	**19.6**	**29.1**	**31.5**	**31.5**	**33.7**	**27.6**	**35.2**	**22.3**	**22.2**	**352.9**	
Irrigation Water Demand (SW)	4.6	2.0	0.0	0.0	0.8	4.1	3.1	4.0	1.7	0.6	4.1	3.7	28.6	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	4.6	4.2	4.6	4.4	4.6	4.4	4.6	4.6	4.4	4.6	4.4	4.6	54.1	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	9.2	6.1	4.6	4.5	5.4	8.5	7.7	8.6	6.1	5.2	8.6	8.3	82.8	
SW Water Balance	**26.4**	**26.1**	**27.7**	**15.1**	**23.7**	**22.9**	**23.8**	**25.2**	**21.5**	**30.1**	**13.7**	**13.9**	**270.1**	**0.0**
Groundwater Potential	**23.3**	**21.9**	**23.3**	**22.4**	**22.8**	**21.8**	**22.3**	**22.3**	**21.6**	**22.4**	**21.7**	**22.2**	**268.1**	
Safety Groundwater Availability (70% of GWP)	**16.3**	**15.3**	**16.3**	**15.7**	**16.0**	**15.3**	**15.6**	**15.6**	**15.1**	**15.7**	**15.2**	**15.5**	**187.6**	
Irrigation Water Demand (GW)	2.2	0.9	0.0	0.0	0.5	2.4	1.7	2.3	0.9	0.4	1.9	1.8	14.9	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (GW)	37.1	33.5	37.1	35.9	37.1	35.9	37.1	37.1	35.9	37.1	35.9	37.1	436.6	
Other Water Demand (GW)	17.4	15.7	17.4	16.9	17.4	16.9	17.4	17.4	16.9	17.4	16.9	17.4	205.0	
Total Water Demand (GW)	56.7	50.2	54.5	52.8	55.0	55.2	56.2	56.8	53.6	54.9	54.7	56.3	656.9	
GW Water Balance	**-40.4**	**-34.9**	**-38.2**	**-37.1**	**-39.0**	**-39.9**	**-40.6**	**-41.2**	**-38.5**	**-39.2**	**-39.5**	**-40.8**	**-469.3**	**-469.3**
Total Water Potential (SW+GW)	**52.0**	**47.6**	**48.6**	**35.2**	**45.0**	**46.7**	**47.2**	**49.4**	**42.7**	**50.9**	**37.4**	**37.7**	**540.5**	
Irrigation Water Demand (Total)	6.7	2.9	0.0	0.0	1.3	6.5	4.8	6.3	2.5	0.9	6.1	5.5	43.5	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Municipal and Industrial Water Demand (Total)	41.7	37.6	41.7	40.3	41.7	40.3	41.7	41.7	40.3	41.7	40.3	41.7	490.8	
Other Water Demand (Total)	17.4	15.7	17.4	16.9	17.4	16.9	17.4	17.4	16.9	17.4	16.9	17.4	205.0	
Total Water Demand (SW+GW)	65.9	56.3	59.1	57.2	60.4	63.7	63.9	65.4	59.7	60.1	63.3	64.7	739.7	
Total Water Balance (SW+GW)	**-13.9**	**-8.7**	**-10.5**	**-22.0**	**-15.3**	**-17.0**	**-16.8**	**-16.0**	**-17.0**	**-9.1**	**-25.8**	**-26.9**	**-199.2**	**-469.3**

Source: JICA Survey Team

Table D-188 Surface and Groundwater Balance of Toledo City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Toledo City Target Year= 2050
Weather Condition: Present Total Area [km2]= 272 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	11.6	19.4	19.9	7.4	52.5	60.6	65.5	48.2	37.9	40.4	21.7	22.2	407.4	
Surface Water Potential	**14.2**	**12.6**	**11.2**	**7.2**	**9.5**	**11.0**	**12.0**	**12.7**	**10.6**	**12.5**	**8.3**	**8.4**	**130.1**	
Irrigation Water Demand (SW)	1.6	0.7	0.0	0.0	0.3	1.5	1.1	1.4	0.6	0.2	1.5	1.3	10.2	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	2.0	1.1	0.4	0.4	0.7	1.8	1.5	1.8	1.0	0.6	1.9	1.7	14.9	
SW Water Balance	**12.1**	**11.5**	**10.8**	**6.9**	**8.9**	**9.1**	**10.5**	**10.8**	**9.6**	**11.9**	**6.4**	**6.6**	**115.1**	**0.0**
Groundwater Potential	**7.5**	**7.0**	**7.5**	**7.3**	**7.5**	**7.2**	**7.5**	**7.5**	**7.2**	**7.5**	**7.2**	**7.5**	**88.5**	
Safety Groundwater Availability (70% of GWP)	**5.3**	**4.9**	**5.3**	**5.1**	**5.2**	**5.1**	**5.2**	**5.2**	**5.1**	**5.2**	**5.1**	**5.2**	**61.9**	
Irrigation Water Demand (GW)	0.2	0.1	0.0	0.0	0.0	0.2	0.1	0.2	0.1	0.0	0.2	0.1	1.2	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	3.6	3.2	3.6	3.4	3.6	3.4	3.6	3.6	3.4	3.6	3.4	3.6	41.9	
Other Water Demand (GW)	3.5	3.2	3.5	3.4	3.5	3.4	3.5	3.5	3.4	3.5	3.4	3.5	41.1	
Total Water Demand (GW)	7.2	6.4	7.1	6.8	7.1	7.0	7.2	7.2	6.9	7.1	7.0	7.2	84.3	
GW Water Balance	**-2.0**	**-1.5**	**-1.8**	**-1.7**	**-1.8**	**-2.0**	**-2.0**	**-2.0**	**-1.8**	**-1.8**	**-1.9**	**-2.0**	**-22.3**	**-22.3**
Total Water Potential (SW+GW)	**19.4**	**17.5**	**16.5**	**12.3**	**14.8**	**16.0**	**17.3**	**17.9**	**15.6**	**17.7**	**13.3**	**13.6**	**192.0**	
Irrigation Water Demand (Total)	1.8	0.8	0.0	0.0	0.3	1.7	1.2	1.6	0.7	0.2	1.6	1.5	11.4	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	4.0	3.6	4.0	3.8	4.0	3.8	4.0	4.0	3.8	4.0	3.8	4.0	46.6	
Other Water Demand (Total)	3.5	3.2	3.5	3.4	3.5	3.4	3.5	3.5	3.4	3.5	3.4	3.5	41.1	
Total Water Demand (SW+GW)	9.3	7.5	7.5	7.2	7.8	8.9	8.7	9.1	7.9	7.7	8.9	8.9	99.2	
Total Water Balance (SW+GW)	**10.2**	**10.0**	**9.0**	**5.1**	**7.0**	**7.2**	**8.6**	**8.8**	**7.8**	**10.0**	**4.5**	**4.6**	**92.8**	**-22.3**

Source: JICA Survey Team

Table D-189 Surface and Groundwater Balance of Tagbilaran City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Tagbilaran City Target Year= 2050
Weather Condition: Present Total Area [km2]= 105 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	9.1	8.7	25.2	4.1	8.5	16.9	15.6	17.0	11.2	14.3	8.9	6.8	146.3	
Surface Water Potential	**1.7**	**1.7**	**6.5**	**0.8**	**0.5**	**2.6**	**2.7**	**3.0**	**2.2**	**2.8**	**1.2**	**1.2**	**27.0**	
Irrigation Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.8	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	6.2	
SW Water Balance	**1.2**	**1.3**	**6.0**	**0.3**	**-0.0**	**2.1**	**2.1**	**2.5**	**1.7**	**2.3**	**0.7**	**0.6**	**20.8**	**-0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	2.5	2.3	2.5	2.4	2.5	2.4	2.5	2.5	2.4	2.5	2.4	2.5	29.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (GW)	2.5	2.3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	29.8	
GW Water Balance	**-2.5**	**-2.3**	**-2.5**	**-2.4**	**-2.5**	**-2.4**	**-2.5**	**-2.5**	**-2.4**	**-2.5**	**-2.4**	**-2.5**	**-29.8**	**-29.8**
Total Water Potential (SW+GW)	**1.7**	**1.8**	**6.5**	**0.8**	**0.5**	**2.6**	**2.7**	**3.0**	**2.2**	**2.9**	**1.2**	**1.2**	**27.0**	
Irrigation Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	3.0	2.7	3.0	2.9	3.0	2.9	3.0	3.0	2.9	3.0	2.9	3.0	35.5	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (SW+GW)	3.1	2.8	3.0	2.9	3.0	2.9	3.1	3.1	3.0	3.0	3.0	3.1	36.0	
Total Water Balance (SW+GW)	**-1.3**	**-1.0**	**3.4**	**-2.1**	**-2.6**	**-0.3**	**-0.4**	**-0.1**	**-0.8**	**-0.2**	**-1.8**	**-1.9**	**-9.0**	**-29.8**

Source: JICA Survey Team

Table D-190 Surface and Groundwater Balance of Panglao City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Panglao Target Year= 2050
Weather Condition: Present Total Area [km2]= 32 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	2.6	2.3	7.7	1.3	2.4	5.3	3.7	4.2	2.7	4.1	2.4	1.2	40.0	
Surface Water Potential	**0.2**	**0.3**	**2.0**	**0.1**	**0.0**	**0.4**	**0.3**	**0.4**	**0.2**	**0.5**	**0.1**	**0.0**	**4.5**	
Irrigation Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SW Water Balance	**0.2**	**0.3**	**2.0**	**0.1**	**0.0**	**0.4**	**0.3**	**0.4**	**0.2**	**0.5**	**0.1**	**0.0**	**4.5**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	1.4	1.3	1.4	1.3	1.4	1.3	1.4	1.4	1.3	1.4	1.3	1.4	16.4	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Total Water Demand (GW)	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	16.8	
GW Water Balance	**-1.4**	**-1.3**	**-1.4**	**-1.4**	**-1.4**	**-1.4**	**-1.4**	**-1.4**	**-1.4**	**-1.4**	**-1.4**	**-1.4**	**-16.8**	**-16.8**
Total Water Potential (SW+GW)	**0.2**	**0.3**	**2.0**	**0.1**	**0.0**	**0.4**	**0.3**	**0.4**	**0.2**	**0.5**	**0.1**	**0.0**	**4.5**	
Irrigation Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	1.4	1.3	1.4	1.3	1.4	1.3	1.4	1.4	1.3	1.4	1.3	1.4	16.4	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Total Water Demand (SW+GW)	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	16.8	
Total Water Balance (SW+GW)	**-1.2**	**-1.0**	**0.5**	**-1.3**	**-1.4**	**-1.0**	**-1.1**	**-1.0**	**-1.1**	**-1.0**	**-1.2**	**-1.4**	**-12.3**	**-16.8**

Source: JICA Survey Team

Table D-191 Surface and Groundwater Balance of Carmen City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Carmen Target Year= 2050
Weather Condition: Present Total Area [km2]= 299 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	38.5	35.7	85.4	6.0	24.8	71.8	59.6	71.4	45.6	38.5	16.2	12.4	505.8	
Surface Water Potential	**15.1**	**15.9**	**32.4**	**11.3**	**6.6**	**18.0**	**22.0**	**27.2**	**24.2**	**17.1**	**7.7**	**6.5**	**204.0**	
Irrigation Water Demand (SW)	1.2	0.6	0.3	0.0	0.2	0.5	1.3	1.2	0.7	0.4	1.2	1.6	9.2	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Municipal and Industrial Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.4	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.3	0.8	0.5	0.2	0.3	0.6	1.4	1.4	0.8	0.5	1.4	1.8	11.0	
SW Water Balance	**13.8**	**15.1**	**31.9**	**11.1**	**6.3**	**17.3**	**20.6**	**25.8**	**23.4**	**16.6**	**6.3**	**4.8**	**193.0**	**0.0**
Groundwater Potential	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.6**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.8	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	4.1	
GW Water Balance	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-3.7**	**-3.7**
Total Water Potential (SW+GW)	**15.2**	**15.9**	**32.4**	**11.3**	**6.6**	**18.0**	**22.0**	**27.2**	**24.2**	**17.2**	**7.8**	**6.6**	**204.4**	
Irrigation Water Demand (Total)	1.2	0.6	0.3	0.0	0.2	0.5	1.3	1.2	0.7	0.4	1.2	1.6	9.2	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (Total)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	1.7	1.1	0.8	0.5	0.7	1.0	1.8	1.7	1.2	0.9	1.7	2.1	15.1	
Total Water Balance (SW+GW)	**13.5**	**14.8**	**31.6**	**10.8**	**6.0**	**17.0**	**20.3**	**25.5**	**23.1**	**16.3**	**6.0**	**4.4**	**189.3**	**-3.7**

Source: JICA Survey Team

Table D-192 Surface and Groundwater Balance of Inabanga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Inabanga Target Year= 2050
Weather Condition: Present Total Area [km2]= 171 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	18.9	18.2	43.6	3.5	13.1	41.9	30.2	38.4	26.8	21.3	7.2	7.4	270.3	
Surface Water Potential	**10.3**	**11.7**	**17.9**	**7.0**	**3.9**	**10.3**	**12.4**	**17.3**	**16.2**	**11.0**	**5.0**	**4.5**	**127.4**	
Irrigation Water Demand (SW)	0.2	0.1	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0.0	0.2	0.2	1.2	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.3	1.9	
SW Water Balance	**10.0**	**11.5**	**17.8**	**6.9**	**3.8**	**10.1**	**12.2**	**17.1**	**16.0**	**10.9**	**4.7**	**4.3**	**125.5**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.8	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.8	
GW Water Balance	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-4.7**	**-4.7**
Total Water Potential (SW+GW)	**10.3**	**11.7**	**17.9**	**7.0**	**3.9**	**10.3**	**12.4**	**17.3**	**16.2**	**11.0**	**5.0**	**4.5**	**127.5**	
Irrigation Water Demand (Total)	0.2	0.1	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0.0	0.2	0.2	1.2	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.5	0.4	0.5	0.4	0.5	0.4	0.5	0.5	0.4	0.5	0.4	0.5	5.4	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	0.6	0.5	0.5	0.4	0.5	0.5	0.6	0.6	0.5	0.5	0.6	0.7	6.7	
Total Water Balance (SW+GW)	**9.7**	**11.2**	**17.4**	**6.5**	**3.5**	**9.8**	**11.8**	**16.7**	**15.7**	**10.5**	**4.3**	**3.9**	**120.9**	**-4.7**

Source: JICA Survey Team

Table D-193 Surface and Groundwater Balance of Dumaguete City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Dumaguete City Target Year= 2050
Weather Condition: Present Total Area [km2]= 52 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	1.6	1.0	3.0	0.9	2.9	5.7	10.1	6.6	5.5	5.5	5.5	11.4	59.5	
Surface Water Potential	**1.7**	**1.3**	**1.5**	**1.1**	**1.1**	**1.3**	**2.0**	**2.1**	**2.1**	**2.0**	**2.1**	**3.1**	**21.5**	
Irrigation Water Demand (SW)	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.6	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.7	0.6	0.7	0.6	0.7	0.6	0.7	0.7	0.6	0.7	0.6	0.7	7.9	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.8	0.6	0.7	0.6	0.8	0.7	0.7	0.7	0.6	0.7	0.7	0.7	8.5	
SW Water Balance	**1.0**	**0.7**	**0.8**	**0.5**	**0.4**	**0.6**	**1.3**	**1.4**	**1.4**	**1.3**	**1.4**	**2.4**	**13.1**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	1.6	1.4	1.6	1.5	1.6	1.5	1.6	1.6	1.5	1.6	1.5	1.6	18.3	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (GW)	1.6	1.4	1.6	1.5	1.6	1.5	1.6	1.6	1.5	1.6	1.5	1.6	18.7	
GW Water Balance	**-1.6**	**-1.4**	**-1.6**	**-1.5**	**-1.6**	**-1.5**	**-1.6**	**-1.6**	**-1.5**	**-1.6**	**-1.5**	**-1.6**	**-18.6**	**-18.6**
Total Water Potential (SW+GW)	**1.7**	**1.3**	**1.5**	**1.1**	**1.1**	**1.3**	**2.0**	**2.1**	**2.1**	**2.0**	**2.1**	**3.2**	**21.6**	
Irrigation Water Demand (Total)	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.6	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	2.2	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	26.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (SW+GW)	2.3	2.1	2.3	2.2	2.3	2.3	2.3	2.3	2.2	2.3	2.3	2.3	27.1	
Total Water Balance (SW+GW)	**-0.6**	**-0.7**	**-0.8**	**-1.1**	**-1.2**	**-1.0**	**-0.3**	**-0.2**	**-0.1**	**-0.3**	**-0.2**	**0.9**	**-5.5**	**-18.6**

Source: JICA Survey Team

Table D-194 Surface and Groundwater Balance of Sibulan City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Sibulan Target Year= 2050
Weather Condition: Present Total Area [km2]= 360 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	14.4	6.3	21.3	8.8	23.5	48.2	94.1	66.6	45.1	53.6	37.7	99.9	519.5	
Surface Water Potential	**20.4**	**15.5**	**15.8**	**13.1**	**12.5**	**12.3**	**24.6**	**34.8**	**27.8**	**25.7**	**26.5**	**42.2**	**271.1**	
Irrigation Water Demand (SW)	1.9	0.6	0.0	0.0	1.9	1.5	1.3	1.2	0.0	1.0	1.5	1.0	11.9	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.9	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	2.4	1.0	0.4	0.4	2.3	1.9	1.7	1.6	0.4	1.4	1.9	1.4	16.9	
SW Water Balance	**18.0**	**14.5**	**15.3**	**12.7**	**10.2**	**10.3**	**22.9**	**33.2**	**27.3**	**24.4**	**24.6**	**40.8**	**254.2**	**0.0**
Groundwater Potential	**0.9**	**0.8**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**10.9**	
Safety Groundwater Availability (70% of GWP)	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.7**	**7.6**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1	1.0	1.1	12.6	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1	1.0	1.1	12.6	
GW Water Balance	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-5.0**	**-5.0**
Total Water Potential (SW+GW)	**21.0**	**16.1**	**16.4**	**13.7**	**13.2**	**12.9**	**25.2**	**35.4**	**28.4**	**26.4**	**27.1**	**42.9**	**278.7**	
Irrigation Water Demand (Total)	1.9	0.6	0.0	0.0	1.9	1.5	1.3	1.2	0.0	1.0	1.5	1.0	11.9	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	1.5	1.3	1.5	1.4	1.5	1.4	1.5	1.5	1.4	1.5	1.4	1.5	17.5	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	3.4	2.0	1.5	1.4	3.4	2.9	2.8	2.7	1.5	2.5	2.9	2.5	29.5	
Total Water Balance (SW+GW)	**17.6**	**14.1**	**14.9**	**12.3**	**9.8**	**9.9**	**22.4**	**32.8**	**26.9**	**23.9**	**24.2**	**40.4**	**249.2**	**-5.0**

Source: JICA Survey Team

Table D-195 Surface and Groundwater Balance of Siquijor Island in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Siquijor Target Year= 2050
Weather Condition: Present Total Area [km2]= 163 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	23.8	6.7	4.6	2.5	7.8	35.9	25.5	12.9	16.1	17.4	29.4	20.4	202.9	
Surface Water Potential	**8.9**	**7.7**	**8.1**	**6.8**	**6.4**	**6.1**	**7.7**	**9.4**	**9.0**	**9.1**	**9.0**	**10.7**	**98.7**	
Irrigation Water Demand (SW)	1.1	0.7	0.0	0.0	0.7	2.4	2.0	2.9	1.2	0.3	1.0	1.1	13.4	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (SW)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	2.4	1.9	1.3	1.3	2.0	3.7	3.3	4.2	2.5	1.6	2.2	2.4	28.7	
SW Water Balance	**6.5**	**5.8**	**6.7**	**5.5**	**4.4**	**2.4**	**4.4**	**5.2**	**6.5**	**7.5**	**6.8**	**8.3**	**70.0**	**0.0**
Groundwater Potential	**0.4**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**4.5**	
Safety Groundwater Availability (70% of GWP)	**0.3**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**3.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.0	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.0	
GW Water Balance	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-4.9**	**-4.9**
Total Water Potential (SW+GW)	**9.2**	**7.9**	**8.3**	**7.0**	**6.6**	**6.3**	**8.0**	**9.6**	**9.3**	**9.4**	**9.3**	**10.9**	**101.9**	
Irrigation Water Demand (Total)	1.1	0.7	0.0	0.0	0.7	2.4	2.0	2.9	1.2	0.3	1.0	1.1	13.4	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (Total)	1.9	1.7	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	22.6	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	3.1	2.5	2.0	1.9	2.7	4.3	4.0	4.9	3.1	2.3	2.9	3.0	36.7	
Total Water Balance (SW+GW)	**6.1**	**5.4**	**6.3**	**5.1**	**3.9**	**2.0**	**4.0**	**4.8**	**6.1**	**7.1**	**6.4**	**7.9**	**65.2**	**-4.9**

Source: JICA Survey Team

Table D-196 Summary of Annual Water Balance and Deficit of Metro Cebu Area at Each Climate Change Condition

Total Area [km^2]= 829.3

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	562.2	-331.4	230.8	0.0	-331.4	-331.4
2	Present	2020	1/5-Dry Year	282.0	-352.3	-70.4	0.0	-352.3	-352.3
3	Present	2020	1/10-Dry Year	88.0	-378.7	-290.6	0.0	-378.7	-378.7
4	Present	2050	Average Year	550.4	-448.4	101.9	0.0	-448.4	-448.4
5	Present	2050	1/5-Dry Year	270.1	-469.3	-199.2	0.0	-469.3	-469.3
6	Present	2050	1/10-Dry Year	76.2	-495.7	-419.5	0.0	-495.7	-495.7
7	CC RCP8.5-High	2050	Average Year	637.0	-445.6	191.4	0.0	-445.6	-445.6
8	CC RCP8.5-High	2050	1/5-Dry Year	286.7	-468.4	-181.7	0.0	-468.4	-468.4
9	CC RCP8.5-High	2050	1/10-Dry Year	77.6	-495.2	-417.6	0.0	-495.2	-495.2
10	CC RCP8.5-Mid.	2050	Average Year	468.2	-460.3	7.9	0.0	-460.3	-460.3
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	183.5	-487.3	-303.9	0.0	-487.3	-487.3
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	43.1	-512.7	-469.6	-0.1	-512.7	-512.8
13	CC RCP8.5-Low	2050	Average Year	477.6	-496.4	-18.9	0.0	-496.4	-496.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	602.8	-517.4	85.4	0.0	-517.4	-517.4
15	CC RCP8.5-Low	2050	1/10-Dry Year	99.4	-538.2	-438.8	0.0	-538.2	-538.2

Source: JICA Survey Team

Table D-197 Summary of Annual Water Balance and Deficit of Toledo City at Each Climate Change Condition

Total Area [km^2]= 272.3

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	209.1	2.4	211.6	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	117.6	2.3	119.9	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	39.8	-3.0	36.9	0.0	-3.5	-3.5
4	Present	2050	Average Year	207.9	-8.9	199.0	0.0	-8.9	-8.9
5	Present	2050	1/5-Dry Year	116.3	-9.0	107.3	0.0	-9.0	-9.0
6	Present	2050	1/10-Dry Year	38.5	-14.3	24.3	0.0	-14.3	-14.3
7	CC RCP8.5-High	2050	Average Year	226.3	-4.8	221.5	0.0	-4.8	-4.8
8	CC RCP8.5-High	2050	1/5-Dry Year	116.9	-5.2	111.7	0.0	-5.2	-5.2
9	CC RCP8.5-High	2050	1/10-Dry Year	36.1	-12.3	23.8	0.0	-12.3	-12.3
10	CC RCP8.5-Mid.	2050	Average Year	205.5	-22.4	183.0	0.0	-22.4	-22.4
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	95.3	-24.0	71.3	0.0	-24.0	-24.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	25.4	-28.0	-2.6	0.0	-28.0	-28.0
13	CC RCP8.5-Low	2050	Average Year	133.1	-23.3	109.7	0.0	-23.3	-23.3
14	CC RCP8.5-Low	2050	1/5-Dry Year	46.8	-26.4	20.4	0.0	-26.4	-26.4
15	CC RCP8.5-Low	2050	1/10-Dry Year	11.7	-30.2	-18.5	0.0	-30.2	-30.2

Source: JICA Survey Team

Table D-198 Summary of Annual Water Balance and Deficit of Tagbilaran City at Each Climate Change Condition

Total Area [km^2]= 105.3

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	47.8	-11.9	35.9	0.0	-11.9	-11.9
2	Present	2020	1/5-Dry Year	24.3	-11.9	12.4	0.0	-11.9	-11.9
3	Present	2020	1/10-Dry Year	27.8	-11.9	15.9	0.0	-11.9	-11.9
4	Present	2050	Average Year	46.3	-18.7	27.5	0.0	-18.7	-18.7
5	Present	2050	1/5-Dry Year	22.8	-18.7	4.1	0.0	-18.7	-18.7
6	Present	2050	1/10-Dry Year	26.3	-18.7	7.6	-0.0	-18.7	-18.8
7	CC RCP8.5-High	2050	Average Year	55.5	-18.7	36.8	0.0	-18.7	-18.7
8	CC RCP8.5-High	2050	1/5-Dry Year	25.2	-18.7	6.5	0.0	-18.7	-18.7
9	CC RCP8.5-High	2050	1/10-Dry Year	30.1	-18.7	11.4	-0.2	-18.7	-18.9
10	CC RCP8.5-Mid.	2050	Average Year	31.0	-18.7	12.3	0.0	-18.7	-18.7
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	18.4	-18.7	-0.4	0.0	-18.7	-18.7
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	20.8	-18.7	2.1	-0.1	-18.7	-18.9
13	CC RCP8.5-Low	2050	Average Year	17.7	-18.7	-1.0	0.0	-18.7	-18.7
14	CC RCP8.5-Low	2050	1/5-Dry Year	11.2	-18.7	-7.6	-0.0	-18.7	-18.8
15	CC RCP8.5-Low	2050	1/10-Dry Year	13.5	-18.7	-5.2	-0.1	-18.7	-18.9

Source: JICA Survey Team

Table D-199 Summary of Annual Water Balance and Deficit of Panglao City at Each Climate Change Condition

Total Area [km^2]= 32.2

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	5.9	-7.4	-1.6	0.0	-7.4	-7.4
2	Present	2020	1/5-Dry Year	4.5	-7.4	-2.9	0.0	-7.4	-7.4
3	Present	2020	1/10-Dry Year	3.0	-7.4	-4.4	0.0	-7.4	-7.4
4	Present	2050	Average Year	5.9	-11.4	-5.5	0.0	-11.4	-11.4
5	Present	2050	1/5-Dry Year	4.5	-11.4	-6.9	0.0	-11.4	-11.4
6	Present	2050	1/10-Dry Year	3.0	-11.4	-8.4	0.0	-11.4	-11.4
7	CC RCP8.5-High	2050	Average Year	6.5	-11.4	-4.9	0.0	-11.4	-11.4
8	CC RCP8.5-High	2050	1/5-Dry Year	5.0	-11.4	-6.3	0.0	-11.4	-11.4
9	CC RCP8.5-High	2050	1/10-Dry Year	3.5	-11.4	-7.9	0.0	-11.4	-11.4
10	CC RCP8.5-Mid.	2050	Average Year	4.5	-11.4	-6.9	0.0	-11.4	-11.4
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	3.5	-11.4	-7.9	0.0	-11.4	-11.4
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2.2	-11.4	-9.2	0.0	-11.4	-11.4
13	CC RCP8.5-Low	2050	Average Year	2.8	-11.4	-8.6	0.0	-11.4	-11.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	1.6	-11.4	-9.8	0.0	-11.4	-11.4
15	CC RCP8.5-Low	2050	1/10-Dry Year	1.2	-11.4	-10.2	0.0	-11.4	-11.4

Source: JICA Survey Team

Table D-200 Summary of Annual Water Balance and Deficit of Carmen City at Each Climate Change Condition

Total Area [km^2]= 299.4

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	311.2	-2.0	309.2	0.0	-2.0	-2.0
2	Present	2020	1/5-Dry Year	196.9	-2.0	194.9	0.0	-2.0	-2.0
3	Present	2020	1/10-Dry Year	228.1	-2.0	226.1	0.0	-2.0	-2.0
4	Present	2050	Average Year	307.4	-3.2	304.2	0.0	-3.2	-3.2
5	Present	2050	1/5-Dry Year	193.1	-3.2	189.9	0.0	-3.2	-3.2
6	Present	2050	1/10-Dry Year	224.3	-3.2	221.1	0.0	-3.2	-3.2
7	CC RCP8.5-High	2050	Average Year	351.3	-3.2	348.1	0.0	-3.2	-3.2
8	CC RCP8.5-High	2050	1/5-Dry Year	216.4	-3.2	213.2	0.0	-3.2	-3.2
9	CC RCP8.5-High	2050	1/10-Dry Year	256.5	-3.2	253.3	0.0	-3.2	-3.2
10	CC RCP8.5-Mid.	2050	Average Year	240.1	-3.2	236.9	0.0	-3.2	-3.2
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	168.2	-3.2	165.0	0.0	-3.2	-3.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	192.8	-3.2	189.5	0.0	-3.2	-3.2
13	CC RCP8.5-Low	2050	Average Year	162.3	-3.2	159.1	0.0	-3.2	-3.2
14	CC RCP8.5-Low	2050	1/5-Dry Year	115.3	-3.2	112.1	0.0	-3.2	-3.2
15	CC RCP8.5-Low	2050	1/10-Dry Year	131.2	-3.2	128.0	0.0	-3.2	-3.2

Source: JICA Survey Team

Table D-201 Summary of Annual Water Balance and Deficit of Inabanga City at Each Climate Change Condition

Total Area [km^2]= 171.0

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	206.9	-2.9	204.0	0.0	-2.9	-2.9
2	Present	2020	1/5-Dry Year	126.2	-2.9	123.3	0.0	-2.9	-2.9
3	Present	2020	1/10-Dry Year	127.0	-2.9	124.1	0.0	-2.9	-2.9
4	Present	2050	Average Year	206.3	-4.1	202.2	0.0	-4.1	-4.1
5	Present	2050	1/5-Dry Year	125.6	-4.1	121.5	0.0	-4.1	-4.1
6	Present	2050	1/10-Dry Year	126.4	-4.1	122.3	0.0	-4.1	-4.1
7	CC RCP8.5-High	2050	Average Year	219.2	-4.1	215.1	0.0	-4.1	-4.1
8	CC RCP8.5-High	2050	1/5-Dry Year	127.9	-4.1	123.8	0.0	-4.1	-4.1
9	CC RCP8.5-High	2050	1/10-Dry Year	128.3	-4.1	124.2	0.0	-4.1	-4.1
10	CC RCP8.5-Mid.	2050	Average Year	149.3	-4.1	145.2	0.0	-4.1	-4.1
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	98.1	-4.1	94.0	0.0	-4.1	-4.1
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	97.3	-4.1	93.2	0.0	-4.1	-4.1
13	CC RCP8.5-Low	2050	Average Year	98.0	-4.1	93.9	0.0	-4.1	-4.1
14	CC RCP8.5-Low	2050	1/5-Dry Year	66.0	-4.1	61.9	0.0	-4.1	-4.1
15	CC RCP8.5-Low	2050	1/10-Dry Year	70.6	-4.1	66.5	0.0	-4.1	-4.1

Source: JICA Survey Team

Table D-202 Summary of Annual Water Balance and Deficit of Dumaguete City at Each Climate Change Condition

Total Area [km^2]= 51.6

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	31.2	-11.2	20.0	0.0	-11.2	-11.2
2	Present	2020	1/5-Dry Year	16.3	-11.2	5.1	0.0	-11.2	-11.2
3	Present	2020	1/10-Dry Year	16.6	-11.2	5.4	0.0	-11.2	-11.2
4	Present	2050	Average Year	30.8	-12.1	18.7	0.0	-12.1	-12.1
5	Present	2050	1/5-Dry Year	15.9	-12.1	3.8	0.0	-12.1	-12.1
6	Present	2050	1/10-Dry Year	16.2	-12.1	4.1	0.0	-12.1	-12.1
7	CC RCP8.5-High	2050	Average Year	32.2	-12.1	20.1	0.0	-12.1	-12.1
8	CC RCP8.5-High	2050	1/5-Dry Year	16.7	-12.1	4.6	0.0	-12.1	-12.1
9	CC RCP8.5-High	2050	1/10-Dry Year	16.5	-12.1	4.4	0.0	-12.1	-12.1
10	CC RCP8.5-Mid.	2050	Average Year	21.6	-12.1	9.5	0.0	-12.1	-12.1
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	12.4	-12.1	0.4	0.0	-12.1	-12.1
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	11.6	-12.1	-0.5	0.0	-12.1	-12.1
13	CC RCP8.5-Low	2050	Average Year	12.5	-12.1	0.4	0.0	-12.1	-12.1
14	CC RCP8.5-Low	2050	1/5-Dry Year	7.3	-12.1	-4.8	0.0	-12.1	-12.1
15	CC RCP8.5-Low	2050	1/10-Dry Year	6.7	-12.1	-5.4	0.0	-12.1	-12.1

Source: JICA Survey Team

Table D-203 Summary of Annual Water Balance and Deficit of Sibulan City at Each Climate Change Condition

Total Area [km^2]= 360.1

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	399.3	0.1	399.4	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	256.7	0.0	256.7	0.0	-0.0	-0.0
3	Present	2020	1/10-Dry Year	261.8	0.0	261.8	0.0	-0.0	-0.0
4	Present	2050	Average Year	397.8	-0.6	397.3	0.0	-0.6	-0.6
5	Present	2050	1/5-Dry Year	255.2	-0.7	254.5	0.0	-0.7	-0.7
6	Present	2050	1/10-Dry Year	260.3	-0.6	259.6	0.0	-0.6	-0.6
7	CC RCP8.5-High	2050	Average Year	426.3	-0.5	425.8	0.0	-0.5	-0.5
8	CC RCP8.5-High	2050	1/5-Dry Year	275.5	-0.7	274.9	0.0	-0.7	-0.7
9	CC RCP8.5-High	2050	1/10-Dry Year	276.2	-0.6	275.5	0.0	-0.6	-0.6
10	CC RCP8.5-Mid.	2050	Average Year	340.9	-0.6	340.3	0.0	-0.6	-0.6
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	223.8	-0.7	223.1	0.0	-0.7	-0.7
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	225.9	-0.7	225.2	0.0	-0.7	-0.7
13	CC RCP8.5-Low	2050	Average Year	240.3	-0.7	239.6	0.0	-0.7	-0.7
14	CC RCP8.5-Low	2050	1/5-Dry Year	153.2	-0.8	152.4	0.0	-0.8	-0.8
15	CC RCP8.5-Low	2050	1/10-Dry Year	155.9	-0.7	155.1	0.0	-0.7	-0.7

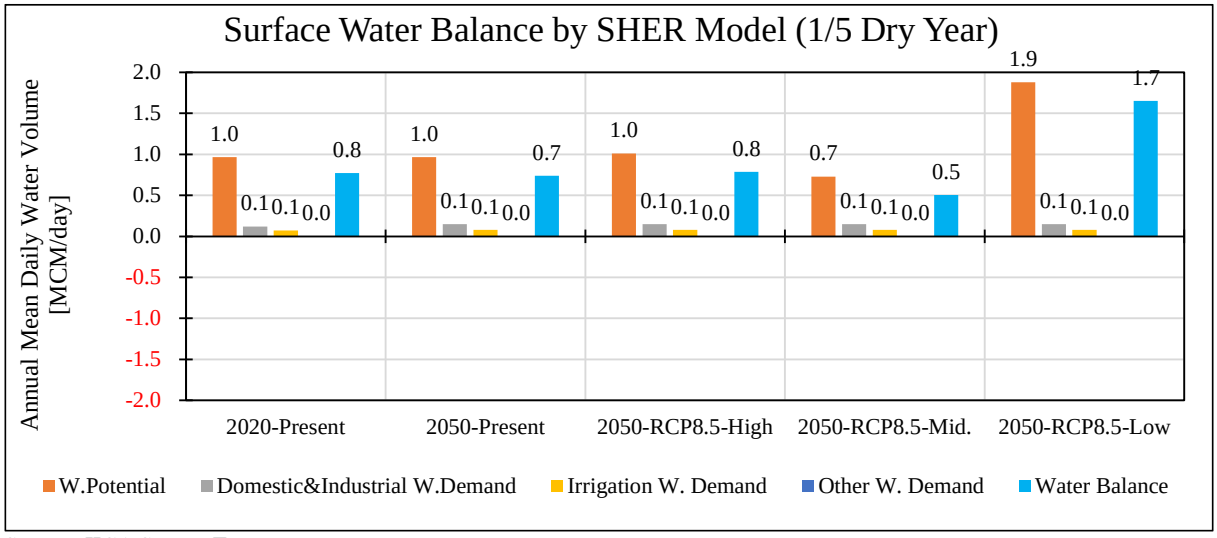
Source: JICA Survey Team

Table D-204 Summary of Annual Water Balance and Deficit of Siquijor Island at Each Climate Change Condition

Total Area [km^2]= 163.1

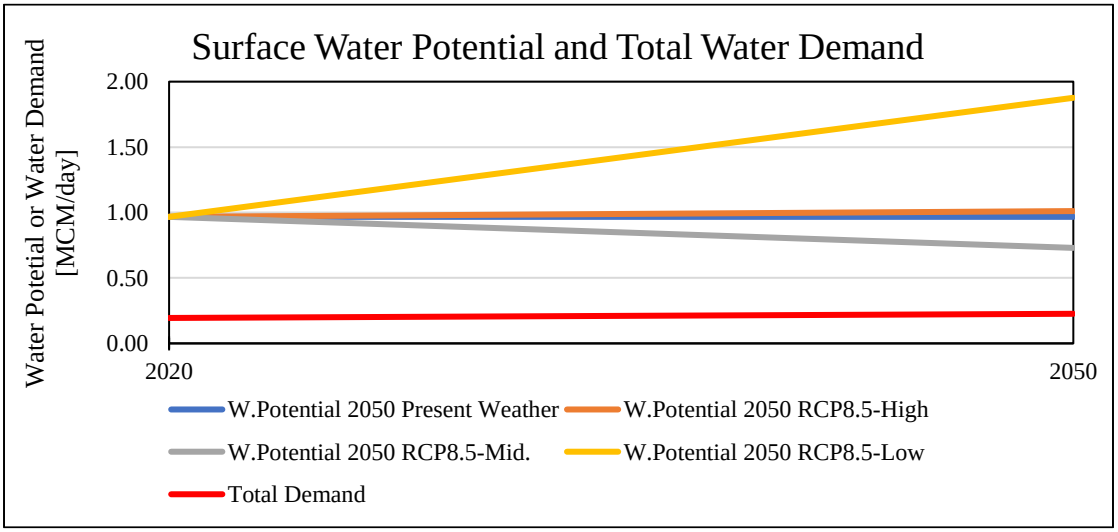
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	85.8	0.3	86.1	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	85.8	0.3	86.1	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	85.8	0.3	86.1	0.0	0.0	0.0
4	Present	2050	Average Year	74.9	-2.2	72.7	0.0	-2.2	-2.2
5	Present	2050	1/5-Dry Year	74.9	-2.2	72.7	0.0	-2.2	-2.2
6	Present	2050	1/10-Dry Year	74.9	-2.2	72.7	0.0	-2.2	-2.2
7	CC RCP8.5-High	2050	Average Year	79.8	-2.2	77.6	0.0	-2.2	-2.2
8	CC RCP8.5-High	2050	1/5-Dry Year	79.8	-2.2	77.6	0.0	-2.2	-2.2
9	CC RCP8.5-High	2050	1/10-Dry Year	79.8	-2.2	77.6	0.0	-2.2	-2.2
10	CC RCP8.5-Mid.	2050	Average Year	63.4	-2.2	61.1	0.0	-2.2	-2.2
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	63.4	-2.2	61.1	0.0	-2.2	-2.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	63.4	-2.2	61.1	0.0	-2.2	-2.2
13	CC RCP8.5-Low	2050	Average Year	34.8	-2.3	32.4	0.0	-2.3	-2.3
14	CC RCP8.5-Low	2050	1/5-Dry Year	34.8	-2.3	32.4	0.0	-2.3	-2.3
15	CC RCP8.5-Low	2050	1/10-Dry Year	34.7	-2.3	32.4	0.0	-2.3	-2.3

Source: JICA Survey Team



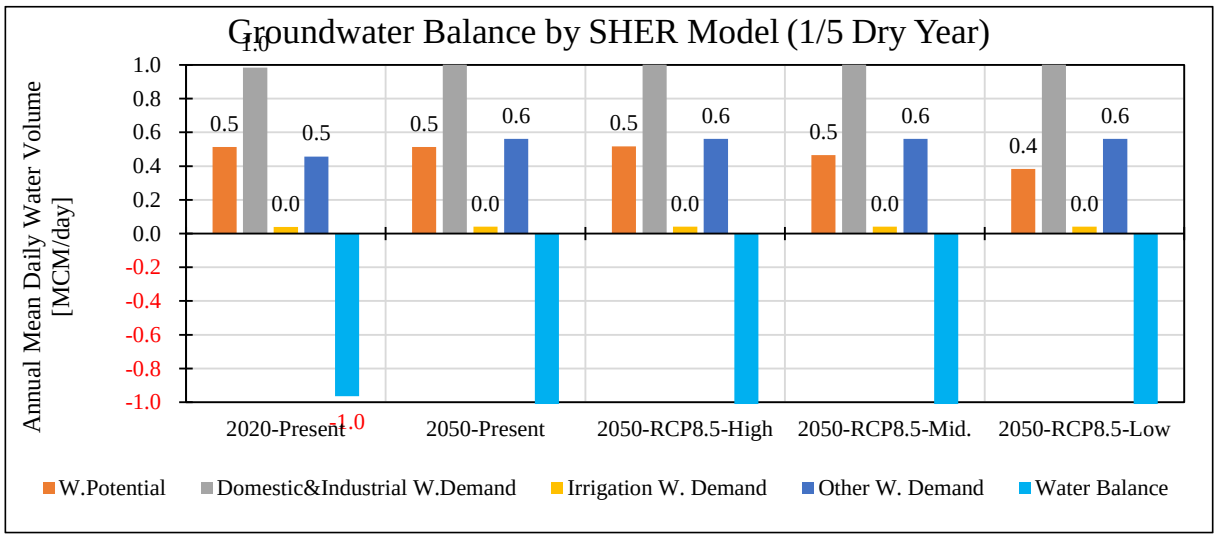
Source: JICA Survey Team

Figure D-431 Surface Water Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



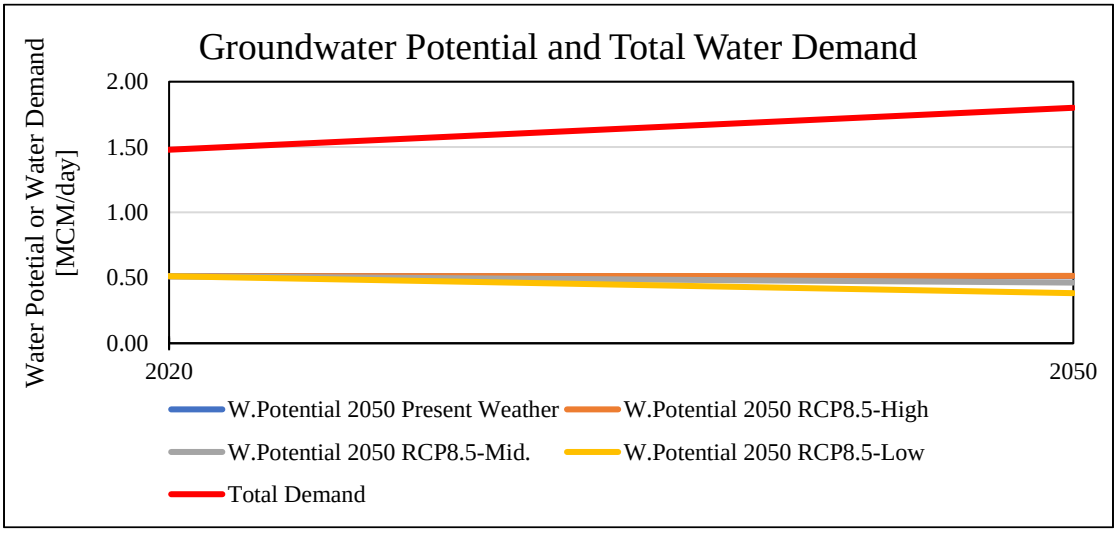
Source: JICA Survey Team

Figure D-432 Surface Water Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



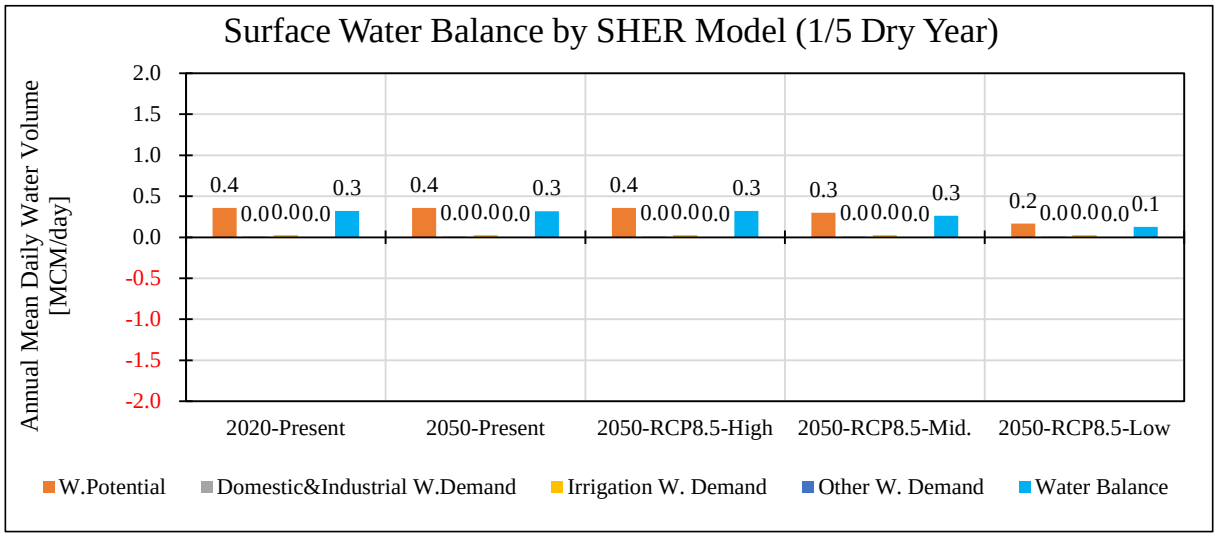
Source: JICA Survey Team

Figure D-433 Groundwater Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



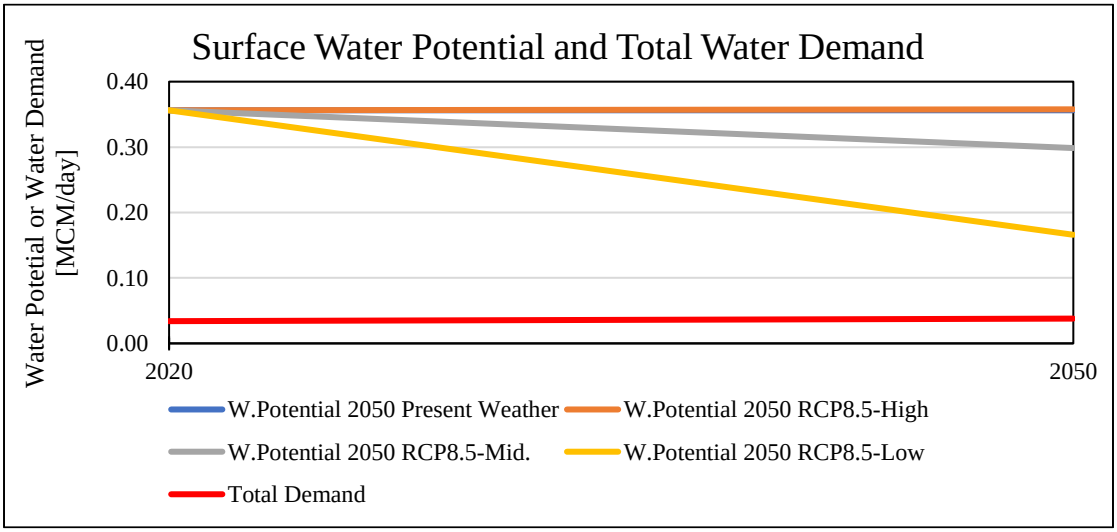
Source: JICA Survey Team

Figure D-434 Groundwater Balance of Metro Cebu in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



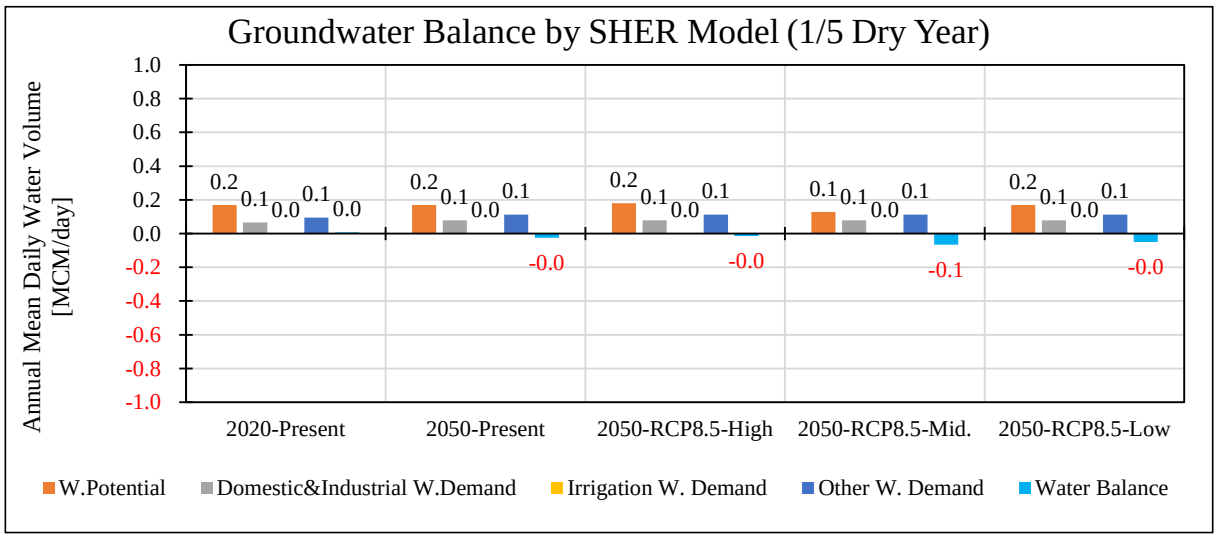
Source: JICA Survey Team

Figure D-435 Surface Water Balance of Toledo City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



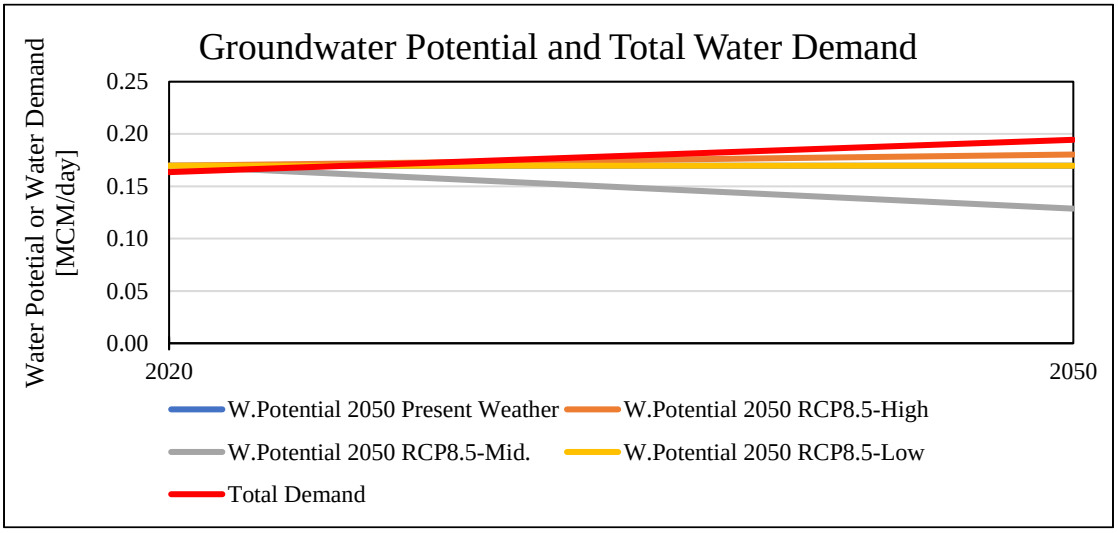
Source: JICA Survey Team

Figure D-436 Surface Water Balance of Toledo City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



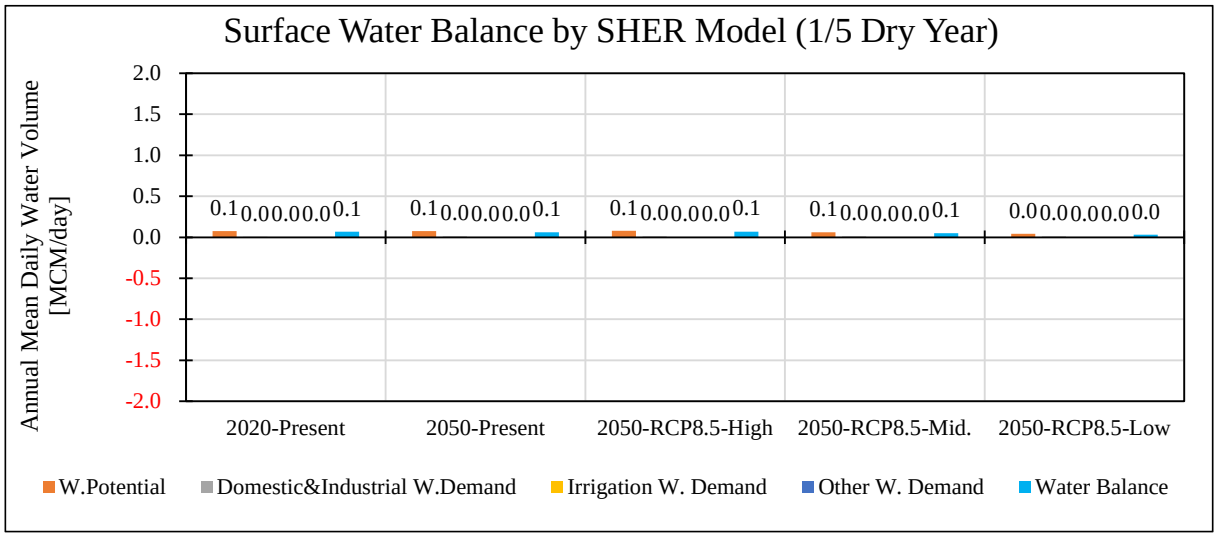
Source: JICA Survey Team

Figure D-437 Groundwater Balance of Toledo City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



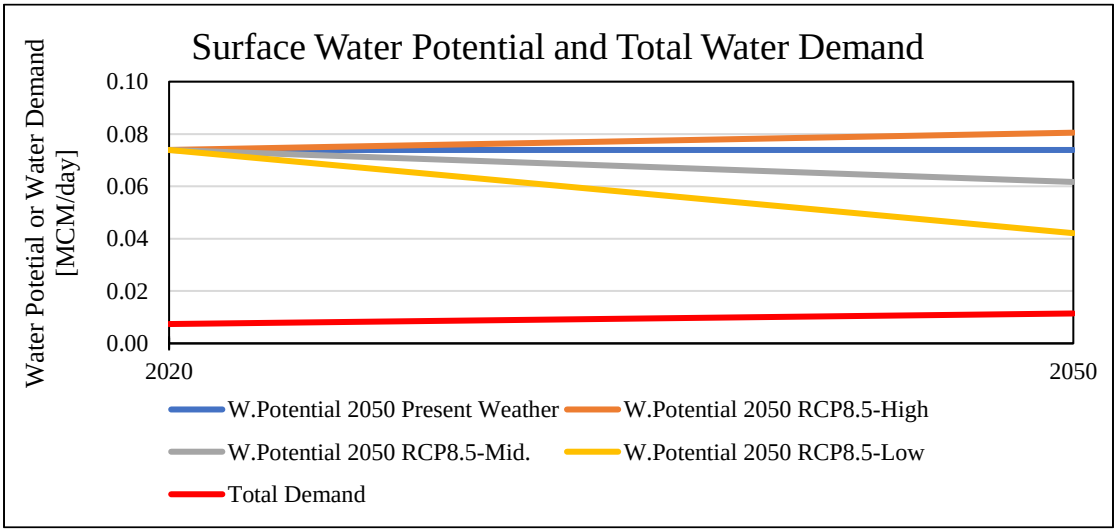
Source: JICA Survey Team

Figure D-438 Groundwater Balance of Toledo City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



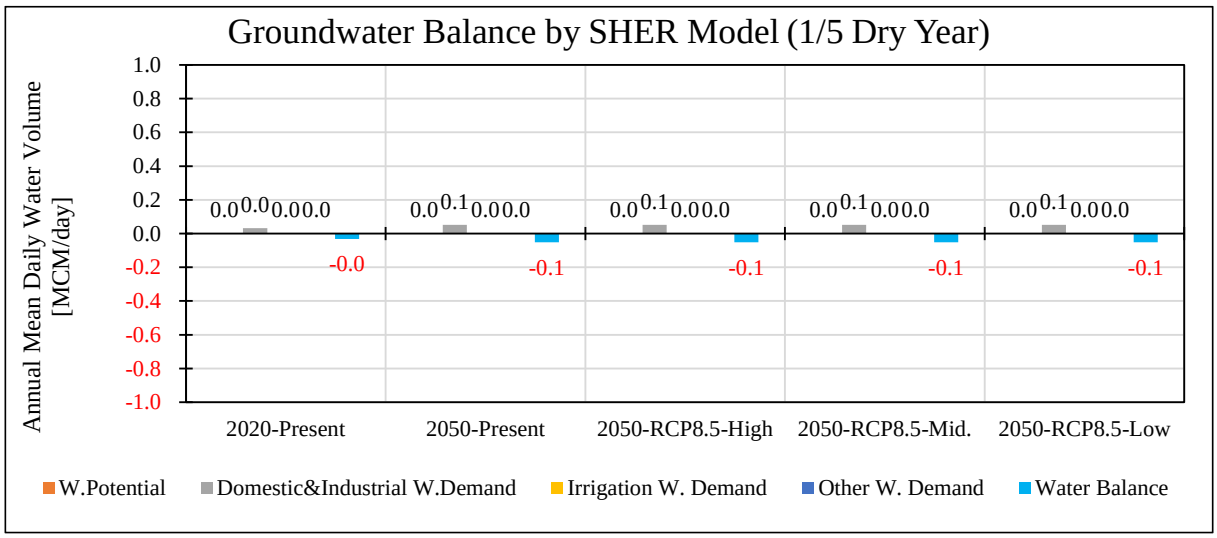
Source: JICA Survey Team

Figure D-439 Surface Water Balance of Tagbilaran City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



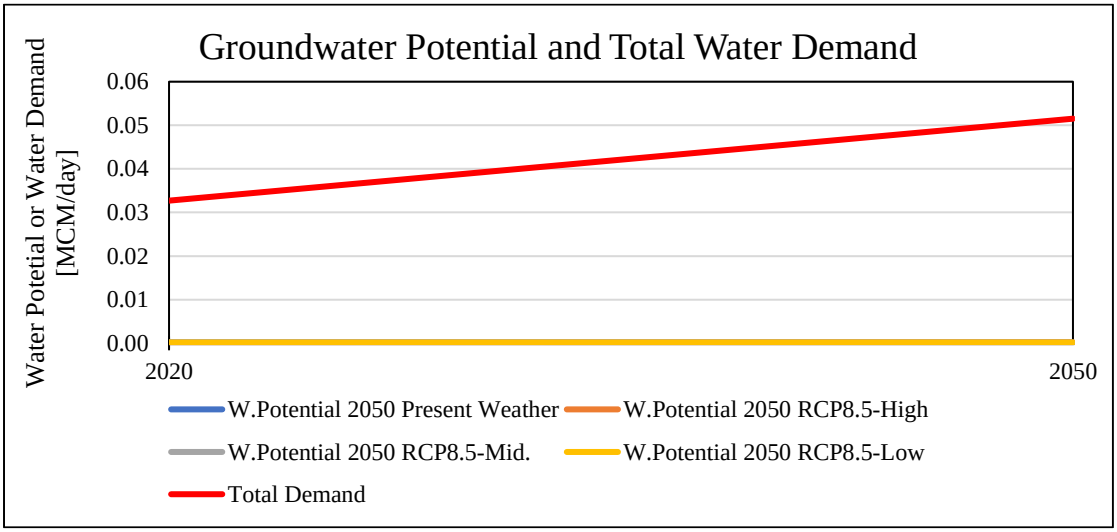
Source: JICA Survey Team

Figure D-440 Surface Water Balance of Tagbilaran City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



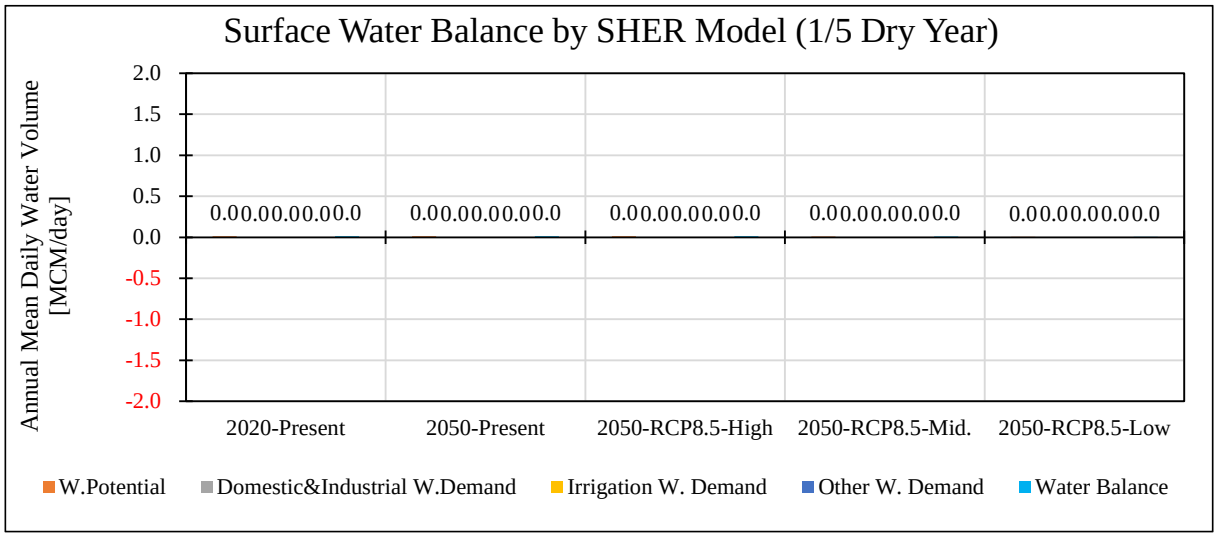
Source: JICA Survey Team

Figure D-441 Groundwater Balance of Tagbilaran City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



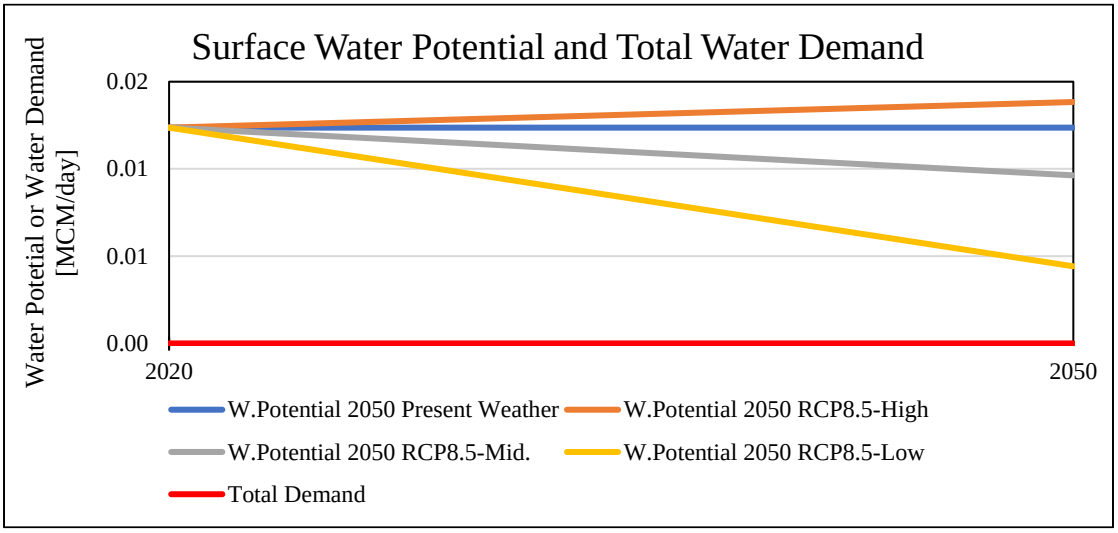
Source: JICA Survey Team

Figure D-442 Groundwater Balance of Tagbilaran City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



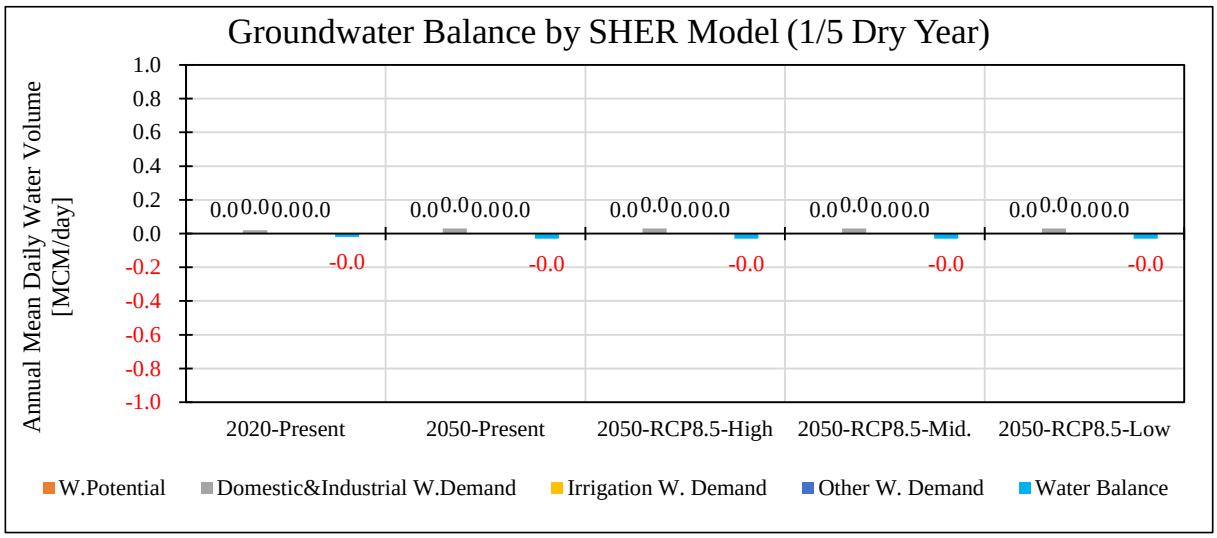
Source: JICA Survey Team

Figure D-443 Surface Water Balance of Panglao City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



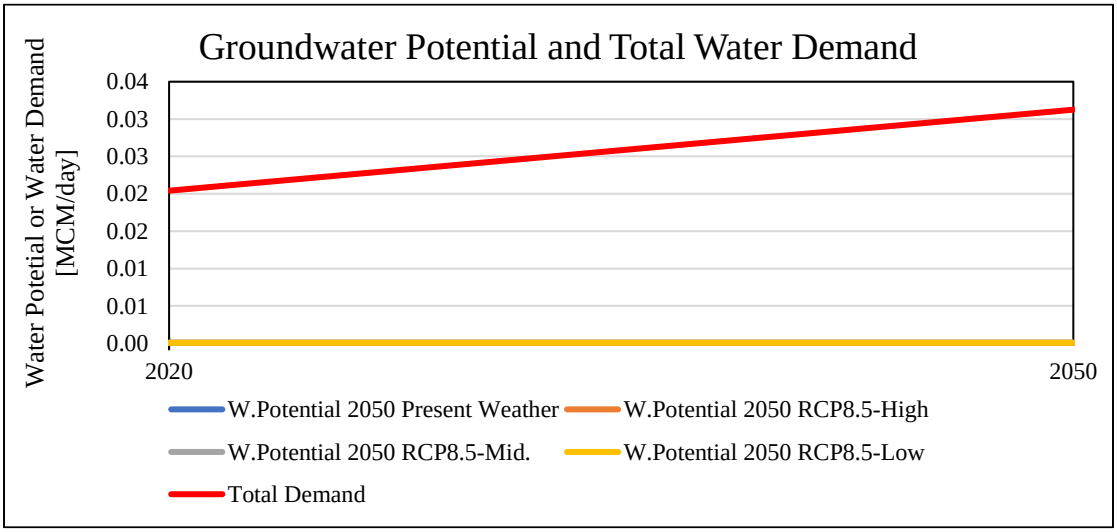
Source: JICA Survey Team

Figure D-444 Surface Water Balance of Panglao City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



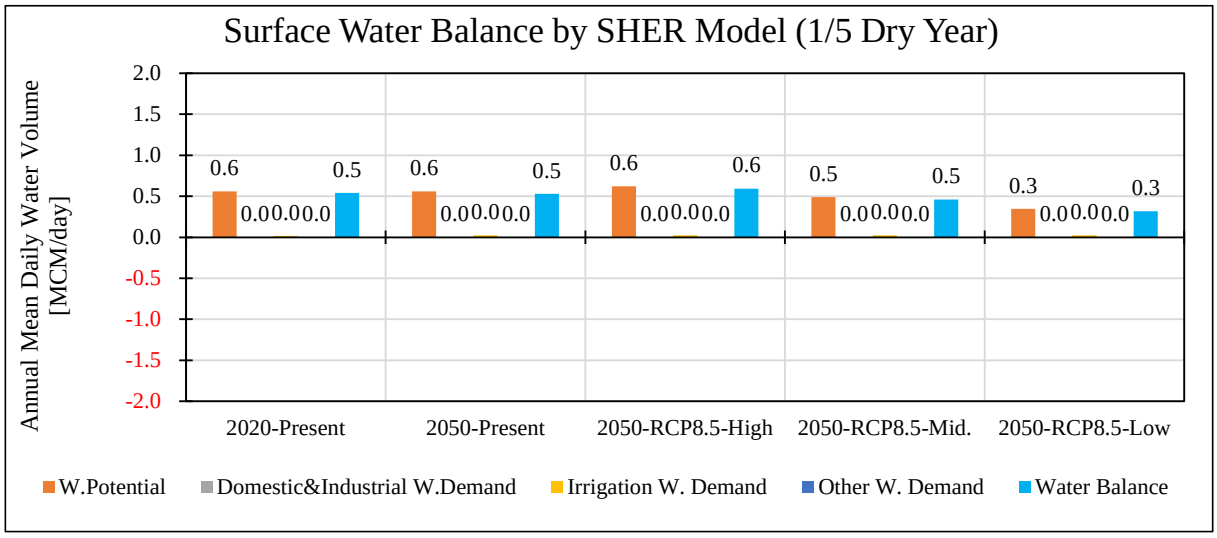
Source: JICA Survey Team

Figure D-445 Groundwater Balance of Panglao City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



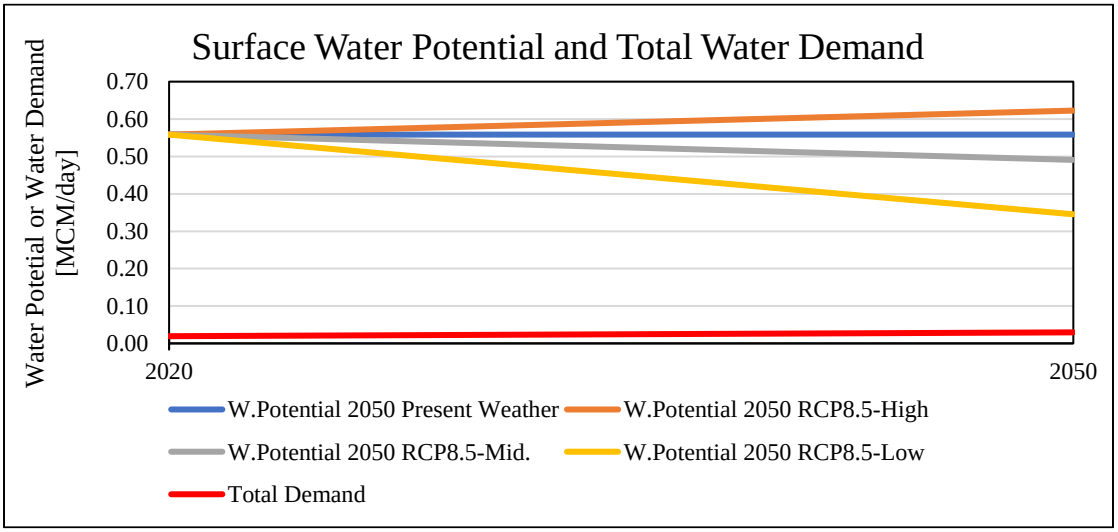
Source: JICA Survey Team

Figure D-446 Groundwater Balance of Panglao City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



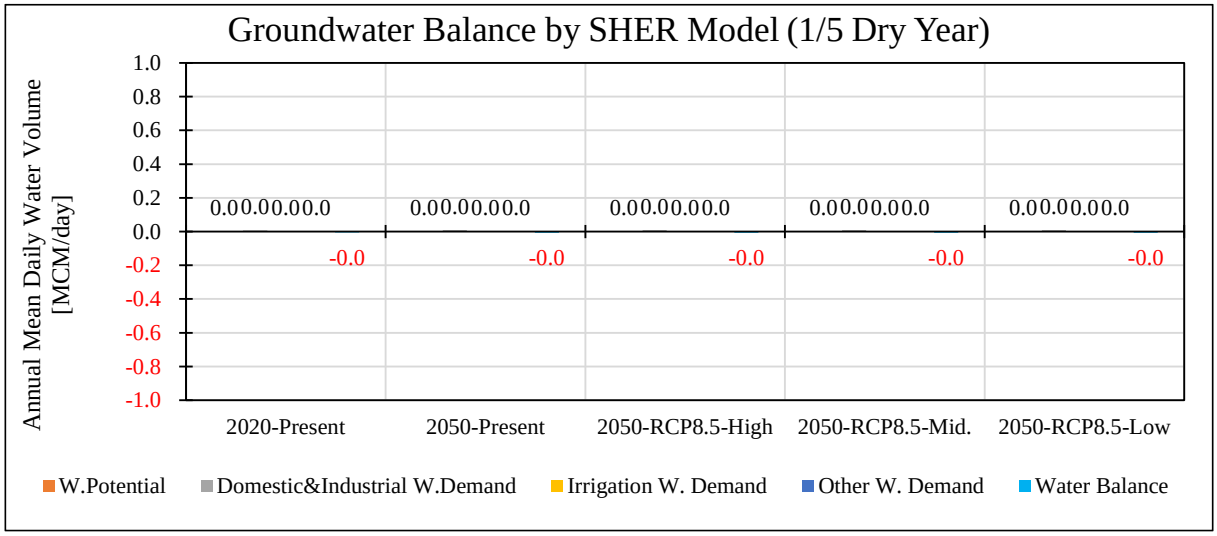
Source: JICA Survey Team

Figure D-447 Surface Water Balance of Carmen City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



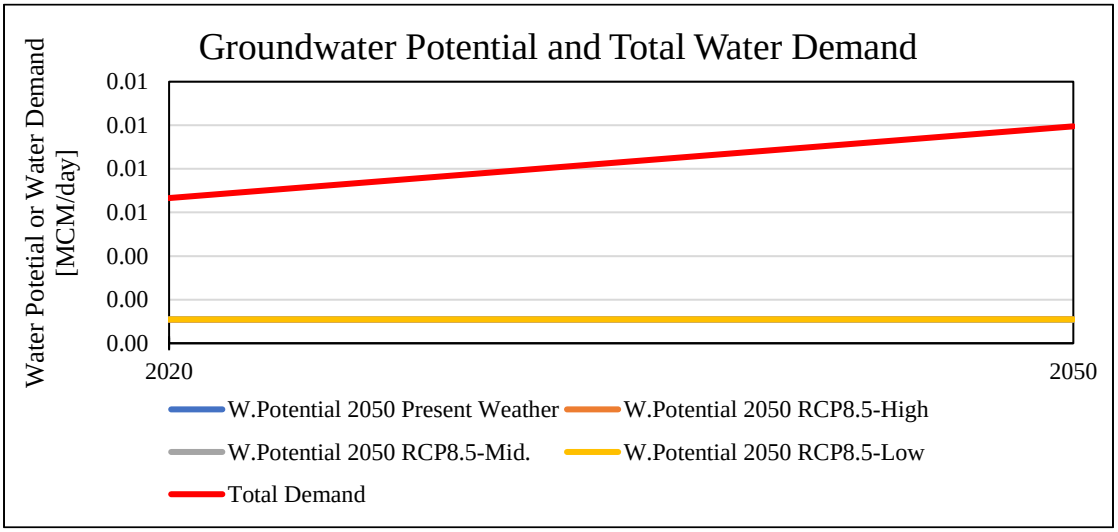
Source: JICA Survey Team

Figure D-448 Surface Water Balance of Carmen City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



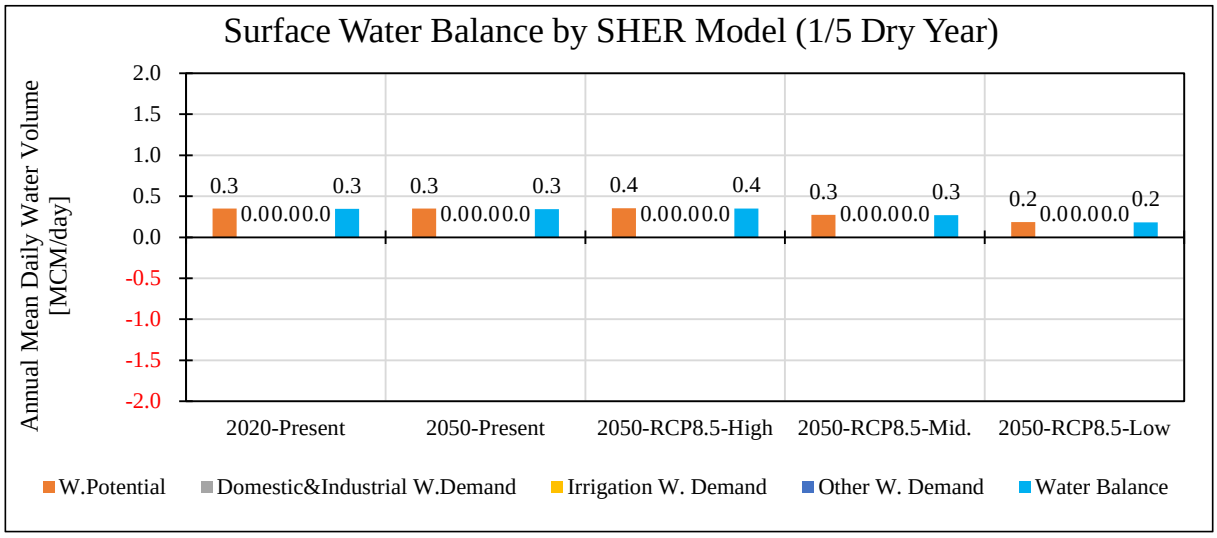
Source: JICA Survey Team

Figure D-449 Groundwater Balance of Carmen City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



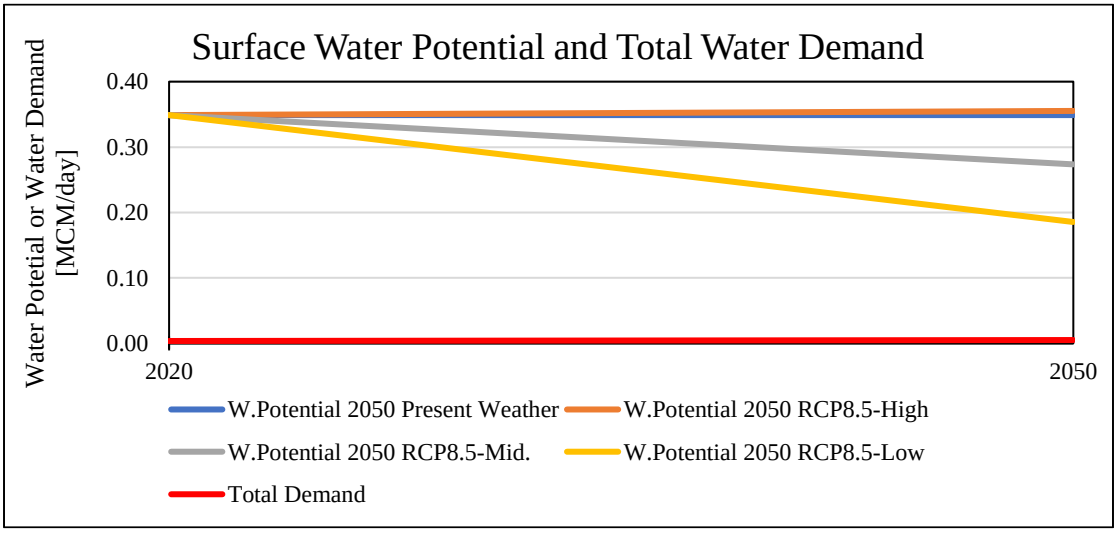
Source: JICA Survey Team

Figure D-450 Groundwater Balance of Carmen City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



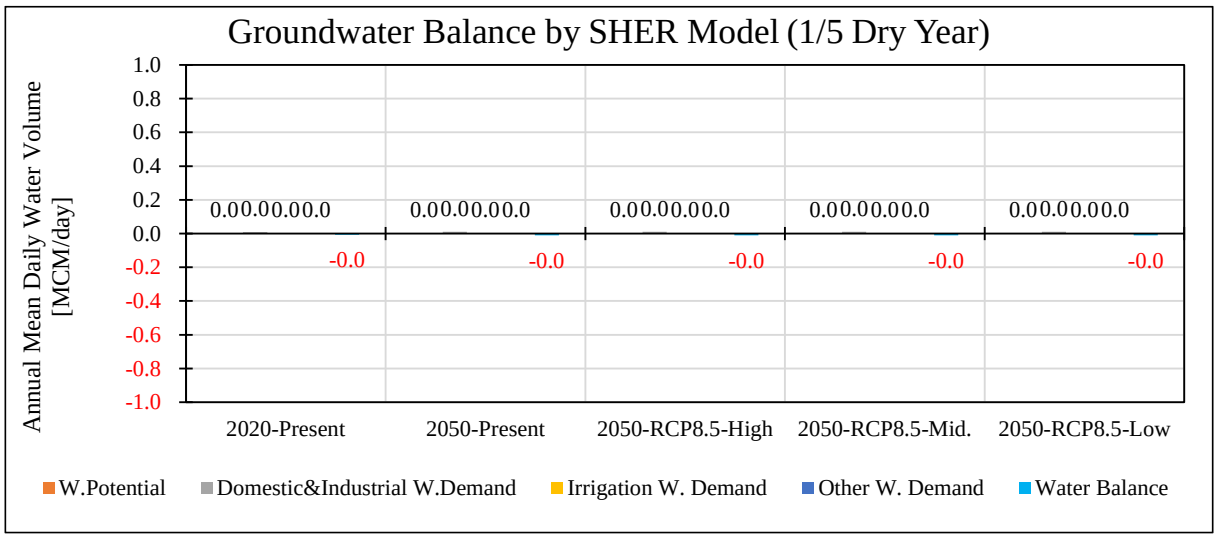
Source: JICA Survey Team

Figure D-451 Surface Water Balance of Inabanga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



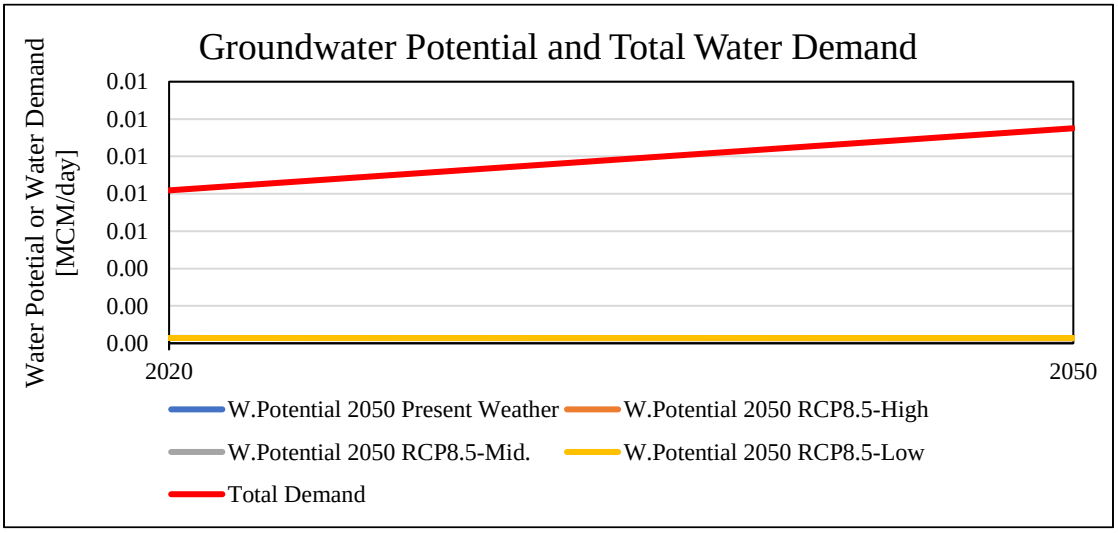
Source: JICA Survey Team

Figure D-452 Surface Water Balance of Inabanga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



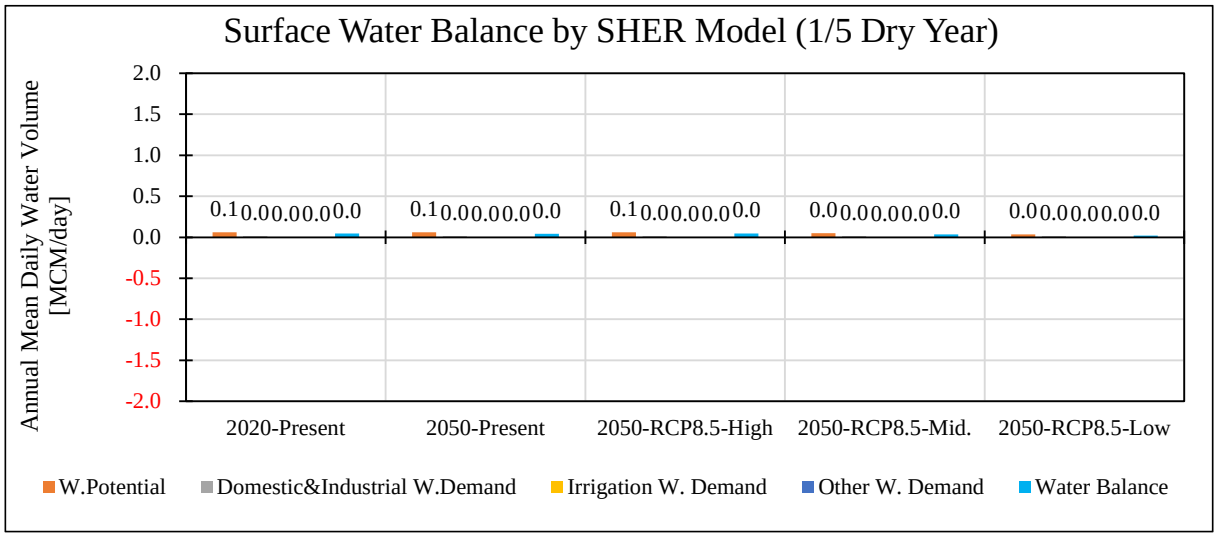
Source: JICA Survey Team

Figure D-453 Groundwater Balance of Inabanga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



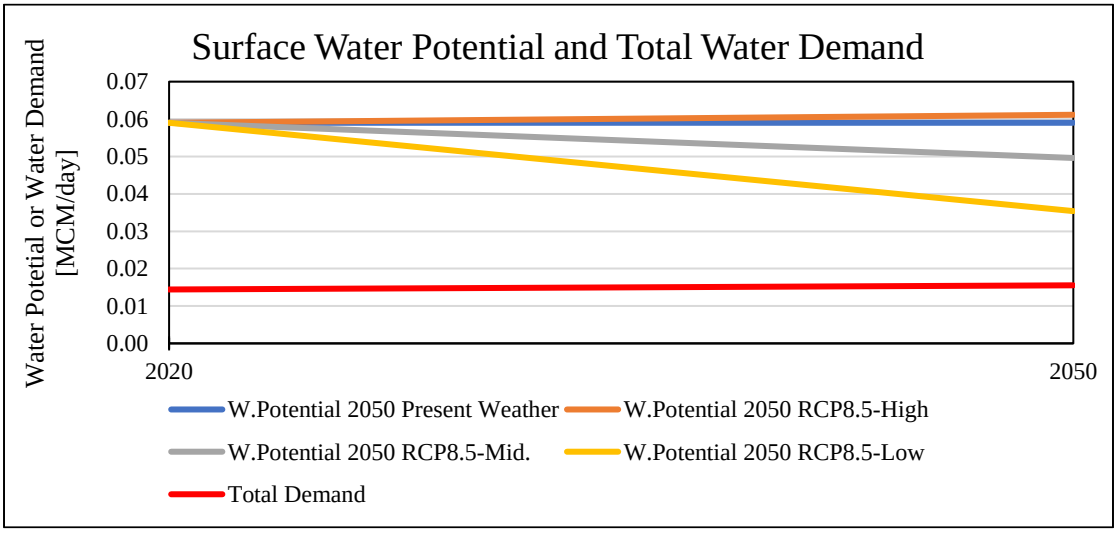
Source: JICA Survey Team

Figure D-454 Groundwater Balance of Inabanga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



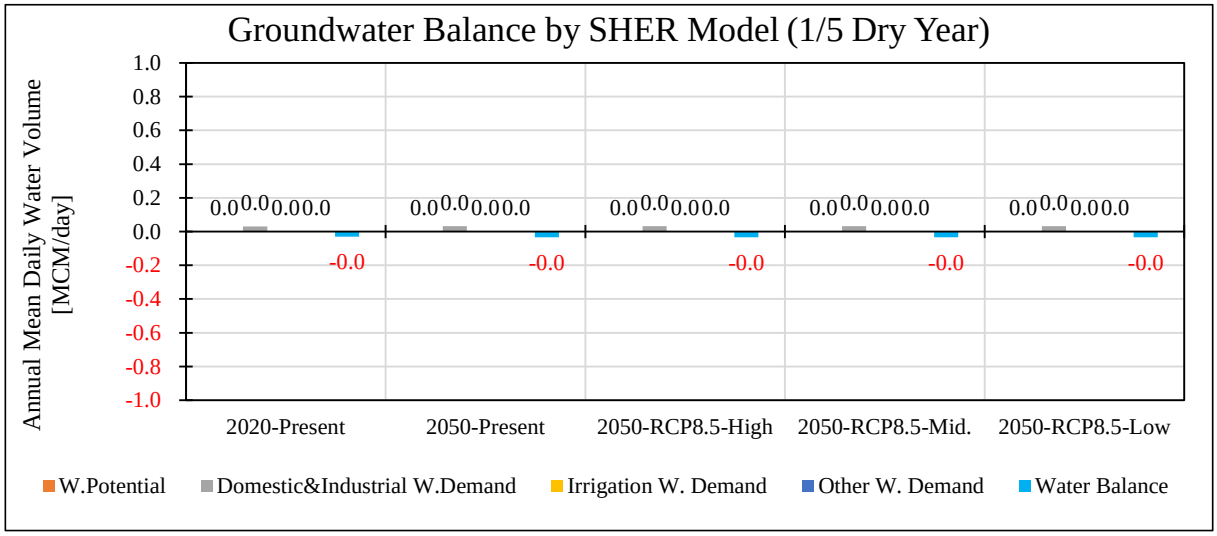
Source: JICA Survey Team

Figure D-455 Surface Water Balance of Dumaguete City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



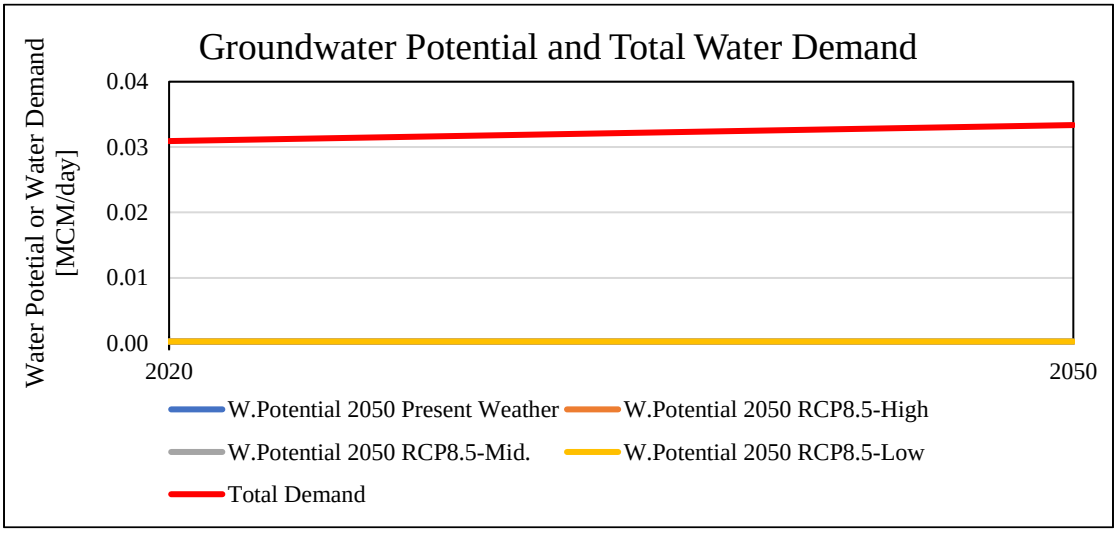
Source: JICA Survey Team

Figure D-456 Surface Water Balance of Dumaguete City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



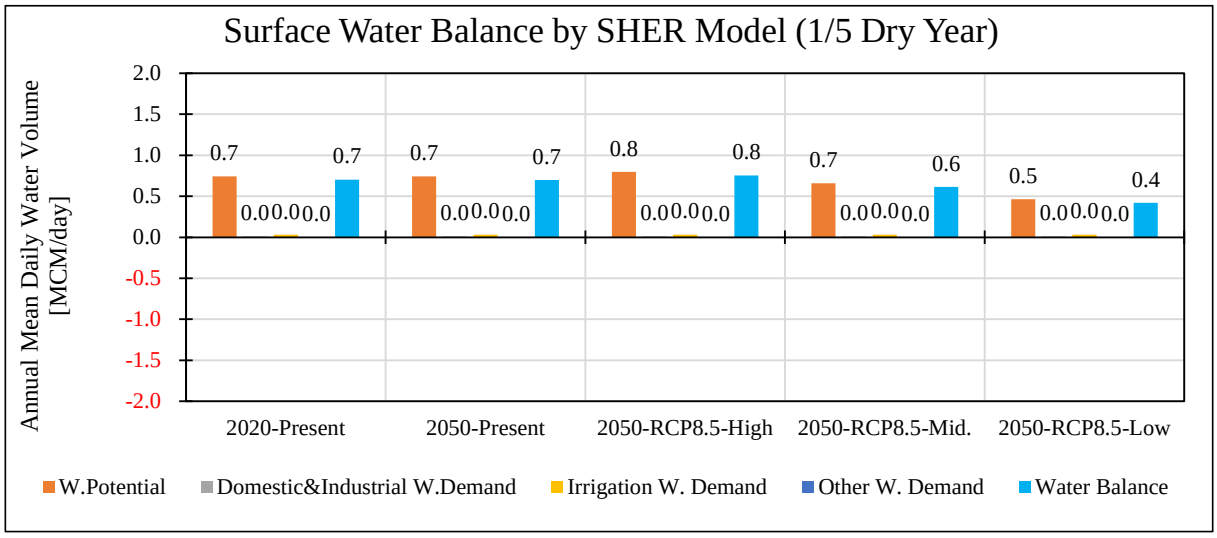
Source: JICA Survey Team

Figure D-457 Groundwater Balance of Dumaguete City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



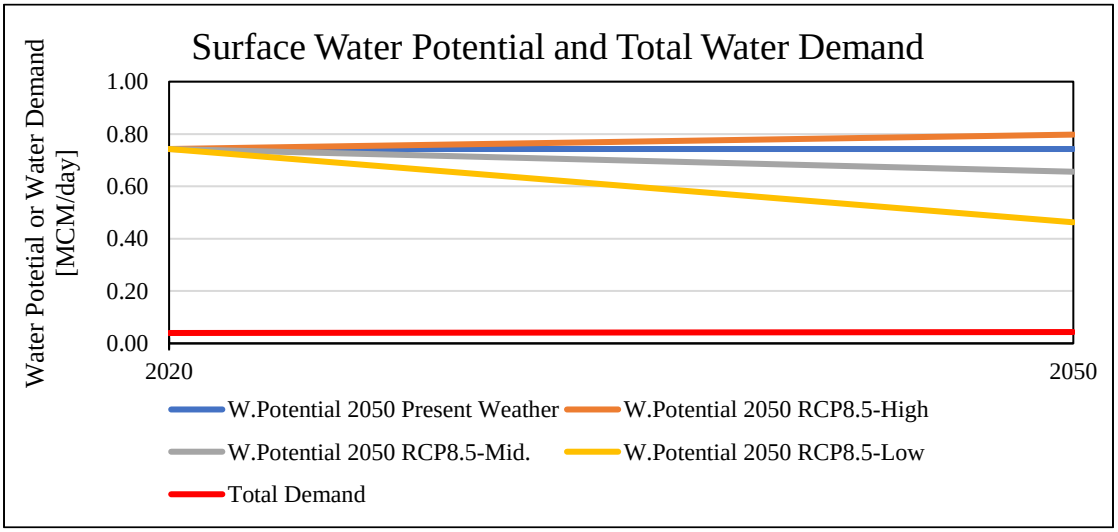
Source: JICA Survey Team

Figure D-458 Groundwater Balance of Dumaguete City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



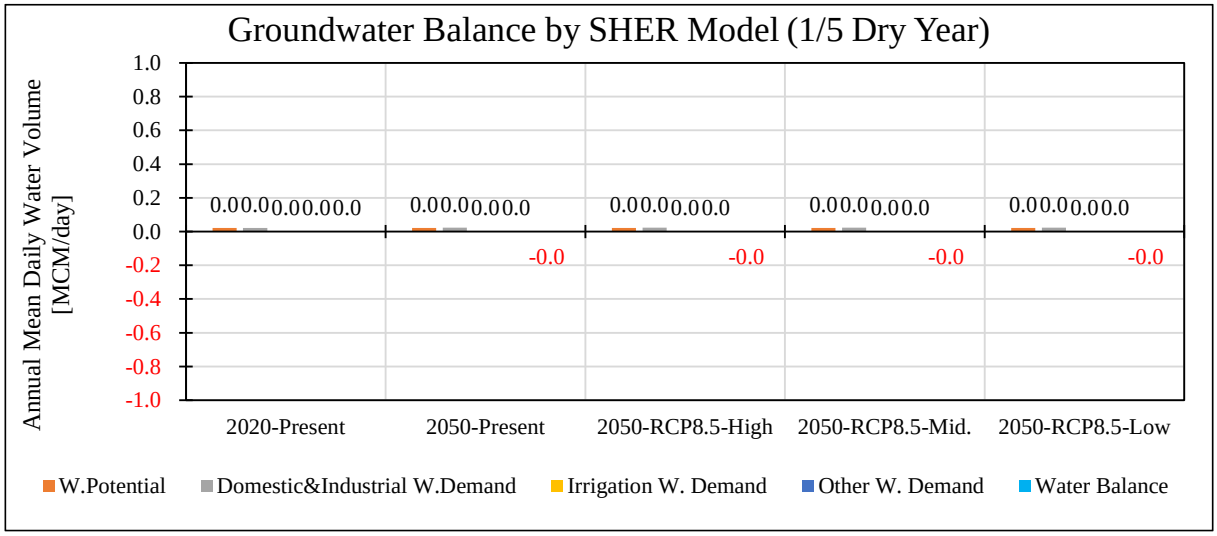
Source: JICA Survey Team

Figure D-459 Surface Water Balance of Sibulan City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



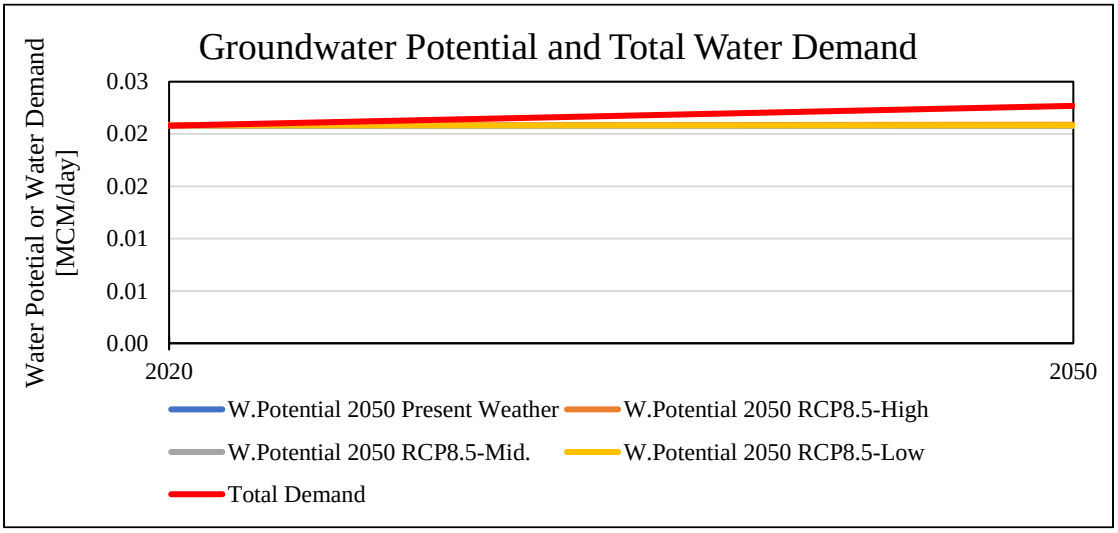
Source: JICA Survey Team

Figure D-460 Surface Water Balance of Sibulan City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



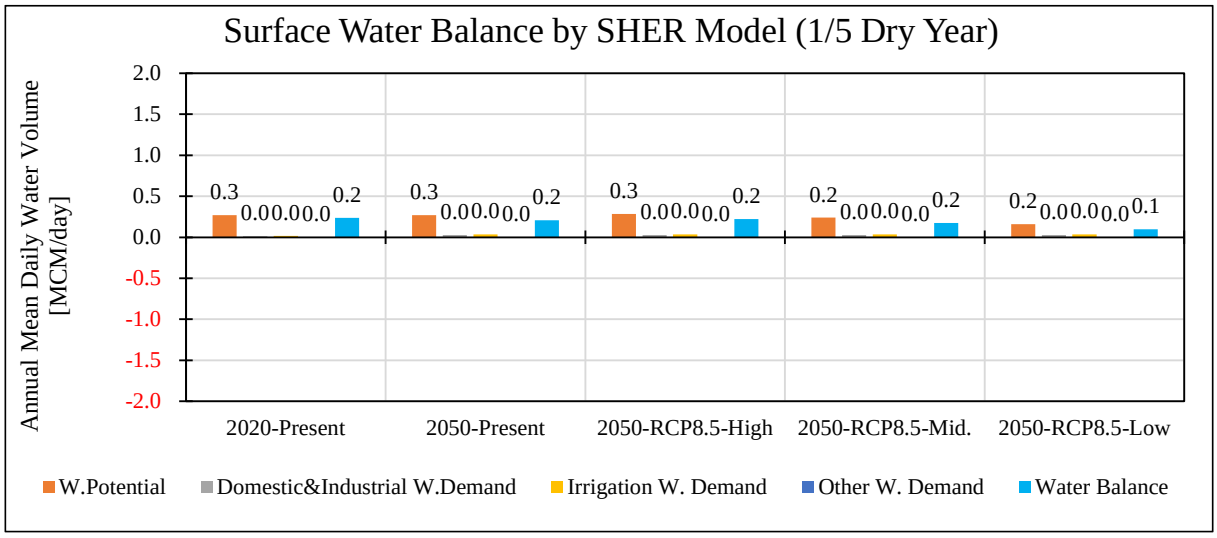
Source: JICA Survey Team

Figure D-461 Groundwater Balance of Sibulan City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



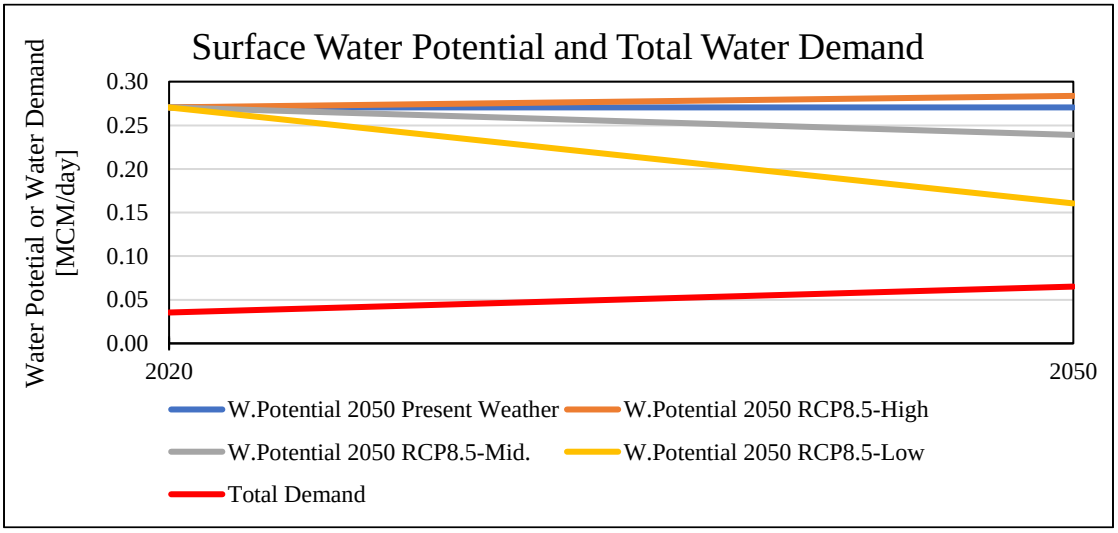
Source: JICA Survey Team

Figure D-462 Groundwater Balance of Sibulan City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



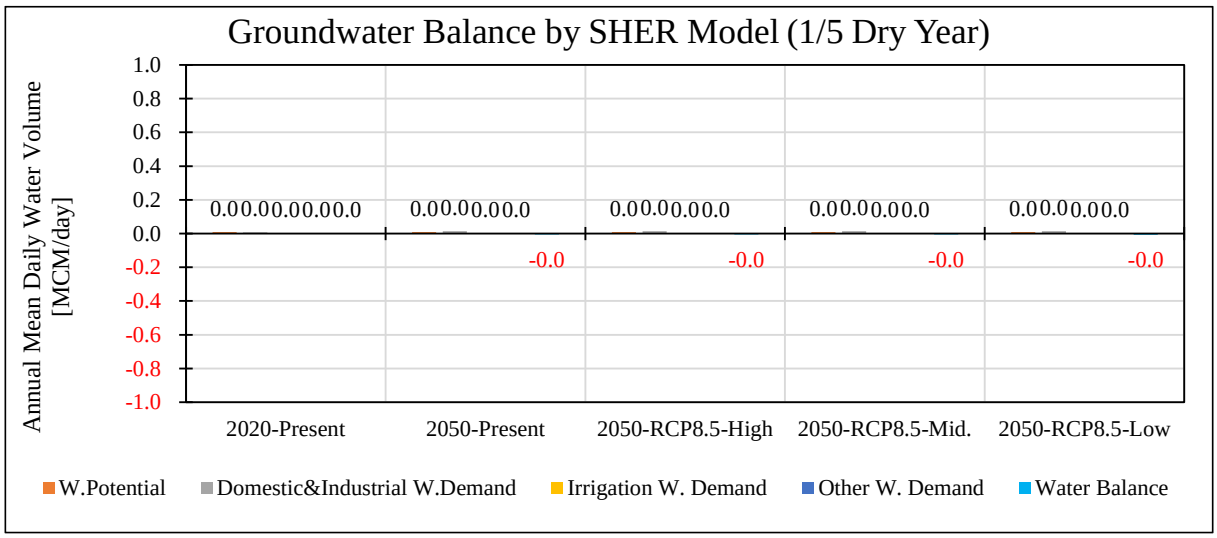
Source: JICA Survey Team

Figure D-463 Surface Water Balance of Siquijor Island in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



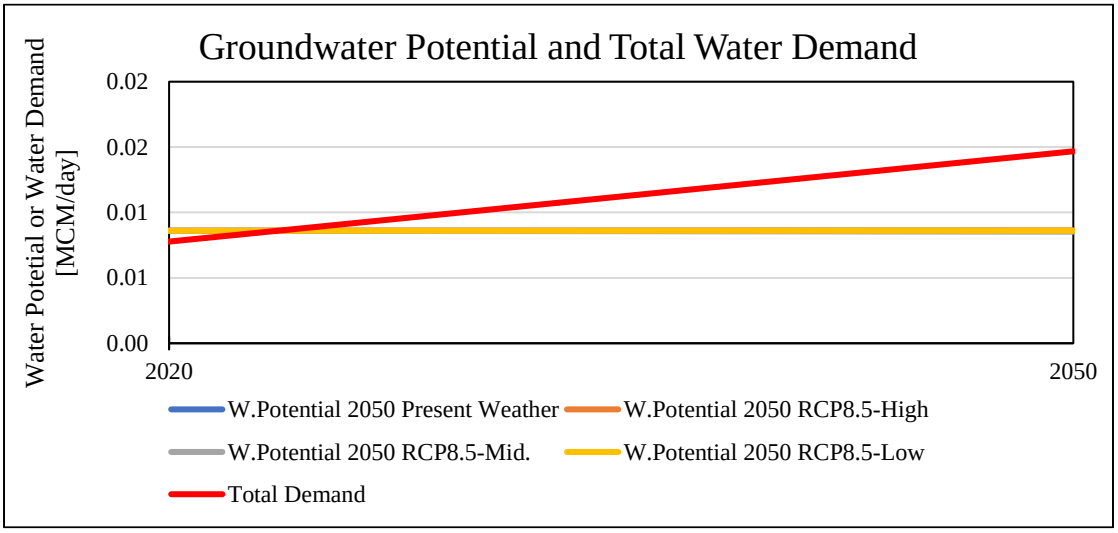
Source: JICA Survey Team

Figure D-464 Surface Water Balance of Siquijor Island in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



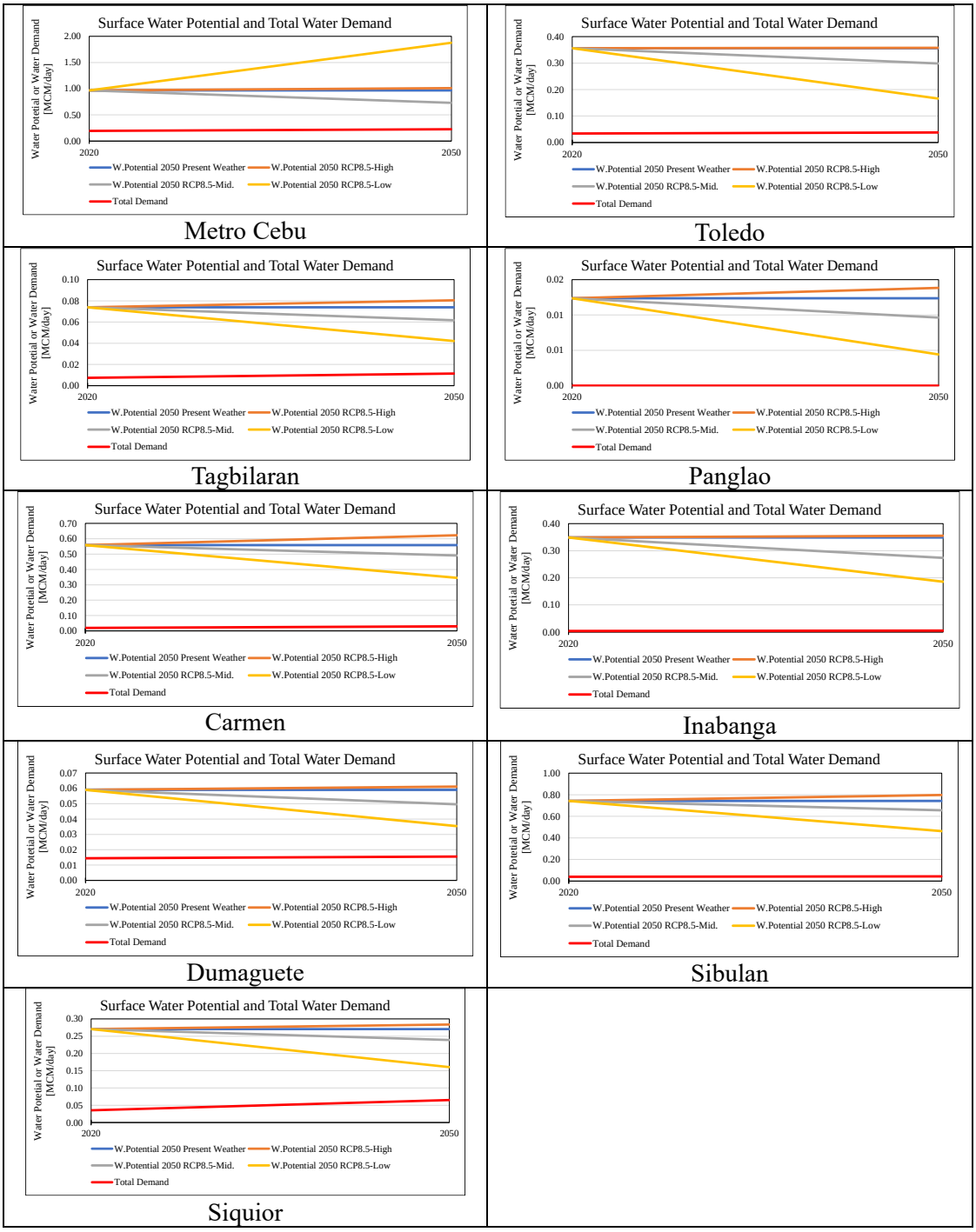
Source: JICA Survey Team

Figure D-465 Groundwater Balance of Siquijor Island in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



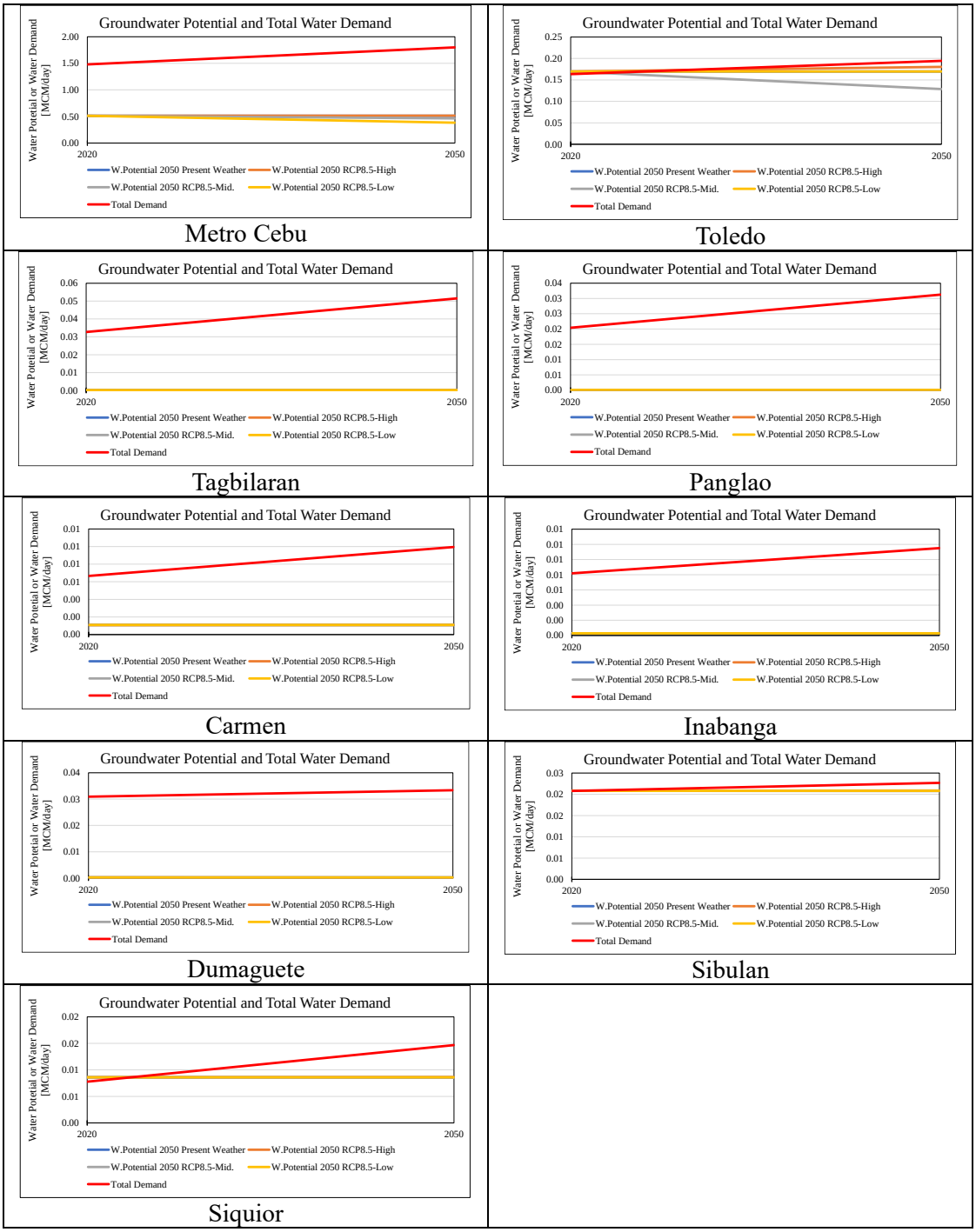
Source: JICA Survey Team

Figure D-466 Groundwater Balance of Siquijor Island in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



Source: JICA Survey Team

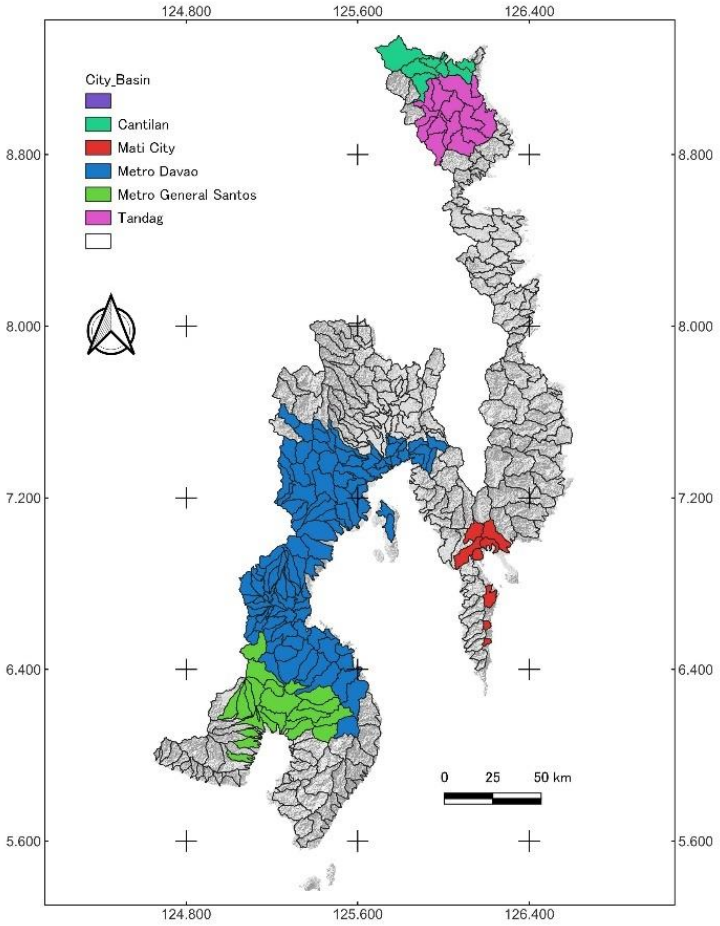
Figure D-467 Surface Water Balance by Major Cities in WRR-VII at Each Climate Change Condition



Source: JICA Survey Team

FigureD-468 Groundwater Balance by Major Cities in WRR-VII at Each Climate Change Condition

11.5.2 WRR-XI



Source: JICA Survey Team

Figure D-469 Location Map of Major Cities in WRR-VII

Table D-205 Surface and Groundwater Balance of Metro Davao in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Metro Davao Target Year= 2050
Weather Condition: Present Total Area [km2]= 5,896 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	754.3	698.4	560.1	350.2	1,244.3	1,747.3	699.4	1,142.8	1,400.9	1,017.5	710.9	471.2	10,797.1	
Surface Water Potential	**773.5**	**478.8**	**398.2**	**257.8**	**409.8**	**736.5**	**453.7**	**557.5**	**811.7**	**629.9**	**525.0**	**374.2**	**6,406.6**	
Irrigation Water Demand (SW)	137.7	96.2	79.5	52.5	44.1	132.0	112.8	125.1	71.0	21.2	112.9	154.0	1,139.1	
Livestock Water Deamnd (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.1	
Municipal and Industrial Water Demand (SW)	10.4	9.4	10.4	10.0	10.4	10.0	10.4	10.4	10.0	10.4	10.0	10.4	122.2	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	148.5	106.0	90.4	62.9	54.9	142.5	123.6	135.9	81.5	32.1	123.3	164.9	1,266.4	
SW Water Balance	**625.0**	**372.9**	**307.8**	**194.8**	**354.9**	**594.1**	**330.1**	**421.6**	**730.2**	**597.8**	**401.7**	**209.3**	**5,140.2**	**0.0**
Groundwater Potential	**6.6**	**6.0**	**4.7**	**4.1**	**4.3**	**5.1**	**4.6**	**4.5**	**4.3**	**4.8**	**6.0**	**5.8**	**60.9**	
Safety Groundwater Availability (70% of GWP)	**4.6**	**4.2**	**3.3**	**2.8**	**3.0**	**3.6**	**3.2**	**3.1**	**3.0**	**3.4**	**4.2**	**4.0**	**42.6**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	43.2	39.0	43.2	41.8	43.2	41.8	43.2	43.2	41.8	43.2	41.8	43.2	508.5	
Other Water Demand (GW)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.9	
Total Water Demand (GW)	44.1	39.9	44.1	42.7	44.1	42.7	44.1	44.1	42.7	44.1	42.7	44.1	519.6	
GW Water Balance	**-39.5**	**-35.7**	**-40.8**	**-39.9**	**-41.1**	**-39.1**	**-40.9**	**-41.0**	**-39.7**	**-40.7**	**-38.5**	**-40.1**	**-477.0**	**-477.0**
Total Water Potential (SW+GW)	**778.1**	**483.0**	**401.5**	**260.6**	**412.9**	**740.1**	**456.9**	**560.7**	**814.7**	**633.3**	**529.2**	**378.2**	**6,449.2**	
Irrigation Water Demand (Total)	137.7	96.2	79.6	52.5	44.1	132.0	112.8	125.1	71.0	21.2	112.9	154.1	1,139.2	
Livestock Water Deamnd (Total)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.3	
Municipal and Industrial Water Demand (Total)	53.6	48.4	53.6	51.8	53.6	51.8	53.6	53.6	51.8	53.6	51.8	53.6	630.7	
Other Water Demand (Total)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.9	
Total Water Demand (SW+GW)	192.7	145.8	134.5	105.7	99.1	185.2	167.7	180.0	124.2	76.2	166.0	209.0	1,786.0	
Total Water Balance (SW+GW)	**585.5**	**337.2**	**267.0**	**155.0**	**313.8**	**554.9**	**289.2**	**380.7**	**690.5**	**557.1**	**363.2**	**169.2**	**4,663.2**	**-477.0**

Source: JICA Survey Team

Table D-206 Surface and Groundwater Balance of Metro General Santos in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Metro General Santos Target Year= 2050
Weather Condition: Present Total Area [km2]= 1,737 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	147.3	166.8	126.3	94.0	165.3	282.4	296.5	154.0	158.7	232.5	134.1	161.7	2,119.7	
Surface Water Potential	**240.8**	**237.8**	**226.8**	**206.0**	**203.1**	**227.4**	**254.8**	**220.5**	**224.0**	**224.3**	**233.5**	**228.9**	**2,727.6**	
Irrigation Water Demand (SW)	12.6	3.7	15.6	30.1	23.9	22.8	5.6	6.5	10.7	15.8	22.4	22.3	191.9	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.3	
Municipal and Industrial Water Demand (SW)	2.5	2.3	2.5	2.4	2.5	2.4	2.5	2.5	2.4	2.5	2.4	2.5	29.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	15.2	6.0	18.2	32.7	26.6	25.3	8.2	9.2	13.3	18.4	24.9	24.9	222.9	
SW Water Balance	**225.6**	**231.7**	**208.6**	**173.3**	**176.5**	**202.1**	**246.6**	**211.3**	**210.7**	**205.9**	**208.5**	**204.0**	**2,504.7**	**0.0**
Groundwater Potential	**7.8**	**6.9**	**3.2**	**1.9**	**2.3**	**4.3**	**2.9**	**2.6**	**2.5**	**3.5**	**6.6**	**5.8**	**50.2**	
Safety Groundwater Availability (70% of GWP)	**5.5**	**4.8**	**2.2**	**1.3**	**1.6**	**3.0**	**2.0**	**1.8**	**1.7**	**2.4**	**4.6**	**4.1**	**35.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.5	
Livestock Water Deamnd (GW)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.5	
Municipal and Industrial Water Demand (GW)	12.5	11.3	12.5	12.1	12.5	12.1	12.5	12.5	12.1	12.5	12.1	12.5	147.3	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	12.8	11.5	12.8	12.4	12.8	12.4	12.7	12.7	12.3	12.8	12.4	12.8	150.3	
GW Water Balance	**-7.3**	**-6.7**	**-10.5**	**-11.1**	**-11.2**	**-9.3**	**-10.7**	**-10.9**	**-10.6**	**-10.3**	**-7.7**	**-8.7**	**-115.2**	**-115.2**
Total Water Potential (SW+GW)	**246.3**	**242.6**	**229.0**	**207.3**	**204.7**	**230.4**	**256.8**	**222.3**	**225.7**	**226.7**	**238.1**	**233.0**	**2,762.7**	
Irrigation Water Demand (Total)	12.6	3.7	15.6	30.2	24.0	22.8	5.6	6.5	10.8	15.8	22.5	22.3	192.4	
Livestock Water Deamnd (Total)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.8	
Municipal and Industrial Water Demand (Total)	15.0	13.6	15.0	14.5	15.0	14.5	15.0	15.0	14.5	15.0	14.5	15.0	177.0	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	28.0	17.5	31.0	45.1	39.4	37.7	20.9	21.9	25.6	31.2	37.3	37.7	373.2	
Total Water Balance (SW+GW)	**218.3**	**225.0**	**198.0**	**162.2**	**165.3**	**192.7**	**235.9**	**200.4**	**200.1**	**195.5**	**200.8**	**195.3**	**2,389.6**	**-115.2**

Source: JICA Survey Team

Table D-207 Surface and Groundwater Balance of Cantilan City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Cantilan Target Year= 2050
Weather Condition: Present Total Area [km2]= 628 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	230.8	153.3	144.9	171.6	163.5	156.4	130.9	97.8	130.8	137.8	246.7	156.8	1,921.4	
Surface Water Potential	**140.7**	**82.6**	**59.5**	**56.6**	**78.0**	**51.4**	**55.9**	**46.2**	**40.1**	**43.8**	**122.7**	**65.7**	**843.2**	
Irrigation Water Demand (SW)	1.4	1.2	0.7	0.0	0.0	2.0	1.5	2.0	1.6	0.0	1.8	1.5	13.8	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.8	1.5	1.1	0.4	0.4	2.4	1.9	2.4	2.0	0.4	2.2	1.9	18.6	
SW Water Balance	**138.9**	**81.0**	**58.4**	**56.2**	**77.6**	**49.0**	**54.0**	**43.8**	**38.0**	**43.4**	**120.5**	**63.7**	**824.6**	**0.0**
Groundwater Potential	**1.5**	**1.4**	**0.8**	**0.6**	**0.7**	**1.0**	**0.8**	**0.8**	**0.7**	**0.9**	**1.3**	**1.2**	**11.9**	
Safety Groundwater Availability (70% of GWP)	**1.1**	**0.9**	**0.6**	**0.4**	**0.5**	**0.7**	**0.6**	**0.5**	**0.5**	**0.6**	**0.9**	**0.9**	**8.3**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.7	
GW Water Balance	**0.9**	**0.8**	**0.4**	**0.3**	**0.3**	**0.6**	**0.4**	**0.4**	**0.4**	**0.5**	**0.8**	**0.7**	**6.6**	**0.0**
Total Water Potential (SW+GW)	**141.8**	**83.5**	**60.1**	**57.0**	**78.5**	**52.1**	**56.5**	**46.7**	**40.6**	**44.4**	**123.6**	**66.5**	**851.5**	
Irrigation Water Demand (Total)	1.4	1.2	0.7	0.0	0.0	2.0	1.5	2.0	1.6	0.0	1.8	1.5	13.8	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.4	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	2.0	1.7	1.3	0.5	0.6	2.6	2.1	2.5	2.2	0.6	2.4	2.1	20.4	
Total Water Balance (SW+GW)	**139.8**	**81.8**	**58.8**	**56.5**	**77.9**	**49.6**	**54.4**	**44.2**	**38.4**	**43.9**	**121.3**	**64.5**	**831.1**	**0.0**

Source: JICA Survey Team

Table D-208 Surface and Groundwater Balance of Tandag City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Tandag Target Year= 2050
Weather Condition: Present Total Area [km2]= 1,283 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	362.4	199.1	386.1	320.2	403.8	348.9	306.2	181.3	253.8	315.3	550.7	260.2	3,888.1	
Surface Water Potential	**146.0**	**118.0**	**143.6**	**115.8**	**180.8**	**123.8**	**146.7**	**99.7**	**92.1**	**141.4**	**222.1**	**127.5**	**1,657.5**	
Irrigation Water Demand (SW)	4.2	2.7	3.8	4.0	3.5	6.2	3.3	4.5	3.8	1.8	6.1	5.8	49.5	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (SW)	0.7	0.6	0.7	0.6	0.7	0.6	0.7	0.7	0.6	0.7	0.6	0.7	7.8	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	4.9	3.3	4.5	4.7	4.2	6.8	3.9	5.1	4.5	2.5	6.7	6.4	57.6	
SW Water Balance	**141.1**	**114.7**	**139.1**	**111.1**	**176.7**	**116.9**	**142.7**	**94.6**	**87.6**	**139.0**	**215.4**	**121.0**	**1,599.9**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.0	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.0	
GW Water Balance	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-0.4**	**-4.9**	**-4.9**
Total Water Potential (SW+GW)	**146.0**	**118.0**	**143.6**	**115.8**	**180.8**	**123.8**	**146.7**	**99.7**	**92.1**	**141.4**	**222.1**	**127.5**	**1,657.6**	
Irrigation Water Demand (Total)	4.2	2.7	3.8	4.0	3.5	6.2	3.3	4.5	3.8	1.8	6.1	5.8	49.5	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (Total)	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	12.8	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	5.3	3.7	4.9	5.1	4.6	7.3	4.4	5.6	4.9	2.9	7.1	6.9	62.6	
Total Water Balance (SW+GW)	**140.7**	**114.3**	**138.7**	**110.7**	**176.3**	**116.5**	**142.3**	**94.2**	**87.2**	**138.5**	**215.0**	**120.6**	**1,595.0**	**-4.9**

Source: JICA Survey Team

Table D-209 Surface and Groundwater Balance of Mati City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

City/Town : Mati City Target Year= 2050
Weather Condition: Present Total Area [km2]= 409 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	4.3	14.3	19.2	9.1	62.6	133.9	86.7	57.2	118.5	183.1	92.2	87.9	869.2	
Surface Water Potential	**20.1**	**18.0**	**17.2**	**19.1**	**14.6**	**39.0**	**41.4**	**33.7**	**46.4**	**113.7**	**53.5**	**45.7**	**462.4**	
Irrigation Water Demand (SW)	12.8	8.3	3.9	0.0	1.0	8.8	6.9	9.4	2.7	0.0	4.5	4.8	63.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.3	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	14.1	9.4	5.1	1.2	2.2	9.9	8.1	10.6	3.9	1.2	5.6	6.0	77.4	
SW Water Balance	**6.1**	**8.6**	**12.1**	**17.9**	**12.4**	**29.0**	**33.3**	**23.0**	**42.5**	**112.5**	**47.9**	**39.7**	**385.0**	**0.0**
Groundwater Potential	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**5.2**	
Safety Groundwater Availability (70% of GWP)	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**3.6**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.7	
GW Water Balance	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**1.9**	**0.0**
Total Water Potential (SW+GW)	**20.4**	**18.3**	**17.5**	**19.4**	**14.9**	**39.3**	**41.7**	**34.0**	**46.7**	**114.0**	**53.8**	**46.0**	**466.0**	
Irrigation Water Demand (Total)	12.8	8.3	3.9	0.0	1.0	8.8	6.9	9.4	2.7	0.0	4.5	4.8	63.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	1.4	1.2	1.4	1.3	1.4	1.3	1.4	1.4	1.3	1.4	1.3	1.4	16.0	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	14.2	9.5	5.3	1.3	2.3	10.1	8.2	10.8	4.1	1.4	5.8	6.1	79.1	
Total Water Balance (SW+GW)	**6.2**	**8.7**	**12.3**	**18.1**	**12.6**	**29.2**	**33.5**	**23.2**	**42.7**	**112.6**	**48.0**	**39.9**	**386.9**	**0.0**

Source: JICA Survey Team

Table D-210 Summary of Annual Water Balance and Deficit of Metro Davao Area at Each Climate Change Condition

Total Area [km^2]= 5,896

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	7,745.5	-281.8	7,463.6	0.0	-281.8	-281.8
2	Present	2020	1/5-Dry Year	5,677.5	-281.9	5,395.6	0.0	-281.9	-281.9
3	Present	2020	1/10-Dry Year	4,862.8	-282.0	4,580.8	0.0	-282.0	-282.0
4	Present	2050	Average Year	7,208.1	-476.9	6,731.2	0.0	-476.9	-476.9
5	Present	2050	1/5-Dry Year	5,140.2	-477.0	4,663.2	0.0	-477.0	-477.0
6	Present	2050	1/10-Dry Year	4,325.4	-477.1	3,848.3	0.0	-477.1	-477.1
7	CC RCP8.5-High	2050	Average Year	6,878.6	-476.9	6,401.7	0.0	-476.9	-476.9
8	CC RCP8.5-High	2050	1/5-Dry Year	5,236.5	-476.9	4,759.6	0.0	-476.9	-476.9
9	CC RCP8.5-High	2050	1/10-Dry Year	4,584.9	-477.0	4,107.9	0.0	-477.0	-477.0
10	CC RCP8.5-Mid.	2050	Average Year	6,553.1	-491.1	6,062.1	0.0	-491.1	-491.1
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	5,037.1	-491.2	4,545.9	0.0	-491.2	-491.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	4,660.8	-491.0	4,169.7	0.0	-491.0	-491.0
13	CC RCP8.5-Low	2050	Average Year	7,253.5	-495.8	6,757.7	0.0	-495.8	-495.8
14	CC RCP8.5-Low	2050	1/5-Dry Year	5,121.9	-495.9	4,626.0	0.0	-495.9	-495.9
15	CC RCP8.5-Low	2050	1/10-Dry Year	4,843.7	-495.6	4,348.0	0.0	-495.6	-495.6

Source: JICA Survey Team

Table D-211 Summary of Annual Water Balance and Deficit of Metro General Santos Area at Each Climate Change Condition

Total Area [km^2]= 1,737

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	2,817.0	-90.0	2,727.1	0.0	-90.0	-90.0
2	Present	2020	1/5-Dry Year	2,576.7	-90.1	2,486.6	0.0	-90.1	-90.1
3	Present	2020	1/10-Dry Year	2,485.3	-90.1	2,395.2	0.0	-90.1	-90.1
4	Present	2050	Average Year	2,745.1	-115.0	2,630.0	0.0	-115.0	-115.0
5	Present	2050	1/5-Dry Year	2,504.7	-115.2	2,389.6	0.0	-115.2	-115.2
6	Present	2050	1/10-Dry Year	2,413.4	-115.1	2,298.2	0.0	-115.1	-115.1
7	CC RCP8.5-High	2050	Average Year	2,646.6	-115.0	2,531.6	0.0	-115.0	-115.0
8	CC RCP8.5-High	2050	1/5-Dry Year	2,401.3	-115.1	2,286.1	0.0	-115.1	-115.1
9	CC RCP8.5-High	2050	1/10-Dry Year	2,400.3	-115.1	2,285.1	0.0	-115.1	-115.1
10	CC RCP8.5-Mid.	2050	Average Year	1,505.9	-125.1	1,380.9	0.0	-125.1	-125.1
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,198.6	-125.2	1,073.5	0.0	-125.2	-125.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,195.4	-125.1	1,070.2	0.0	-125.1	-125.1
13	CC RCP8.5-Low	2050	Average Year	2,819.8	-130.7	2,689.1	0.0	-130.7	-130.7
14	CC RCP8.5-Low	2050	1/5-Dry Year	2,645.2	-130.8	2,514.4	0.0	-130.8	-130.8
15	CC RCP8.5-Low	2050	1/10-Dry Year	2,483.8	-130.8	2,353.0	0.0	-130.8	-130.8

Source: JICA Survey Team

Table D-212 Summary of Annual Water Balance and Deficit of Cantilan City at Each Climate Change Condition

Total Area [km^2]= 628

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	995.8	7.0	1,002.8	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	835.1	7.0	842.1	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	664.4	7.0	671.4	0.0	0.0	0.0
4	Present	2050	Average Year	985.4	6.6	991.9	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	824.6	6.6	831.1	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	653.9	6.6	660.5	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	1,267.8	6.6	1,274.4	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	1,018.3	6.6	1,024.8	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	808.4	6.6	815.0	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	1,870.3	15.2	1,885.4	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,843.3	15.2	1,858.5	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,529.3	15.6	1,544.9	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	905.0	8.0	913.1	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	531.4	8.0	539.4	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	456.0	8.0	464.1	0.0	0.0	0.0

Source: JICA Survey Team

Table D-213 Summary of Annual Water Balance and Deficit of Tandag City at Each Climate Change Condition

Total Area [km^2]= 1,283

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	3,441.5	-3.7	3,437.8	0.0	-3.7	-3.7
2	Present	2020	1/5-Dry Year	1,628.0	-3.7	1,624.4	0.0	-3.7	-3.7
3	Present	2020	1/10-Dry Year	1,097.0	-3.7	1,093.3	0.0	-3.7	-3.7
4	Present	2050	Average Year	3,413.4	-4.9	3,408.5	0.0	-4.9	-4.9
5	Present	2050	1/5-Dry Year	1,599.9	-4.9	1,595.0	0.0	-4.9	-4.9
6	Present	2050	1/10-Dry Year	1,068.8	-4.9	1,063.9	0.0	-4.9	-4.9
7	CC RCP8.5-High	2050	Average Year	3,940.5	-4.9	3,935.6	0.0	-4.9	-4.9
8	CC RCP8.5-High	2050	1/5-Dry Year	1,882.8	-4.9	1,877.9	0.0	-4.9	-4.9
9	CC RCP8.5-High	2050	1/10-Dry Year	1,229.2	-4.9	1,224.3	0.0	-4.9	-4.9
10	CC RCP8.5-Mid.	2050	Average Year	4,311.2	-0.6	4,310.6	0.0	-0.6	-0.6
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	2,036.9	-0.6	2,036.3	0.0	-0.6	-0.6
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,256.9	-0.3	1,256.5	0.0	-0.3	-0.3
13	CC RCP8.5-Low	2050	Average Year	4,198.2	-1.6	4,196.6	0.0	-1.6	-1.6
14	CC RCP8.5-Low	2050	1/5-Dry Year	3,796.4	-1.6	3,794.8	0.0	-1.6	-1.6
15	CC RCP8.5-Low	2050	1/10-Dry Year	1,850.2	-4.6	1,845.6	0.0	-4.6	-4.6

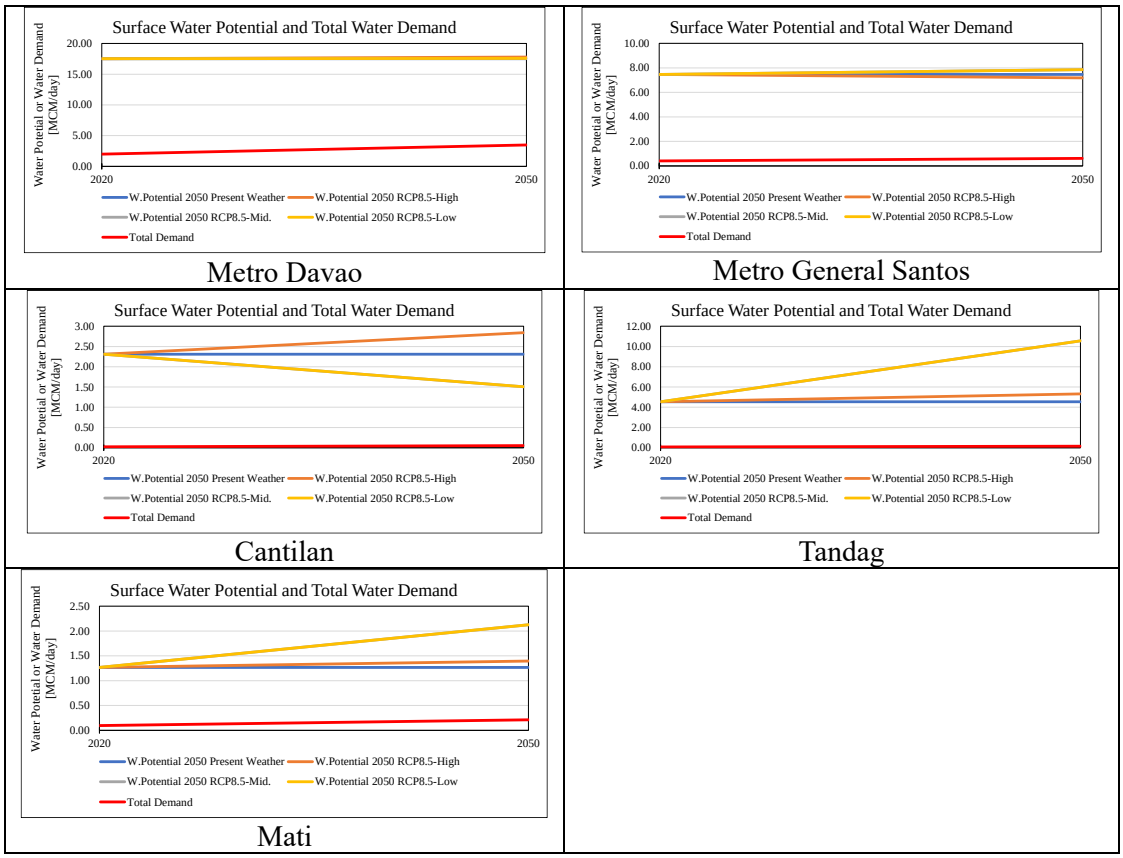
Source: JICA Survey Team

Table D-214 Summary of Annual Water Balance and Deficit of Mati City at Each Climate Change Condition

Total Area [km^2]= 409

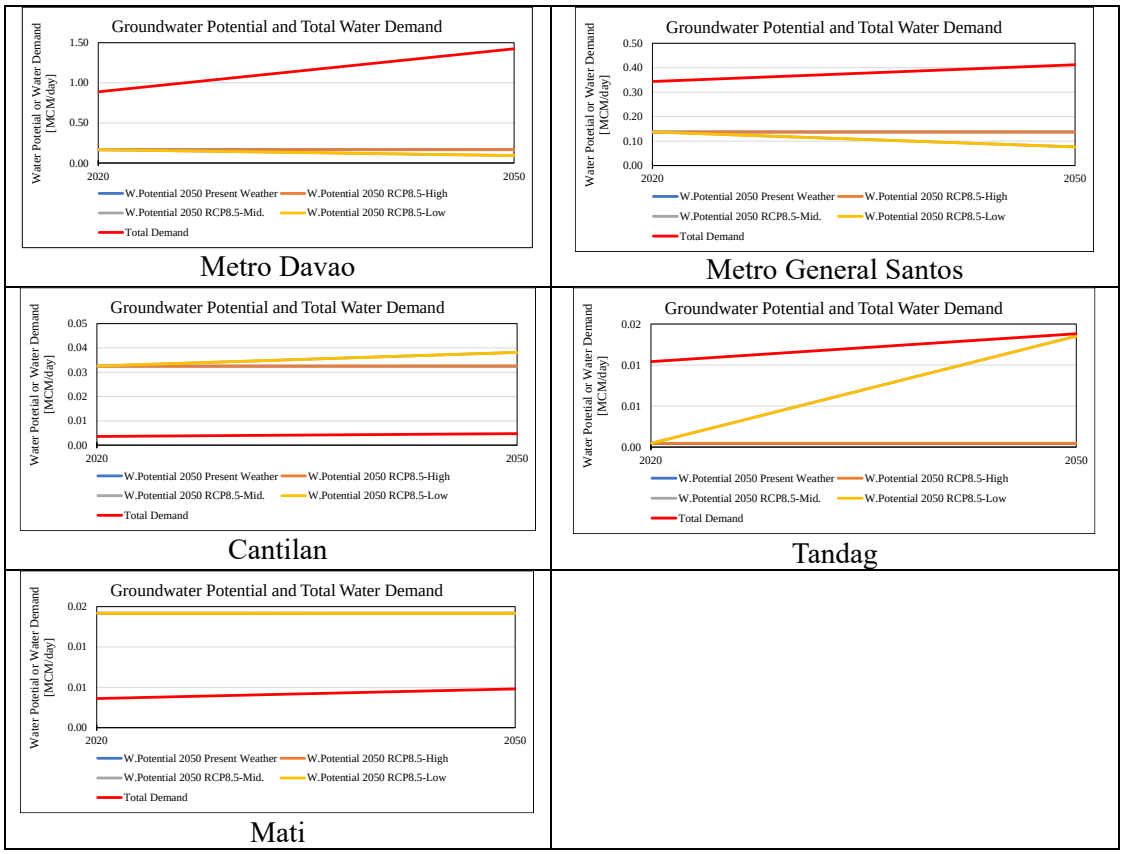
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	442.6	2.3	444.9	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	426.9	2.3	429.3	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	458.0	2.3	460.3	0.0	0.0	0.0
4	Present	2050	Average Year	400.6	1.9	402.5	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	385.0	1.9	386.9	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	416.1	1.9	418.0	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	457.0	1.9	458.9	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	432.2	1.9	434.1	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	459.8	1.9	461.7	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	662.3	-1.0	661.3	0.0	-1.0	-1.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	635.6	-1.0	634.6	0.0	-1.0	-1.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	557.1	-1.0	556.1	0.0	-1.0	-1.0
13	CC RCP8.5-Low	2050	Average Year	697.8	1.9	699.7	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	699.0	1.9	700.9	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	304.4	1.9	306.3	0.0	0.0	0.0

Source: JICA Survey Team



Source: JICA Survey Team

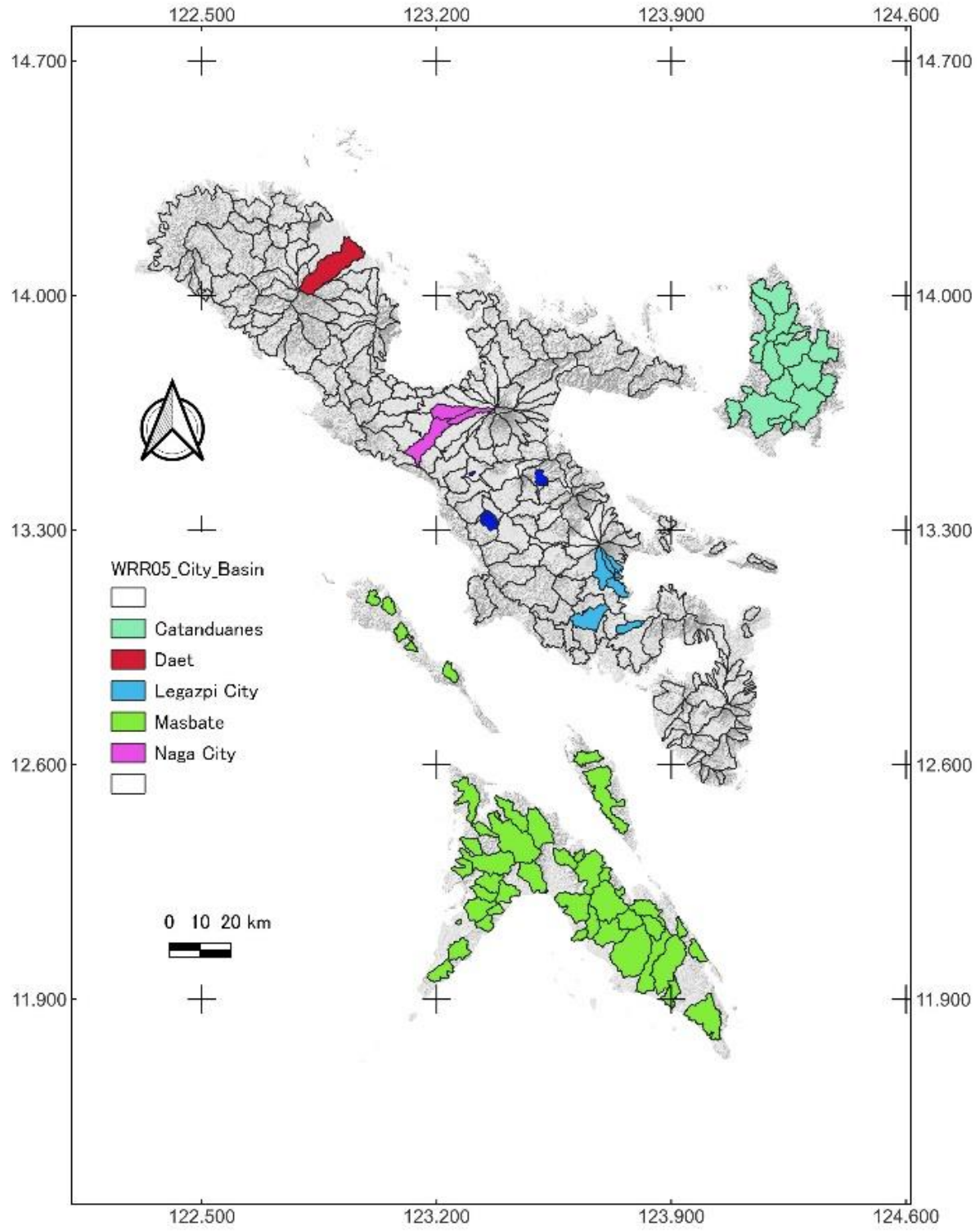
Figure D-470 Surface Water Balance by Major Cities in WRR-XI at Each Climate Change Condition



Source: JICA Survey Team

Figure D-471 Groundwater Balance by Major Cities in WRR-XI at Each Climate Change Condition

11.5.3 WRR-V



Source: JICA Survey Team

Figure D-472 Location Map of Major Cities in WRR-VII

Table D-215 Surface and Groundwater Balance of Legazpi City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Town/City: Legazpi City Target Year= 2050
Weather Condition: Present Total Area [km2]= 177 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	37.4	24.1	21.1	23.9	26.3	17.9	50.9	49.4	50.1	39.1	72.7	59.0	471.9	
Surface Water Potential	**28.2**	**18.2**	**17.8**	**15.8**	**13.7**	**11.7**	**19.1**	**30.2**	**32.2**	**22.8**	**46.4**	**33.0**	**289.1**	
Irrigation Water Demand (SW)	6.1	5.2	8.0	1.5	7.4	7.5	4.1	3.7	0.6	0.0	0.0	4.3	48.2	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	1.7	1.5	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	20.2	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	7.8	6.8	9.7	3.1	9.1	9.2	5.8	5.5	2.2	1.7	1.7	6.0	68.5	
SW Water Balance	**20.4**	**11.4**	**8.1**	**12.6**	**4.6**	**2.6**	**13.3**	**24.8**	**30.0**	**21.1**	**44.8**	**27.0**	**220.6**	**0.0**
Groundwater Potential	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**2.4**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**1.7**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	1.2	1.1	1.2	1.1	1.2	1.1	1.2	1.2	1.1	1.2	1.1	1.2	13.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (GW)	1.2	1.1	1.2	1.1	1.2	1.1	1.2	1.2	1.1	1.2	1.1	1.2	13.8	
GW Water Balance	**-1.0**	**-0.9**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-12.2**	**-12.2**
Total Water Potential (SW+GW)	**28.4**	**18.3**	**17.9**	**15.9**	**13.8**	**11.8**	**19.3**	**30.4**	**32.3**	**22.9**	**46.6**	**33.1**	**290.8**	
Irrigation Water Demand (Total)	6.1	5.2	8.0	1.5	7.4	7.5	4.1	3.7	0.6	0.0	0.0	4.3	48.2	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	2.9	2.6	2.9	2.8	2.9	2.8	2.9	2.9	2.8	2.9	2.8	2.9	33.9	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (SW+GW)	9.0	7.8	10.9	4.3	10.3	10.3	7.0	6.6	3.4	2.9	2.8	7.2	82.3	
Total Water Balance (SW+GW)	**19.4**	**10.5**	**7.1**	**11.6**	**3.6**	**1.6**	**12.3**	**23.7**	**29.0**	**20.0**	**43.8**	**26.0**	**208.4**	**-12.2**

Source: JICA Survey Team

Table D-216 Surface and Groundwater Balance of Daet City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Town/City: Daet Target Year= 2050
Weather Condition: Present Total Area [km2]= 142 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	34.1	31.1	39.0	6.2	35.4	30.5	23.6	30.9	16.7	75.1	108.7	50.9	482.1	
Surface Water Potential	**33.5**	**23.5**	**23.6**	**15.0**	**14.0**	**16.3**	**11.8**	**14.9**	**10.9**	**33.5**	**54.3**	**61.1**	**312.2**	
Irrigation Water Demand (SW)	2.2	1.9	2.3	0.3	2.4	1.0	1.3	1.2	0.0	0.0	0.0	1.2	13.7	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.9	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	3.1	2.7	3.3	1.2	3.3	1.9	2.2	2.1	0.9	0.9	0.9	2.1	24.6	
SW Water Balance	**30.4**	**20.8**	**20.3**	**13.8**	**10.7**	**14.4**	**9.6**	**12.8**	**10.0**	**32.6**	**53.4**	**58.9**	**287.5**	**0.0**
Groundwater Potential	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**2.2**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**1.6**	
Irrigation Water Demand (GW)	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1	1.0	1.1	12.6	
Other Water Demand (GW)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.1	
Total Water Demand (GW)	2.3	2.1	2.3	2.2	2.3	2.2	2.3	2.3	2.2	2.3	2.2	2.3	27.1	
GW Water Balance	**-2.2**	**-2.0**	**-2.2**	**-2.1**	**-2.2**	**-2.1**	**-2.2**	**-2.2**	**-2.1**	**-2.1**	**-2.1**	**-2.2**	**-25.6**	**-25.6**
Total Water Potential (SW+GW)	**33.7**	**23.6**	**23.7**	**15.1**	**14.1**	**16.4**	**11.9**	**15.0**	**11.0**	**33.6**	**54.4**	**61.2**	**313.7**	
Irrigation Water Demand (Total)	2.3	1.9	2.4	0.3	2.4	1.0	1.3	1.2	0.0	0.0	0.0	1.2	14.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	2.0	1.8	2.0	1.9	2.0	1.9	2.0	2.0	1.9	2.0	1.9	2.0	23.5	
Other Water Demand (Total)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.1	
Total Water Demand (SW+GW)	5.5	4.8	5.6	3.4	5.6	4.1	4.5	4.4	3.1	3.2	3.1	4.4	51.8	
Total Water Balance (SW+GW)	**28.2**	**18.8**	**18.1**	**11.7**	**8.5**	**12.3**	**7.4**	**10.6**	**7.9**	**30.4**	**51.3**	**56.8**	**261.9**	**-25.6**

Source: JICA Survey Team

Table D-217 Surface and Groundwater Balance of Naga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Town/City: Naga City Target Year= 2050
Weather Condition: Present Total Area [km2]= 148 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	16.8	9.6	10.9	7.0	18.1	14.6	41.5	43.4	50.2	35.1	54.4	35.5	337.1	
Surface Water Potential	**60.1**	**40.9**	**32.9**	**30.2**	**20.0**	**16.3**	**39.1**	**14.4**	**22.7**	**25.7**	**45.5**	**33.8**	**381.6**	
Irrigation Water Demand (SW)	19.5	20.9	29.3	3.8	19.4	21.1	15.0	16.1	0.0	0.0	0.0	10.5	155.7	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	19.6	21.0	29.3	3.9	19.5	21.1	15.1	16.1	0.0	0.1	0.0	10.6	156.3	
SW Water Balance	**40.5**	**20.0**	**3.6**	**26.3**	**0.5**	**-4.8**	**24.0**	**-1.7**	**22.7**	**25.7**	**45.4**	**23.3**	**225.3**	**-6.5**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	
Irrigation Water Demand (GW)	0.4	0.5	0.6	0.1	0.5	0.5	0.4	0.4	0.0	0.0	0.0	0.2	3.6	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (GW)	4.6	4.1	4.6	4.4	4.6	4.4	4.6	4.6	4.4	4.6	4.4	4.6	53.6	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	5.0	4.6	5.2	4.5	5.1	4.9	4.9	5.0	4.4	4.6	4.4	4.8	57.5	
GW Water Balance	**-5.0**	**-4.6**	**-5.2**	**-4.5**	**-5.0**	**-4.9**	**-4.9**	**-5.0**	**-4.4**	**-4.6**	**-4.4**	**-4.8**	**-57.4**	**-57.4**
Total Water Potential (SW+GW)	**60.1**	**40.9**	**32.9**	**30.2**	**20.0**	**16.3**	**39.1**	**14.4**	**22.7**	**25.7**	**45.5**	**33.8**	**381.7**	
Irrigation Water Demand (Total)	20.0	21.4	29.9	3.9	19.9	21.6	15.4	16.5	0.0	0.0	0.0	10.7	159.3	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Municipal and Industrial Water Demand (Total)	4.6	4.1	4.6	4.4	4.6	4.4	4.6	4.6	4.4	4.6	4.4	4.6	53.9	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	24.6	25.6	34.5	8.4	24.5	26.1	20.0	21.1	4.5	4.6	4.5	15.4	213.8	
Total Water Balance (SW+GW)	**35.5**	**15.4**	**-1.6**	**21.8**	**-4.6**	**-9.7**	**19.1**	**-6.7**	**18.3**	**21.1**	**41.0**	**18.5**	**167.9**	**-64.0**

Source: JICA Survey Team

Table D-218 Summary of Annual Water Balance and Deficit of Legazpi City at Each Climate Change Condition

Total Area [km^2]= 177

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	233.5	-4.9	228.6	0.0	-4.9	-4.9
2	Present	2020	1/5-Dry Year	258.4	-4.9	253.5	0.0	-4.9	-4.9
3	Present	2020	1/10-Dry Year	198.8	-4.9	193.9	0.0	-4.9	-4.9
4	Present	2050	Average Year	203.8	-7.0	196.8	-2.7	-7.0	-9.6
5	Present	2050	1/5-Dry Year	228.7	-7.0	221.7	0.0	-7.0	-7.0
6	Present	2050	1/10-Dry Year	169.0	-7.0	162.0	-2.8	-7.0	-9.7
7	CC RCP8.5-High	2050	Average Year	269.6	-7.0	262.6	-0.7	-7.0	-7.7
8	CC RCP8.5-High	2050	1/5-Dry Year	296.1	-7.0	289.2	0.0	-7.0	-7.0
9	CC RCP8.5-High	2050	1/10-Dry Year	231.3	-7.0	224.3	-0.7	-7.0	-7.6
10	CC RCP8.5-Mid.	2050	Average Year	213.8	-7.0	206.9	-2.8	-7.0	-9.7
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	229.1	-7.0	222.1	0.0	-7.0	-7.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	171.0	-7.0	164.1	-3.0	-7.0	-10.0
13	CC RCP8.5-Low	2050	Average Year	141.3	-7.0	134.3	-8.0	-7.0	-15.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	167.1	-7.0	160.1	0.0	-7.0	-7.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	117.2	-7.0	110.2	-6.7	-7.0	-13.6

Source: JICA Survey Team

Table D-219 Summary of Annual Water Balance and Deficit of Daet City at Each Climate Change Condition

Total Area [km^2]= 142

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	347.4	-13.3	334.1	0.0	-13.3	-13.3
2	Present	2020	1/5-Dry Year	302.4	-13.3	289.1	0.0	-13.3	-13.3
3	Present	2020	1/10-Dry Year	223.2	-13.4	209.8	-0.8	-13.4	-14.2
4	Present	2050	Average Year	336.3	-20.9	315.5	0.0	-20.9	-20.9
5	Present	2050	1/5-Dry Year	291.3	-20.9	270.5	0.0	-20.9	-20.9
6	Present	2050	1/10-Dry Year	212.1	-20.9	191.2	-3.6	-20.9	-24.5
7	CC RCP8.5-High	2050	Average Year	413.0	-20.9	392.2	0.0	-20.9	-20.9
8	CC RCP8.5-High	2050	1/5-Dry Year	363.7	-20.8	342.8	0.0	-20.8	-20.8
9	CC RCP8.5-High	2050	1/10-Dry Year	267.1	-20.9	246.2	-3.5	-20.9	-24.4
10	CC RCP8.5-Mid.	2050	Average Year	345.9	-20.9	325.1	0.0	-20.9	-20.9
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	303.9	-20.9	283.0	0.0	-20.9	-20.9
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	219.2	-20.9	198.3	-4.6	-20.9	-25.5
13	CC RCP8.5-Low	2050	Average Year	308.7	-20.9	287.8	0.0	-20.9	-20.9
14	CC RCP8.5-Low	2050	1/5-Dry Year	229.7	-20.9	208.8	0.0	-20.9	-20.9
15	CC RCP8.5-Low	2050	1/10-Dry Year	180.4	-20.9	159.5	-6.3	-20.9	-27.2

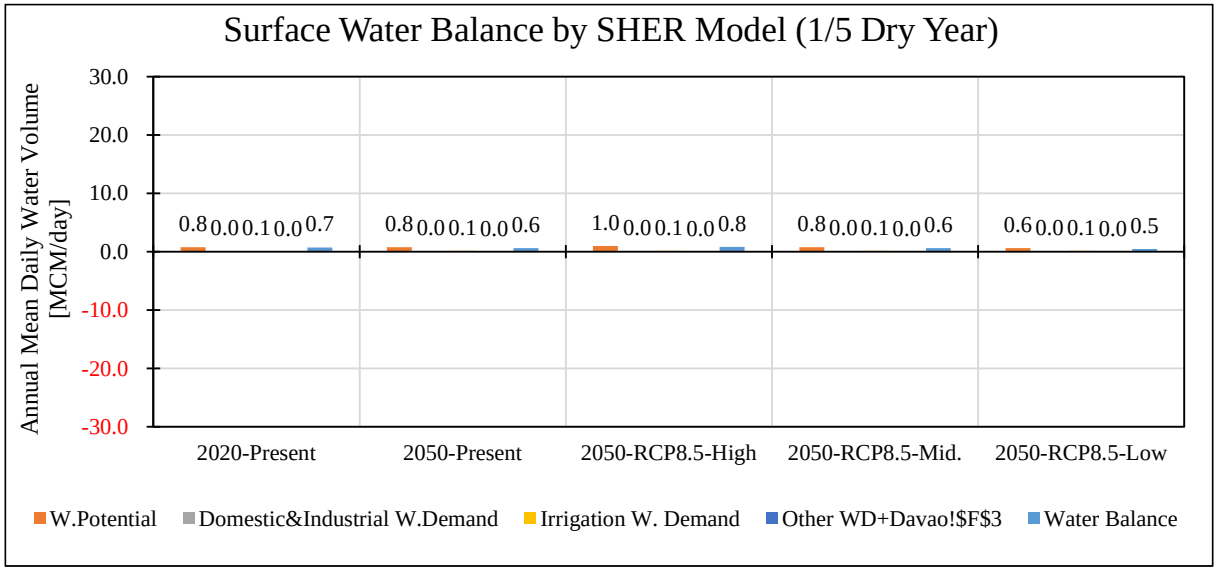
Source: JICA Survey Team

Table D-220 Summary of Annual Water Balance and Deficit of Naga City at Each Climate Change Condition

Total Area [km^2]= 148

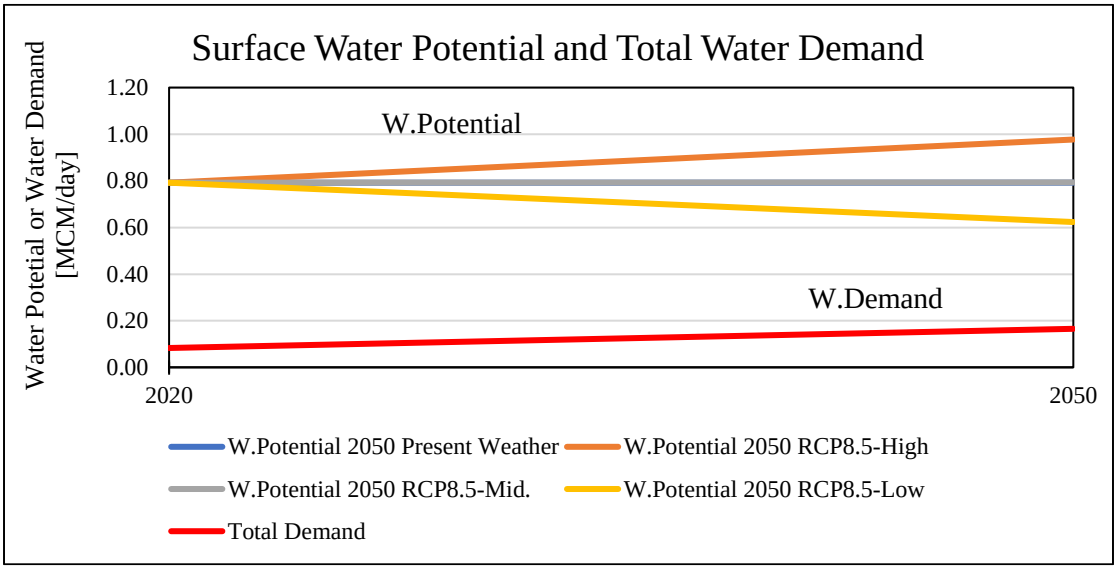
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	421.6	-22.4	399.2	0.0	-22.4	-22.4
2	Present	2020	1/5-Dry Year	321.1	-22.4	298.7	0.0	-22.4	-22.4
3	Present	2020	1/10-Dry Year	326.7	-22.4	304.2	0.0	-22.4	-22.4
4	Present	2050	Average Year	326.0	-35.0	290.9	0.0	-35.0	-35.0
5	Present	2050	1/5-Dry Year	225.4	-35.0	190.4	-6.5	-35.0	-41.5
6	Present	2050	1/10-Dry Year	231.0	-35.0	196.0	-4.5	-35.0	-39.5
7	CC RCP8.5-High	2050	Average Year	387.8	-35.0	352.8	0.0	-35.0	-35.0
8	CC RCP8.5-High	2050	1/5-Dry Year	266.1	-35.0	231.1	-3.2	-35.0	-38.3
9	CC RCP8.5-High	2050	1/10-Dry Year	314.3	-35.0	279.3	-4.1	-35.0	-39.2
10	CC RCP8.5-Mid.	2050	Average Year	315.3	-35.0	280.3	0.0	-35.0	-35.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	213.9	-35.0	178.9	-9.0	-35.0	-44.1
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	259.4	-35.0	224.4	-5.3	-35.0	-40.4
13	CC RCP8.5-Low	2050	Average Year	128.0	-35.0	92.9	-33.3	-35.0	-68.3
14	CC RCP8.5-Low	2050	1/5-Dry Year	77.0	-35.0	42.0	-37.5	-35.0	-72.6
15	CC RCP8.5-Low	2050	1/10-Dry Year	57.7	-35.0	22.6	-35.6	-35.0	-70.6

Source: JICA Survey Team



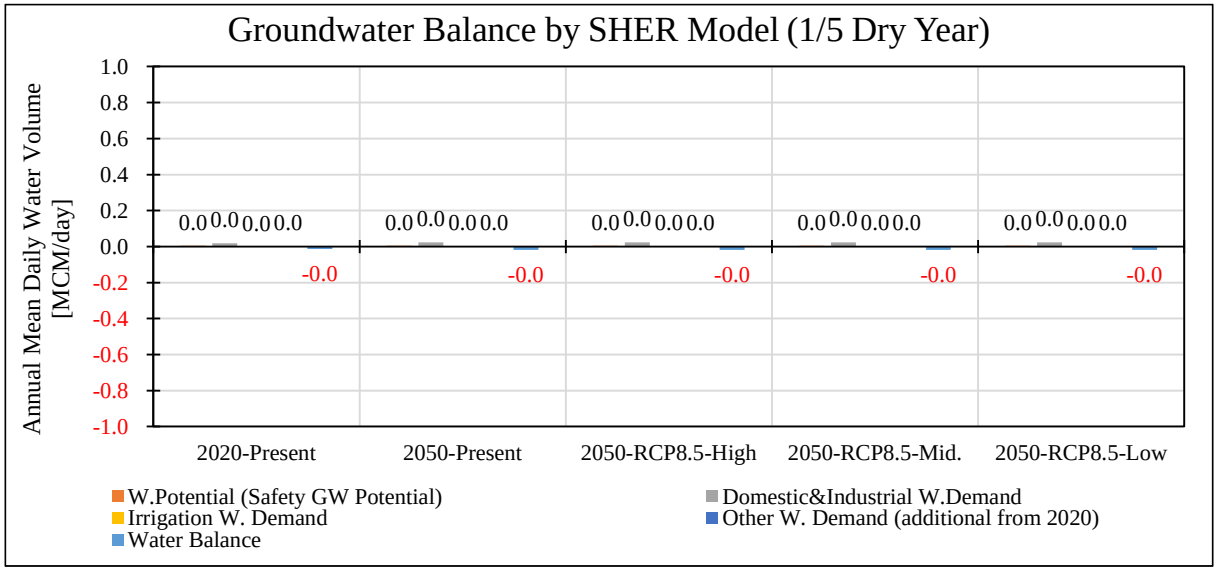
Source: JICA Survey Team

Figure D-473 Surface Water Balance of Legazpi City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



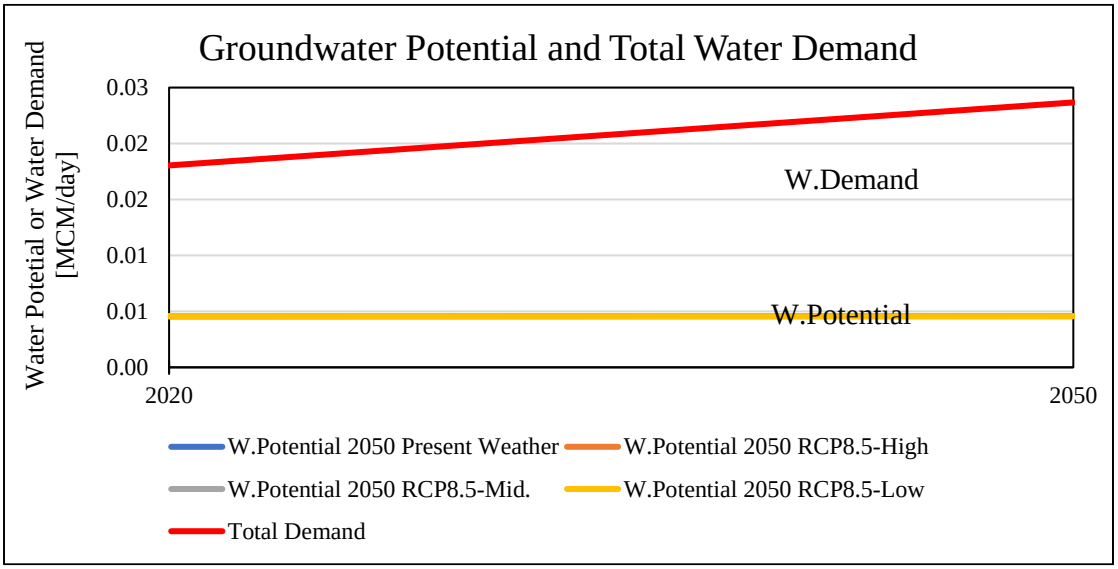
Source: JICA Survey Team

Figure D-474 Surface Water Balance of Legazpi City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



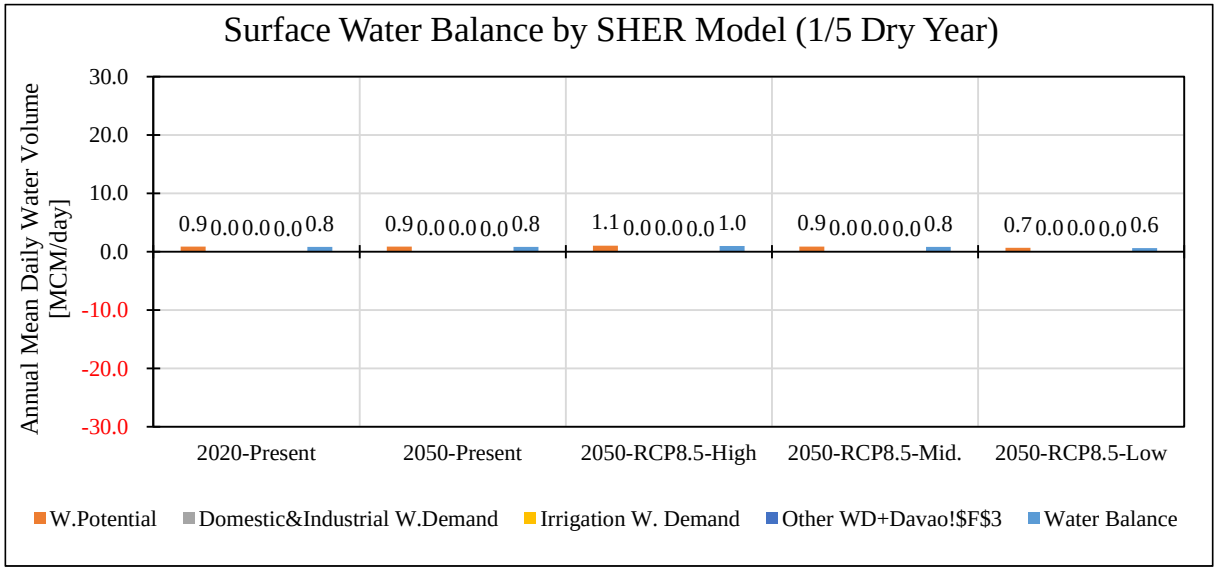
Source: JICA Survey Team

Figure D-475 Groundwater Balance of Legazpi City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



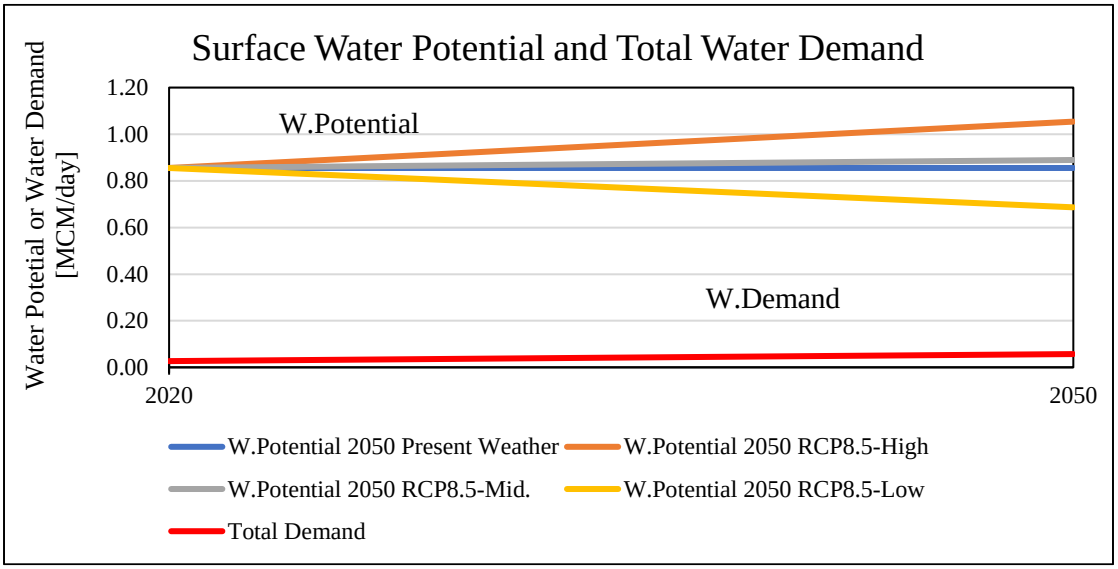
Source: JICA Survey Team

Figure D-476 Groundwater Balance of Legazpi City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



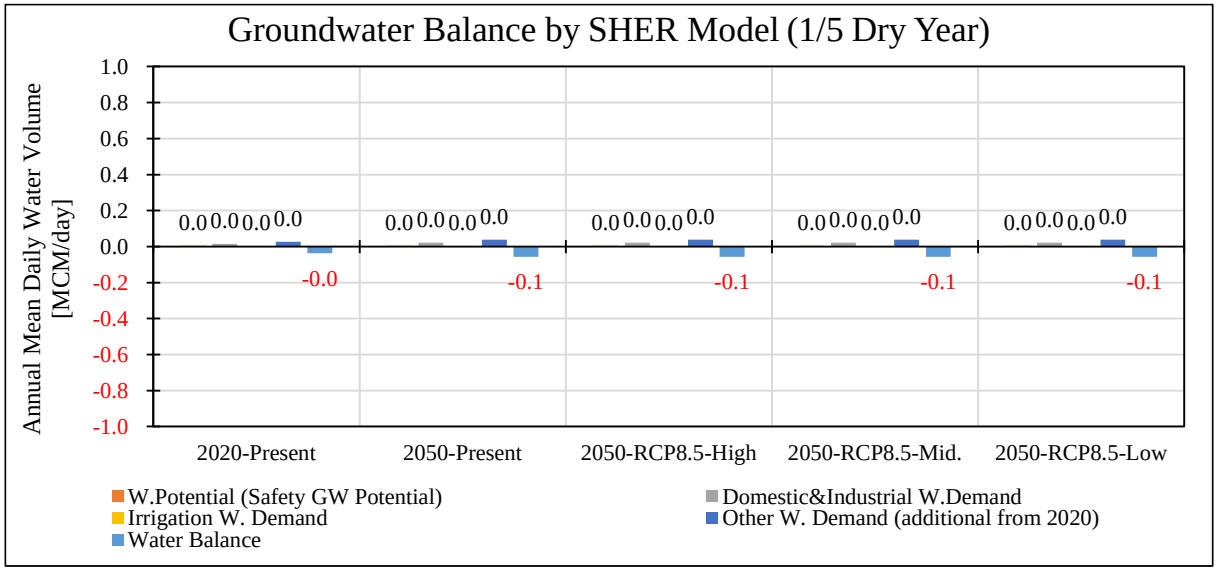
Source: JICA Survey Team

Figure D-477 Surface Water Balance of Daet City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



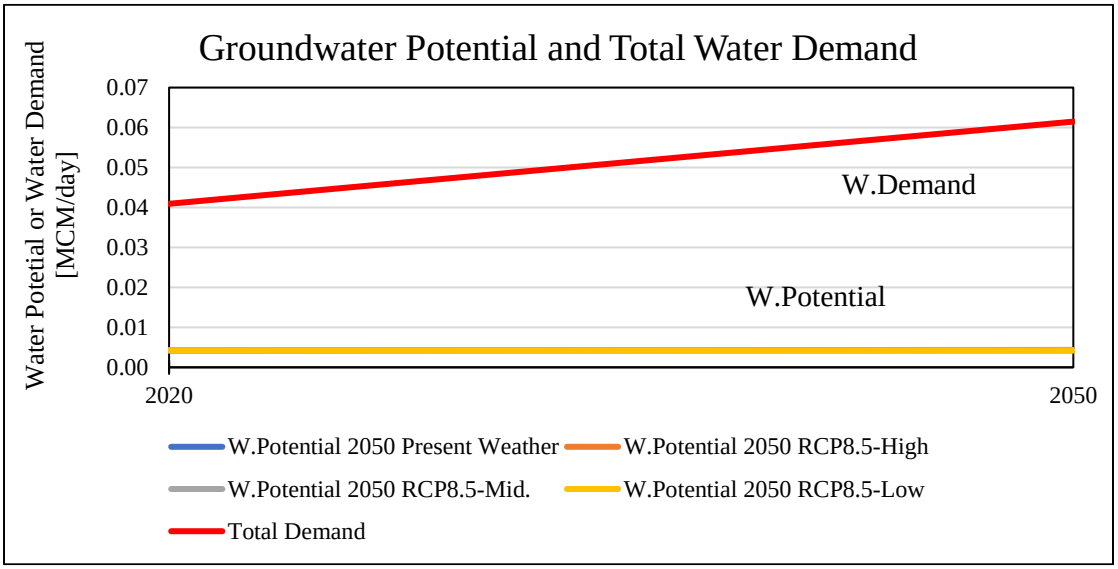
Source: JICA Survey Team

Figure D-478 Surface Water Balance of Daet City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



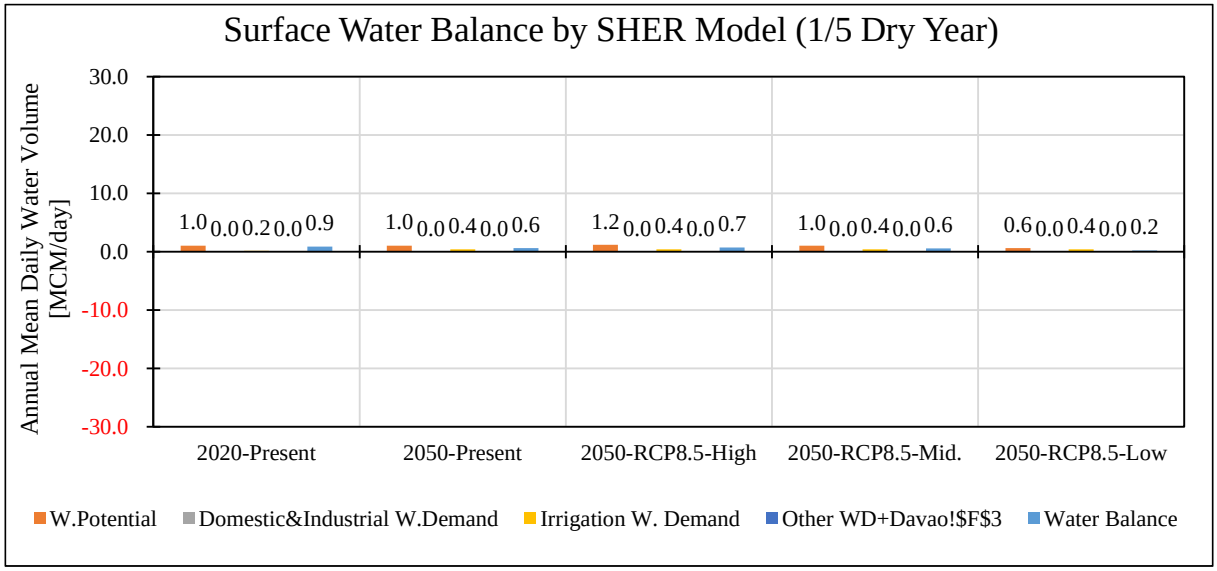
Source: JICA Survey Team

Figure D-479 Groundwater Balance of Daet City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



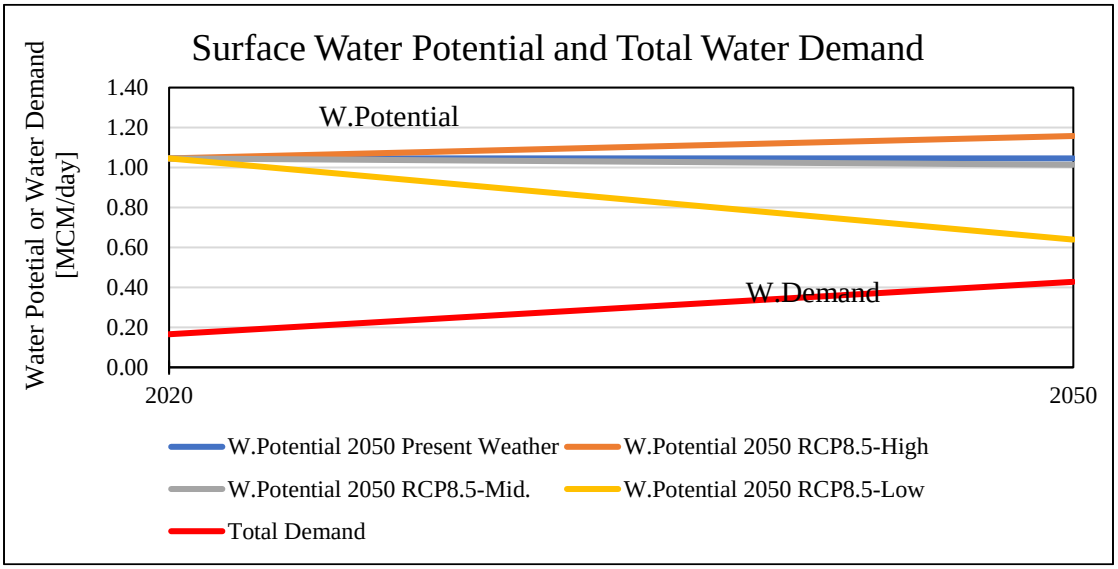
Source: JICA Survey Team

Figure D-480 Groundwater Balance of Daet City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



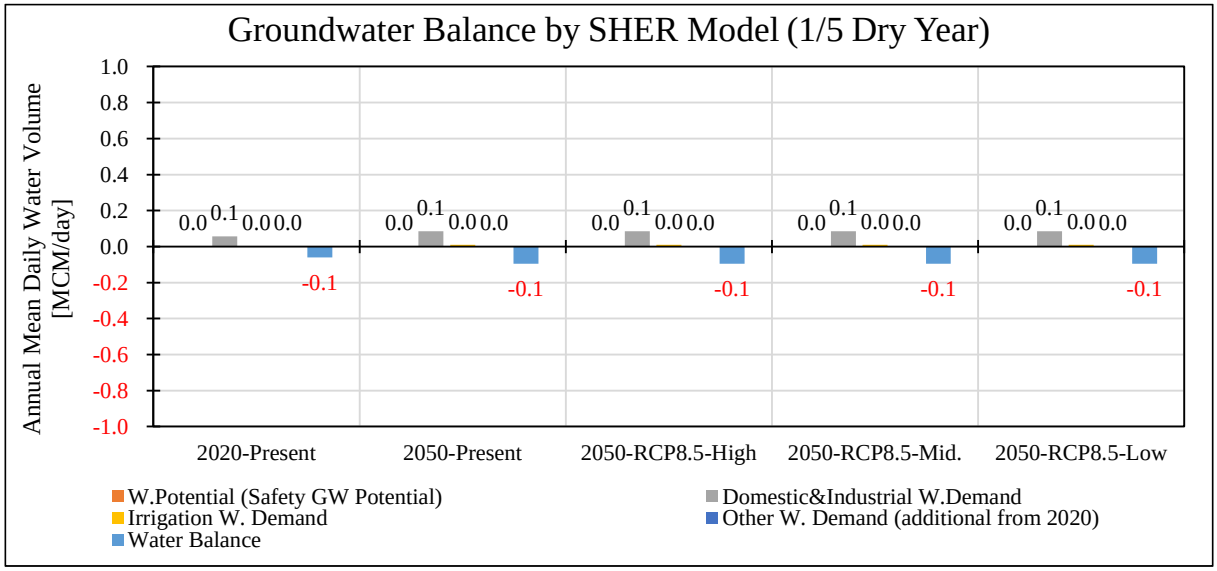
Source: JICA Survey Team

Figure D-481 Surface Water Balance of Naga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



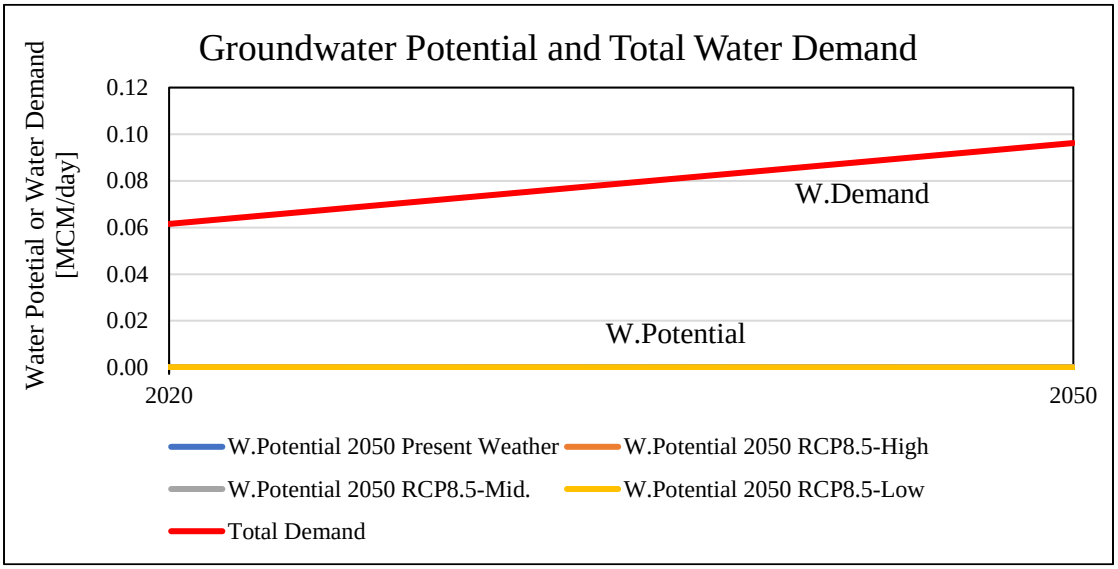
Source: JICA Survey Team

Figure D-482 Surface Water Balance of Naga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



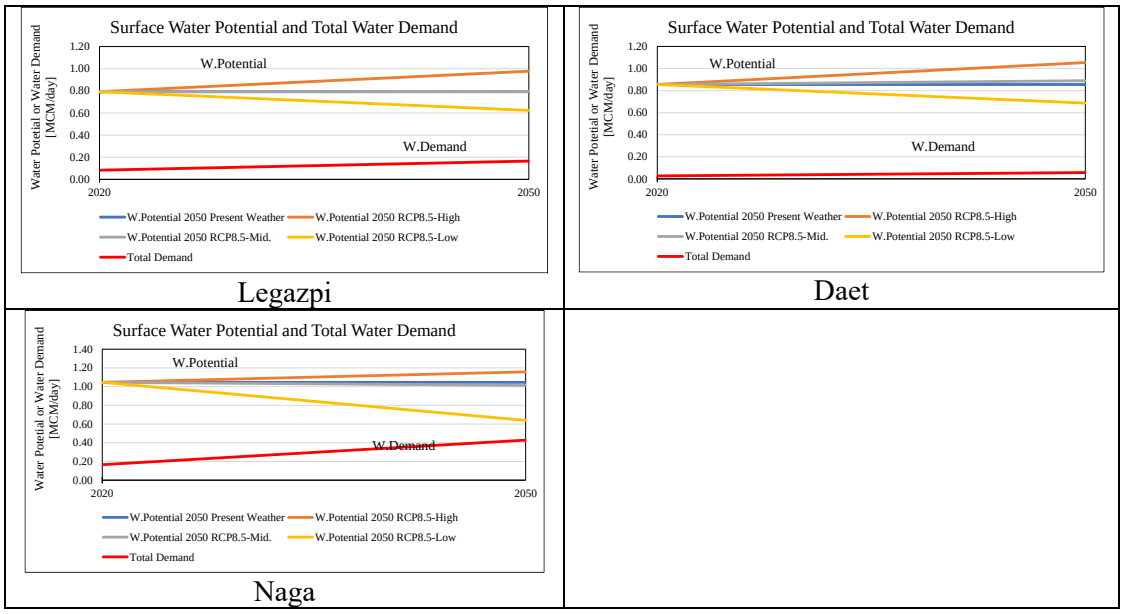
Source: JICA Survey Team

Figure D-483 Groundwater Balance of Naga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



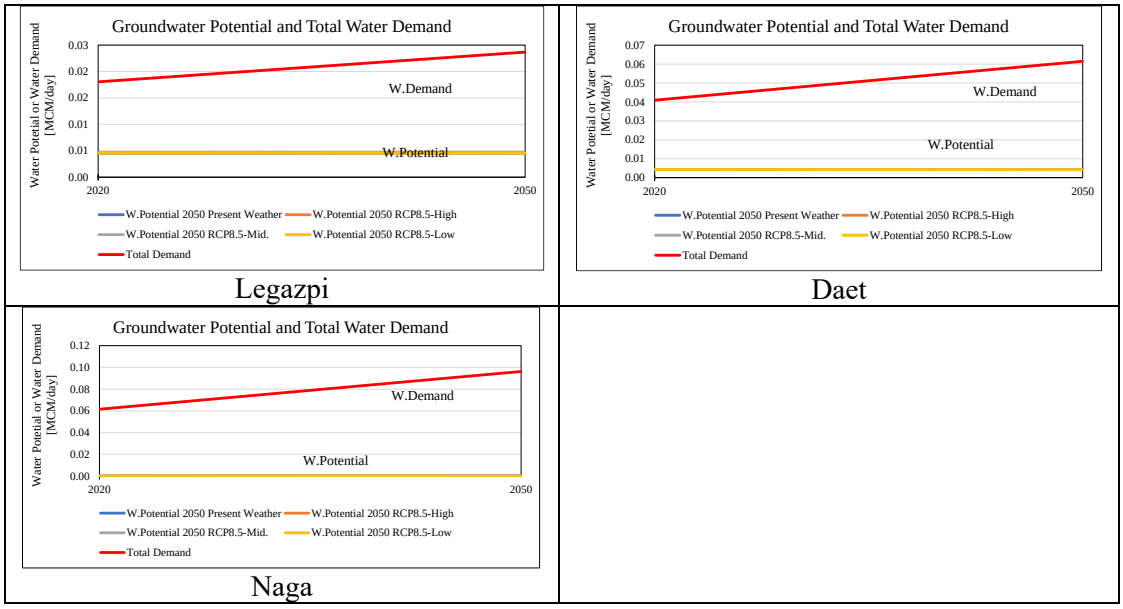
Source: JICA Survey Team

Figure D-484 Groundwater Balance of Naga City in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)



Source: JICA Survey Team

Figure D-485 Surface Water Balance by Major Cities in WRR-V at Each Climate Change Condition

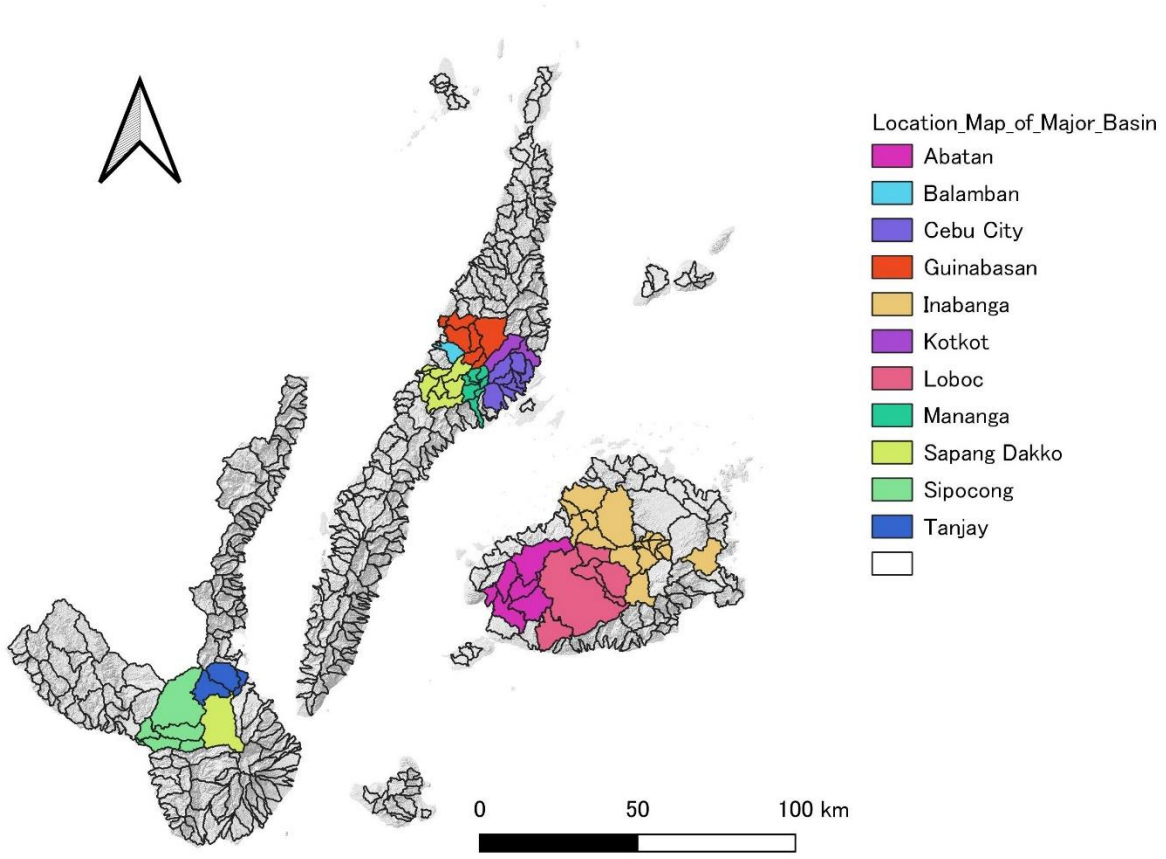


Source: JICA Survey Team

Figure D-486 Groundwater Balance by Major Cities in WRR-V at Each Climate Change Condition

11.6 Data and Results of Major River Basin-wise Water Balance

11.6.1 WRR-VII



Source: JICA Survey Team

Figure D-487 Location Map of Major River Basins in WRR-VII

Table D-221 Surface and Groundwater Balance of Guinabasan River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Guinabasan Target Year= 2050
Weather Condition: Present Total Area [km2]= 236 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	14.0	18.5	21.5	6.4	43.4	47.1	47.1	34.5	32.1	37.1	22.1	18.4	342.1	
Surface Water Potential	**10.2**	**8.7**	**8.5**	**5.6**	**5.8**	**6.6**	**7.1**	**7.5**	**6.4**	**8.1**	**5.2**	**5.3**	**85.0**	
Irrigation Water Demand (SW)	2.8	1.2	0.0	0.0	0.5	2.5	1.9	2.4	1.0	0.4	2.5	2.3	17.4	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.7	
Municipal and Industrial Water Demand (SW)	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	9.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	3.7	2.1	1.0	0.9	1.4	3.4	2.9	3.4	1.9	1.3	3.5	3.2	28.7	
SW Water Balance	**6.5**	**6.7**	**7.5**	**4.7**	**4.4**	**3.2**	**4.2**	**4.1**	**4.5**	**6.8**	**1.7**	**2.1**	**56.2**	**0.0**
Groundwater Potential	**7.6**	**7.1**	**7.5**	**7.3**	**7.5**	**7.2**	**7.4**	**7.4**	**7.1**	**7.4**	**7.2**	**7.3**	**87.9**	
Safety Groundwater Availability (70% of GWP)	**5.3**	**4.9**	**5.3**	**5.1**	**5.2**	**5.0**	**5.2**	**5.2**	**5.0**	**5.2**	**5.0**	**5.1**	**61.5**	
Irrigation Water Demand (GW)	0.3	0.1	0.0	0.0	0.1	0.4	0.3	0.4	0.1	0.1	0.3	0.3	2.3	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (GW)	1.5	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	17.8	
Other Water Demand (GW)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.8	
Total Water Demand (GW)	2.8	2.4	2.4	2.4	2.5	2.7	2.7	2.8	2.5	2.5	2.7	2.7	31.1	
GW Water Balance	**2.5**	**2.6**	**2.8**	**2.7**	**2.7**	**2.3**	**2.5**	**2.4**	**2.5**	**2.7**	**2.4**	**2.4**	**30.5**	**0.0**
Total Water Potential (SW+GW)	**15.5**	**13.7**	**13.8**	**10.7**	**11.0**	**11.7**	**12.2**	**12.6**	**11.4**	**13.3**	**10.2**	**10.4**	**146.5**	
Irrigation Water Demand (Total)	3.1	1.3	0.0	0.0	0.5	2.9	2.2	2.8	1.1	0.4	2.8	2.6	19.7	
Livestock Water Deamnd (Total)	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.8	
Municipal and Industrial Water Demand (Total)	2.3	2.1	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	27.5	
Other Water Demand (Total)	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.8	
Total Water Demand (SW+GW)	6.5	4.4	3.4	3.3	4.0	6.2	5.6	6.2	4.4	3.8	6.1	6.0	59.8	
Total Water Balance (SW+GW)	**9.0**	**9.3**	**10.4**	**7.4**	**7.1**	**5.5**	**6.7**	**6.5**	**7.0**	**9.4**	**4.1**	**4.5**	**86.7**	**0.0**

Source: JICA Survey Team

Table D-222 Surface and Groundwater Balance of Balamban River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Balamban Target Year= 2050
Weather Condition: Present Total Area [km2]= 33 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	1.7	2.5	2.8	0.9	6.3	7.6	6.9	5.1	4.5	5.1	2.9	2.7	49.1	
Surface Water Potential	**1.8**	**1.4**	**1.2**	**0.6**	**0.6**	**0.7**	**0.7**	**0.9**	**0.8**	**1.1**	**0.7**	**0.7**	**11.4**	
Irrigation Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8	
SW Water Balance	**1.7**	**1.4**	**1.1**	**0.5**	**0.5**	**0.7**	**0.7**	**0.9**	**0.7**	**1.1**	**0.7**	**0.7**	**10.6**	**0.0**
Groundwater Potential	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**13.6**	
Safety Groundwater Availability (70% of GWP)	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**9.5**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
GW Water Balance	**0.8**	**0.7**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**9.3**	**0.0**
Total Water Potential (SW+GW)	**2.6**	**2.2**	**2.0**	**1.4**	**1.4**	**1.5**	**1.5**	**1.7**	**1.6**	**1.9**	**1.5**	**1.5**	**20.9**	
Irrigation Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.9	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.9	
Total Water Balance (SW+GW)	**2.5**	**2.1**	**1.9**	**1.3**	**1.3**	**1.4**	**1.5**	**1.7**	**1.5**	**1.9**	**1.5**	**1.4**	**19.9**	**0.0**

Source: JICA Survey Team

Table D-223 Surface and Groundwater Balance of Sapang Dakko River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Sapang Dakko Target Year= 2050
Weather Condition: Present Total Area [km2]= 352 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	15.4	23.0	26.1	10.0	62.8	77.0	88.1	65.7	49.1	53.2	28.4	36.7	535.6	
Surface Water Potential	**16.5**	**13.7**	**12.2**	**7.9**	**9.0**	**10.5**	**16.5**	**21.0**	**14.4**	**15.5**	**12.2**	**17.1**	**166.5**	
Irrigation Water Demand (SW)	2.0	0.8	0.0	0.0	0.9	1.7	1.3	1.5	0.5	0.5	1.7	1.4	12.2	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	2.4	1.2	0.4	0.4	1.3	2.1	1.7	1.9	0.9	0.9	2.1	1.8	17.1	
SW Water Balance	**14.2**	**12.6**	**11.8**	**7.4**	**7.7**	**8.5**	**14.7**	**19.1**	**13.5**	**14.6**	**10.1**	**15.3**	**149.4**	**0.0**
Groundwater Potential	**10.2**	**9.5**	**10.2**	**9.8**	**10.1**	**9.7**	**10.0**	**10.1**	**9.7**	**10.1**	**9.7**	**10.0**	**119.2**	
Safety Groundwater Availability (70% of GWP)	**7.1**	**6.7**	**7.1**	**6.9**	**7.1**	**6.8**	**7.0**	**7.0**	**6.8**	**7.0**	**6.8**	**7.0**	**83.4**	
Irrigation Water Demand (GW)	0.1	0.1	0.0	0.0	0.0	0.2	0.1	0.2	0.1	0.0	0.1	0.1	1.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	3.2	2.9	3.2	3.1	3.2	3.1	3.2	3.2	3.1	3.2	3.1	3.2	37.4	
Other Water Demand (GW)	2.6	2.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	31.0	
Total Water Demand (GW)	6.0	5.3	5.8	5.6	5.8	5.8	5.9	6.0	5.7	5.8	5.8	5.9	69.4	
GW Water Balance	**1.2**	**1.3**	**1.3**	**1.2**	**1.2**	**1.0**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**	**1.1**	**14.0**	**0.0**
Total Water Potential (SW+GW)	**23.7**	**20.4**	**19.3**	**14.7**	**16.1**	**17.4**	**23.5**	**28.1**	**21.2**	**22.6**	**19.0**	**24.1**	**250.0**	
Irrigation Water Demand (Total)	2.1	0.8	0.0	0.0	0.9	1.8	1.4	1.7	0.5	0.5	1.8	1.5	13.1	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	3.6	3.2	3.6	3.5	3.6	3.5	3.6	3.6	3.5	3.6	3.5	3.6	42.3	
Other Water Demand (Total)	2.6	2.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	31.0	
Total Water Demand (SW+GW)	8.3	6.5	6.2	6.0	7.2	7.9	7.7	7.9	6.6	6.8	7.8	7.7	86.6	
Total Water Balance (SW+GW)	**15.3**	**13.9**	**13.1**	**8.7**	**8.9**	**9.5**	**15.8**	**20.2**	**14.6**	**15.8**	**11.2**	**16.4**	**163.4**	**0.0**

Source: JICA Survey Team

Table D-224 Surface and Groundwater Balance of Mananga River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Mananga Target Year= 2050
Weather Condition: Present Total Area [km2]= 85 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	4.0	5.9	6.6	2.1	15.1	18.7	19.4	15.8	11.4	12.9	5.4	5.7	123.0	
Surface Water Potential	**2.8**	**2.4**	**2.5**	**2.1**	**2.3**	**2.3**	**2.5**	**2.7**	**2.4**	**2.7**	**2.1**	**2.1**	**29.0**	
Irrigation Water Demand (SW)	1.7	0.7	0.0	0.0	0.3	1.5	1.1	1.5	0.6	0.2	1.5	1.4	10.6	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1	1.0	1.1	12.5	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	2.7	1.7	1.1	1.0	1.3	2.5	2.2	2.5	1.6	1.3	2.6	2.4	23.0	
SW Water Balance	**0.0**	**0.7**	**1.4**	**1.1**	**0.9**	**-0.2**	**0.3**	**0.2**	**0.8**	**1.4**	**-0.4**	**-0.3**	**5.9**	**-1.0**
Groundwater Potential	**3.8**	**3.5**	**3.8**	**3.6**	**3.6**	**3.4**	**3.4**	**3.4**	**3.3**	**3.4**	**3.3**	**3.3**	**41.7**	
Safety Groundwater Availability (70% of GWP)	**2.6**	**2.5**	**2.6**	**2.5**	**2.5**	**2.4**	**2.4**	**2.4**	**2.3**	**2.4**	**2.3**	**2.3**	**29.2**	
Irrigation Water Demand (GW)	0.9	0.4	0.0	0.0	0.2	1.0	0.7	1.0	0.4	0.1	0.8	0.8	6.3	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	4.5	4.1	4.5	4.4	4.5	4.4	4.5	4.5	4.4	4.5	4.4	4.5	53.3	
Other Water Demand (GW)	2.9	2.7	2.9	2.8	2.9	2.8	2.9	2.9	2.8	2.9	2.8	2.9	34.6	
Total Water Demand (GW)	8.4	7.1	7.5	7.2	7.7	8.2	8.2	8.4	7.6	7.6	8.0	8.2	94.3	
GW Water Balance	**-5.7**	**-4.7**	**-4.8**	**-4.7**	**-5.2**	**-5.9**	**-5.8**	**-6.1**	**-5.3**	**-5.2**	**-5.7**	**-5.9**	**-65.1**	**-65.1**
Total Water Potential (SW+GW)	**5.4**	**4.9**	**5.1**	**4.6**	**4.8**	**4.7**	**4.9**	**5.1**	**4.7**	**5.1**	**4.4**	**4.4**	**58.2**	
Irrigation Water Demand (Total)	2.6	1.1	0.0	0.0	0.5	2.5	1.9	2.4	1.0	0.4	2.3	2.1	16.8	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	5.6	5.0	5.6	5.4	5.6	5.4	5.6	5.6	5.4	5.6	5.4	5.6	65.8	
Other Water Demand (Total)	2.9	2.7	2.9	2.8	2.9	2.8	2.9	2.9	2.8	2.9	2.8	2.9	34.6	
Total Water Demand (SW+GW)	11.1	8.8	8.5	8.3	9.0	10.8	10.4	11.0	9.2	8.9	10.6	10.7	117.3	
Total Water Balance (SW+GW)	**-5.7**	**-3.9**	**-3.4**	**-3.6**	**-4.3**	**-6.1**	**-5.5**	**-5.8**	**-4.5**	**-3.8**	**-6.2**	**-6.2**	**-59.1**	**-66.0**

Source: JICA Survey Team

Table D-225 Surface and Groundwater Balance of Cebu City Area Small River Basins in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Cebu City Target Year= 2050
Weather Condition: Present Total Area [km2]= 182 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	10.6	13.9	13.9	4.3	26.6	31.9	34.0	26.7	24.0	27.6	13.4	12.1	239.1	
Surface Water Potential	**8.4**	**7.6**	**7.7**	**3.4**	**8.2**	**9.5**	**9.6**	**9.4**	**7.6**	**10.2**	**5.1**	**4.9**	**91.5**	
Irrigation Water Demand (SW)	1.3	0.6	0.0	0.0	0.2	1.2	0.9	1.2	0.5	0.2	1.2	1.1	8.4	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	2.5	2.3	2.5	2.4	2.5	2.4	2.5	2.5	2.4	2.5	2.4	2.5	29.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	3.9	2.9	2.5	2.4	2.7	3.6	3.4	3.7	2.9	2.7	3.7	3.6	38.0	
SW Water Balance	**4.5**	**4.8**	**5.2**	**0.9**	**5.4**	**5.9**	**6.2**	**5.7**	**4.6**	**7.5**	**1.5**	**1.3**	**53.5**	**0.0**
Groundwater Potential	**3.5**	**3.3**	**3.5**	**3.4**	**3.5**	**3.3**	**3.4**	**3.4**	**3.3**	**3.4**	**3.3**	**3.4**	**40.8**	
Safety Groundwater Availability (70% of GWP)	**2.4**	**2.3**	**2.4**	**2.3**	**2.4**	**2.3**	**2.4**	**2.4**	**2.3**	**2.4**	**2.3**	**2.4**	**28.6**	
Irrigation Water Demand (GW)	0.8	0.3	0.0	0.0	0.2	0.9	0.6	0.8	0.3	0.1	0.7	0.7	5.4	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	12.5	11.3	12.5	12.1	12.5	12.1	12.5	12.5	12.1	12.5	12.1	12.5	147.7	
Other Water Demand (GW)	5.0	4.5	5.0	4.8	5.0	4.8	5.0	5.0	4.8	5.0	4.8	5.0	59.0	
Total Water Demand (GW)	18.3	16.2	17.6	17.0	17.7	17.9	18.2	18.4	17.3	17.7	17.7	18.2	212.2	
GW Water Balance	**-15.9**	**-13.9**	**-15.1**	**-14.6**	**-15.3**	**-15.5**	**-15.8**	**-16.0**	**-15.0**	**-15.3**	**-15.3**	**-15.8**	**-183.6**	**-183.6**
Total Water Potential (SW+GW)	**10.8**	**9.9**	**10.1**	**5.7**	**10.6**	**11.9**	**12.0**	**11.8**	**9.9**	**12.6**	**7.4**	**7.3**	**120.1**	
Irrigation Water Demand (Total)	2.1	0.9	0.0	0.0	0.4	2.1	1.5	2.0	0.8	0.3	1.9	1.7	13.8	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (Total)	15.1	13.6	15.1	14.6	15.1	14.6	15.1	15.1	14.6	15.1	14.6	15.1	177.3	
Other Water Demand (Total)	5.0	4.5	5.0	4.8	5.0	4.8	5.0	5.0	4.8	5.0	4.8	5.0	59.0	
Total Water Demand (SW+GW)	22.2	19.1	20.1	19.4	20.5	21.5	21.6	22.1	20.2	20.4	21.3	21.8	250.2	
Total Water Balance (SW+GW)	**-11.4**	**-9.1**	**-10.0**	**-13.7**	**-9.9**	**-9.6**	**-9.6**	**-10.3**	**-10.3**	**-7.8**	**-13.9**	**-14.5**	**-130.1**	**-183.6**

Source: JICA Survey Team

Table D-226 Surface and Groundwater Balance of Kotkot River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Kotkot Target Year= 2050
Weather Condition: Present Total Area [km2]= 84 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	5.8	7.4	8.0	2.4	14.4	14.5	16.3	12.2	11.7	13.7	7.4	6.6	120.5	
Surface Water Potential	**5.0**	**4.6**	**4.7**	**2.6**	**3.7**	**3.8**	**3.8**	**4.3**	**3.1**	**4.4**	**2.5**	**2.8**	**45.4**	
Irrigation Water Demand (SW)	0.3	0.1	0.0	0.0	0.1	0.3	0.2	0.3	0.1	0.0	0.3	0.3	1.9	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.3	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.9	0.7	0.6	0.6	0.7	0.9	0.8	0.9	0.7	0.7	0.9	0.9	9.3	
SW Water Balance	**4.1**	**3.9**	**4.1**	**2.0**	**3.0**	**2.9**	**3.0**	**3.4**	**2.4**	**3.7**	**1.6**	**1.9**	**36.1**	**0.0**
Groundwater Potential	**1.4**	**1.3**	**1.4**	**1.3**	**1.4**	**1.3**	**1.4**	**1.4**	**1.3**	**1.4**	**1.3**	**1.4**	**16.2**	
Safety Groundwater Availability (70% of GWP)	**1.0**	**0.9**	**1.0**	**0.9**	**1.0**	**0.9**	**1.0**	**1.0**	**0.9**	**1.0**	**0.9**	**1.0**	**11.4**	
Irrigation Water Demand (GW)	0.2	0.1	0.0	0.0	0.0	0.2	0.2	0.2	0.1	0.0	0.2	0.2	1.3	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	3.0	2.7	3.0	2.9	3.0	2.9	3.0	3.0	2.9	3.0	2.9	3.0	35.0	
Other Water Demand (GW)	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	12.8	
Total Water Demand (GW)	4.3	3.8	4.1	3.9	4.1	4.2	4.2	4.3	4.0	4.1	4.1	4.2	49.3	
GW Water Balance	**-3.3**	**-2.9**	**-3.1**	**-3.0**	**-3.2**	**-3.2**	**-3.3**	**-3.3**	**-3.1**	**-3.1**	**-3.2**	**-3.3**	**-37.9**	**-37.9**
Total Water Potential (SW+GW)	**6.0**	**5.5**	**5.7**	**3.5**	**4.6**	**4.8**	**4.8**	**5.3**	**4.1**	**5.4**	**3.4**	**3.8**	**56.8**	
Irrigation Water Demand (Total)	0.5	0.2	0.0	0.0	0.1	0.5	0.4	0.5	0.2	0.1	0.5	0.4	3.3	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	3.6	3.3	3.6	3.5	3.6	3.5	3.6	3.6	3.5	3.6	3.5	3.6	42.4	
Other Water Demand (Total)	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	12.8	
Total Water Demand (SW+GW)	5.2	4.5	4.7	4.5	4.8	5.0	5.1	5.2	4.7	4.8	5.0	5.1	58.5	
Total Water Balance (SW+GW)	**0.8**	**1.1**	**1.0**	**-1.0**	**-0.2**	**-0.3**	**-0.3**	**0.1**	**-0.7**	**0.6**	**-1.6**	**-1.3**	**-1.7**	**-37.9**

Source: JICA Survey Team

Table D-227 Surface and Groundwater Balance of Sipocong River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Sipocong Target Year= 2050
Weather Condition: Present Total Area [km2]= 370 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	17.6	5.9	12.2	11.2	27.4	51.5	137.7	94.5	69.0	75.9	34.9	119.9	657.6	
Surface Water Potential	**25.8**	**17.2**	**15.7**	**12.1**	**11.8**	**10.9**	**25.7**	**38.5**	**33.3**	**35.2**	**28.7**	**49.9**	**304.9**	
Irrigation Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.0	
SW Water Balance	**25.2**	**16.7**	**15.1**	**11.5**	**11.2**	**10.3**	**25.1**	**37.9**	**32.7**	**34.6**	**28.1**	**49.3**	**297.8**	**0.0**
Groundwater Potential	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**8.5**	
Safety Groundwater Availability (70% of GWP)	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**6.0**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.2	
GW Water Balance	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**4.8**	**0.0**
Total Water Potential (SW+GW)	**26.3**	**17.7**	**16.2**	**12.5**	**12.3**	**11.4**	**26.2**	**39.0**	**33.8**	**35.8**	**29.2**	**50.4**	**310.9**	
Irrigation Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.2	
Total Water Balance (SW+GW)	**25.6**	**17.0**	**15.5**	**11.9**	**11.6**	**10.7**	**25.5**	**38.3**	**33.1**	**35.1**	**28.5**	**49.7**	**302.6**	**0.0**

Source: JICA Survey Team

Table D-228 Surface and Groundwater Balance of Tanjay River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Tanjay Target Year= 2050
Weather Condition: Present Total Area [km2]= 145 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	5.9	2.6	9.5	6.2	9.9	19.0	36.7	24.7	20.2	26.6	17.5	43.5	222.2	
Surface Water Potential	**7.9**	**5.4**	**5.3**	**3.8**	**3.9**	**3.6**	**6.3**	**6.8**	**6.1**	**6.7**	**7.5**	**12.2**	**75.5**	
Irrigation Water Demand (SW)	1.0	0.3	0.0	0.0	1.0	0.8	0.7	0.6	0.0	0.5	0.8	0.5	6.4	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.3	0.6	0.3	0.3	1.3	1.1	0.9	0.9	0.3	0.8	1.1	0.8	9.4	
SW Water Balance	**6.6**	**4.8**	**5.0**	**3.6**	**2.7**	**2.5**	**5.3**	**5.9**	**5.8**	**5.9**	**6.5**	**11.4**	**66.1**	**0.0**
Groundwater Potential	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**2.7**	
Safety Groundwater Availability (70% of GWP)	**0.2**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**1.9**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.5	
GW Water Balance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	**0.0**
Total Water Potential (SW+GW)	**8.1**	**5.5**	**5.5**	**4.0**	**4.1**	**3.7**	**6.4**	**7.0**	**6.3**	**6.8**	**7.7**	**12.3**	**77.4**	
Irrigation Water Demand (Total)	1.0	0.3	0.0	0.0	1.0	0.8	0.7	0.6	0.0	0.5	0.8	0.5	6.4	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.3	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (SW+GW)	1.4	0.7	0.4	0.4	1.4	1.2	1.1	1.0	0.4	0.9	1.2	0.9	10.9	
Total Water Balance (SW+GW)	**6.6**	**4.8**	**5.1**	**3.6**	**2.7**	**2.5**	**5.3**	**6.0**	**5.9**	**5.9**	**6.5**	**11.4**	**66.5**	**0.0**

Source: JICA Survey Team

Table D-229 Surface and Groundwater Balance of Abatan River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Abatan Target Year= 2050
Weather Condition: Present Total Area [km2]= 385 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	34.0	34.9	95.4	13.6	31.8	75.4	61.3	71.7	46.0	54.3	31.9	28.8	579.1	
Surface Water Potential	**6.2**	**7.2**	**26.4**	**4.4**	**2.4**	**11.2**	**11.8**	**13.8**	**10.1**	**11.9**	**4.4**	**5.3**	**115.1**	
Irrigation Water Demand (SW)	0.7	0.4	0.2	0.0	0.1	0.3	0.8	0.8	0.4	0.2	0.8	1.0	5.7	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.2	0.8	0.6	0.4	0.5	0.7	1.2	1.2	0.8	0.7	1.2	1.5	10.8	
SW Water Balance	**5.0**	**6.4**	**25.8**	**4.0**	**1.9**	**10.4**	**10.6**	**12.6**	**9.2**	**11.3**	**3.2**	**3.8**	**104.2**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.5**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Total Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.3	
GW Water Balance	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-6.0**	**-6.0**
Total Water Potential (SW+GW)	**6.2**	**7.3**	**26.4**	**4.5**	**2.5**	**11.2**	**11.8**	**13.8**	**10.1**	**11.9**	**4.4**	**5.3**	**115.4**	
Irrigation Water Demand (Total)	0.7	0.4	0.2	0.0	0.1	0.3	0.8	0.8	0.4	0.2	0.8	1.0	5.7	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	11.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Total Water Demand (SW+GW)	1.7	1.3	1.2	0.9	1.1	1.2	1.8	1.7	1.4	1.2	1.7	2.0	17.2	
Total Water Balance (SW+GW)	**4.5**	**6.0**	**25.3**	**3.5**	**1.4**	**9.9**	**10.1**	**12.1**	**8.7**	**10.7**	**2.7**	**3.3**	**98.2**	**-6.0**

Source: JICA Survey Team

Table D-230 Surface and Groundwater Balance of Loboc River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Loboc Target Year= 2050
Weather Condition: Present Total Area [km2]= 674 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	78.0	71.9	182.1	16.5	55.2	155.3	119.0	150.3	91.9	91.6	40.4	36.3	1,088.6	
Surface Water Potential	**38.9**	**38.0**	**60.0**	**24.6**	**15.9**	**35.5**	**38.6**	**48.5**	**45.4**	**37.4**	**24.1**	**21.7**	**428.7**	
Irrigation Water Demand (SW)	1.2	0.6	0.3	0.0	0.2	0.5	1.3	1.2	0.7	0.4	1.2	1.6	9.1	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Municipal and Industrial Water Demand (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.2	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	1.7	1.1	0.8	0.5	0.6	1.0	1.7	1.7	1.1	0.8	1.7	2.1	14.7	
SW Water Balance	**37.3**	**37.0**	**59.2**	**24.1**	**15.3**	**34.6**	**36.8**	**46.8**	**44.3**	**36.6**	**22.4**	**19.6**	**413.9**	**0.0**
Groundwater Potential	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.8**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.6**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.4	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.6	0.5	0.6	0.5	0.6	0.5	0.6	0.6	0.5	0.6	0.5	0.6	6.6	
GW Water Balance	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-6.1**	**-6.1**
Total Water Potential (SW+GW)	**39.0**	**38.1**	**60.1**	**24.6**	**16.0**	**35.6**	**38.6**	**48.5**	**45.4**	**37.5**	**24.1**	**21.7**	**429.2**	
Irrigation Water Demand (Total)	1.2	0.6	0.3	0.0	0.2	0.5	1.3	1.2	0.7	0.4	1.2	1.6	9.1	
Livestock Water Deamnd (Total)	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	
Municipal and Industrial Water Demand (Total)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	11.6	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	2.2	1.6	1.3	1.0	1.2	1.5	2.3	2.2	1.7	1.4	2.2	2.7	21.4	
Total Water Balance (SW+GW)	**36.8**	**36.5**	**58.7**	**23.6**	**14.8**	**34.1**	**36.3**	**46.3**	**43.8**	**36.1**	**21.9**	**19.1**	**407.9**	**-6.1**

Source: JICA Survey Team

Table D-231 Surface and Groundwater Balance of Inabanga River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Inabanga Target Year= 2050
Weather Condition: Present Total Area [km2]= 690 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	106.2	89.8	180.9	13.9	53.1	158.2	130.8	165.3	108.3	91.3	31.5	26.0	1,155.3	
Surface Water Potential	**85.9**	**107.6**	**131.5**	**34.1**	**26.7**	**88.7**	**108.2**	**157.3**	**131.4**	**68.0**	**45.8**	**43.2**	**1,028.5**	
Irrigation Water Demand (SW)	19.9	10.7	4.9	0.0	2.9	8.3	21.4	20.4	11.2	6.1	20.9	27.4	154.1	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.6	
Municipal and Industrial Water Demand (SW)	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.4	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	20.4	11.2	5.4	0.5	3.4	8.8	21.9	20.9	11.7	6.6	21.4	27.9	160.2	
SW Water Balance	**65.6**	**96.4**	**126.0**	**33.6**	**23.3**	**79.8**	**86.3**	**136.3**	**119.7**	**61.4**	**24.4**	**15.3**	**868.3**	**0.0**
Groundwater Potential	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.6**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	11.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	11.8	
GW Water Balance	**-1.0**	**-0.9**	**-1.0**	**-0.9**	**-1.0**	**-0.9**	**-1.0**	**-1.0**	**-0.9**	**-1.0**	**-0.9**	**-1.0**	**-11.4**	**-11.4**
Total Water Potential (SW+GW)	**86.0**	**107.7**	**131.5**	**34.2**	**26.7**	**88.7**	**108.3**	**157.3**	**131.5**	**68.0**	**45.8**	**43.3**	**1,028.9**	
Irrigation Water Demand (Total)	19.9	10.7	4.9	0.0	2.9	8.3	21.4	20.4	11.2	6.1	20.9	27.4	154.1	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.7	
Municipal and Industrial Water Demand (Total)	1.4	1.2	1.4	1.3	1.4	1.3	1.4	1.4	1.3	1.4	1.3	1.4	16.1	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	21.4	12.1	6.4	1.5	4.4	9.8	22.9	21.9	12.7	7.6	22.4	28.9	172.0	
Total Water Balance (SW+GW)	**64.6**	**95.6**	**125.1**	**32.7**	**22.3**	**78.9**	**85.4**	**135.4**	**118.8**	**60.5**	**23.5**	**14.3**	**856.9**	**-11.4**

Source: JICA Survey Team

Table D-232 Summary of Annual Water Balance and Deficit of Guinabasan River Basin at Each Climate Change Condition

Total Area [km^2]= 235.9

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	152.5	41.5	194.0	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	62.6	40.9	103.5	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	12.4	31.7	44.2	-3.0	0.0	-3.0
4	Present	2050	Average Year	148.7	37.0	185.8	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	58.9	36.4	95.3	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	8.7	27.2	35.9	-3.7	0.0	-3.7
7	CC RCP8.5-High	2050	Average Year	157.8	51.5	209.3	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	55.8	43.9	99.7	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	6.4	30.4	36.8	-3.8	0.0	-3.8
10	CC RCP8.5-Mid.	2050	Average Year	185.0	49.7	234.7	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	69.9	47.4	117.3	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	15.8	37.8	53.6	-1.1	0.0	-1.1
13	CC RCP8.5-Low	2050	Average Year	113.6	48.8	162.4	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	30.7	40.0	70.7	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	6.4	32.5	38.9	-3.5	0.0	-3.5

Source: JICA Survey Team

Table D-233 Summary of Annual Water Balance and Deficit of Balamban River Basin at Each Climate Change Condition

Total Area [km^2]= 32.6

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	22.6	9.3	32.0	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	10.8	9.4	20.2	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	2.3	8.4	10.7	0.0	0.0	0.0
4	Present	2050	Average Year	22.5	9.3	31.8	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	10.7	9.3	20.0	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	2.2	8.4	10.6	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	26.0	9.3	35.3	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	11.4	9.3	20.8	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	1.9	8.3	10.2	-0.0	0.0	-0.0
10	CC RCP8.5-Mid.	2050	Average Year	22.0	13.5	35.5	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	7.4	13.4	20.8	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1.3	11.5	12.8	-0.1	0.0	-0.1
13	CC RCP8.5-Low	2050	Average Year	13.8	13.5	27.2	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	1.9	12.0	13.9	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	0.3	10.8	11.0	-0.2	0.0	-0.2

Source: JICA Survey Team

Table D-234 Summary of Annual Water Balance and Deficit of Sapang Dakko River Basin at Each Climate Change Condition

Total Area [km^2]= 351.6

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	266.1	35.3	301.4	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	152.2	35.0	187.2	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	63.3	26.2	89.5	0.0	0.0	0.0
4	Present	2050	Average Year	264.7	26.3	291.0	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	150.7	26.1	176.8	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	61.8	17.2	79.1	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	283.9	33.4	317.3	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	151.9	32.7	184.6	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	59.5	20.6	80.2	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	302.7	10.1	312.9	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	148.2	7.5	155.7	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	53.1	1.1	54.2	0.0	-1.4	-1.4
13	CC RCP8.5-Low	2050	Average Year	199.7	8.7	208.4	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	83.4	3.7	87.0	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	31.0	-1.8	29.2	0.0	-3.2	-3.2

Source: JICA Survey Team

Table D-235 Summary of Annual Water Balance and Deficit of Mananga River Basin at Each Climate Change Condition

Total Area [km^2]= 85.2

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	27.4	-25.0	2.4	0.0	-25.0	-25.0
2	Present	2020	1/5-Dry Year	12.6	-32.7	-20.1	0.0	-32.7	-32.7
3	Present	2020	1/10-Dry Year	1.6	-39.9	-38.3	-2.5	-39.9	-42.4
4	Present	2050	Average Year	25.2	-38.3	-13.1	0.0	-38.3	-38.3
5	Present	2050	1/5-Dry Year	10.4	-46.0	-35.6	-0.1	-46.0	-46.1
6	Present	2050	1/10-Dry Year	-0.6	-53.2	-53.9	-3.9	-53.2	-57.2
7	CC RCP8.5-High	2050	Average Year	31.2	-37.2	-6.0	0.0	-37.2	-37.2
8	CC RCP8.5-High	2050	1/5-Dry Year	10.9	-45.7	-34.8	-0.1	-45.7	-45.7
9	CC RCP8.5-High	2050	1/10-Dry Year	-0.6	-52.9	-53.5	-4.0	-52.9	-56.9
10	CC RCP8.5-Mid.	2050	Average Year	17.0	-42.5	-25.5	0.0	-42.5	-42.5
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	4.0	-51.4	-47.3	-1.6	-51.4	-53.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	-5.0	-57.3	-62.3	-6.5	-57.3	-63.8
13	CC RCP8.5-Low	2050	Average Year	80.6	-48.4	32.2	0.0	-48.4	-48.4
14	CC RCP8.5-Low	2050	1/5-Dry Year	23.9	-53.8	-29.9	0.0	-53.8	-53.8
15	CC RCP8.5-Low	2050	1/10-Dry Year	-0.0	-58.5	-58.5	-3.6	-58.5	-62.1

Source: JICA Survey Team

Table D-236 Summary of Annual Water Balance and Deficit of Cebu City Small River Basins at Each Climate Change Condition

Total Area [km^2]= 182.1

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	136.7	-100.4	36.3	0.0	-100.4	-100.4
2	Present	2020	1/5-Dry Year	68.2	-101.5	-33.3	0.0	-101.5	-101.5
3	Present	2020	1/10-Dry Year	30.3	-103.6	-73.3	0.0	-103.6	-103.6
4	Present	2050	Average Year	132.6	-129.7	2.9	0.0	-129.7	-129.7
5	Present	2050	1/5-Dry Year	64.1	-130.8	-66.7	0.0	-130.8	-130.8
6	Present	2050	1/10-Dry Year	26.2	-132.9	-106.7	0.0	-132.9	-132.9
7	CC RCP8.5-High	2050	Average Year	155.0	-129.5	25.5	0.0	-129.5	-129.5
8	CC RCP8.5-High	2050	1/5-Dry Year	69.8	-130.7	-60.9	0.0	-130.7	-130.7
9	CC RCP8.5-High	2050	1/10-Dry Year	28.3	-132.9	-104.6	0.0	-132.9	-132.9
10	CC RCP8.5-Mid.	2050	Average Year	114.1	-130.7	-16.6	0.0	-130.7	-130.7
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	45.7	-132.9	-87.2	0.0	-132.9	-132.9
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	19.2	-135.3	-116.2	-0.7	-135.3	-136.1
13	CC RCP8.5-Low	2050	Average Year	72.7	-143.9	-71.2	0.0	-143.9	-143.9
14	CC RCP8.5-Low	2050	1/5-Dry Year	490.0	-145.9	344.1	0.0	-145.9	-145.9
15	CC RCP8.5-Low	2050	1/10-Dry Year	60.6	-146.4	-85.9	0.0	-146.4	-146.4

Source: JICA Survey Team

Table D-237 Summary of Annual Water Balance and Deficit of Kotkot River Basin at Each Climate Change Condition

Total Area [km^2]= 84.0

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	82.4	-18.7	63.7	0.0	-18.7	-18.7
2	Present	2020	1/5-Dry Year	39.8	-18.6	21.2	0.0	-18.6	-18.6
3	Present	2020	1/10-Dry Year	7.7	-19.0	-11.3	0.0	-19.0	-19.0
4	Present	2050	Average Year	81.4	-25.4	56.0	0.0	-25.4	-25.4
5	Present	2050	1/5-Dry Year	38.8	-25.4	13.4	0.0	-25.4	-25.4
6	Present	2050	1/10-Dry Year	6.7	-25.7	-19.1	0.0	-25.7	-25.7
7	CC RCP8.5-High	2050	Average Year	92.0	-25.4	66.6	0.0	-25.4	-25.4
8	CC RCP8.5-High	2050	1/5-Dry Year	40.6	-25.4	15.2	0.0	-25.4	-25.4
9	CC RCP8.5-High	2050	1/10-Dry Year	5.6	-25.8	-20.1	0.0	-25.8	-25.8
10	CC RCP8.5-Mid.	2050	Average Year	71.3	-25.4	45.9	0.0	-25.4	-25.4
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	27.3	-25.4	1.9	0.0	-25.4	-25.4
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2.6	-26.0	-23.4	-0.4	-26.0	-26.4
13	CC RCP8.5-Low	2050	Average Year	31.8	-21.2	10.6	0.0	-21.2	-21.2
14	CC RCP8.5-Low	2050	1/5-Dry Year	3.4	-22.7	-19.3	-0.2	-22.7	-22.9
15	CC RCP8.5-Low	2050	1/10-Dry Year	-2.8	-24.0	-26.8	-2.8	-24.0	-26.8

Source: JICA Survey Team

Table D-238 Summary of Annual Water Balance and Deficit of Sipocong River Basin at Each Climate Change Condition

Total Area [km^2]= 370.4

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	477.4	5.3	482.7	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	300.5	5.2	305.8	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	304.5	5.3	309.7	0.0	0.0	0.0
4	Present	2050	Average Year	476.1	5.1	481.2	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	299.2	5.1	304.3	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	303.2	5.1	308.3	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	500.2	5.2	505.4	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	314.6	5.1	319.8	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	312.6	5.1	317.8	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	398.8	5.1	404.0	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	253.8	5.1	258.9	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	254.7	5.1	259.8	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	277.1	5.1	282.2	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	161.9	5.1	167.0	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	167.4	5.1	172.5	0.0	0.0	0.0

Source: JICA Survey Team

Table D-239 Summary of Annual Water Balance and Deficit of Tanjay River Basin at Each Climate Change Condition

Total Area [km^2]= 145.0

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	153.5	0.9	154.3	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	67.4	0.9	68.3	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	87.3	0.9	88.2	0.0	0.0	0.0
4	Present	2050	Average Year	152.4	0.6	153.0	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	66.4	0.6	67.0	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	86.3	0.6	86.8	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	160.1	0.6	160.7	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	67.0	0.6	67.5	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	86.4	0.6	87.0	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	123.4	0.6	124.0	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	49.7	0.6	50.3	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	63.0	0.6	63.5	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	77.2	0.6	77.8	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	28.6	0.6	29.1	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	33.4	0.6	34.0	0.0	0.0	0.0

Source: JICA Survey Team

Table D-240 Summary of Annual Water Balance and Deficit of Abatan River Basin at Each Climate Change Condition

Total Area [km^2]= 385.0

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	250.5	-3.2	247.3	0.0	-3.2	-3.2
2	Present	2020	1/5-Dry Year	108.1	-3.2	104.9	0.0	-3.2	-3.2
3	Present	2020	1/10-Dry Year	145.9	-3.2	142.7	0.0	-3.2	-3.2
4	Present	2050	Average Year	247.3	-4.8	242.5	0.0	-4.8	-4.8
5	Present	2050	1/5-Dry Year	104.9	-4.8	100.2	0.0	-4.8	-4.8
6	Present	2050	1/10-Dry Year	142.7	-4.8	138.0	0.0	-4.8	-4.8
7	CC RCP8.5-High	2050	Average Year	301.2	-4.8	296.5	0.0	-4.8	-4.8
8	CC RCP8.5-High	2050	1/5-Dry Year	116.8	-4.8	112.0	0.0	-4.8	-4.8
9	CC RCP8.5-High	2050	1/10-Dry Year	161.1	-4.8	156.4	0.0	-4.8	-4.8
10	CC RCP8.5-Mid.	2050	Average Year	150.4	-4.8	145.6	0.0	-4.8	-4.8
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	87.8	-4.8	83.0	0.0	-4.8	-4.8
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	116.0	-4.8	111.2	0.0	-4.8	-4.8
13	CC RCP8.5-Low	2050	Average Year	85.0	-4.8	80.2	0.0	-4.8	-4.8
14	CC RCP8.5-Low	2050	1/5-Dry Year	57.6	-4.8	52.8	0.0	-4.8	-4.8
15	CC RCP8.5-Low	2050	1/10-Dry Year	79.2	-4.8	74.4	0.0	-4.8	-4.8

Source: JICA Survey Team

Table D-241 Summary of Annual Water Balance and Deficit of Loboc River Basin at Each Climate Change Condition

Total Area [km^2]= 673.6

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	538.2	-3.5	534.7	0.0	-3.5	-3.5
2	Present	2020	1/5-Dry Year	419.2	-3.5	415.8	0.0	-3.5	-3.5
3	Present	2020	1/10-Dry Year	481.4	-3.5	477.9	0.0	-3.5	-3.5
4	Present	2050	Average Year	533.5	-5.3	528.2	0.0	-5.3	-5.3
5	Present	2050	1/5-Dry Year	414.6	-5.3	409.3	0.0	-5.3	-5.3
6	Present	2050	1/10-Dry Year	476.7	-5.3	471.5	0.0	-5.3	-5.3
7	CC RCP8.5-High	2050	Average Year	603.5	-5.3	598.2	0.0	-5.3	-5.3
8	CC RCP8.5-High	2050	1/5-Dry Year	449.0	-5.3	443.7	0.0	-5.3	-5.3
9	CC RCP8.5-High	2050	1/10-Dry Year	527.8	-5.3	522.5	0.0	-5.3	-5.3
10	CC RCP8.5-Mid.	2050	Average Year	464.3	-5.3	459.1	0.0	-5.3	-5.3
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	365.9	-5.3	360.6	0.0	-5.3	-5.3
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	419.6	-5.3	414.4	0.0	-5.3	-5.3
13	CC RCP8.5-Low	2050	Average Year	340.1	-5.3	334.8	0.0	-5.3	-5.3
14	CC RCP8.5-Low	2050	1/5-Dry Year	275.7	-5.3	270.4	0.0	-5.3	-5.3
15	CC RCP8.5-Low	2050	1/10-Dry Year	300.7	-5.3	295.4	0.0	-5.3	-5.3

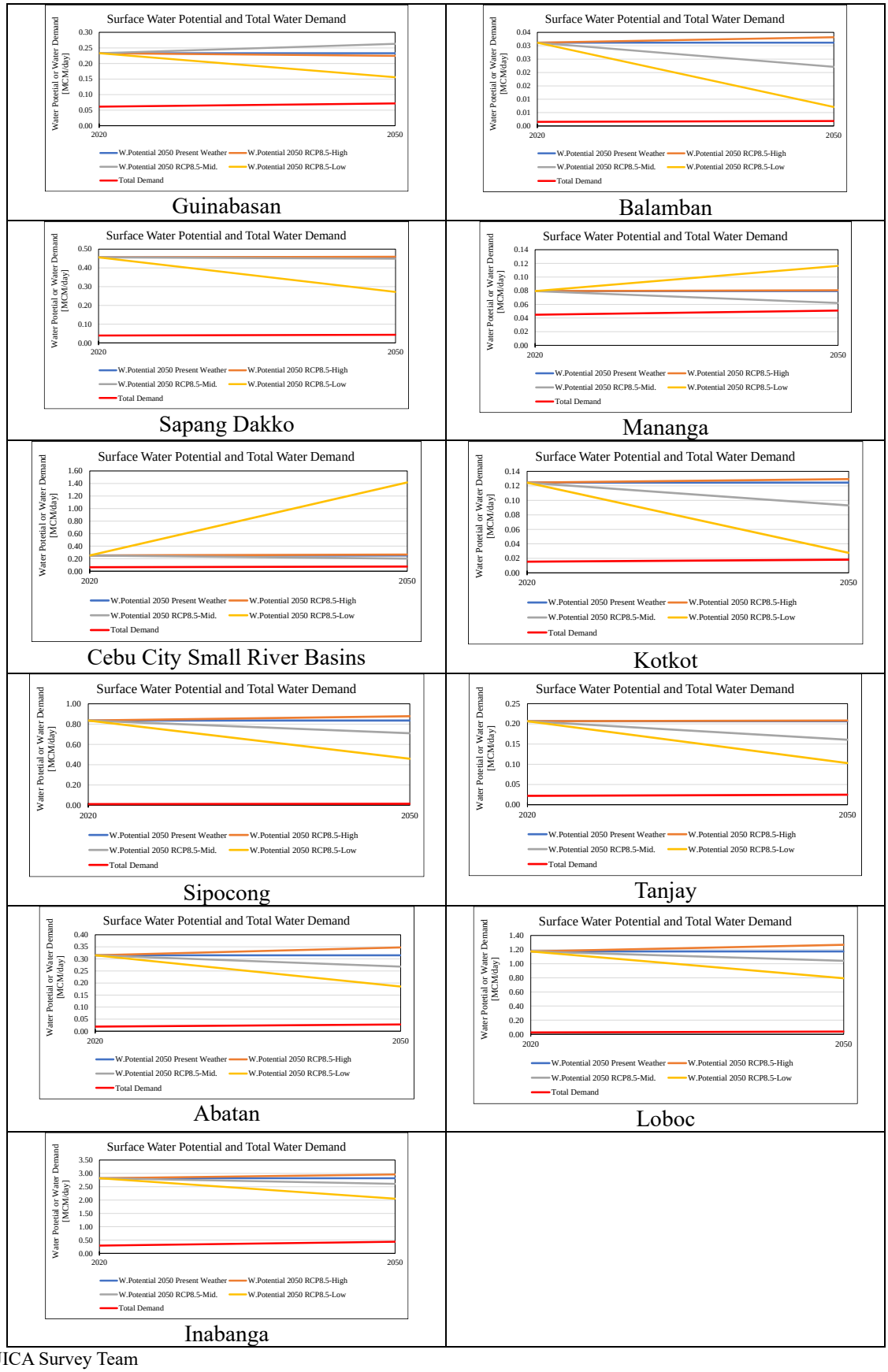
Source: JICA Survey Team

Table D-242 Summary of Annual Water Balance and Deficit of Inabanga River Basin at Each Climate Change Condition

Total Area [km^2]= 690.0

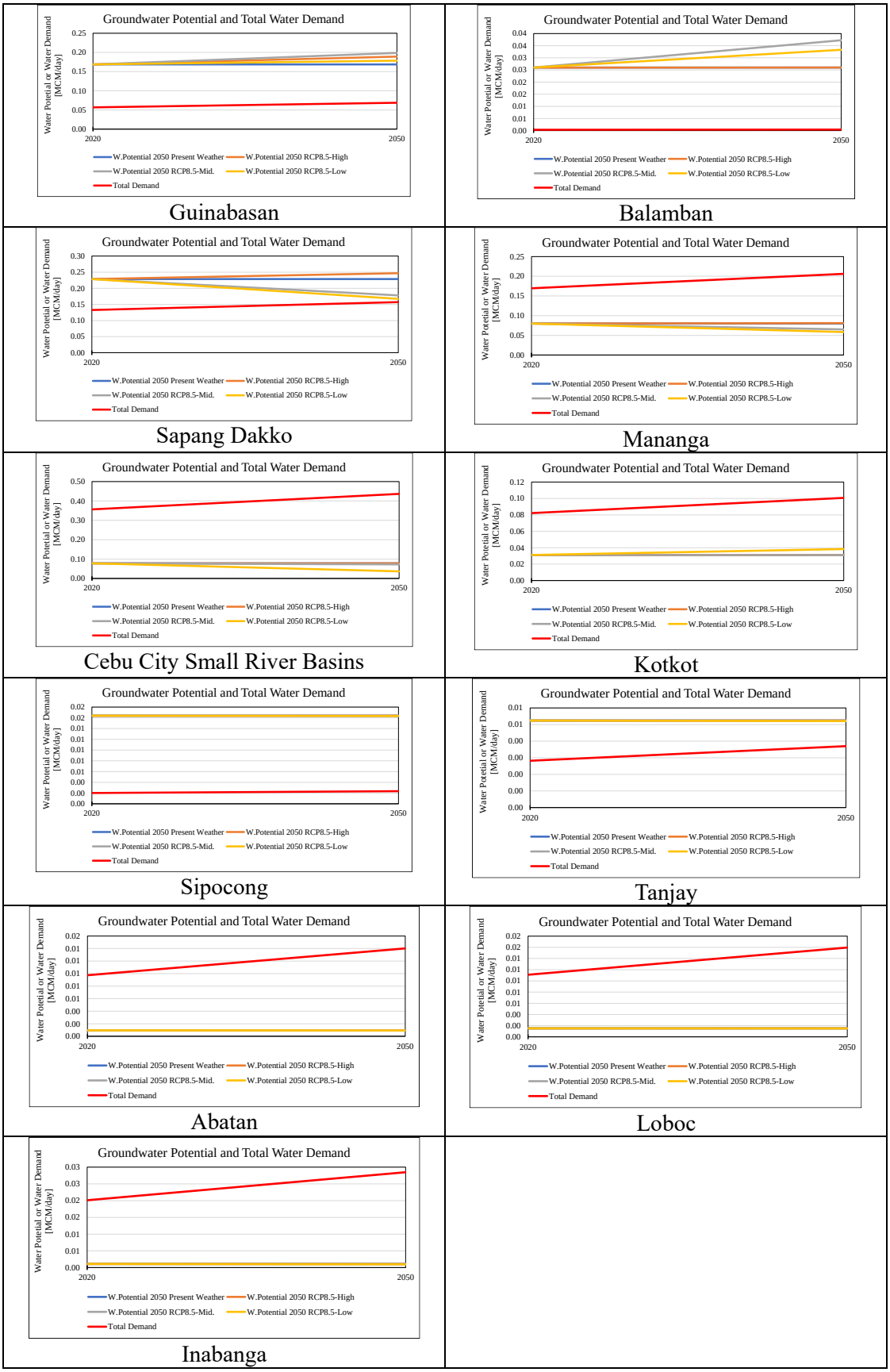
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	1,270.0	-6.9	1,263.0	0.0	-6.9	-6.9
2	Present	2020	1/5-Dry Year	922.4	-6.9	915.4	0.0	-6.9	-6.9
3	Present	2020	1/10-Dry Year	860.6	-6.9	853.7	0.0	-6.9	-6.9
4	Present	2050	Average Year	1,216.5	-10.0	1,206.5	0.0	-10.0	-10.0
5	Present	2050	1/5-Dry Year	868.9	-10.0	858.9	0.0	-10.0	-10.0
6	Present	2050	1/10-Dry Year	807.1	-10.0	797.1	0.0	-10.0	-10.0
7	CC RCP8.5-High	2050	Average Year	1,294.7	-10.0	1,284.7	0.0	-10.0	-10.0
8	CC RCP8.5-High	2050	1/5-Dry Year	921.2	-10.0	911.2	0.0	-10.0	-10.0
9	CC RCP8.5-High	2050	1/10-Dry Year	858.4	-10.0	848.5	0.0	-10.0	-10.0
10	CC RCP8.5-Mid.	2050	Average Year	1,078.4	-10.0	1,068.4	0.0	-10.0	-10.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	792.2	-10.0	782.2	0.0	-10.0	-10.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	736.1	-10.0	726.1	0.0	-10.0	-10.0
13	CC RCP8.5-Low	2050	Average Year	807.1	-10.0	797.1	0.0	-10.0	-10.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	590.0	-10.0	580.0	0.0	-10.0	-10.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	563.0	-10.0	552.9	0.0	-10.0	-10.0

Source: JICA Survey Team



Source: JICA Survey Team

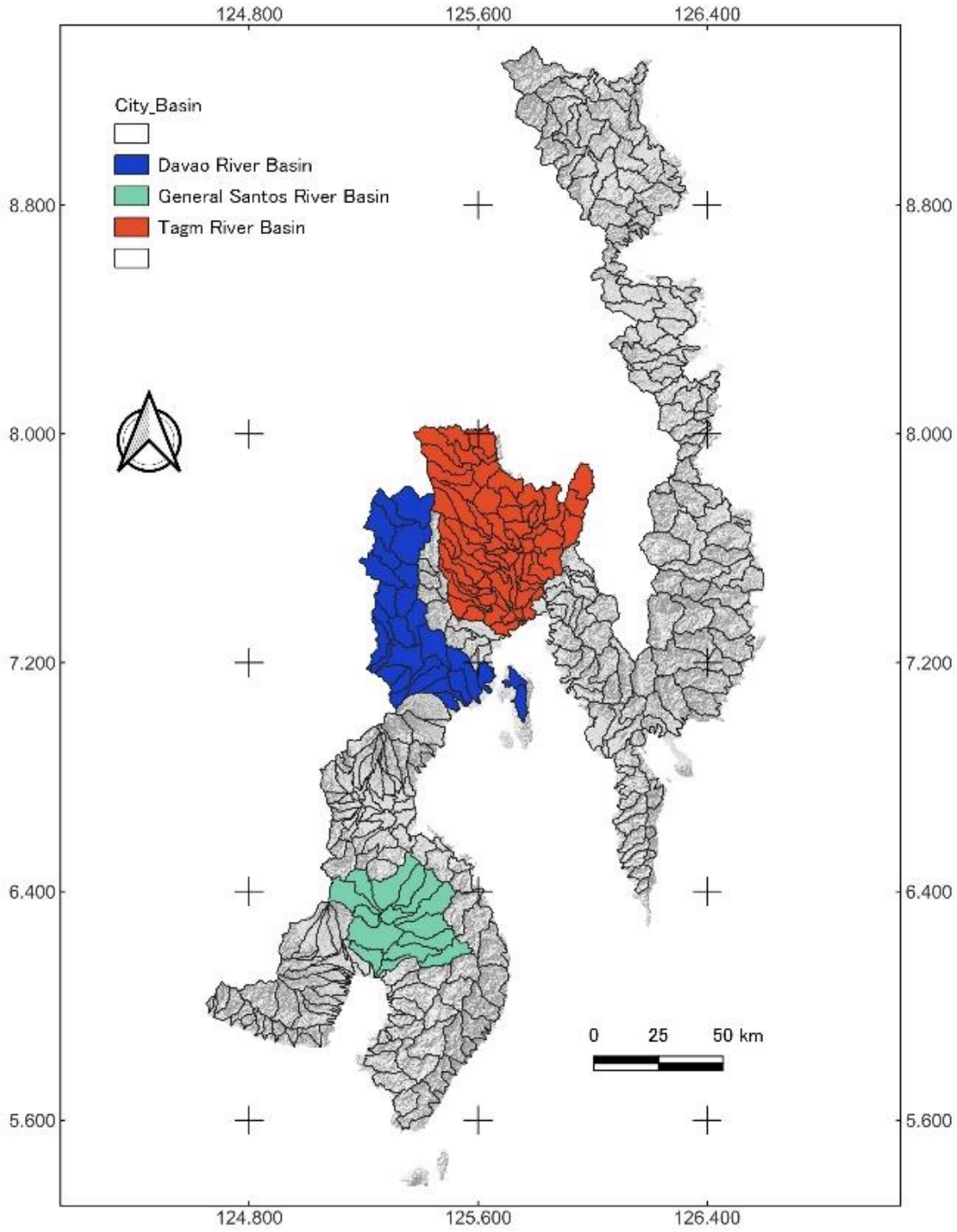
Figure D-488 Surface Water Balance by Major River Basins in WRR-VII at Each Climate Change Condition



Source: JICA Survey Team

FigureD-489 Groundwater Balance by Major River Basins in WRR-VII at Each Climate Change Condition

11.6.2 WRR-XI



Source: JICA Survey Team

Figure D-490 Location Map of Major River Basins in WRR-XI

Table D-243 Surface and Groundwater Balance of Davao River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Davao River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 2,144 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	305.8	293.8	266.7	152.1	596.4	757.0	301.7	550.4	673.6	415.8	320.6	183.0	4,816.7	
Surface Water Potential	**280.9**	**176.1**	**180.6**	**145.0**	**226.3**	**321.1**	**198.5**	**259.5**	**355.5**	**262.0**	**210.7**	**146.5**	**2,762.7**	
Irrigation Water Demand (SW)	21.6	20.3	13.6	0.0	0.1	19.0	16.6	21.9	10.8	0.0	12.8	16.0	152.7	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	
Municipal and Industrial Water Demand (SW)	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	17.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	23.1	21.7	15.1	1.4	1.6	20.5	18.1	23.4	12.2	1.5	14.2	17.5	170.3	
SW Water Balance	**257.7**	**154.4**	**165.5**	**143.6**	**224.8**	**300.6**	**180.3**	**236.2**	**343.3**	**260.5**	**196.5**	**129.0**	**2,592.4**	**0.0**
Groundwater Potential	**1.4**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.4**	**1.3**	**1.4**	**16.0**	
Safety Groundwater Availability (70% of GWP)	**1.0**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**1.0**	**11.2**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	28.2	25.5	28.2	27.3	28.2	27.3	28.2	28.2	27.3	28.2	27.3	28.2	332.2	
Other Water Demand (GW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.2	
Total Water Demand (GW)	28.7	26.0	28.7	27.8	28.7	27.8	28.7	28.7	27.8	28.7	27.8	28.7	338.4	
GW Water Balance	**-27.8**	**-25.1**	**-27.8**	**-26.9**	**-27.8**	**-26.9**	**-27.8**	**-27.8**	**-26.9**	**-27.8**	**-26.9**	**-27.8**	**-327.2**	**-327.2**
Total Water Potential (SW+GW)	**281.8**	**177.0**	**181.5**	**145.9**	**227.3**	**322.0**	**199.4**	**260.5**	**356.4**	**262.9**	**211.6**	**147.5**	**2,773.8**	
Irrigation Water Demand (Total)	21.6	20.3	13.6	0.0	0.1	19.0	16.6	21.9	10.8	0.0	12.8	16.0	152.7	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	
Municipal and Industrial Water Demand (Total)	29.7	26.8	29.7	28.7	29.7	28.7	29.7	29.7	28.7	29.7	28.7	29.7	349.2	
Other Water Demand (Total)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.2	
Total Water Demand (SW+GW)	51.9	47.6	43.8	29.3	30.3	48.3	46.9	52.1	40.0	30.2	42.0	46.2	508.6	
Total Water Balance (SW+GW)	**230.0**	**129.4**	**137.7**	**116.7**	**197.0**	**273.7**	**152.5**	**208.4**	**316.4**	**232.7**	**169.6**	**101.2**	**2,265.2**	**-327.2**

Source: JICA Survey Team

Table D-244 Surface and Groundwater Balance of Tagm River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: Tagm River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 3,208 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	788.6	630.6	518.5	314.1	760.9	1,050.6	438.7	847.6	1,170.8	661.4	477.6	308.5	7,967.9	
Surface Water Potential	**705.9**	**284.0**	**227.2**	**145.6**	**242.2**	**392.2**	**206.2**	**406.1**	**763.2**	**458.1**	**248.0**	**152.5**	**4,231.1**	
Irrigation Water Demand (SW)	99.1	75.4	37.6	0.3	0.9	98.3	71.4	100.5	62.9	0.0	50.0	89.7	686.2	
Livestock Water Deamnd (SW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.8	
Municipal and Industrial Water Demand (SW)	6.6	6.0	6.6	6.4	6.6	6.4	6.6	6.6	6.4	6.6	6.4	6.6	77.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	106.1	81.8	44.7	7.1	7.9	105.1	78.4	107.5	69.7	7.0	56.8	96.7	768.7	
SW Water Balance	**599.8**	**202.2**	**182.6**	**138.5**	**234.3**	**287.1**	**127.7**	**298.6**	**693.5**	**451.1**	**191.2**	**55.8**	**3,462.4**	**0.0**
Groundwater Potential	**14.1**	**12.4**	**11.7**	**10.3**	**10.3**	**11.2**	**11.7**	**12.0**	**11.9**	**12.6**	**13.1**	**12.6**	**144.0**	
Safety Groundwater Availability (70% of GWP)	**9.9**	**8.7**	**8.2**	**7.2**	**7.2**	**7.9**	**8.2**	**8.4**	**8.3**	**8.8**	**9.2**	**8.8**	**100.8**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	2.6	2.4	2.6	2.5	2.6	2.5	2.6	2.6	2.5	2.6	2.5	2.6	30.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (GW)	2.6	2.4	2.6	2.5	2.6	2.5	2.6	2.6	2.5	2.6	2.5	2.6	31.0	
GW Water Balance	**7.3**	**6.3**	**5.5**	**4.7**	**4.6**	**5.3**	**5.6**	**5.7**	**5.8**	**6.2**	**6.6**	**6.2**	**69.8**	**0.0**
Total Water Potential (SW+GW)	**715.8**	**292.6**	**235.4**	**152.9**	**249.4**	**400.0**	**214.4**	**414.5**	**771.5**	**466.9**	**257.2**	**161.3**	**4,332.0**	
Irrigation Water Demand (Total)	99.1	75.4	37.6	0.3	0.9	98.3	71.4	100.5	62.9	0.0	50.0	89.7	686.2	
Livestock Water Deamnd (Total)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.9	
Municipal and Industrial Water Demand (Total)	9.2	8.3	9.2	8.9	9.2	8.9	9.2	9.2	8.9	9.2	8.9	9.2	108.4	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (SW+GW)	108.7	84.1	47.3	9.7	10.5	107.7	81.1	110.1	72.2	9.6	59.3	99.3	799.7	
Total Water Balance (SW+GW)	**607.1**	**208.5**	**188.1**	**143.2**	**238.9**	**292.4**	**133.3**	**304.4**	**699.3**	**457.3**	**197.8**	**62.0**	**3,532.3**	**0.0**

Source: JICA Survey Team

Table D-245 Surface and Groundwater Balance of General Santos River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

River Basin: General Santos River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 1,505 Unit: MCM

Items	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Annual Total	Annual Deficit
Rainfall	127.0	183.1	112.8	78.5	159.9	261.0	223.5	129.8	214.3	245.3	152.3	170.0	2,057.6	
Surface Water Potential	**48.1**	**48.3**	**53.8**	**35.8**	**33.8**	**52.9**	**54.4**	**39.9**	**52.2**	**65.3**	**52.0**	**46.3**	**582.8**	
Irrigation Water Demand (SW)	10.2	4.9	6.7	9.6	7.7	12.5	7.6	7.4	5.7	4.9	11.9	13.2	102.3	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Municipal and Industrial Water Demand (SW)	1.8	1.6	1.8	1.7	1.8	1.7	1.8	1.8	1.7	1.8	1.7	1.8	20.7	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	11.9	6.5	8.5	11.4	9.5	14.3	9.4	9.2	7.5	6.7	13.6	15.0	123.5	
SW Water Balance	**36.2**	**41.7**	**45.4**	**24.4**	**24.2**	**38.6**	**45.0**	**30.7**	**44.7**	**58.6**	**38.3**	**31.3**	**459.4**	**0.0**
Groundwater Potential	**8.0**	**7.3**	**6.6**	**6.1**	**6.4**	**6.8**	**6.6**	**6.5**	**6.3**	**6.7**	**7.5**	**7.4**	**82.1**	
Safety Groundwater Availability (70% of GWP)	**5.6**	**5.1**	**4.7**	**4.2**	**4.5**	**4.8**	**4.6**	**4.5**	**4.4**	**4.7**	**5.2**	**5.2**	**57.5**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Livestock Water Deamnd (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1	
Municipal and Industrial Water Demand (GW)	6.0	5.5	6.0	5.8	6.0	5.8	6.0	6.0	5.8	6.0	5.8	6.0	71.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Total Water Demand (GW)	6.2	5.6	6.2	6.0	6.2	6.0	6.2	6.2	6.0	6.2	6.0	6.2	72.7	
GW Water Balance	**-0.5**	**-0.5**	**-1.5**	**-1.8**	**-1.7**	**-1.2**	**-1.6**	**-1.6**	**-1.6**	**-1.5**	**-0.7**	**-1.0**	**-15.2**	**-15.2**
Total Water Potential (SW+GW)	**53.8**	**53.4**	**58.5**	**40.0**	**38.2**	**57.6**	**59.0**	**44.4**	**56.6**	**70.0**	**57.2**	**51.5**	**640.3**	
Irrigation Water Demand (Total)	10.2	4.9	6.7	9.7	7.8	12.5	7.6	7.4	5.8	4.9	11.9	13.2	102.5	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.5	
Municipal and Industrial Water Demand (Total)	7.8	7.0	7.8	7.6	7.8	7.6	7.8	7.8	7.6	7.8	7.6	7.8	91.9	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Total Water Demand (SW+GW)	18.1	12.1	14.6	17.4	15.7	20.2	15.5	15.3	13.4	12.9	19.6	21.2	196.1	
Total Water Balance (SW+GW)	**35.7**	**41.3**	**43.9**	**22.7**	**22.5**	**37.4**	**43.5**	**29.1**	**43.1**	**57.2**	**37.6**	**30.3**	**444.2**	**-15.2**

Source: JICA Survey Team

Table D-246 Summary of Annual Water Balance and Deficit of Davao River Basin at Each Climate Change Condition

Total Area [km^2]= 2,144

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	3,431.8	-196.8	3,235.1	0.0	-196.8	-196.8
2	Present	2020	1/5-Dry Year	2,654.7	-196.8	2,457.9	0.0	-196.8	-196.8
3	Present	2020	1/10-Dry Year	2,233.6	-196.8	2,036.8	0.0	-196.8	-196.8
4	Present	2050	Average Year	3,369.5	-327.1	3,042.3	0.0	-327.1	-327.1
5	Present	2050	1/5-Dry Year	2,592.4	-327.2	2,265.2	0.0	-327.2	-327.2
6	Present	2050	1/10-Dry Year	2,171.3	-327.2	1,844.1	0.0	-327.2	-327.2
7	CC RCP8.5-High	2050	Average Year	2,677.0	-327.1	2,349.9	0.0	-327.1	-327.1
8	CC RCP8.5-High	2050	1/5-Dry Year	2,184.6	-327.2	1,857.5	0.0	-327.2	-327.2
9	CC RCP8.5-High	2050	1/10-Dry Year	1,943.8	-327.2	1,616.6	0.0	-327.2	-327.2
10	CC RCP8.5-Mid.	2050	Average Year	3,233.9	-326.8	2,907.2	0.0	-326.8	-326.8
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	2,932.6	-326.9	2,605.8	0.0	-326.9	-326.9
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2,782.2	-326.9	2,455.2	0.0	-326.9	-326.9
13	CC RCP8.5-Low	2050	Average Year	3,189.6	-326.2	2,863.4	0.0	-326.2	-326.2
14	CC RCP8.5-Low	2050	1/5-Dry Year	2,418.8	-326.3	2,092.4	0.0	-326.3	-326.3
15	CC RCP8.5-Low	2050	1/10-Dry Year	2,022.9	-326.3	1,696.6	0.0	-326.3	-326.3

Source: JICA Survey Team

Table D-247 Summary of Annual Water Balance and Deficit of Tagm River Basin at Each Climate Change Condition

Total Area [km^2]= 3,208

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	5,559.1	80.6	5,639.7	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	3,866.8	77.2	3,944.0	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	3,263.2	72.0	3,335.2	0.0	0.0	0.0
4	Present	2050	Average Year	5,154.7	73.3	5,228.0	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	3,462.4	69.8	3,532.3	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	2,858.8	64.7	2,923.5	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	6,109.8	73.7	6,183.5	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	4,124.4	70.2	4,194.6	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	3,493.9	65.8	3,559.7	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	4,288.3	63.4	4,351.8	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	2,778.6	58.6	2,837.2	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2,300.5	57.0	2,357.5	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	6,084.2	72.6	6,156.8	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	4,671.8	69.7	4,741.5	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	3,572.6	64.8	3,637.4	0.0	0.0	0.0

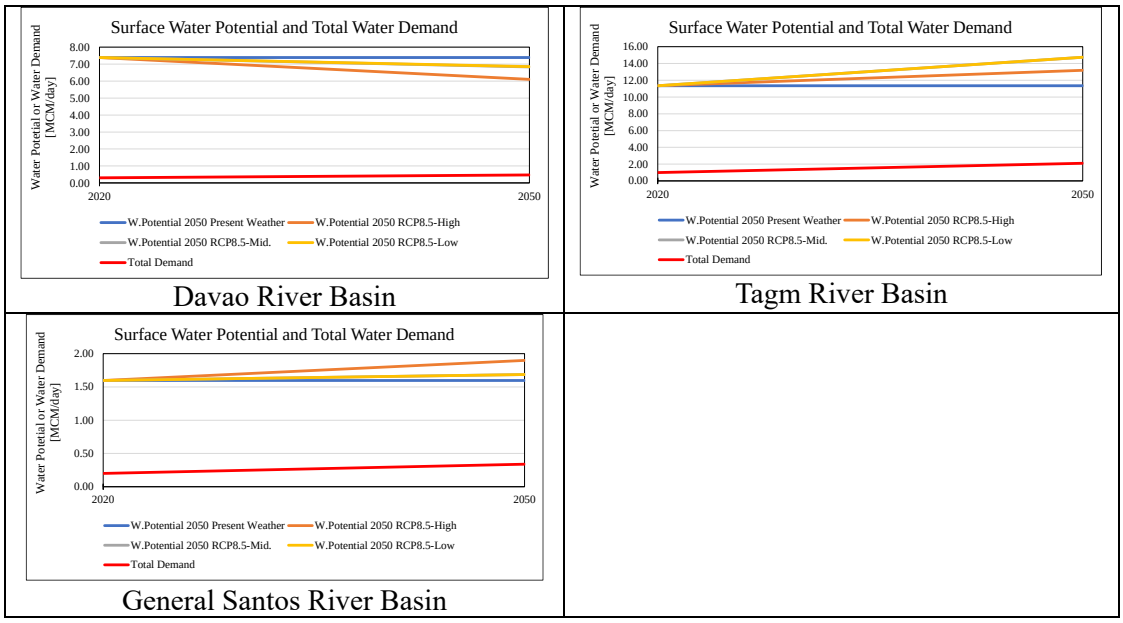
Source: JICA Survey Team

Table D-248 Summary of Annual Water Balance and Deficit of General Santos River Basin at Each Climate Change Condition

Total Area [km^2]= 1,505

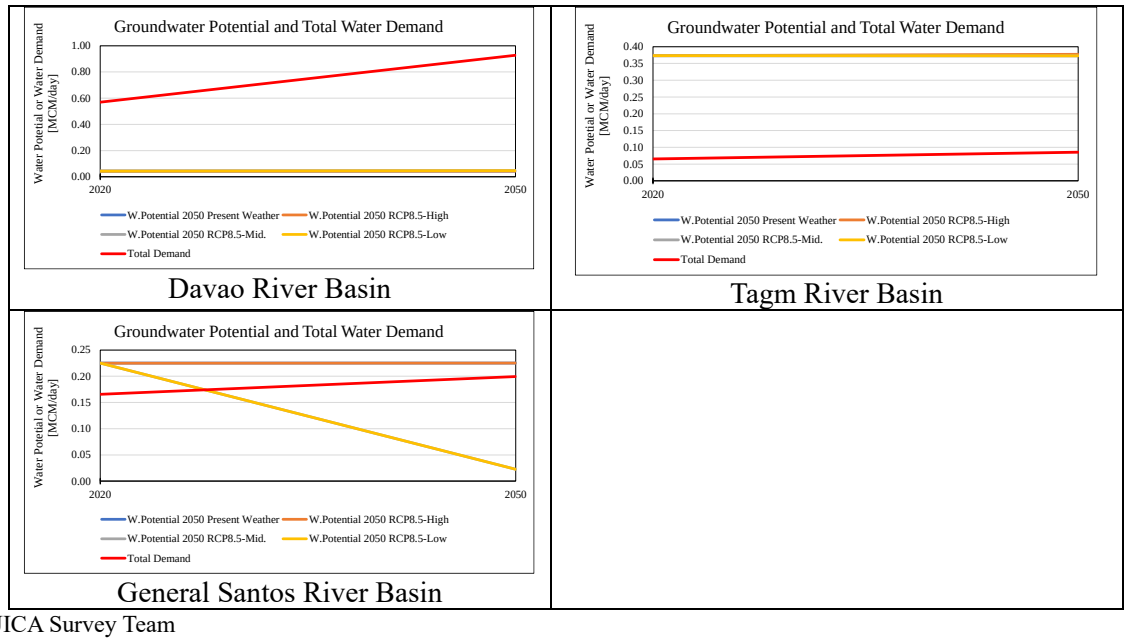
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW.Deficit [MCM/year]	GW.Deficit [MCM/year]	Total W.Deficit [MCM/year]
1	Present	2020	Average Year	792.6	-2.8	789.8	0.0	-4.1	-4.1
2	Present	2020	1/5-Dry Year	509.5	-2.8	506.6	0.0	-4.2	-4.2
3	Present	2020	1/10-Dry Year	454.1	-2.9	451.3	0.0	-4.2	-4.2
4	Present	2050	Average Year	742.5	-15.1	727.3	0.0	-15.1	-15.1
5	Present	2050	1/5-Dry Year	459.4	-15.2	444.2	0.0	-15.2	-15.2
6	Present	2050	1/10-Dry Year	404.0	-15.2	388.8	0.0	-15.2	-15.2
7	CC RCP8.5-High	2050	Average Year	837.8	-15.1	822.7	0.0	-15.1	-15.1
8	CC RCP8.5-High	2050	1/5-Dry Year	569.7	-15.1	554.6	0.0	-15.1	-15.1
9	CC RCP8.5-High	2050	1/10-Dry Year	514.8	-15.2	499.6	0.0	-15.2	-15.2
10	CC RCP8.5-Mid.	2050	Average Year	1,865.2	-47.4	1,817.8	0.0	-47.4	-47.4
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,512.8	-47.5	1,465.3	0.0	-47.5	-47.5
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,370.0	-47.5	1,322.5	0.0	-47.5	-47.5
13	CC RCP8.5-Low	2050	Average Year	741.1	-66.9	674.3	0.0	-66.9	-66.9
14	CC RCP8.5-Low	2050	1/5-Dry Year	491.9	-66.9	425.1	0.0	-66.9	-66.9
15	CC RCP8.5-Low	2050	1/10-Dry Year	183.2	-66.9	116.3	0.0	-66.9	-66.9

Source: JICA Survey Team



Source: JICA Survey Team

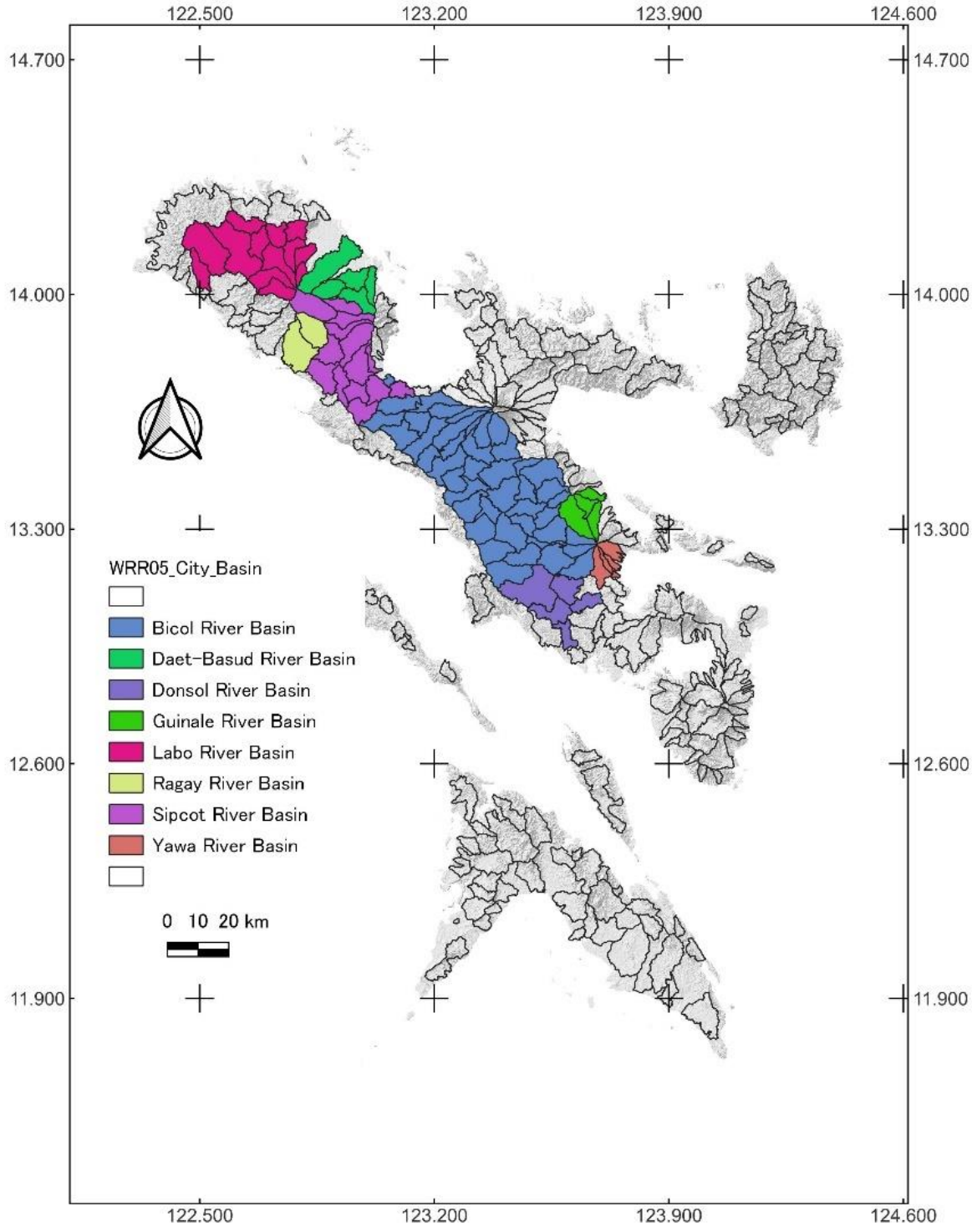
Figure D-491 Surface Water Balance by Major River Basins in WRR-XI at Each Climate Change Condition



Source: JICA Survey Team

Figure D-492 Groundwater Balance by Major River Basins in WRR-XI at Each Climate Change Condition

11.6.3 WRR-V



Source: JICA Survey Team

Figure D-493 Location Map of Major River Basins in WRR-XI

Table D-249 Surface and Groundwater Balance of Bicol River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Basin: Bicol River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 2,284 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	330.2	191.6	198.1	162.2	322.1	233.8	695.7	729.5	800.3	513.8	864.8	540.5	5,582.6	
Surface Water Potential	**422.2**	**286.5**	**258.5**	**240.8**	**188.7**	**157.3**	**318.7**	**483.9**	**584.3**	**472.2**	**713.5**	**541.1**	**4,667.6**	
Irrigation Water Demand (SW)	208.5	207.6	300.2	43.8	223.1	236.7	153.2	157.2	6.6	0.0	0.0	122.9	1,659.8	
Livestock Water Deamnd (SW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.7	
Municipal and Industrial Water Demand (SW)	4.8	4.3	4.8	4.6	4.8	4.6	4.8	4.8	4.6	4.8	4.6	4.8	56.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (SW)	213.6	212.2	305.3	48.7	228.2	241.7	158.3	162.3	11.5	5.1	4.9	128.0	1,719.8	
SW Water Balance	**208.6**	**74.2**	**-46.8**	**192.0**	**-39.5**	**-84.4**	**160.3**	**321.6**	**572.8**	**467.1**	**708.6**	**413.1**	**2,947.8**	**-170.7**
Groundwater Potential	**2.0**	**1.8**	**2.0**	**1.8**	**2.0**	**1.9**	**1.9**	**1.9**	**1.8**	**1.9**	**1.8**	**1.9**	**22.8**	
Safety Groundwater Availability (70% of GWP)	**1.4**	**1.3**	**1.4**	**1.3**	**1.4**	**1.3**	**1.4**	**1.4**	**1.3**	**1.3**	**1.3**	**1.4**	**16.0**	
Irrigation Water Demand (GW)	11.1	5.0	7.2	1.0	5.5	5.9	3.9	4.1	0.1	0.0	0.0	2.9	46.7	
Livestock Water Deamnd (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.7	
Municipal and Industrial Water Demand (GW)	10.8	9.7	10.8	10.4	10.8	10.4	10.8	10.8	10.4	10.8	10.4	10.8	126.8	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (GW)	22.2	15.1	18.3	11.8	16.6	16.6	15.0	15.2	10.8	11.1	10.7	13.9	177.3	
GW Water Balance	**-20.8**	**-13.8**	**-16.9**	**-10.5**	**-15.2**	**-15.3**	**-13.7**	**-13.8**	**-9.6**	**-9.8**	**-9.4**	**-12.6**	**-161.3**	**-161.3**
Total Water Potential (SW+GW)	**423.6**	**287.7**	**259.8**	**242.0**	**190.0**	**158.6**	**320.0**	**485.3**	**585.6**	**473.6**	**714.8**	**542.5**	**4,683.6**	
Irrigation Water Demand (Total)	219.6	212.6	307.4	44.8	228.5	242.6	157.1	161.3	6.7	0.0	0.0	125.8	1,706.4	
Livestock Water Deamnd (Total)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.4	
Municipal and Industrial Water Demand (Total)	15.5	14.0	15.5	15.0	15.5	15.0	15.5	15.5	15.0	15.5	15.0	15.5	182.8	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Total Water Demand (SW+GW)	235.8	227.3	323.6	60.5	244.7	258.3	173.3	177.5	22.3	16.2	15.7	141.9	1,897.1	
Total Water Balance (SW+GW)	**187.9**	**60.4**	**-63.7**	**181.5**	**-54.7**	**-99.7**	**146.7**	**307.8**	**563.3**	**457.4**	**699.1**	**400.5**	**2,786.5**	**-332.0**

Source: JICA Survey Team

Table D-250 Surface and Groundwater Balance of Sipcot River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Basin: Sipcot River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 737 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	132.2	77.0	107.3	45.6	115.8	82.2	199.9	249.1	237.0	221.0	352.6	302.1	2,121.7	
Surface Water Potential	**82.1**	**64.6**	**56.7**	**31.1**	**23.5**	**33.7**	**58.7**	**168.6**	**203.7**	**170.3**	**340.5**	**283.8**	**1,517.3**	
Irrigation Water Demand (SW)	29.5	30.7	42.4	5.5	29.8	29.3	21.9	23.0	0.0	0.0	0.0	16.0	228.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Municipal and Industrial Water Demand (SW)	0.6	0.5	0.6	0.5	0.6	0.5	0.6	0.6	0.5	0.6	0.5	0.6	6.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (SW)	30.2	31.2	43.0	6.1	30.4	29.9	22.5	23.6	0.6	0.6	0.6	16.6	235.5	
SW Water Balance	**52.0**	**33.3**	**13.7**	**25.0**	**-6.9**	**3.8**	**36.2**	**145.0**	**203.0**	**169.7**	**339.8**	**267.1**	**1,281.8**	**-6.9**
Groundwater Potential	**0.2**	**0.2**	**0.2**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.1**	**0.1**	**0.1**	**0.2**	**1.9**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**1.3**	
Irrigation Water Demand (GW)	2.6	2.8	3.9	0.5	2.9	3.0	2.2	2.3	0.0	0.0	0.0	1.4	21.7	
Livestock Water Deamnd (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.5	
Municipal and Industrial Water Demand (GW)	1.4	1.2	1.4	1.3	1.4	1.3	1.4	1.4	1.3	1.4	1.3	1.4	16.3	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	4.1	4.2	5.4	2.0	4.4	4.5	3.7	3.8	1.5	1.5	1.5	2.9	39.4	
GW Water Balance	**-4.0**	**-4.0**	**-5.3**	**-1.9**	**-4.2**	**-4.4**	**-3.6**	**-3.7**	**-1.4**	**-1.4**	**-1.4**	**-2.8**	**-38.1**	**-38.1**
Total Water Potential (SW+GW)	**82.3**	**64.7**	**56.8**	**31.1**	**23.6**	**33.9**	**58.8**	**168.7**	**203.8**	**170.4**	**340.5**	**283.9**	**1,518.6**	
Irrigation Water Demand (Total)	32.2	33.5	46.3	6.0	32.6	32.3	24.1	25.3	0.0	0.0	0.0	17.4	249.7	
Livestock Water Deamnd (Total)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.0	
Municipal and Industrial Water Demand (Total)	1.9	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	22.9	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Total Water Demand (SW+GW)	34.3	35.4	48.4	8.1	34.8	34.4	26.2	27.5	2.1	2.1	2.1	19.5	274.9	
Total Water Balance (SW+GW)	**48.0**	**29.3**	**8.4**	**23.1**	**-11.2**	**-0.6**	**32.6**	**141.2**	**201.7**	**168.3**	**338.5**	**264.3**	**1,243.7**	**-45.0**

Source: JICA Survey Team

Table D-251 Surface and Groundwater Balance of Labo River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Basin: Labo River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 807 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	180.5	132.0	161.7	47.7	164.8	192.5	195.2	153.8	112.7	390.7	509.4	278.0	2,519.1	
Surface Water Potential	**160.8**	**83.1**	**82.4**	**44.3**	**50.5**	**98.8**	**118.1**	**103.8**	**82.2**	**257.5**	**379.3**	**269.9**	**1,730.8**	
Irrigation Water Demand (SW)	33.8	28.8	35.6	4.2	35.9	16.3	19.4	18.5	0.1	0.0	0.5	18.4	211.4	
Livestock Water Deamnd (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.2	
Municipal and Industrial Water Demand (SW)	1.6	1.4	1.6	1.5	1.6	1.5	1.6	1.6	1.5	1.6	1.5	1.6	18.6	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	35.4	30.3	37.2	5.8	37.6	17.9	21.1	20.2	1.7	1.7	2.1	20.1	231.2	
SW Water Balance	**125.4**	**52.8**	**45.2**	**38.5**	**12.9**	**80.9**	**97.0**	**83.6**	**80.5**	**255.8**	**377.1**	**249.8**	**1,499.6**	**0.0**
Groundwater Potential	**1.7**	**1.6**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**20.3**	
Safety Groundwater Availability (70% of GWP)	**1.2**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**14.2**	
Irrigation Water Demand (GW)	0.8	0.7	0.9	0.1	0.9	0.4	0.5	0.4	0.0	0.0	0.0	0.5	5.1	
Livestock Water Deamnd (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1	
Municipal and Industrial Water Demand (GW)	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.4	0.3	0.4	0.3	0.4	4.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	1.3	1.1	1.3	0.5	1.3	0.8	0.9	0.9	0.4	0.4	0.4	0.9	10.4	
GW Water Balance	**-0.1**	**0.0**	**-0.1**	**0.6**	**-0.1**	**0.4**	**0.3**	**0.3**	**0.7**	**0.8**	**0.7**	**0.3**	**3.8**	**-0.3**
Total Water Potential (SW+GW)	**162.0**	**84.3**	**83.6**	**45.5**	**51.7**	**100.0**	**119.3**	**105.0**	**83.4**	**258.7**	**380.5**	**271.1**	**1,745.0**	
Irrigation Water Demand (Total)	34.6	29.5	36.4	4.3	36.8	16.6	19.8	19.0	0.1	0.0	0.5	18.9	216.5	
Livestock Water Deamnd (Total)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.3	
Municipal and Industrial Water Demand (Total)	1.9	1.7	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	22.8	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	36.7	31.4	38.6	6.4	38.9	18.7	22.0	21.1	2.1	2.1	2.6	21.0	241.6	
Total Water Balance (SW+GW)	**125.3**	**52.8**	**45.0**	**39.1**	**12.8**	**81.3**	**97.3**	**83.9**	**81.3**	**256.5**	**377.9**	**250.1**	**1,503.4**	**-0.3**

Source: JICA Survey Team

Table D-252 Surface and Groundwater Balance of Daet-Basud River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Basin: Daet-Basud River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 326 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	79.7	70.5	90.1	14.8	80.8	69.4	58.0	72.1	43.9	164.3	242.4	120.0	1,105.9	
Surface Water Potential	**60.3**	**51.5**	**74.1**	**20.4**	**26.6**	**42.1**	**24.3**	**50.2**	**24.5**	**125.4**	**202.2**	**139.6**	**840.9**	
Irrigation Water Demand (SW)	10.8	9.5	11.0	1.4	11.1	5.5	6.2	6.1	0.1	0.0	0.2	6.2	68.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	
Municipal and Industrial Water Demand (SW)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.0	
Other Water Demand (SW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8	
Total Water Demand (SW)	12.0	10.6	12.3	2.6	12.4	6.8	7.5	7.4	1.3	1.3	1.5	7.5	83.3	
SW Water Balance	**48.2**	**40.8**	**61.8**	**17.8**	**14.2**	**35.3**	**16.7**	**42.9**	**23.1**	**124.1**	**200.7**	**132.1**	**757.6**	**0.0**
Groundwater Potential	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**1.4**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.9**	
Irrigation Water Demand (GW)	0.2	0.2	0.2	0.0	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.1	1.3	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (GW)	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	13.0	
Other Water Demand (GW)	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	14.1	
Total Water Demand (GW)	2.5	2.3	2.6	2.3	2.6	2.3	2.4	2.4	2.3	2.3	2.3	2.4	28.7	
GW Water Balance	**-2.5**	**-2.2**	**-2.5**	**-2.2**	**-2.5**	**-2.3**	**-2.4**	**-2.4**	**-2.2**	**-2.3**	**-2.2**	**-2.4**	**-27.8**	**-27.8**
Total Water Potential (SW+GW)	**60.4**	**51.5**	**74.2**	**20.5**	**26.7**	**42.1**	**24.3**	**50.3**	**24.5**	**125.4**	**202.2**	**139.7**	**841.8**	
Irrigation Water Demand (Total)	11.0	9.7	11.2	1.4	11.3	5.6	6.3	6.2	0.1	0.0	0.2	6.3	69.3	
Livestock Water Deamnd (Total)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	
Municipal and Industrial Water Demand (Total)	2.3	2.1	2.3	2.2	2.3	2.2	2.3	2.3	2.2	2.3	2.2	2.3	27.1	
Other Water Demand (Total)	1.3	1.1	1.3	1.2	1.3	1.2	1.3	1.3	1.2	1.3	1.2	1.3	14.9	
Total Water Demand (SW+GW)	14.6	12.9	14.8	4.9	15.0	9.1	10.0	9.8	3.6	3.6	3.7	9.9	112.0	
Total Water Balance (SW+GW)	**45.8**	**38.6**	**59.3**	**15.5**	**11.7**	**33.0**	**14.4**	**40.5**	**21.0**	**121.8**	**198.5**	**129.8**	**729.9**	**-27.8**

Source: JICA Survey Team

Table D-253 Surface and Groundwater Balance of Ragay River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Basin: Ragay River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 197 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	36.1	21.3	33.1	13.0	38.0	23.9	58.5	74.3	71.2	65.5	99.5	97.2	631.8	
Surface Water Potential	**11.5**	**11.1**	**12.5**	**8.2**	**8.2**	**9.7**	**14.6**	**22.8**	**25.8**	**19.4**	**51.7**	**61.4**	**256.9**	
Irrigation Water Demand (SW)	3.1	2.8	3.7	0.4	3.2	2.0	1.9	1.9	0.0	0.0	0.0	1.7	20.7	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	3.1	2.8	3.7	0.5	3.2	2.0	1.9	1.9	0.0	0.0	0.0	1.7	20.8	
SW Water Balance	**8.4**	**8.3**	**8.8**	**7.7**	**5.0**	**7.8**	**12.6**	**20.9**	**25.8**	**19.4**	**51.7**	**59.8**	**236.1**	**0.0**
Groundwater Potential	**0.1**	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.6**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	
Irrigation Water Demand (GW)	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (GW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.5	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.4	0.3	0.3	0.3	0.4	4.1	
GW Water Balance	**-0.4**	**-0.3**	**-0.4**	**-0.3**	**-0.4**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-3.7**	**-3.7**
Total Water Potential (SW+GW)	**11.6**	**11.1**	**12.5**	**8.2**	**8.2**	**9.8**	**14.6**	**22.9**	**25.8**	**19.4**	**51.8**	**61.5**	**257.3**	
Irrigation Water Demand (Total)	3.2	2.9	3.8	0.5	3.3	2.0	2.0	1.9	0.0	0.0	0.0	1.7	21.2	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (Total)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.5	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	3.5	3.2	4.1	0.8	3.6	2.3	2.3	2.2	0.3	0.3	0.3	2.0	24.9	
Total Water Balance (SW+GW)	**8.1**	**8.0**	**8.4**	**7.4**	**4.6**	**7.5**	**12.3**	**20.6**	**25.5**	**19.1**	**51.5**	**59.4**	**232.4**	**-3.7**

Source: JICA Survey Team

Table D-254 Surface and Groundwater Balance of Guinale River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Basin: Guinale River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 169 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	36.6	22.7	20.2	23.5	37.2	18.0	50.1	43.1	51.3	41.1	74.4	50.4	468.8	
Surface Water Potential	**28.2**	**19.9**	**23.1**	**25.1**	**23.6**	**19.5**	**29.0**	**35.5**	**38.6**	**32.1**	**51.5**	**57.0**	**383.1**	
Irrigation Water Demand (SW)	18.8	19.8	27.9	3.7	19.1	20.6	14.3	15.1	0.2	0.0	0.0	10.4	150.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (SW)	1.7	1.5	1.7	1.6	1.7	1.6	1.7	1.7	1.6	1.7	1.6	1.7	19.8	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	20.5	21.3	29.6	5.4	20.8	22.3	16.0	16.8	1.8	1.7	1.6	12.1	170.0	
SW Water Balance	**7.7**	**-1.4**	**-6.5**	**19.7**	**2.8**	**-2.8**	**13.0**	**18.6**	**36.8**	**30.4**	**49.8**	**44.9**	**213.1**	**-10.7**
Groundwater Potential	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**2.9**	
Safety Groundwater Availability (70% of GWP)	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**2.0**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.4	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.4	
GW Water Balance	**0.1**	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.6**	**0.0**
Total Water Potential (SW+GW)	**28.4**	**20.1**	**23.3**	**25.3**	**23.8**	**19.6**	**29.2**	**35.6**	**38.8**	**32.3**	**51.6**	**57.2**	**385.2**	
Irrigation Water Demand (Total)	18.8	19.8	27.9	3.7	19.1	20.6	14.3	15.1	0.2	0.0	0.0	10.4	150.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
Municipal and Industrial Water Demand (Total)	1.8	1.6	1.8	1.7	1.8	1.7	1.8	1.8	1.7	1.8	1.7	1.8	21.2	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	20.6	21.4	29.7	5.5	21.0	22.4	16.1	16.9	1.9	1.8	1.8	12.2	171.5	
Total Water Balance (SW+GW)	**7.8**	**-1.3**	**-6.4**	**19.8**	**2.8**	**-2.8**	**13.1**	**18.7**	**36.8**	**30.5**	**49.9**	**44.9**	**213.7**	**-10.7**

Source: JICA Survey Team

Table D-255 Surface and Groundwater Balance of Donsol River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Basin: Donsol River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 364 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	55.9	36.2	28.2	30.0	38.0	41.6	133.1	124.7	120.8	69.2	117.3	87.0	881.9	
Surface Water Potential	**19.7**	**14.6**	**9.4**	**8.0**	**7.5**	**8.5**	**53.3**	**74.8**	**76.0**	**28.2**	**79.5**	**48.4**	**427.9**	
Irrigation Water Demand (SW)	8.6	7.5	11.1	2.0	10.3	10.4	5.7	5.3	0.8	0.0	0.0	6.0	67.8	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (SW)	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.0	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	9.3	8.1	11.8	2.7	11.0	11.1	6.4	6.0	1.5	0.7	0.7	6.7	76.0	
SW Water Balance	**10.4**	**6.5**	**-2.5**	**5.3**	**-3.5**	**-2.6**	**46.9**	**68.8**	**74.6**	**27.5**	**78.8**	**41.6**	**351.9**	**-8.5**
Groundwater Potential	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**1.5**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**1.1**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.7	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (GW)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	8.8	
GW Water Balance	**-0.7**	**-0.6**	**-0.7**	**-0.6**	**-0.7**	**-0.6**	**-0.7**	**-0.7**	**-0.6**	**-0.7**	**-0.6**	**-0.7**	**-7.7**	**-7.7**
Total Water Potential (SW+GW)	**19.8**	**14.7**	**9.4**	**8.1**	**7.6**	**8.6**	**53.4**	**74.9**	**76.1**	**28.3**	**79.6**	**48.5**	**429.0**	
Irrigation Water Demand (Total)	8.6	7.5	11.1	2.0	10.3	10.4	5.7	5.3	0.8	0.0	0.0	6.0	67.8	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
Municipal and Industrial Water Demand (Total)	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	16.7	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total Water Demand (SW+GW)	10.1	8.8	12.6	3.4	11.7	11.8	7.2	6.7	2.2	1.4	1.4	7.5	84.8	
Total Water Balance (SW+GW)	**9.7**	**5.9**	**-3.1**	**4.6**	**-4.1**	**-3.2**	**46.2**	**68.1**	**73.9**	**26.9**	**78.2**	**41.0**	**344.2**	**-16.2**

Source: JICA Survey Team

Table D-256 Surface and Groundwater Balance of Yawa River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Basin: Yawa River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 104 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	25.0	15.5	14.5	16.3	18.7	10.7	28.4	28.5	30.2	26.3	47.6	39.7	301.5	
Surface Water Potential	**18.6**	**12.6**	**13.1**	**12.1**	**10.7**	**9.2**	**11.1**	**13.9**	**15.0**	**13.4**	**21.8**	**17.6**	**169.2**	
Irrigation Water Demand (SW)	6.1	5.2	8.0	1.5	7.4	7.5	4.0	3.7	0.6	0.0	0.0	4.2	48.1	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (SW)	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	12.3	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	7.1	6.1	9.0	2.5	8.4	8.5	5.1	4.8	1.6	1.1	1.0	5.3	60.5	
SW Water Balance	**11.5**	**6.4**	**4.1**	**9.6**	**2.3**	**0.7**	**6.0**	**9.1**	**13.4**	**12.4**	**20.8**	**12.3**	**108.7**	**0.0**
Groundwater Potential	**0.2**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**1.9**	
Safety Groundwater Availability (70% of GWP)	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**1.3**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.2	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.2	
GW Water Balance	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-5.9**	**-5.9**
Total Water Potential (SW+GW)	**18.7**	**12.7**	**13.3**	**12.2**	**10.8**	**9.3**	**11.2**	**14.0**	**15.1**	**13.5**	**21.9**	**17.7**	**170.5**	
Irrigation Water Demand (Total)	6.1	5.2	8.0	1.5	7.4	7.5	4.0	3.7	0.6	0.0	0.0	4.2	48.1	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Municipal and Industrial Water Demand (Total)	1.7	1.5	1.7	1.6	1.7	1.6	1.7	1.7	1.6	1.7	1.6	1.7	19.4	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	7.8	6.7	9.6	3.1	9.0	9.1	5.7	5.4	2.2	1.7	1.6	5.9	67.8	
Total Water Balance (SW+GW)	**11.0**	**6.0**	**3.6**	**9.1**	**1.8**	**0.2**	**5.5**	**8.6**	**12.9**	**11.9**	**20.3**	**11.8**	**102.7**	**-5.9**

Source: JICA Survey Team

Table D-257 Surface and Groundwater Balance of Lanang River Basin in 1/5-Dry Year, (Present Weather Condition, Water Demand=2050)

Basin: Lanang River Basin Target Year= 2050
Weather Condition: Present Total Area [km2]= 139 Unit: MCM

Items	1	2	3	4	5	6	7	8	9	10	11	12	Annual	Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Deficit
Rainfall	9.6	8.5	13.3	5.1	25.9	31.7	41.8	39.5	18.3	35.0	25.0	15.7	269.3	
Surface Water Potential	**5.3**	**3.5**	**3.9**	**3.4**	**3.9**	**6.5**	**15.6**	**23.4**	**15.3**	**17.4**	**18.9**	**12.1**	**129.3**	
Irrigation Water Demand (SW)	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	1.0	
Livestock Water Deamnd (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (SW)	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.3	
Other Water Demand (SW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW)	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5	5.4	
SW Water Balance	**4.8**	**3.0**	**3.4**	**3.0**	**3.4**	**6.0**	**15.2**	**22.9**	**14.9**	**17.0**	**18.6**	**11.6**	**123.9**	**0.0**
Groundwater Potential	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	
Safety Groundwater Availability (70% of GWP)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	
Irrigation Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Livestock Water Deamnd (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Other Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (GW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
GW Water Balance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**	**0.0**
Total Water Potential (SW+GW)	**5.3**	**3.5**	**3.9**	**3.4**	**4.0**	**6.5**	**15.7**	**23.4**	**15.3**	**17.4**	**18.9**	**12.1**	**129.6**	
Irrigation Water Demand (Total)	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	1.0	
Livestock Water Deamnd (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Municipal and Industrial Water Demand (Total)	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.4	
Other Water Demand (Total)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Water Demand (SW+GW)	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5	5.4	
Total Water Balance (SW+GW)	**4.8**	**3.1**	**3.4**	**3.0**	**3.5**	**6.0**	**15.2**	**23.0**	**14.9**	**17.0**	**18.6**	**11.7**	**124.1**	**0.0**

Source: JICA Survey Team

Table D-258 Summary of Annual Water Balance and Deficit of Bicol River Basin at Each Climate Change Condition

Total Area [km^2]= 2,284

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	4,361.6	-93.4	4,268.1	0.0	-93.4	-93.4
2	Present	2020	1/5-Dry Year	3,925.4	-93.4	3,832.0	0.0	-93.4	-93.4
3	Present	2020	1/10-Dry Year	3,325.5	-93.4	3,232.1	0.0	-93.4	-93.4
4	Present	2050	Average Year	3,384.0	-161.4	3,222.6	-117.7	-161.4	-279.0
5	Present	2050	1/5-Dry Year	2,947.8	-161.3	2,786.5	-170.7	-161.3	-332.0
6	Present	2050	1/10-Dry Year	2,347.9	-161.3	2,186.5	-241.5	-161.3	-402.8
7	CC RCP8.5-High	2050	Average Year	4,162.7	-161.3	4,001.4	-40.4	-161.3	-201.7
8	CC RCP8.5-High	2050	1/5-Dry Year	3,477.1	-161.2	3,315.9	-70.1	-161.2	-231.4
9	CC RCP8.5-High	2050	1/10-Dry Year	2,934.8	-161.3	2,773.5	-181.0	-161.3	-342.3
10	CC RCP8.5-Mid.	2050	Average Year	3,377.1	-161.4	3,215.7	-114.0	-161.4	-275.4
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	2,823.8	-161.3	2,662.6	-168.5	-161.3	-329.8
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	2,367.0	-161.3	2,205.6	-247.4	-161.3	-408.8
13	CC RCP8.5-Low	2050	Average Year	2,133.2	-161.4	1,971.7	-303.2	-161.4	-464.7
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,687.4	-161.3	1,526.0	-287.1	-161.3	-448.4
15	CC RCP8.5-Low	2050	1/10-Dry Year	1,271.7	-161.4	1,110.3	-346.8	-161.4	-508.1

Source: JICA Survey Team

Table D-259 Summary of Annual Water Balance and Deficit of Sipcot River Basin at Each Climate Change Condition

Total Area [km^2]= 737

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	1,776.7	-20.0	1,756.7	0.0	-20.0	-20.0
2	Present	2020	1/5-Dry Year	1,424.3	-20.0	1,404.2	0.0	-20.0	-20.0
3	Present	2020	1/10-Dry Year	1,230.3	-20.0	1,210.3	0.0	-20.0	-20.0
4	Present	2050	Average Year	1,634.2	-38.1	1,596.2	0.0	-38.1	-38.1
5	Present	2050	1/5-Dry Year	1,281.8	-38.1	1,243.7	-6.9	-38.1	-45.0
6	Present	2050	1/10-Dry Year	1,087.8	-38.1	1,049.7	-32.7	-38.1	-70.8
7	CC RCP8.5-High	2050	Average Year	1,933.7	-38.1	1,895.6	0.0	-38.1	-38.1
8	CC RCP8.5-High	2050	1/5-Dry Year	1,552.5	-38.1	1,514.4	-1.0	-38.1	-39.1
9	CC RCP8.5-High	2050	1/10-Dry Year	1,325.9	-38.1	1,287.8	-22.1	-38.1	-60.2
10	CC RCP8.5-Mid.	2050	Average Year	1,621.6	-38.1	1,583.5	0.0	-38.1	-38.1
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,276.9	-38.1	1,238.8	-6.6	-38.1	-44.7
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,118.0	-38.1	1,079.9	-33.1	-38.1	-71.2
13	CC RCP8.5-Low	2050	Average Year	1,201.8	-38.1	1,163.7	0.0	-38.1	-38.1
14	CC RCP8.5-Low	2050	1/5-Dry Year	846.3	-38.1	808.2	-22.1	-38.1	-60.2
15	CC RCP8.5-Low	2050	1/10-Dry Year	754.4	-38.1	716.3	-52.5	-38.1	-90.6

Source: JICA Survey Team

Table D-260 Summary of Annual Water Balance and Deficit of Labo River Basin at Each Climate Change Condition

Total Area [km^2]= 807

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	2,169.6	8.6	2,178.2	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	1,638.5	8.7	1,647.2	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	1,462.7	8.6	1,471.3	0.0	0.0	0.0
4	Present	2050	Average Year	2,030.6	3.8	2,034.4	0.0	-0.3	-0.3
5	Present	2050	1/5-Dry Year	1,499.6	3.8	1,503.4	0.0	-0.3	-0.3
6	Present	2050	1/10-Dry Year	1,323.7	3.8	1,327.5	-5.0	-0.3	-5.3
7	CC RCP8.5-High	2050	Average Year	2,383.4	3.8	2,387.3	0.0	-0.3	-0.3
8	CC RCP8.5-High	2050	1/5-Dry Year	1,959.9	3.9	1,963.8	0.0	-0.3	-0.3
9	CC RCP8.5-High	2050	1/10-Dry Year	1,702.7	3.8	1,706.5	0.0	-0.3	-0.3
10	CC RCP8.5-Mid.	2050	Average Year	2,084.9	3.8	2,088.7	0.0	-0.3	-0.3
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	1,521.6	3.8	1,525.4	0.0	-0.3	-0.3
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	1,344.4	3.8	1,348.1	-6.0	-0.3	-6.3
13	CC RCP8.5-Low	2050	Average Year	1,677.1	3.8	1,680.9	-4.0	-0.3	-4.3
14	CC RCP8.5-Low	2050	1/5-Dry Year	1,149.4	3.8	1,153.2	0.0	-0.3	-0.3
15	CC RCP8.5-Low	2050	1/10-Dry Year	1,068.3	3.8	1,072.0	-13.2	-0.3	-13.6

Source: JICA Survey Team

Table D-261 Summary of Annual Water Balance and Deficit of Daet-Basud River Basin at Each Climate Change Condition

Total Area [km^2]= 326

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	910.8	-18.1	892.7	0.0	-18.1	-18.1
2	Present	2020	1/5-Dry Year	807.2	-18.1	789.1	0.0	-18.1	-18.1
3	Present	2020	1/10-Dry Year	691.7	-18.1	673.5	0.0	-18.1	-18.1
4	Present	2050	Average Year	861.2	-27.8	833.4	-2.4	-27.8	-30.2
5	Present	2050	1/5-Dry Year	757.6	-27.8	729.9	0.0	-27.8	-27.8
6	Present	2050	1/10-Dry Year	642.1	-27.8	614.3	-5.8	-27.8	-33.6
7	CC RCP8.5-High	2050	Average Year	1,053.1	-27.8	1,025.3	-1.8	-27.8	-29.6
8	CC RCP8.5-High	2050	1/5-Dry Year	937.8	-27.8	910.0	0.0	-27.8	-27.8
9	CC RCP8.5-High	2050	1/10-Dry Year	686.4	-27.8	658.6	-6.1	-27.8	-33.9
10	CC RCP8.5-Mid.	2050	Average Year	885.1	-27.8	857.3	-2.4	-27.8	-30.2
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	785.2	-27.8	757.4	0.0	-27.8	-27.8
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	639.9	-27.8	612.1	-6.1	-27.8	-34.0
13	CC RCP8.5-Low	2050	Average Year	696.0	-27.8	668.2	-3.3	-27.8	-31.1
14	CC RCP8.5-Low	2050	1/5-Dry Year	547.4	-27.8	519.6	0.0	-27.8	-27.8
15	CC RCP8.5-Low	2050	1/10-Dry Year	430.1	-27.8	402.3	-9.1	-27.8	-36.9

Source: JICA Survey Team

Table D-262 Summary of Annual Water Balance and Deficit of Ragay River Basin at Each Climate Change Condition

Total Area [km^2]= 197

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	317.5	-2.4	315.1	0.0	-2.4	-2.4
2	Present	2020	1/5-Dry Year	249.1	-2.4	246.7	0.0	-2.4	-2.4
3	Present	2020	1/10-Dry Year	224.2	-2.4	221.8	0.0	-2.4	-2.4
4	Present	2050	Average Year	304.5	-3.7	300.8	0.0	-3.7	-3.7
5	Present	2050	1/5-Dry Year	236.1	-3.7	232.4	0.0	-3.7	-3.7
6	Present	2050	1/10-Dry Year	211.1	-3.7	207.5	0.0	-3.7	-3.7
7	CC RCP8.5-High	2050	Average Year	368.5	-3.7	364.9	0.0	-3.7	-3.7
8	CC RCP8.5-High	2050	1/5-Dry Year	292.3	-3.7	288.6	0.0	-3.7	-3.7
9	CC RCP8.5-High	2050	1/10-Dry Year	262.7	-3.7	259.0	0.0	-3.7	-3.7
10	CC RCP8.5-Mid.	2050	Average Year	309.6	-3.7	305.9	0.0	-3.7	-3.7
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	235.8	-3.7	232.1	0.0	-3.7	-3.7
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	220.7	-3.7	217.0	0.0	-3.7	-3.7
13	CC RCP8.5-Low	2050	Average Year	170.8	-3.7	167.1	0.0	-3.7	-3.7
14	CC RCP8.5-Low	2050	1/5-Dry Year	171.9	-3.7	168.2	0.0	-3.7	-3.7
15	CC RCP8.5-Low	2050	1/10-Dry Year	190.0	-3.7	186.4	0.0	-3.7	-3.7

Source: JICA Survey Team

Table D-263 Summary of Annual Water Balance and Deficit of Guinale River Basin at Each Climate Change Condition

Total Area [km^2]= 169

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	342.7	0.9	343.7	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	308.0	0.9	308.9	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	256.4	0.9	257.3	0.0	0.0	0.0
4	Present	2050	Average Year	247.9	0.6	248.5	-31.2	0.0	-31.2
5	Present	2050	1/5-Dry Year	213.1	0.6	213.7	-10.7	0.0	-10.7
6	Present	2050	1/10-Dry Year	161.5	0.6	162.1	-27.9	0.0	-27.9
7	CC RCP8.5-High	2050	Average Year	#DIV/0!	0.6	#DIV/0!	-17.5	0.0	-17.5
8	CC RCP8.5-High	2050	1/5-Dry Year	294.3	0.6	294.9	-5.0	0.0	-5.0
9	CC RCP8.5-High	2050	1/10-Dry Year	209.9	0.6	210.5	-22.2	0.0	-22.2
10	CC RCP8.5-Mid.	2050	Average Year	266.0	0.6	266.6	-31.3	0.0	-31.3
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	216.0	0.6	216.6	-11.4	0.0	-11.4
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	160.1	0.6	160.8	-28.2	0.0	-28.2
13	CC RCP8.5-Low	2050	Average Year	138.2	0.6	138.8	-43.7	0.0	-43.7
14	CC RCP8.5-Low	2050	1/5-Dry Year	156.8	0.6	157.4	-21.6	0.0	-21.6
15	CC RCP8.5-Low	2050	1/10-Dry Year	122.4	0.6	123.0	-34.7	0.0	-34.7

Source: JICA Survey Team

Table D-264 Summary of Annual Water Balance and Deficit of Donsol River Basin at Each Climate Change Condition

Total Area [km^2]= 364

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	472.3	-5.7	466.6	-1.2	-5.7	-6.9
2	Present	2020	1/5-Dry Year	390.1	-5.7	384.4	0.0	-5.7	-5.7
3	Present	2020	1/10-Dry Year	405.2	-5.7	399.5	0.0	-5.7	-5.7
4	Present	2050	Average Year	434.1	-7.7	426.3	-24.0	-7.7	-31.8
5	Present	2050	1/5-Dry Year	351.9	-7.7	344.2	-8.5	-7.7	-16.2
6	Present	2050	1/10-Dry Year	367.0	-7.7	359.3	-17.9	-7.7	-25.6
7	CC RCP8.5-High	2050	Average Year	516.0	-7.7	508.3	-8.4	-7.7	-16.1
8	CC RCP8.5-High	2050	1/5-Dry Year	481.1	-7.7	473.4	0.0	-7.7	-7.7
9	CC RCP8.5-High	2050	1/10-Dry Year	458.1	-7.7	450.4	-15.0	-7.7	-22.7
10	CC RCP8.5-Mid.	2050	Average Year	385.3	-7.7	377.5	-24.9	-7.7	-32.6
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	346.6	-7.7	338.8	-10.5	-7.7	-18.2
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	364.0	-7.7	356.3	-19.4	-7.7	-27.1
13	CC RCP8.5-Low	2050	Average Year	324.5	-7.7	316.8	-34.3	-7.7	-42.1
14	CC RCP8.5-Low	2050	1/5-Dry Year	237.6	-7.7	229.9	-19.5	-7.7	-27.3
15	CC RCP8.5-Low	2050	1/10-Dry Year	282.3	-7.7	274.6	-23.7	-7.7	-31.4

Source: JICA Survey Team

Table D-265 Summary of Annual Water Balance and Deficit of Yawa River Basin at Each Climate Change Condition

Total Area [km^2]= 104

Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	107.0	-4.3	102.7	0.0	-4.3	-4.3
2	Present	2020	1/5-Dry Year	138.1	-4.3	133.8	0.0	-4.3	-4.3
3	Present	2020	1/10-Dry Year	86.6	-4.3	82.3	0.0	-4.3	-4.3
4	Present	2050	Average Year	77.5	-5.9	71.6	-8.4	-5.9	-14.3
5	Present	2050	1/5-Dry Year	108.7	-5.9	102.7	0.0	-5.9	-5.9
6	Present	2050	1/10-Dry Year	57.1	-5.9	51.2	-8.3	-5.9	-14.2
7	CC RCP8.5-High	2050	Average Year	115.9	-5.9	109.9	-3.4	-5.9	-9.3
8	CC RCP8.5-High	2050	1/5-Dry Year	147.3	-5.9	141.4	0.0	-5.9	-5.9
9	CC RCP8.5-High	2050	1/10-Dry Year	91.5	-5.9	85.6	-3.9	-5.9	-9.8
10	CC RCP8.5-Mid.	2050	Average Year	82.9	-5.9	76.9	-8.6	-5.9	-14.6
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	110.6	-5.9	104.7	0.0	-5.9	-5.9
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	58.3	-5.9	52.4	-8.3	-5.9	-14.2
13	CC RCP8.5-Low	2050	Average Year	45.9	-5.9	40.0	-17.6	-5.9	-23.5
14	CC RCP8.5-Low	2050	1/5-Dry Year	77.1	-5.9	71.2	-1.1	-5.9	-7.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	35.5	-5.9	29.5	-12.0	-5.9	-17.9

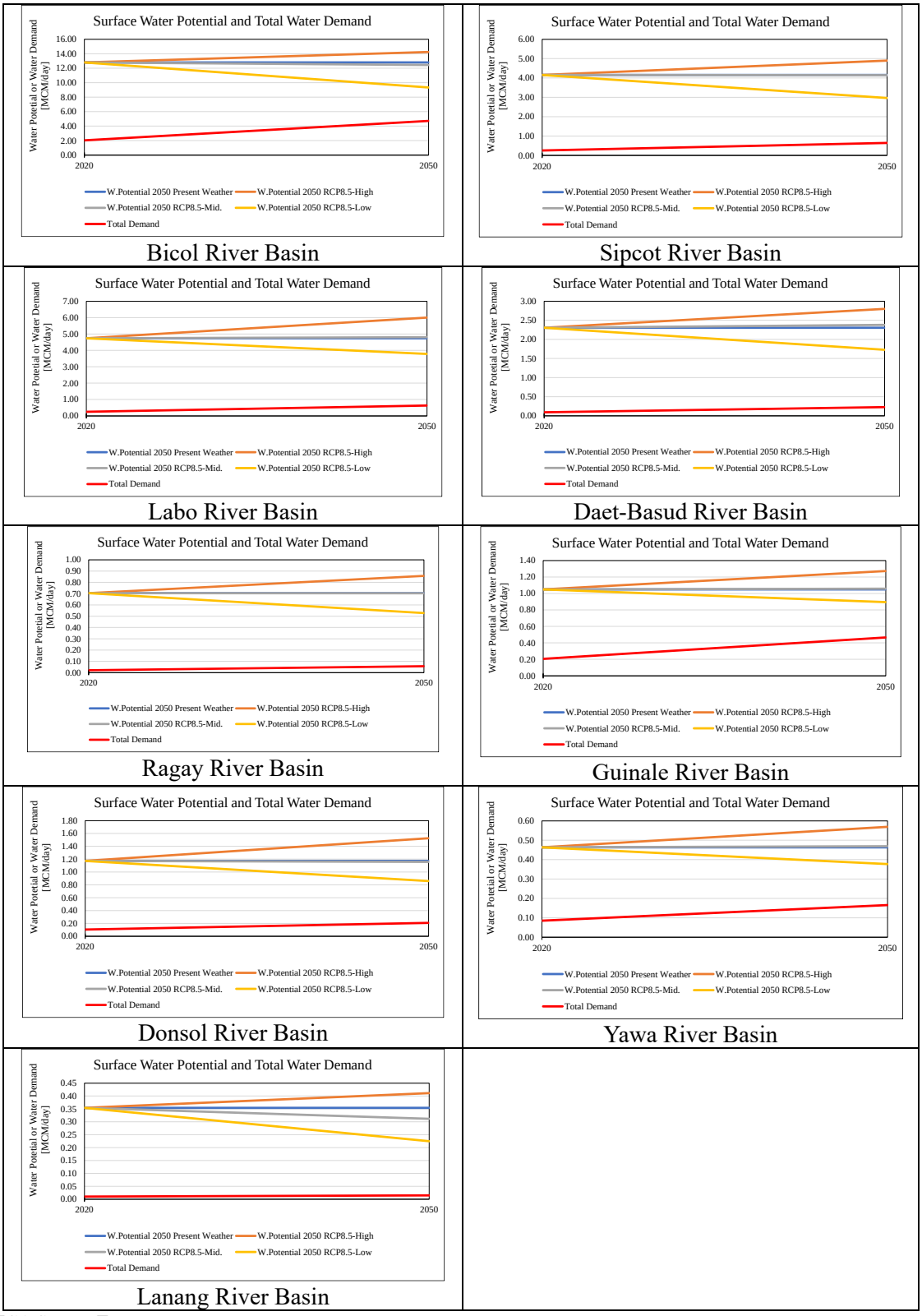
Source: JICA Survey Team

Table D-266 Summary of Annual Water Balance and Deficit of Lanang River Basin at Each Climate Change Condition

Total Area [km^2]= 139

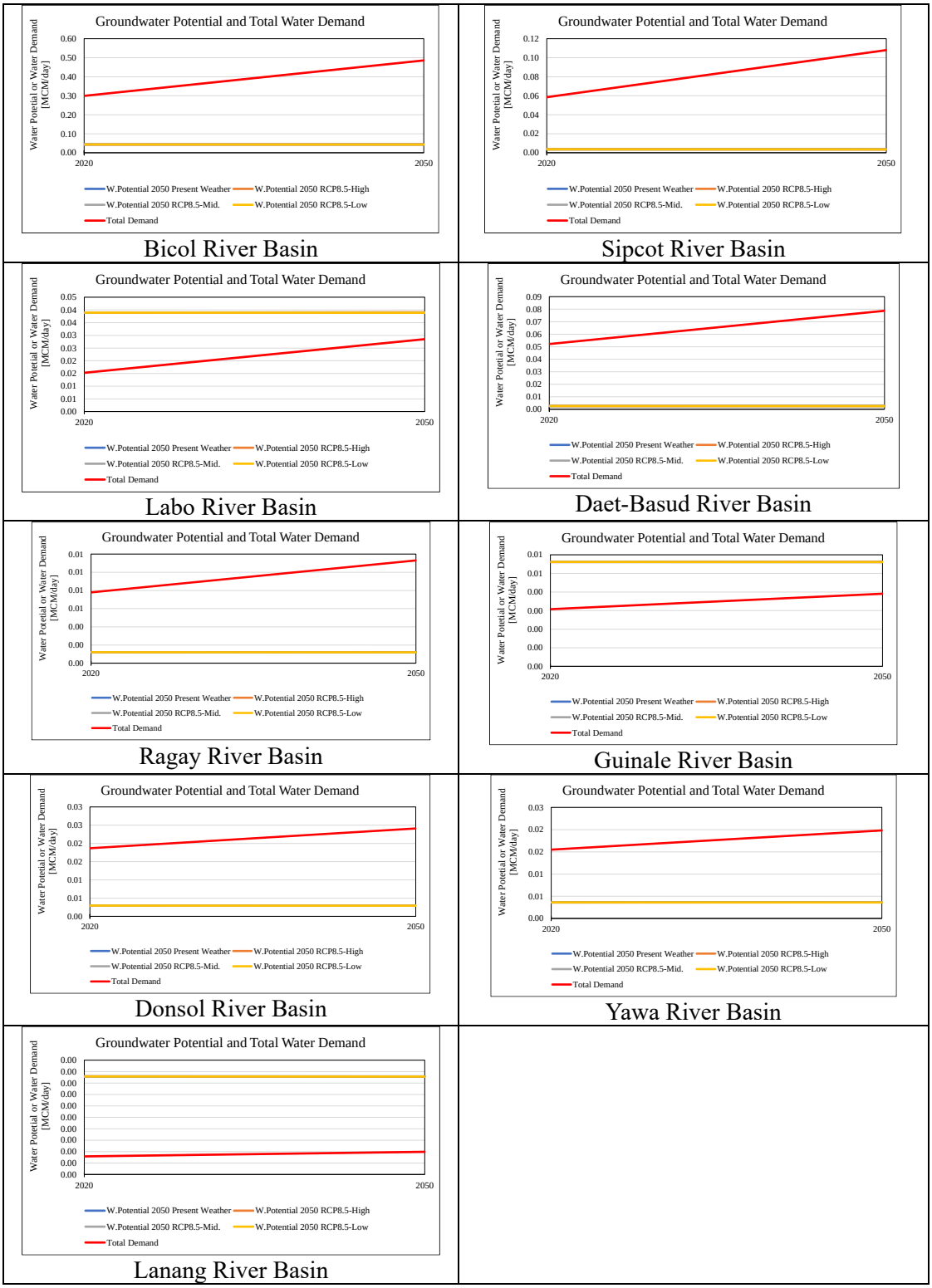
Case No.	Weather Condition	Water Demand	Target Year	SW.Balance [MCM/year]	GW.Balance [MCM/year]	Total W.Balance [MCM/year]	SW Deficit [MCM/year]	GW Deficit [MCM/year]	Total Deficit [MCM/year]
1	Present	2020	Average Year	198.6	0.3	198.8	0.0	0.0	0.0
2	Present	2020	1/5-Dry Year	125.7	0.3	125.9	0.0	0.0	0.0
3	Present	2020	1/10-Dry Year	121.2	0.3	121.5	0.0	0.0	0.0
4	Present	2050	Average Year	196.8	0.2	197.0	0.0	0.0	0.0
5	Present	2050	1/5-Dry Year	123.9	0.2	124.1	0.0	0.0	0.0
6	Present	2050	1/10-Dry Year	119.5	0.2	119.7	0.0	0.0	0.0
7	CC RCP8.5-High	2050	Average Year	240.8	0.2	241.1	0.0	0.0	0.0
8	CC RCP8.5-High	2050	1/5-Dry Year	144.7	0.2	145.0	0.0	0.0	0.0
9	CC RCP8.5-High	2050	1/10-Dry Year	149.0	0.2	149.2	0.0	0.0	0.0
10	CC RCP8.5-Mid.	2050	Average Year	191.8	0.2	192.1	0.0	0.0	0.0
11	CC RCP8.5-Mid.	2050	1/5-Dry Year	108.4	0.2	108.6	0.0	0.0	0.0
12	CC RCP8.5-Mid.	2050	1/10-Dry Year	108.9	0.2	109.2	0.0	0.0	0.0
13	CC RCP8.5-Low	2050	Average Year	150.6	0.2	150.9	0.0	0.0	0.0
14	CC RCP8.5-Low	2050	1/5-Dry Year	76.7	0.2	77.0	0.0	0.0	0.0
15	CC RCP8.5-Low	2050	1/10-Dry Year	80.8	0.2	81.0	0.0	0.0	0.0

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-494 Surface Water Balance by Major River Basins in WRR-V at Each Climate Change Condition



Source: JICA Survey Team

Figure D-495 Groundwater Balance by Major River Basins in WRR-V at Each Climate Change Condition

CHAPTER 12 PRELIMINALY RESERVOIR OPERTION STUDY FOR PROPOSED DAMS

12.1 WRR-VII

12.1.1 Location of Proposed Dam Sites in WRR-VII

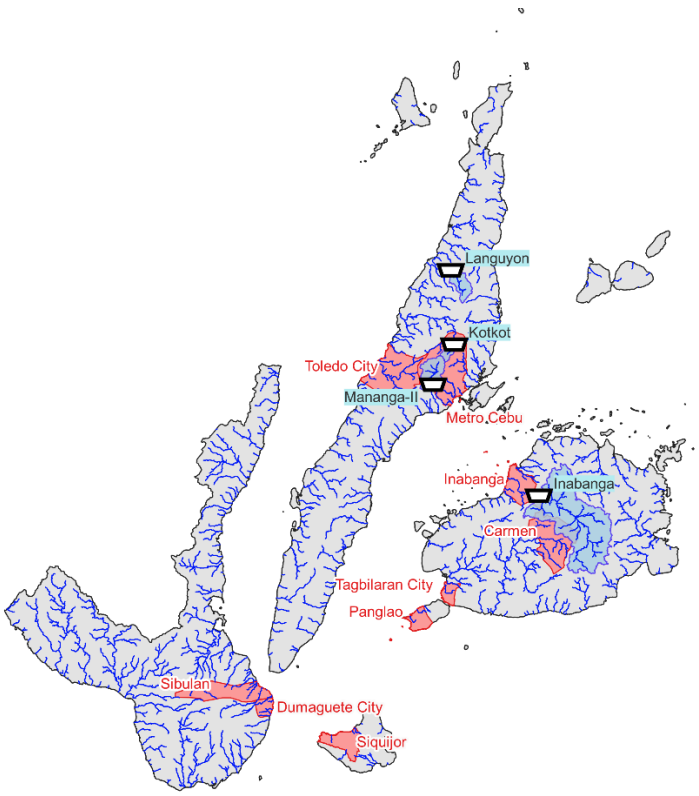
List of proposed dam sites in WRR-VII is shown in Table below.

Table D-267 List o Proposed Dam Sites in WRR-VII

No.	Name	Owner	Status	Challenges
N1	Managa II Dam	(MCWD/DPWH)	Pre-F/S	✓ F/S is not yet financed ✓ Setup of implementing organization ✓ Possibility of scale-down
N2a	Kotkot Dam (a)	MCWD	?	✓ Social issues
N3	Kawasan Dam	MCWD	No plan	✓ No plan yet
N4	Languyon Dam	NIA	F/S on-going	✓ See the result of F/S, RAP, EIA
N5	Kotkot Dam (b)	NIA	Pre F/S	✓ F/S is not yet ✓ Possibility of multipurpose development (water supply, flood control)

Source: JICA Survey Team

The location map of proposed dam sites in WRR-VII is shown in Figure below.



Source: JICA Survey Team

Figure D-496 Location Map of Proposed Dam Sites in WRR-VII

12.1.2 River Flow

In this reservoir operation study, river flow was used the results of surface water analysis model (SHER Model). The inflow at dam site was calculate by using catchment area ratio at dam site and modelled block.

12.1.3 Environmental Flow

According to resolution No. 03-0613 of NWRB, in general, dependable flow of rivers, which is 80% of flow duration shall be used in technical evaluation to determine the available water to be allocated (maximum amount to be granted in fae water. permit application) and an environmental flow of 1 0% of the dependable flow shall be retained. In this study, environmental flow from proposed dams were set at 10% of 80% dependable flow which is 80% discharge of flow duration curve (FDC).

12.1.4 Sediment Yield

One of important information of reservoir operation study, reservoir sedimentation is essential. The sediment yield was calculated by using following three (3) methods.

1) Joglekar's Equation (1960)[7]

Joglekar's Equation is presented as follows.

$$Qs = 0.00597*(A)^{(0.76)}$$

where, Qs = Annual sedimentation yield rate (million m^3/year), A= Catchment area (km^2)

2) Khosla's Equation (1953)[8]

Khosla's Equation is presented as follows.

$$Qs = 0.00323*(A)^{(0.72)}$$

where, Qs = Annual sedimentation yield rate (million m^3/year), A= Catchment area (km^2)

3) Magat Dam Sediment Yield Study Value by Adonis Sue White (1996).[9]

[7] Joglekar D.V.,(1960) "Silting of Reservoirs", Journal of the Institution of Engineers (India), Voll.40.8, PartI.
[8] Khosla A.N., (1953) "Silting of Reservoirs", Central Board of Irrigation and power, Publication No.51.
[9] Sue White (1996) "Erosion, sediment delivery and sediment yield patterns in the Philippines", Erosion and Sediment Yield: Global and Regional Perspectives (Proceedings of the Exeter Symposium, July 1996). IAHS Publ. no. 236, 1996.

Sy = 3,800 [t/km^2/year]

Results from sediment yield measurements at various scales and with various land uses in the Magat Dam catchment of northern Luzon are discussed by Sue White (1996). Using the data from Magat, a theory for an erosion-sediment delivery system in the Philippines is put forward. The results of sediment yield measurements at different scales are also considered in terms of sediment delivery ratios, which do not appear to be directly applicable in the Philippines. From 1984 to 1988 an intensive field measurement programme was carried out in the Magat catchment in northern Luzon. Data were collected at many catchment scales, ranging from small single use catchments at Aritao and Dallao to river sites at Santa Fe, Aritao and Baretbet and measurements in the Magat reservoir. By comparison, average sediment yield to the reservoir (catchment area 4143 km^2) estimated from the 1984 echo-sounder survey was 3800 t/km^2/year for the 2 years since impoundment.

12.1.5 Trap Efficiency

Trap efficiency is the ratio of deposited sediment to the total in flow for a given period within the reservoirs` economic lifetime; it calculates the percentage of the inflowing sediment mass that remains permanently in the reservoir. There are several trap efficiency methods. These methods estimate amount of sediments accumulated in a reservoir depending on reservoir capacity and inflow to the reservoir. Brune (1953) developed Curve of trap efficiency with reservoir capacity-inflow ratio by using data from 44 reservoirs in USA, starting from original equation[10]:

$$T_e = 1 - \frac{0.5}{\sqrt{\Delta\tau_t}}$$

Where,

T_e=Trap efficiency (% in decimal units)

$\Delta\tau_t$=the local residence time change in years, and

$$\Delta\tau_t = \frac{\sum_{i=1}^{nj} V_i}{I}$$

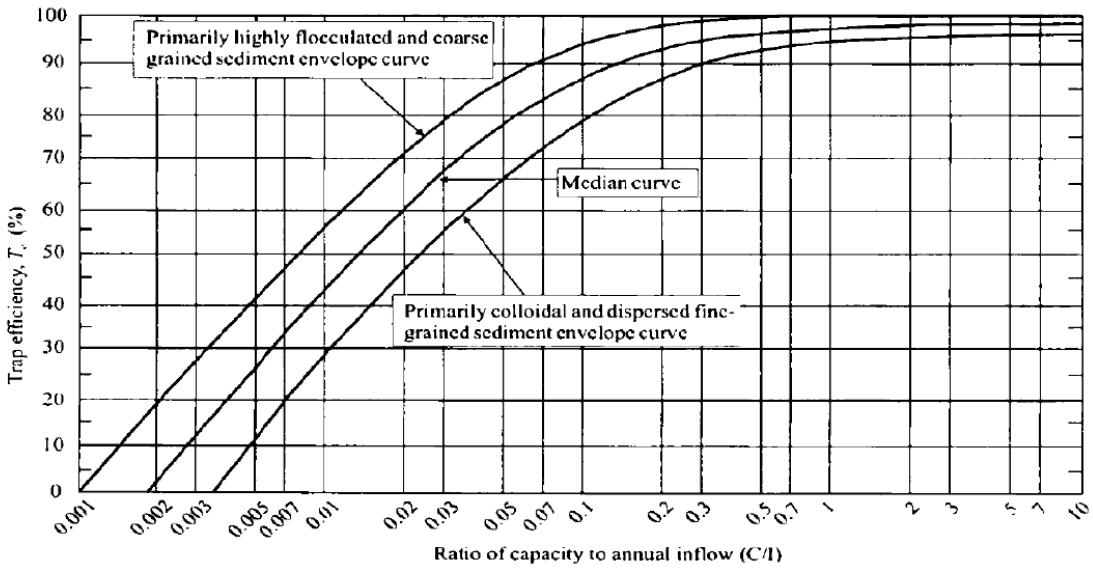
Where,

V=Storage capacity of the reservoir in km^3

I= inflow volume in km^3/day

Reservoir sediment trapping efficiency as per Brune (1953) is shown in Figure below.

[10] Brune, GM.,1953. Trap Efficiency of Reservoirs. Trans. Am. Geophysical Union, 34 (3), 407-418.



Source: Brune (1953)

Figure D-497 Reservoir Sediment Trapping Efficiency as per Brune (1953)

Reservoir sedimentation is calculated by 100-years.

12.1.6 Design Outflow and Reservoir Operation Rule Curves

For the reservoir operation study, design outflow/intake from dams were calculated by using the maximum year of water deficit between the water demands, that are irrigation water demand, municipal & industrial water demand, livestock and other water demands in 2050, and surface/groundwater potentials. The design outflow from dams were set as a parameter by percentage of the water deficit.

The target provable return period of design outflow from dams were set at 1/10-dry years (4-times deficit per 42-years) or 1/20-dry years (2-times deficit per 42-years).

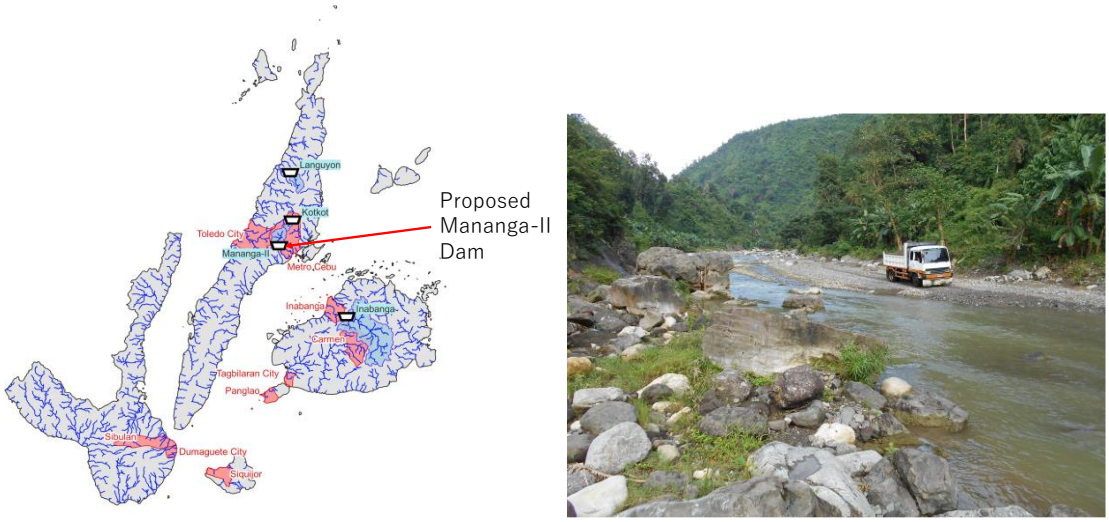
12.1.7 Evaporation and Rainfall at Reservoir Water Surface

Evaporation from reservoir water surface was calculated by the FAO Penman-Montheith method (ETo) using daily temperature at located province by ERA5-Land (ECMWF). Also, rainfall at reservoir surface is used daily mean rainfall at located province.

12.1.8 Preliminary Reservoir Operation Study

(1) Proposed Mananga-II Dam (Cebu)

Location map of proposed Mananga-II dam site is shown Figure below.



Source: JICA Survey Team

Figure D-498 Location Map of Proposed Mananga-II Dam Site in WRR-VII (Cebu)

Photos of proposed Mananga-II dam site is shown in Figure below.



Site Inspection to Mananga II Dam Site
Dec. 09, 2022

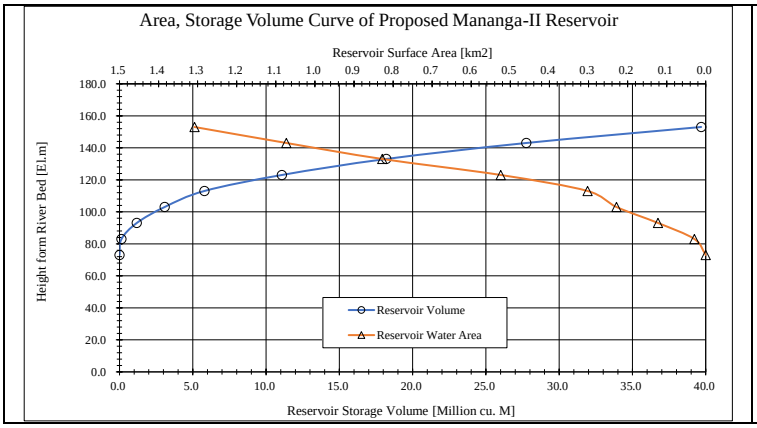




Source: JICA Survey Team

Figure D-499 Photos of Proposed Mananga-II Dam Site in WRR-VII (Cebu)

Reservoir area-storage curve of proposed Mananga-II dam site is shown Figure below.



Reservoir Elevation	Reservoir Volume	Reservoir Area
(El.m)	(MCM)	(km2)
73.00	0.00	0.000
83.00	0.14	0.029
93.00	1.18	0.122
103.00	3.09	0.229
113.00	5.79	0.302
123.00	11.08	0.524
133.00	18.20	0.828
143.00	27.76	1.073
153.00	39.69	1.308

Source: JICA Survey Team

Figure D-500 Reservoir Area-Storage Curve of Proposed Mananga-II Dam Site in WRR-VII (Cebu)

The results of reservoir operation study of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 1.58 mm/year and proposed maximum dam height at 41.5m are shown in following Table. In this case, reservoir capacity at full supply water level (FSL) will be filled by sedimentation around 61 years. Thus, sediment dredging countermeasures will be required.

Table D-268 Futures of Proposed Mananga-II Dam in WRR-VII (Cebu) [Case: Sediment Yield=1.58 mm/year, Dam Height=41.5m]

Catchment Area at Dam Site [km2]	68.00	
Dam Height [m]	41.50	
Dam Bottom Elevation [El.m]	73.00	
Dam Crest Elevation [El.m]	114.50	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	113.00	
Full Supply Volume [MCM]	5.79	
Annual Sediment Yield Volume [million m3/year]	0.1074	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	14.1%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	11,183	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	1.580	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	2,212	
Mean Inflow [m3/sec]	1.60	at Dam Site
Annual Inflow Volume [km3/year]	50,309	at Dam Site
Ratio of Capacity to Annual Inflow	0.115	C/I
Trap Efficiency [%]	88.4%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	9.49	
Dead Storage Volume [MCM}	9.49	
Minimum Operation WL (MOL) [El.m]	120.00	at Dead Storage Volume
Effective Storage Capacity [MCM]	-3.70	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	61.02	at FSL

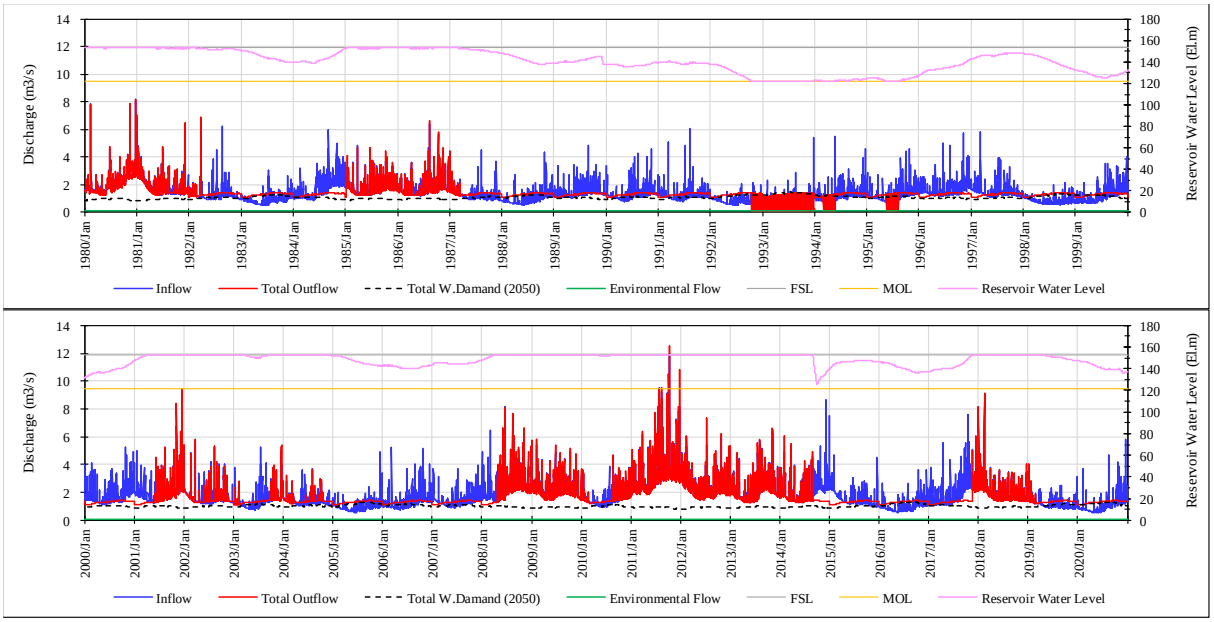
Source: JICA Survey Team

The results of reservoir operation study of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 1.58 mm/year and proposed maximum dam height at 81.5 m are shown in following Tables and Figure. In this case, it is available to supply water from proposed Mananga-II dam at dam height of 81.5m at average annual water supply of 37.24 MCM/year that is 18.5% of water demands of Metro Cebu.

Table D-269 Futures of Proposed Mananga-II Dam in WRR-VII (Cebu) [Case: Sediment Yield=1.58 mm/year, Dam Height=81.5 m, Design Demand=18.5%]

Catchment Area at Dam Site [km2]	68.00	
Dam Height [m]	81.50	
Dam Bottom Elevation [El.m]	73.00	
Dam Crest Elevation [El.m]	154.50	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	153.00	
Full Supply Volume [MCM]	39.69	
Annual Sediment Yield Volume [million m3/year]	0.1074	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	14.1%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	11,183	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	1.580	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	2,212	
Mean Inflow [m3/sec]	1.60	at Dam Site
Annual Inflow Volume [km3/year]	50,309	at Dam Site
Ratio of Capacity to Annual Inflow	0.789	C/I
Trap Efficiency [%]	98.2%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	10.55	
Dead Storage Volume [MCM}	10.55	
Minimum Operation WL (MOL) [El.m]	122.00	at Dead Storage Volume
Effective Storage Capacity [MCM]	29.14	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	376.13	at FSL

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-501 Results of Reservoir Operation Study of Proposed Mananga-II Dam Site in WRR-VII (Cebu) [Case: Sediment Yield=1.58 mm/year, Dam Height=81.5 m, Design Demand=18.5%]

Table D-270 Results of Proposed Mananga-II Dam in WRR-VII (Cebu) [Case: Sediment Yield=1.58 mm/year, Dam Height=81.5 m, Design Demand=18.5%] (1/3)

Dam Height (not incl. Freeboard) [m]=	80.00	Province =	Cebu	Province =	Cebu
Demand Rate [%]=	18.50%	1/5-Dry Year=	2004	1/10-Dry Year=	1998
Average W.D. [m3/s]=	1.05	W.D. in 1/5-Dry Year [m3/s]=	1.03	W.D. in 1/10-Dry Year [m3/s]=	1.21
Average W.Supply Vol. [m3/s]=	1.18	W.Supply in 1/5-Dry Year [m3/s]=	1.21	W.Supply in 1/10-Dry Year [m3/s]=	1.20
Average W.D. [MCM/year]=	33.10	W.D. in 1/5-Dry Year [MCM/year]=	32.33	W.D. in 1/10-Dry Year [MCM/year]=	38.02
Average W.Supply Vol. [MCM/year]=	37.24	W.Supply in 1/5-Dry Year [MCM/year]=	38.01	W.Supply in 1/10-Dry Year [MCM/year]=	37.92
Provability of Deficit (1/Years)=	10.25				

Source: JICA Survey Team

Table D-271 Results of Proposed Mananga-II Dam in WRR-VII (Cebu) [Case: Sediment Yield=1.58 mm/year, Dam Height=81.5 m, Design Demand=18.5%] (2/3)

Unit: MCM/year

No.	Year	SW River Flow	GW Flow	SW Potential	GW Potential	SW DIW WD	GW DIW WD	SW Irrigation WD	GW Irrigation WD	SW Livestock WD	GW Livestock WD	SW Other WD	GW Other WD	SW Total W.Demand	GW Total W.Demand	SW Water Balance	GW Water Balance	Total Water Balance	SW Deficit	GW Deficit	W.Demand
1	1980	1,190.35	323.15	1,191.68	329.78	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,149.51	-170.24	979.27	0.00	-163.62	-163.62
2	1981	937.25	325.01	938.76	331.58	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	896.54	-167.04	729.51	0.00	-160.47	-160.47
3	1982	584.28	308.51	585.99	315.11	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	543.57	-183.54	360.03	0.00	-176.94	-176.94
4	1983	376.91	284.62	378.81	291.24	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	336.20	-207.43	128.78	0.00	-200.81	-200.81
5	1984	1,075.09	305.35	1,077.20	312.03	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,034.25	-188.05	846.20	0.00	-181.37	-181.37
6	1985	1,052.74	319.73	1,055.02	326.36	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	1,012.03	-172.32	839.72	0.00	-165.69	-165.69
7	1986	939.19	317.82	941.67	324.48	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	898.48	-174.22	724.26	0.00	-167.56	-167.56
8	1987	510.29	306.52	512.96	313.20	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	469.58	-185.53	284.05	0.00	-178.85	-178.85
9	1988	461.45	283.68	465.06	290.60	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	420.62	-209.72	210.90	0.00	-202.79	-202.79
10	1989	878.96	307.35	882.37	314.64	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	838.25	-184.70	653.55	0.00	-177.40	-177.40
11	1990	628.55	303.66	631.93	309.27	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	587.84	-188.39	399.45	0.00	-182.78	-182.78
12	1991	567.63	303.03	570.98	311.27	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	526.92	-189.02	337.90	0.00	-180.78	-180.78
13	1992	282.88	279.86	286.52	287.92	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	242.05	-213.54	28.51	0.00	-205.48	-205.48
14	1993	312.87	252.41	315.99	257.49	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	272.16	-239.64	32.52	0.00	-234.56	-234.56
15	1994	758.18	288.53	761.67	293.57	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	717.47	-203.51	513.95	0.00	-198.48	-198.48
16	1995	727.98	297.11	732.09	302.58	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	687.28	-194.94	492.33	0.00	-189.47	-189.47
17	1996	1,091.97	311.49	1,096.10	317.25	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,051.13	-181.91	869.23	0.00	-176.15	-176.15
18	1997	758.56	312.05	763.32	318.12	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	717.86	-180.00	537.86	0.00	-173.93	-173.93
19	1998	285.92	279.87	291.17	286.55	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	245.22	-212.18	33.04	0.00	-205.50	-205.50
20	1999	754.44	282.65	757.91	287.25	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	713.74	-209.40	504.34	0.00	-204.80	-204.80
21	2000	1,130.58	312.56	1,135.94	319.68	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,089.74	-180.83	908.91	0.00	-173.72	-173.72
22	2001	1,197.88	319.04	1,203.19	326.86	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	1,157.17	-173.01	984.16	0.00	-165.19	-165.19
23	2002	791.52	317.70	797.36	325.52	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	750.82	-174.35	576.47	0.00	-166.52	-166.52
24	2003	683.37	303.67	688.53	311.70	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	642.67	-188.38	454.29	0.00	-180.35	-180.35
25	2004	681.60	310.40	687.74	318.15	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	640.76	-182.99	457.77	0.00	-175.25	-175.25
26	2005	389.17	285.92	395.50	293.80	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	348.47	-206.12	142.35	0.00	-198.25	-198.25
27	2006	780.75	296.62	786.60	304.03	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	740.05	-195.42	544.63	0.00	-188.01	-188.01
28	2007	797.15	305.68	803.55	313.33	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	756.45	-186.37	570.08	0.00	-178.72	-178.72
29	2008	1,429.59	320.30	1,436.43	327.92	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,388.76	-173.10	1,215.66	0.00	-165.48	-165.48
30	2009	1,222.14	327.84	1,229.48	335.65	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	1,181.44	-164.20	1,017.23	0.00	-156.40	-156.40
31	2010	744.45	313.35	751.78	321.13	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	703.73	-178.70	525.03	0.00	-170.92	-170.92
32	2011	2,091.21	329.19	2,099.40	336.28	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	2,050.49	-162.87	1,887.63	0.00	-155.77	-155.77
33	2012	1,343.76	331.35	1,352.38	339.21	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,302.93	-162.05	1,140.88	0.00	-154.18	-154.18
34	2013	1,204.79	325.39	1,213.38	333.02	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,164.07	-166.66	997.41	0.00	-159.03	-159.03
35	2014	1,261.29	323.91	1,270.01	331.73	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,220.57	-168.14	1,052.43	0.00	-160.32	-160.32
36	2015	717.53	317.77	726.26	325.30	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	676.81	-174.28	502.53	0.00	-166.75	-166.75
37	2016	392.18	283.56	400.80	290.49	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	351.34	-209.84	141.50	0.00	-202.91	-202.91
38	2017	1,360.01	310.59	1,367.28	317.17	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,319.29	-181.47	1,137.83	0.00	-174.88	-174.88
39	2018	1,196.39	326.06	1,205.24	332.72	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,155.67	-165.99	989.68	0.00	-159.33	-159.33
40	2019	480.26	303.80	489.25	310.14	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	439.54	-188.26	251.28	0.00	-181.91	-181.91
41	2020	560.58	284.36	568.09	290.19	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	519.74	-209.03	310.71	0.00	-203.21	-203.21
Max.		2,091.21	331.35	2,099.40	339.21	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	2,050.49	-162.05	1,888.45	0.00	-154.18	-154.18
Ave.		844.68	305.89	849.89	312.79	34.96	285.80	5.71	1.08	0.07	0.33	0.00	205.20	40.74	492.41	803.93	-186.52	617.41	0.00	-179.62	-179.62
Min.		282.88	252.41	286.52	257.49	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	242.05	-239.64	2.41	0.00	-234.56	-234.56
Times of Deficit																					41
Provability of Deficit (%)																					100.00%
Provability of Deficit (1/Years)																					1.00

Source: JICA Survey Team

Table D-272 Results of Proposed Mananga-II Dam in WRR-VII (Cebu) [Case: Sediment Yield=1.58 mm/year, Dam Height=81.5 m, Design Demand=18.5%] (3/3)

Unit: MCM/year

No.	Year	Total W.Demand in Metro Cebu	W.Demand	W.Supply	Deficit
1	1980	-163.62	38.01	38.01	0.00
2	1981	-160.47	37.92	37.92	0.00
3	1982	-176.94	37.92	37.92	0.00
4	1983	-200.81	37.92	37.92	0.00
5	1984	-181.37	38.01	38.01	0.00
6	1985	-165.69	37.92	37.92	0.00
7	1986	-167.56	37.92	37.92	0.00
8	1987	-178.85	37.92	37.92	0.00
9	1988	-202.79	38.01	38.01	0.00
10	1989	-177.40	37.92	37.92	0.00
11	1990	-182.78	37.92	37.92	0.00
12	1991	-180.78	37.92	37.92	0.00
13	1992	-205.48	38.01	34.10	-3.92
14	1993	-234.56	37.92	19.43	-18.49
15	1994	-198.48	37.92	35.41	-2.51
16	1995	-189.47	37.92	35.69	-2.23
17	1996	-176.15	38.01	38.01	0.00
18	1997	-173.93	37.92	37.92	0.00
19	1998	-205.50	37.92	37.92	0.00
20	1999	-204.80	37.92	37.92	0.00
21	2000	-173.72	38.01	38.01	0.00
22	2001	-165.19	37.92	37.92	0.00
23	2002	-166.52	37.92	37.92	0.00
24	2003	-180.35	37.92	37.92	0.00
25	2004	-175.25	38.01	38.01	0.00
26	2005	-198.25	37.92	37.92	0.00
27	2006	-188.01	37.92	37.92	0.00
28	2007	-178.72	37.92	37.92	0.00
29	2008	-165.48	38.01	38.01	0.00
30	2009	-156.40	37.92	37.92	0.00
31	2010	-170.92	37.92	37.92	0.00
32	2011	-155.77	37.92	37.92	0.00
33	2012	-154.18	38.01	38.01	0.00
34	2013	-159.03	37.92	37.92	0.00
35	2014	-160.32	37.92	37.92	0.00
36	2015	-166.75	37.92	37.92	0.00
37	2016	-202.91	38.01	38.01	0.00
38	2017	-174.88	37.92	37.92	0.00
39	2018	-159.33	37.92	37.92	0.00
40	2019	-181.91	37.92	37.92	0.00
41	2020	-203.21	38.01	38.01	0.00
Max.		-154.18	38.01	38.01	0.00
Ave.		-179.62	37.95	37.28	-0.66
Min.		-234.56	37.92	19.43	-18.49
Times of Deficit					4
Provability of Deficit (%)					9.8%
Provability of Deficit (1/Years)					10.25

Source: JICA Survey Team

Table below shows the summary of results of reservoir operation study of proposed Mananga-II dam in WRR-VII.

In all cases of sediment yield and dam height at 41.5 m, are not available to supply water from proposed Mananga-II dam for Metro Cebu water demands after counter measures of water demand management of domestic and irrigation water demands, without any countermeasures of sediment dredging.

For the cased of proposed dam height at 81.5m, all cases of sediment yield are available to supply water from proposed Mananga-II dam for Metro Cebu water demands.

Table D-273 Summary of Reservoir Operation Study for Proposed Mananga-II Dam in WRR-VII (Cebu)

Dam Site	Unit	Mananga-II (Low Dam Case)				Mananga-II (High Dam Case)			
Case No.		1	2	3	4	5	6	**7**	8
Location (Province)	-	Cebu	Cebu	Cebu	Cebu	Cebu	Cebu	**Cebu**	Cebu
Catchment Area	(km^2)	68.00	68.00	68.00	68.00	68.00	68.00	**68.00**	68.00
Proposed Dam Height	(m)	41.5	41.5	41.5	41.5	81.5	81.5	**81.5**	81.5
Annual Sediment Yield Volume	(million m3/year)	0.147	0.067	0.107	0.185	0.147	0.067	**0.107**	0.185
Annual Sediment Yield	(mm/year)	2.17	0.99	1.58	2.71	2.17	0.99	**1.58**	2.71
Annual Sediment Yield Volume	(t/km2/year)	3,036	1,387	2,212	3,800	3,036	1,387	**2,212**	3,800
Source of Sediment Yield	-	Joglekar's Equation (1960)	Khosla's equation (1953)	Average of Joglekar & Khosla Equation	Magat Dam, Sue White (1996)	Joglekar's Equation (1960)	Khosla's equation (1953)	**Average of Joglekar & Khosla Equation**	Magat Dam, Sue White (1996)
Full Supply Volume	(MCM)	5.79	5.79	5.79	5.79	39.69	39.69	**39.69**	39.69
Full Supply WL (FSL)	(El.m)	113.00	113.00	113.00	113.00	153.00	153.00	**153.00**	153.00
Dead Storage Volume	(MCM)	14.06	6.43	9.49	16.31	14.75	6.62	**10.55**	18.13
Minimum Operation WL (MOL)	(El.m)	127.19	114.20	120.00	130.35	128.16	114.56	**122.00**	132.90
Effective Storage Volume	(MCM)	-8.27	-0.63	-3.70	-10.52	24.93	33.07	**29.14**	21.56
Target Supply Area/City (Demand Area)	-	Metro Cebu	Metro Cebu	Metro Cebu	Metro Cebu	Metro Cebu	Metro Cebu	**Metro Cebu**	Metro Cebu
Supply Ratio for Demand	(%)	-	-	-	-	17.7%	18.7%	**18.5%**	17.5%
Ave. Supply Water from Dam	(MCM//Year)	-	-	-	-	35.81	37.67	**37.24**	35.37
Supply Available Return Period	(Year)	-	-	-	-	10.25	10.25	**10.25**	10.25
Years of Full Sedimentation of Reservoir	(Year)	41.2	90.2	61.0	35.5	269.0	599.6	**376.1**	218.9
Notes	-	Need to be Sediment Dredging	Need to be Sediment Dredging	Need to be Sediment Dredging	Need to be Sediment Dredging				

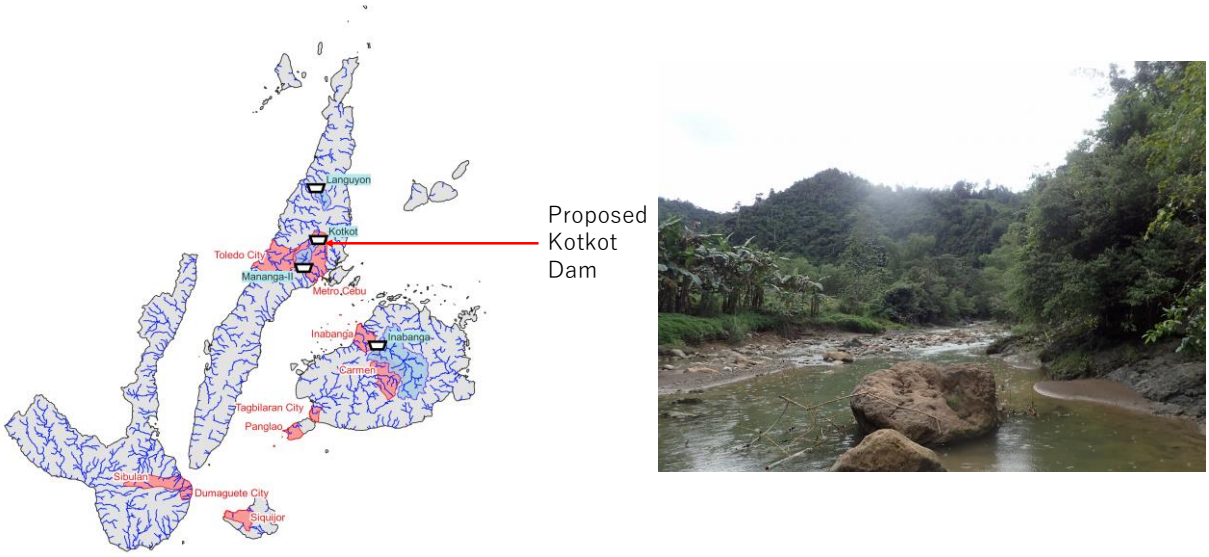
Notes:

Joglekar's Equation (1960)	Qs = 0.00597*(A)^(0.76)
Khosla's equation (1953)	Qs = 0.00323*(A)^(0.72)
Magat Dam, Sue White (1996)	SY = 3,800 [t/km2/year]

Source: JICA Survey Team

(2) Proposed Kotkot Dam (Cebu)

Location map of proposed Kotkot dam site is shown Figure below.



Source: JICA Survey Team

Figure D-502 Location Map of Proposed Kotkot Dam Site in WRR-VII (Cebu)

Photos of proposed Kotkot dam site is shown in Figure below.



Site Inspection to Teruvian Weir in Kotkot River D/s of Kotkot Dam Site Dec. 09, 2022



Site Inspection to Kotkot Dam Site Dec. 09, 2022

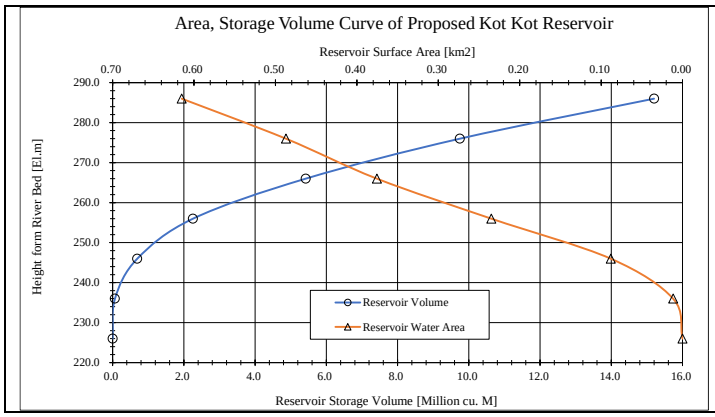


Site Inspection to Kotkot Dam Site Dec. 09, 2022

Source: JICA Survey Team

Figure D-503 Photos of Proposed Kotkot Dam Site in WRR-VII (Cebu)

Reservoir area-storage curve of proposed Kotkot dam site is shown in figure below.



Reservoir Elevation	Reservoir Volume	Reservoir Area
(El.m)	(MCM)	(km2)
226.00	0.00	0.000
236.00	0.06	0.012
246.00	0.69	0.088
256.00	2.26	0.235
266.00	5.42	0.375
276.00	9.75	0.487
286.00	15.20	0.615

Source: JICA Survey Team

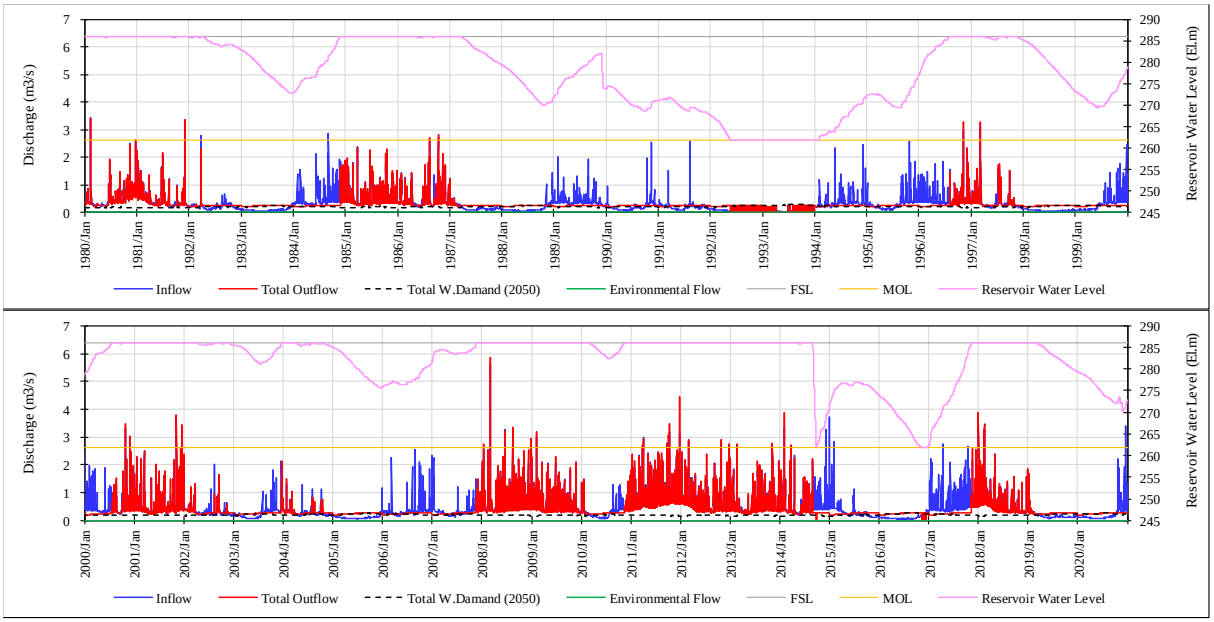
Figure D-504 Reservoir Area-Storage Curve of Proposed Kotkot Dam Site in WRR-VII (Cebu)

The results of reservoir operation study of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 2.179 mm/year and proposed maximum dam height at 61.5m are shown in following Tables and Figure. In this case, 3.7% water demands of Metro Cebu at average of 7.33 MCM/year will be able to supply from proposed Kotkot dam.

Table D-274 Futures of Proposed Kotkot Dam in WRR-VII (Cebu) [Case: Sediment Yield=2.179 mm/year, Dam Height=61.5m, Design Demand=3.7%]

Catchment Area at Dam Site [km2]	19.04	
Dam Height [m]	61.50	
Dam Bottom Elevation [El.m]	226.00	
Dam Crest Elevation [El.m]	287.50	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	286.00	
Full Supply Volume [MCM]	15.20	
Annual Sediment Yield Volume [million m3/year]	0.0415	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	18.6%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	11,749	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	2.179	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	3,051	
Mean Inflow [m3/sec]	0.37	at Dam Site
Annual Inflow Volume [km3/year]	11,759	at Dam Site
Ratio of Capacity to Annual Inflow	1.293	C/I
Trap Efficiency [%]	98.6%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	4.09	
Dead Storage Volume [MCM}	4.09	
Minimum Operation WL (MOL) [El.m]	261.81	at Dead Storage Volume
Effective Storage Capacity [MCM]	11.11	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	371.42	at FSL

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-505 Results of Reservoir Operation Study of Proposed Kotkot Dam Site in WRR-VII (Cebu) [Case: Sediment Yield=2.179 mm/year, Dam Height=61.5m, Design Demand=3.7%]

Table D-275 Results of Proposed Kotkot Dam in WRR-VII (Cebu) [Case: Sediment Yield=2.179 mm/year, Dam Height=61.5m, Design Demand=3.7%] (1/3)

Dam Height (not incl. Freeboard) [m]=	60.00
Demand Rate [%]=	3.70%
Average W.D. [m3/s]=	0.21
Average W.Supply Vol. [m3/s]=	0.23
Average W.D. [MCM/year]=	6.62
Average W.Supply Vol. [MCM/year]=	7.33
Provability of Deficit (1/Years)=	10.25

Province =	Cebu
1/5-Dry Year=	2004
W.D. in 1/5-Dry Year [m3/s]=	0.21
W.Supply in 1/5-Dry Year [m3/s]=	0.24
W.D. in 1/5-Dry Year [MCM/year]=	6.47
W.Supply in 1/5-Dry Year [MCM/year]=	7.60

Province =	Cebu
1/10-Dry Year=	1998
W.D. in 1/10-Dry Year [m3/s]=	0.24
W.Supply in 1/10-Dry Year [m3/s]=	0.24
W.D. in 1/10-Dry Year [MCM/year]=	7.60
W.Supply in 1/10-Dry Year [MCM/year]=	7.58

Source: JICA Survey Team

Table D-276 Results of Proposed Kotkot Dam in WRR-VII (Cebu) [Case: Sediment Yield=2.179 mm/year, Dam Height=61.5m, Design Demand=3.7%] (2/3)

Unit: MCM/year

No.	Year	SW River Flow	GW Flow	SW Potential	GW Potential	SW DIW WD	GW DIW WD	SW Irrigation WD	GW Irrigation WD	SW Livestock WD	GW Livestock WD	SW Other WD	GW Other WD	SW Total W.Demand	GW Total W.Demand	SW Water Balance	GW Water Balance	Total Water Balance	SW Deficit	GW Deficit	W.Demand
1	1980	1,190.35	323.15	1,191.68	329.78	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,149.51	-170.24	979.27	0.00	-163.62	-163.62
2	1981	937.25	325.01	938.76	331.58	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	896.54	-167.04	729.51	0.00	-160.47	-160.47
3	1982	584.28	308.51	585.99	315.11	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	543.57	-183.54	360.03	0.00	-176.94	-176.94
4	1983	376.91	284.62	378.81	291.24	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	336.20	-207.43	128.78	0.00	-200.81	-200.81
5	1984	1,075.09	305.35	1,077.20	312.03	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,034.25	-188.05	846.20	0.00	-181.37	-181.37
6	1985	1,052.74	319.73	1,055.02	326.36	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	1,012.03	-172.32	839.72	0.00	-165.69	-165.69
7	1986	939.19	317.82	941.67	324.48	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	898.48	-174.22	724.26	0.00	-167.56	-167.56
8	1987	510.29	306.52	512.96	313.20	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	469.58	-185.53	284.05	0.00	-178.85	-178.85
9	1988	461.45	283.68	465.06	290.60	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	420.62	-209.72	210.90	0.00	-202.79	-202.79
10	1989	878.96	307.35	882.37	314.64	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	838.25	-184.70	653.55	0.00	-177.40	-177.40
11	1990	628.55	303.66	631.93	309.27	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	587.84	-188.39	399.45	0.00	-182.78	-182.78
12	1991	567.63	303.03	570.98	311.27	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	526.92	-189.02	337.90	0.00	-180.78	-180.78
13	1992	282.88	279.86	286.52	287.92	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	242.05	-213.54	28.51	0.00	-205.48	-205.48
14	1993	312.87	252.41	315.99	257.49	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	272.16	-239.64	32.52	0.00	-234.56	-234.56
15	1994	758.18	288.53	761.67	293.57	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	717.47	-203.51	513.95	0.00	-198.48	-198.48
16	1995	727.98	297.11	732.09	302.58	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	687.28	-194.94	492.33	0.00	-189.47	-189.47
17	1996	1,091.97	311.49	1,096.10	317.25	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,051.13	-181.91	869.23	0.00	-176.15	-176.15
18	1997	758.56	312.05	763.32	318.12	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	717.86	-180.00	537.86	0.00	-173.93	-173.93
19	1998	285.92	279.87	291.17	286.55	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	245.22	-212.18	33.04	0.00	-205.50	-205.50
20	1999	754.44	282.65	757.91	287.25	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	713.74	-209.40	504.34	0.00	-204.80	-204.80
21	2000	1,130.58	312.56	1,135.94	319.68	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,089.74	-180.83	908.91	0.00	-173.72	-173.72
22	2001	1,197.88	319.04	1,203.19	326.86	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	1,157.17	-173.01	984.16	0.00	-165.19	-165.19
23	2002	791.52	317.70	797.36	325.52	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	750.82	-174.35	576.47	0.00	-166.52	-166.52
24	2003	683.37	303.67	688.53	311.70	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	642.67	-188.38	454.29	0.00	-180.35	-180.35
25	2004	681.60	310.40	687.74	318.15	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	640.76	-182.99	457.77	0.00	-175.25	-175.25
26	2005	389.17	285.92	395.50	293.80	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	348.47	-206.12	142.35	0.00	-198.25	-198.25
27	2006	780.75	296.62	786.60	304.03	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	740.05	-195.42	544.63	0.00	-188.01	-188.01
28	2007	797.15	305.68	803.55	313.33	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	756.45	-186.37	570.08	0.00	-178.72	-178.72
29	2008	1,429.59	320.30	1,436.43	327.92	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,388.76	-173.10	1,215.66	0.00	-165.48	-165.48
30	2009	1,222.14	327.84	1,229.48	335.65	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	1,181.44	-164.20	1,017.23	0.00	-156.40	-156.40
31	2010	744.45	313.35	751.78	321.13	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	703.73	-178.70	525.03	0.00	-170.92	-170.92
32	2011	2,091.21	329.19	2,099.40	336.28	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	2,050.49	-162.87	1,887.63	0.00	-155.77	-155.77
33	2012	1,343.76	331.35	1,352.38	339.21	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,302.93	-162.05	1,140.88	0.00	-154.18	-154.18
34	2013	1,204.79	325.39	1,213.38	333.02	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,164.07	-166.66	997.41	0.00	-159.03	-159.03
35	2014	1,261.29	323.91	1,270.01	331.73	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,220.57	-168.14	1,052.43	0.00	-160.32	-160.32
36	2015	717.53	317.77	726.26	325.30	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	676.81	-174.28	502.53	0.00	-166.75	-166.75
37	2016	392.18	283.56	400.80	290.49	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	351.34	-209.84	141.50	0.00	-202.91	-202.91
38	2017	1,360.01	310.59	1,367.28	317.17	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,319.29	-181.47	1,137.83	0.00	-174.88	-174.88
39	2018	1,196.39	326.06	1,205.24	332.72	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,155.67	-165.99	989.68	0.00	-159.33	-159.33
40	2019	480.26	303.80	489.25	310.14	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	439.54	-188.26	251.28	0.00	-181.91	-181.91
41	2020	560.58	284.36	568.09	290.19	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	519.74	-209.03	310.71	0.00	-203.21	-203.21
Max.		2,091.21	331.35	2,099.40	339.21	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	2,050.49	-162.05	1,888.45	0.00	-154.18	-154.18
Ave.		844.68	305.89	849.89	312.79	34.96	285.80	5.71	1.08	0.07	0.33	0.00	205.20	40.74	492.41	803.93	-186.52	617.41	0.00	-179.62	-179.62
Min.		282.88	252.41	286.52	257.49	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	242.05	-239.64	2.41	0.00	-234.56	-234.56
Times of Deficit																					41
Provability of Deficit (%)																					100.00%
Provability of Deficit (1/Years)																					1.00

Source: JICA Survey Team

Table D-277 Results of Proposed Kotkot Dam in WRR-VII (Cebu) [Case: Sediment Yield=2.179 mm/year, Dam Height=61.5m, Design Demand=3.7%] (3/3)

Unit: MCM/year

No.	Year	Total W.Demand in Metro Cebu	W.Demand	W.Supply	Deficit
1	1980	-163.62	7.60	7.60	0.00
2	1981	-160.47	7.58	7.58	0.00
3	1982	-176.94	7.58	7.58	0.00
4	1983	-200.81	7.58	7.58	0.00
5	1984	-181.37	7.60	7.60	0.00
6	1985	-165.69	7.58	7.58	0.00
7	1986	-167.56	7.58	7.58	0.00
8	1987	-178.85	7.58	7.58	0.00
9	1988	-202.79	7.60	7.60	0.00
10	1989	-177.40	7.58	7.58	0.00
11	1990	-182.78	7.58	7.58	0.00
12	1991	-180.78	7.58	7.58	0.00
13	1992	-205.48	7.60	3.71	-3.89
14	1993	-234.56	7.58	1.48	-6.10
15	1994	-198.48	7.58	7.58	0.00
16	1995	-189.47	7.58	7.58	0.00
17	1996	-176.15	7.60	7.60	0.00
18	1997	-173.93	7.58	7.58	0.00
19	1998	-205.50	7.58	7.58	0.00
20	1999	-204.80	7.58	7.58	0.00
21	2000	-173.72	7.60	7.60	0.00
22	2001	-165.19	7.58	7.58	0.00
23	2002	-166.52	7.58	7.58	0.00
24	2003	-180.35	7.58	7.58	0.00
25	2004	-175.25	7.60	7.60	0.00
26	2005	-198.25	7.58	7.58	0.00
27	2006	-188.01	7.58	7.58	0.00
28	2007	-178.72	7.58	7.58	0.00
29	2008	-165.48	7.60	7.60	0.00
30	2009	-156.40	7.58	7.58	0.00
31	2010	-170.92	7.58	7.58	0.00
32	2011	-155.77	7.58	7.58	0.00
33	2012	-154.18	7.60	7.60	0.00
34	2013	-159.03	7.58	7.58	0.00
35	2014	-160.32	7.58	7.47	-0.11
36	2015	-166.75	7.58	7.58	0.00
37	2016	-202.91	7.60	7.39	-0.22
38	2017	-174.88	7.58	7.58	0.00
39	2018	-159.33	7.58	7.58	0.00
40	2019	-181.91	7.58	7.58	0.00
41	2020	-203.21	7.60	7.60	0.00
Max.		-154.18	7.60	7.60	0.00
Ave.		-179.62	7.59	7.34	-0.25
Min.		-234.56	7.58	1.48	-6.10
Times of Deficit					4
Provability of Deficit (%)					9.8%
Provability of Deficit (1/Years)					10.25

Source: JICA Survey Team

Table below shows the summary of results of reservoir operation study of proposed Kotkot dam in WRR-VII. In the cases of dam height at 61.5 m, all cases of sediment yield are available to supply water 3.7 % (=7.33 MCM/year) of Metro Cebu water demand (deficit) in 2050 from proposed Kotkot dam.

Table D-278 Summary of Reservoir Operation Study for Proposed Kotkot Dam in WRR-VII (Cebu)

Dam Site	Unit	Kotkot			
Case No.		9	10	**11**	12
Location (Province)	-	Cebu	Cebu	**Cebu**	Cebu
Catchment Area	(km^2)	19.04	19.04	**19.04**	19.04
Proposed Dam Height	(m)	61.5	61.5	**61.5**	61.5
Annual Sediment Yield Volume	(million m3/year)	0.056	0.027	**0.041**	0.052
Annual Sediment Yield	(mm/year)	2.94	1.42	**2.18**	2.71
Annual Sediment Yield Volume	(t/km2/year)	4,121	1,982	**3,051**	3,800
Source of Sediment Yield	-	Joglekar's Equation (1960)	Khosla's equation (1953)	**Average of Joglekar & Khosla Equation**	Magat Dam, Sue White (1996)
Full Supply Volume	(MCM)	15.20	15.20	**15.20**	15.20
Full Supply WL (FSL)	(El.m)	286.00	286.00	**286.00**	286.00
Dead Storage Volume	(MCM)	5.53	2.66	**4.09**	5.10
Minimum Operation WL (MOL)	(El.m)	266.25	257.27	**261.81**	264.98
Effective Storage Volume	(MCM)	9.67	12.54	**11.11**	10.10
Target Supply Area/City (Demand Area)	-	Metro Cebu	Metro Cebu	**Metro Cebu**	Metro Cebu
Supply Ratio for Demand	(%)	3.70%	3.70%	**3.70%**	3.70%
Ave. Supply Water from Dam	(MCM//Year)	7.29	7.37	**7.33**	7.30
Supply Available Return Period	(Year)	10.25	10.25	**10.25**	10.25
Years of Full Sedimentation of Reservoir	(Year)	275.0	571.9	**371.4**	298.2
Notes	-				

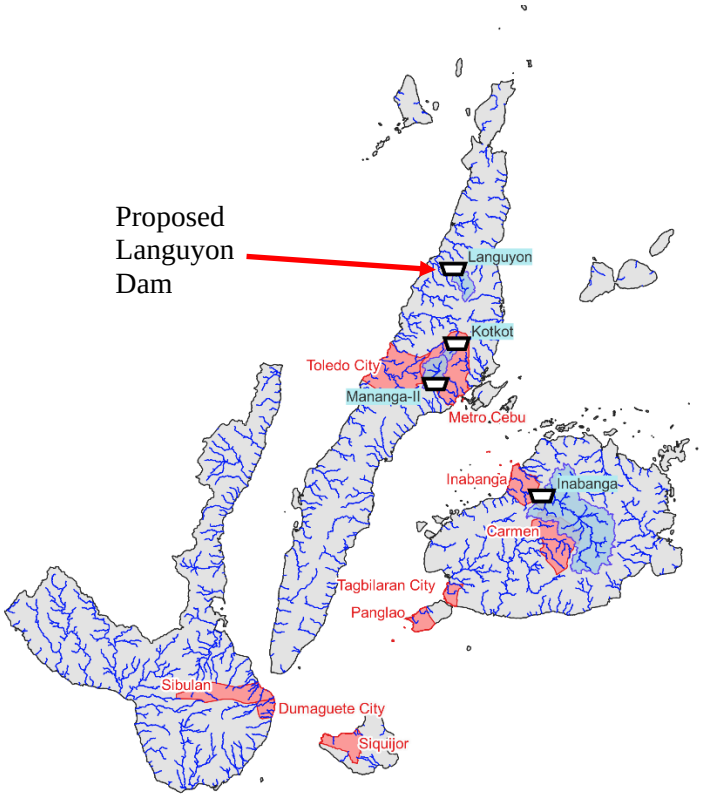
Notes:

Joglekar's Equation (1960)	Qs = 0.00597*(A)^(0.76)
Khosla's equation (1953)	Qs = 0.00323*(A)^(0.72)
Magat Dam, Sue White (1996)	SY = 3,800 [t/km2/year]

Source: JICA Survey Team

(3) Proposed Languyon Dam (Cebu)

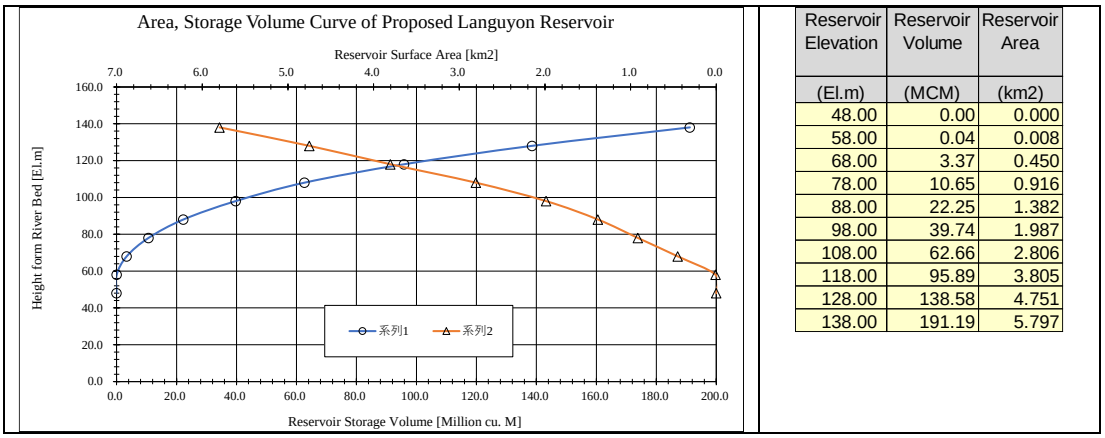
Location map of proposed Languyon dam site is shown Figure below.



Source: JICA Survey Team

Figure D-506 Location Map of Proposed Languyon Dam Site in WRR-VII (Cebu)

Reservoir area-storage curve of proposed Languyon dam site is shown Figure below.



Reservoir Elevation	Reservoir Volume	Reservoir Area
(El.m)	(MCM)	(km2)
48.00	0.00	0.000
58.00	0.04	0.008
68.00	3.37	0.450
78.00	10.65	0.916
88.00	22.25	1.382
98.00	39.74	1.987
108.00	62.66	2.806
118.00	95.89	3.805
128.00	138.58	4.751
138.00	191.19	5.797

Source: JICA Survey Team

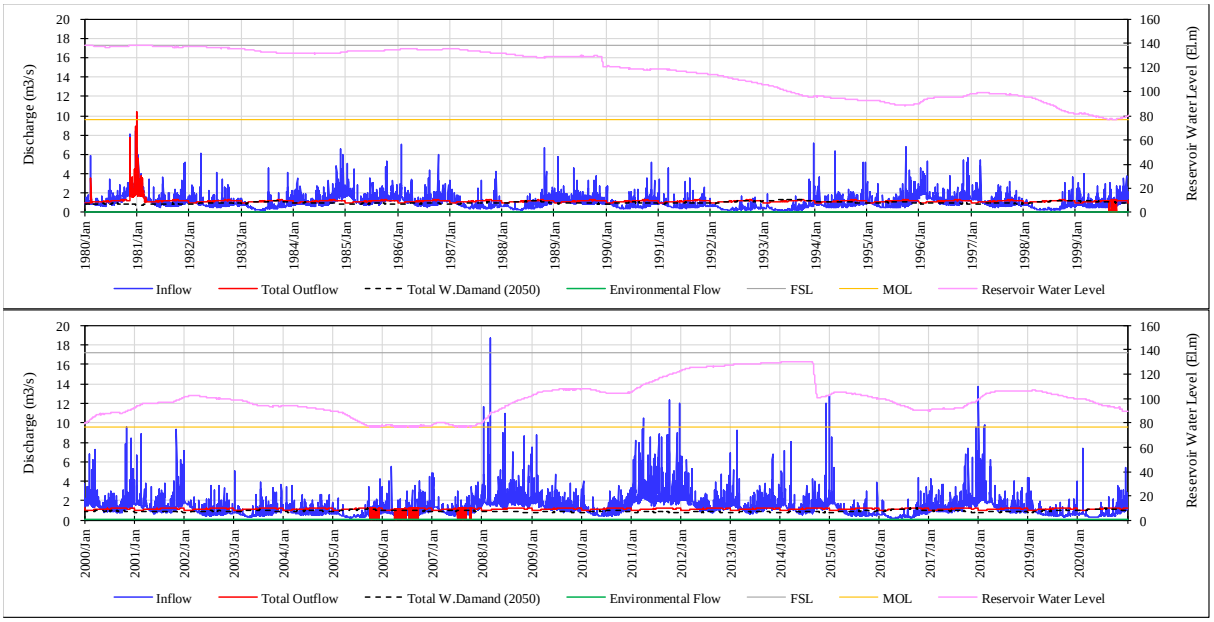
Figure D-507 Reservoir Area-Storage Curve of Proposed Languyon Dam Site in WRR-VII (Cebu)

The results of reservoir operation study of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 0.84 mm/year and proposed maximum dam height at 91.5m are shown in following Tables and Figure.

Table D-279 Futures of Proposed Languyon Dam in WRR-VII (Cebu)
[Case: Sediment Yield=1.684 mm/year, Dam Height=91.5 m, Design Demand=17.0%]

Catchment Area at Dam Site [km2]	52.84	
Dam Height [m]	91.50	
Dam Bottom Elevation [El.m]	48.00	
Dam Crest Elevation [El.m]	139.50	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	138.00	
Full Supply Volume [MCM]	191.19	
Annual Sediment Yield Volume [million m3/year]	0.0890	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	14.9%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	11,292	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	1.684	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	2,357	
Mean Inflow [m3/sec]	1.20	at Dam Site
Annual Inflow Volume [km3/year]	37,971	at Dam Site
Ratio of Capacity to Annual Inflow	5.035	C/I
Trap Efficiency [%]	111.3%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	9.90	
Dead Storage Volume [MCM}	9.90	
Minimum Operation WL (MOL) [El.m]	76.98	at Dead Storage Volume
Effective Storage Capacity [MCM]	181.29	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	1,931.25	at FSL

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-508 Results of Reservoir Operation Study of Proposed Languyon Dam Site in WRR-VII (Cebu) [Case: Sediment Yield=1.684 mm/year, Dam Height=91.5 m, Design Demand=17.0%]

Table D-280 Results of Proposed Languyon Dam in WRR-VII (Cebu) [Case: Sediment Yield=1.684 mm/year, Dam Height=91.5 m, Design Demand=17.0%] (1/3)

Dam Height (not incl. Freeboard) [m]=	90.00
Demand Rate [%]=	17.00%
Average W.D. [m3/s]=	0.96
Average W.Supply Vol. [m3/s]=	1.09
Average W.D. [MCM/year]=	30.41
Average W.Supply Vol. [MCM/year]=	34.52
Provability of Deficit (1/Years)=	10.25

Province =	Cebu
1/5-Dry Year=	2004
W.D. in 1/5-Dry Year [m3/s]=	0.94
W.Supply in 1/5-Dry Year [m3/s]=	1.11
W.D. in 1/5-Dry Year [MCM/year]=	29.71
W.Supply in 1/5-Dry Year [MCM/year]=	34.93

Province =	Cebu
1/10-Dry Year=	1998
W.D. in 1/10-Dry Year [m3/s]=	1.11
W.Supply in 1/10-Dry Year [m3/s]=	1.10
W.D. in 1/10-Dry Year [MCM/year]=	34.93
W.Supply in 1/10-Dry Year [MCM/year]=	34.85

Source: JICA Survey Team

Table D-281 Results of Proposed Languyon Dam in WRR-VII (Cebu) [Case: Sediment Yield=1.684 mm/year, Dam Height=91.5 m, Design Demand=17.0%] (2/3)

Unit: MCM/year

No.	Year	SW River Flow	GW Flow	SW Potential	GW Potential	SW DIW WD	GW DIW WD	SW Irrigation WD	GW Irrigation WD	SW Livestock WD	GW Livestock WD	SW Other WD	GW Other WD	SW Total W.Demand	GW Total W.Demand	SW Water Balance	GW Water Balance	Total Water Balance	SW Deficit	GW Deficit	W.Demand
1	1980	1,190.35	323.15	1,191.68	329.78	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,149.51	-170.24	979.27	0.00	-163.62	-163.62
2	1981	937.25	325.01	938.76	331.58	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	896.54	-167.04	729.51	0.00	-160.47	-160.47
3	1982	584.28	308.51	585.99	315.11	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	543.57	-183.54	360.03	0.00	-176.94	-176.94
4	1983	376.91	284.62	378.81	291.24	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	336.20	-207.43	128.78	0.00	-200.81	-200.81
5	1984	1,075.09	305.35	1,077.20	312.03	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,034.25	-188.05	846.20	0.00	-181.37	-181.37
6	1985	1,052.74	319.73	1,055.02	326.36	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	1,012.03	-172.32	839.72	0.00	-165.69	-165.69
7	1986	939.19	317.82	941.67	324.48	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	898.48	-174.22	724.26	0.00	-167.56	-167.56
8	1987	510.29	306.52	512.96	313.20	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	469.58	-185.53	284.05	0.00	-178.85	-178.85
9	1988	461.45	283.68	465.06	290.60	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	420.62	-209.72	210.90	0.00	-202.79	-202.79
10	1989	878.96	307.35	882.37	314.64	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	838.25	-184.70	653.55	0.00	-177.40	-177.40
11	1990	628.55	303.66	631.93	309.27	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	587.84	-188.39	399.45	0.00	-182.78	-182.78
12	1991	567.63	303.03	570.98	311.27	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	526.92	-189.02	337.90	0.00	-180.78	-180.78
13	1992	282.88	279.86	286.52	287.92	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	242.05	-213.54	28.51	0.00	-205.48	-205.48
14	1993	312.87	252.41	315.99	257.49	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	272.16	-239.64	32.52	0.00	-234.56	-234.56
15	1994	758.18	288.53	761.67	293.57	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	717.47	-203.51	513.95	0.00	-198.48	-198.48
16	1995	727.98	297.11	732.09	302.58	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	687.28	-194.94	492.33	0.00	-189.47	-189.47
17	1996	1,091.97	311.49	1,096.10	317.25	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,051.13	-181.91	869.23	0.00	-176.15	-176.15
18	1997	758.56	312.05	763.32	318.12	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	717.86	-180.00	537.86	0.00	-173.93	-173.93
19	1998	285.92	279.87	291.17	286.55	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	245.22	-212.18	33.04	0.00	-205.50	-205.50
20	1999	754.44	282.65	757.91	287.25	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	713.74	-209.40	504.34	0.00	-204.80	-204.80
21	2000	1,130.58	312.56	1,135.94	319.68	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,089.74	-180.83	908.91	0.00	-173.72	-173.72
22	2001	1,197.88	319.04	1,203.19	326.86	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	1,157.17	-173.01	984.16	0.00	-165.19	-165.19
23	2002	791.52	317.70	797.36	325.52	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	750.82	-174.35	576.47	0.00	-166.52	-166.52
24	2003	683.37	303.67	688.53	311.70	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	642.67	-188.38	454.29	0.00	-180.35	-180.35
25	2004	681.60	310.40	687.74	318.15	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	640.76	-182.99	457.77	0.00	-175.25	-175.25
26	2005	389.17	285.92	395.50	293.80	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	348.47	-206.12	142.35	0.00	-198.25	-198.25
27	2006	780.75	296.62	786.60	304.03	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	740.05	-195.42	544.63	0.00	-188.01	-188.01
28	2007	797.15	305.68	803.55	313.33	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	756.45	-186.37	570.08	0.00	-178.72	-178.72
29	2008	1,429.59	320.30	1,436.43	327.92	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,388.76	-173.10	1,215.66	0.00	-165.48	-165.48
30	2009	1,222.14	327.84	1,229.48	335.65	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	1,181.44	-164.20	1,017.23	0.00	-156.40	-156.40
31	2010	744.45	313.35	751.78	321.13	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	703.73	-178.70	525.03	0.00	-170.92	-170.92
32	2011	2,091.21	329.19	2,099.40	336.28	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	2,050.49	-162.87	1,887.63	0.00	-155.77	-155.77
33	2012	1,343.76	331.35	1,352.38	339.21	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,302.93	-162.05	1,140.88	0.00	-154.18	-154.18
34	2013	1,204.79	325.39	1,213.38	333.02	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,164.07	-166.66	997.41	0.00	-159.03	-159.03
35	2014	1,261.29	323.91	1,270.01	331.73	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,220.57	-168.14	1,052.43	0.00	-160.32	-160.32
36	2015	717.53	317.77	726.26	325.30	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	676.81	-174.28	502.53	0.00	-166.75	-166.75
37	2016	392.18	283.56	400.80	290.49	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	351.34	-209.84	141.50	0.00	-202.91	-202.91
38	2017	1,360.01	310.59	1,367.28	317.17	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,319.29	-181.47	1,137.83	0.00	-174.88	-174.88
39	2018	1,196.39	326.06	1,205.24	332.72	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,155.67	-165.99	989.68	0.00	-159.33	-159.33
40	2019	480.26	303.80	489.25	310.14	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	439.54	-188.26	251.28	0.00	-181.91	-181.91
41	2020	560.58	284.36	568.09	290.19	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	519.74	-209.03	310.71	0.00	-203.21	-203.21
Max.		2,091.21	331.35	2,099.40	339.21	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	2,050.49	-162.05	1,888.45	0.00	-154.18	-154.18
Ave.		844.68	305.89	849.89	312.79	34.96	285.80	5.71	1.08	0.07	0.33	0.00	205.20	40.74	492.41	803.93	-186.52	617.41	0.00	-179.62	-179.62
Min.		282.88	252.41	286.52	257.49	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	242.05	-239.64	2.41	0.00	-234.56	-234.56
Times of Deficit																					41
Provability of Deficit (%)																					100.00%
Provability of Deficit (1/Years)																					1.00

Source: JICA Survey Team

Table D-282 Results of Proposed Languyon Dam in WRR-VII (Cebu) [Case: Sediment Yield=1.684 mm/year, Dam Height=91.5 m, Design Demand=17.0%] (3/3)

Unit: MCM/year

No.	Year	Total W.Demand in Metro Cebu	W.Demand	W.Supply	Deficit
1	1980	-163.62	34.93	34.93	0.00
2	1981	-160.47	34.85	34.85	0.00
3	1982	-176.94	34.85	34.85	0.00
4	1983	-200.81	34.85	34.85	0.00
5	1984	-181.37	34.93	34.93	0.00
6	1985	-165.69	34.85	34.85	0.00
7	1986	-167.56	34.85	34.85	0.00
8	1987	-178.85	34.85	34.85	0.00
9	1988	-202.79	34.93	34.93	0.00
10	1989	-177.40	34.85	34.85	0.00
11	1990	-182.78	34.85	34.85	0.00
12	1991	-180.78	34.85	34.85	0.00
13	1992	-205.48	34.93	34.93	0.00
14	1993	-234.56	34.85	34.85	0.00
15	1994	-198.48	34.85	34.85	0.00
16	1995	-189.47	34.85	34.85	0.00
17	1996	-176.15	34.93	34.93	0.00
18	1997	-173.93	34.85	34.85	0.00
19	1998	-205.50	34.85	34.85	0.00
20	1999	-204.80	34.85	33.48	-1.36
21	2000	-173.72	34.93	34.93	0.00
22	2001	-165.19	34.85	34.85	0.00
23	2002	-166.52	34.85	34.85	0.00
24	2003	-180.35	34.85	34.85	0.00
25	2004	-175.25	34.93	34.93	0.00
26	2005	-198.25	34.85	31.88	-2.97
27	2006	-188.01	34.85	28.61	-6.23
28	2007	-178.72	34.85	32.59	-2.26
29	2008	-165.48	34.93	34.93	0.00
30	2009	-156.40	34.85	34.85	0.00
31	2010	-170.92	34.85	34.85	0.00
32	2011	-155.77	34.85	34.85	0.00
33	2012	-154.18	34.93	34.93	0.00
34	2013	-159.03	34.85	34.85	0.00
35	2014	-160.32	34.85	34.85	0.00
36	2015	-166.75	34.85	34.85	0.00
37	2016	-202.91	34.93	34.93	0.00
38	2017	-174.88	34.85	34.85	0.00
39	2018	-159.33	34.85	34.85	0.00
40	2019	-181.91	34.85	34.85	0.00
41	2020	-203.21	34.93	34.93	0.00
Max.		-154.18	34.93	34.93	0.00
Ave.		-179.62	34.87	34.56	-0.31
Min.		-234.56	34.85	28.61	-6.23
Times of Deficit					4
Provability of Deficit (%)					9.8%
Provability of Deficit (1/Years)					10.25

Source: JICA Survey Team

Table below shows the summary of results of reservoir operation study of proposed Languyon dam in WRR-VII.

In the cases of dam height at 91.5 m, all cases of the sediment yield will be available to supply water from proposed Languyon dam to Metro Cebu by around 17.0% of demand equivalent to 34.52 MCM/year.

Table D-283 Summary of Reservoir Operation Study for Proposed Languyon Dam in WRR-VII (Cebu)

Dam Site	Unit	Languyon			
Case No.		13	14	**15**	16
Location (Province)	-	Cebu	Cebu	**Cebu**	Cebu
Catchment Area	(km^2)	52.84	52.84	**52.84**	52.84
Proposed Dam Height	(m)	91.5	91.5	**91.5**	91.5
Annual Sediment Yield Volume	(million m3/year)	0.122	0.056	**0.089**	0.143
Annual Sediment Yield	(mm/year)	2.30	1.06	**1.68**	2.71
Annual Sediment Yield Volume	(t/km2/year)	3,226	1,489	**2,357**	3,800
Source of Sediment Yield	-	Joglekar's Equation (1960)	Khosla's equation (1953)	**Average of Joglekar & Khosla Equation**	Magat Dam, Sue White (1996)
Full Supply Volume	(MCM)	191.19	191.19	**191.19**	191.19
Full Supply WL (FSL)	(El.m)	138.00	138.00	**138.00**	138.00
Dead Storage Volume	(MCM)	13.55	6.25	**9.90**	15.96
Minimum Operation WL (MOL)	(El.m)	80.50	71.96	**76.98**	82.58
Effective Storage Volume	(MCM)	177.65	184.94	**181.29**	175.23
Target Supply Area/City (Demand Area)	-	Metro Cebu	Metro Cebu	**Metro Cebu**	Metro Cebu
Supply Ratio for Demand	(%)	17.0%	17.2%	**17.0%**	16.8%
Ave. Supply Water from Dam	(MCM//Year)	34.42	34.80	**34.52**	34.18
Supply Available Return Period	(Year)	10.25	10.25	**10.25**	10.25
Years of Full Sedimentation of Reservoir	(Year)	1,411.4	3,057.3	**1,931.2**	1,198.0
Notes	-				

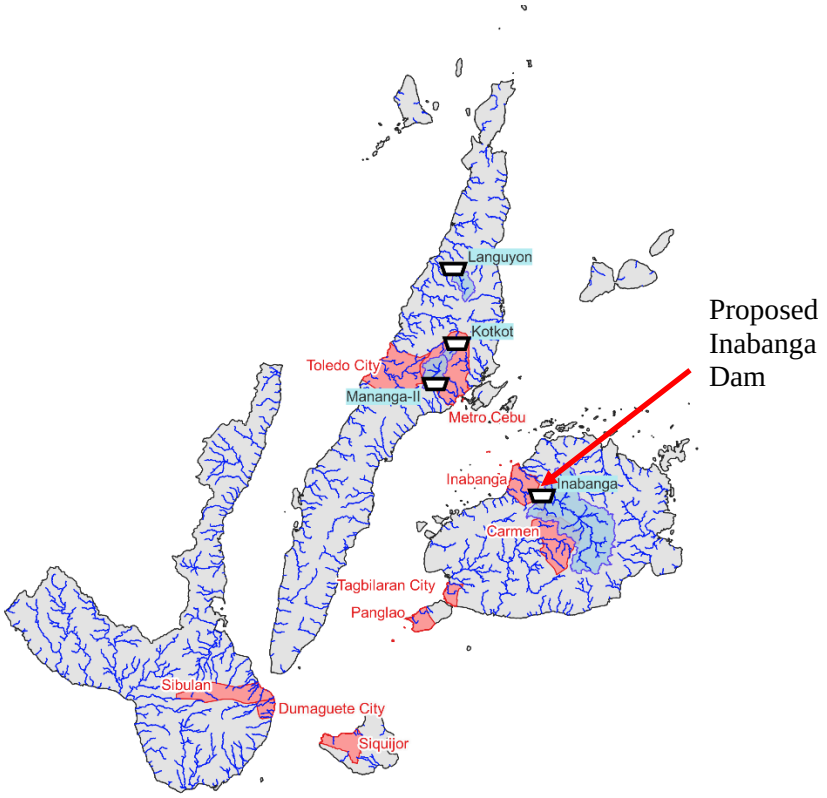
Notes:

Joglekar's Equation (1960)	Qs = 0.00597*(A)^(0.76)
Khosla's equation (1953)	Qs = 0.00323*(A)^(0.72)
Magat Dam, Sue White (1996)	SY = 3,800 [t/km2/year]

Source: JICA Survey Team

(4) Proposed Inabanga Dam (Bohol)

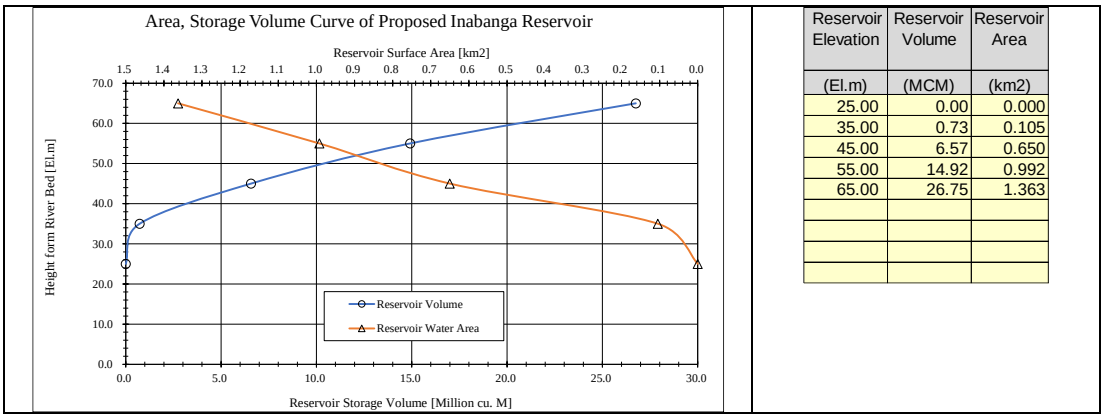
Location map of proposed Inabanga dam site is shown Figure below.



Source: JICA Survey Team

Figure D-509 Location Map of Proposed Inabanga Dam Site in WRR-VII (Bohol)

Reservoir area-storage curve of proposed Inabanga dam site is shown Figure below.



Reservoir Elevation	Reservoir Volume	Reservoir Area
(El.m)	(MCM)	(km2)
25.00	0.00	0.000
35.00	0.73	0.105
45.00	6.57	0.650
55.00	14.92	0.992
65.00	26.75	1.363

Source: JICA Survey Team

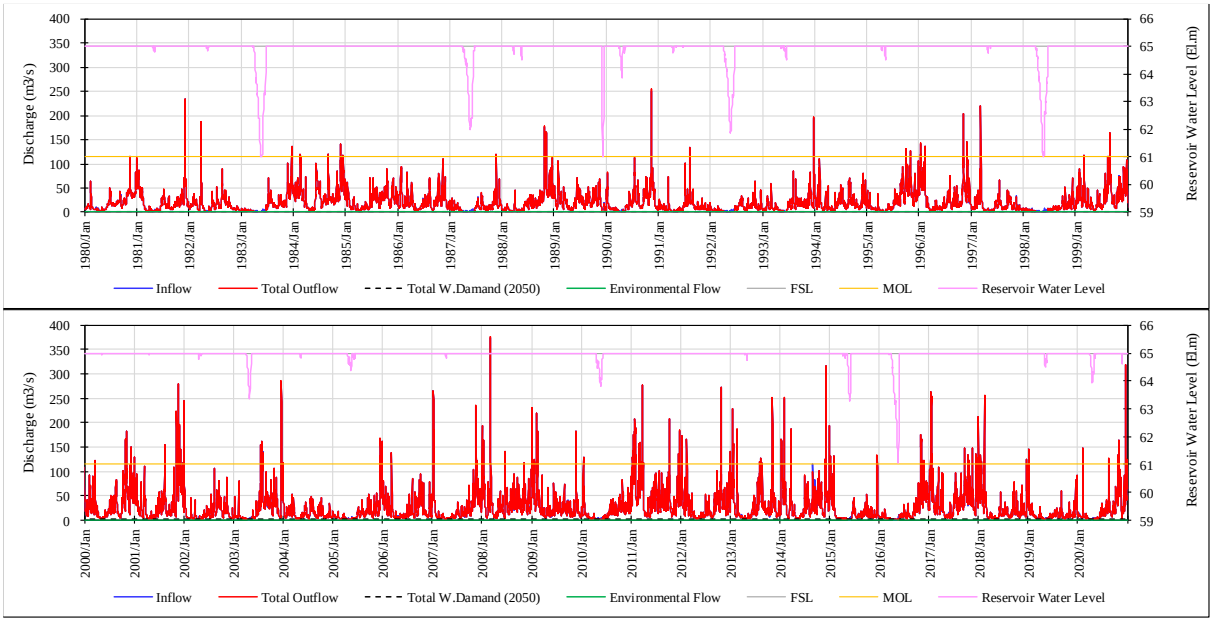
Figure D-510 Reservoir Area-Storage Curve of Proposed Inabanga Dam Site in WRR-VII (Bohol)

The results of reservoir operation study of the case of sediment yield by Khosla's equation at 0.553 mm/year and proposed maximum dam height at 41.5m are shown in following Tables and Figure.

Table D-284 Futures of Proposed Inabanga Dam in WRR-VII (Bohol) [Case: Sediment Yield=0.553 mm/year, Dam Height=41.5m, Design Demand=20.0%]

Catchment Area at Dam Site [km2]	547.55	
Dam Height [m]	41.50	
Dam Bottom Elevation [El.m]	25.00	
Dam Crest Elevation [El.m]	66.50	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	65.00	
Full Supply Volume [MCM]	26.75	
Annual Sediment Yield Volume [million m3/year]	0.3026	Khosla's equation (1953) Qs = 0.00323*(A)^(0.72)
Sediment Delivery Ratio (SDR) [%]	9.0%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	6,113	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	0.553	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	774	
Mean Inflow [m3/sec]	22.36	at Dam Site
Annual Inflow Volume [km3/year]	705,280	at Dam Site
Ratio of Capacity to Annual Inflow	0.038	C/I
Trap Efficiency [%]	72.9%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	22.05	
Dead Storage Volume [MCM}	22.05	
Minimum Operation WL (MOL) [El.m]	61.02	at Dead Storage Volume
Effective Storage Capacity [MCM]	4.70	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	121.33	at FSL

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-511 Results of Reservoir Operation Study of Proposed Inabanga Dam Site in WRR-VII (Bohol) [Case: Sediment Yield=0.553 mm/year, Dam Height=41.5m, Design Demand=20.0%]

Table D-285 Results of Proposed Inabanga Dam in WRR-VII (Bohol) [Case: Sediment Yield=0.553 mm/year, Dam Height=41.5m, Design Demand=20.0%] (1/3)

Dam Height (not incl. Freeboard) [m]=	40.00	Province =	Cebu	Province =	Cebu
Demand Rate [%]=	20.00%	1/5-Dry Year=	2004	1/10-Dry Year=	1998
Average W.D. [m3/s]=	1.13	W.D. in 1/5-Dry Year [m3/s]=	1.11	W.D. in 1/10-Dry Year [m3/s]=	1.30
Average W.Supply Vol. [m3/s]=	1.30	W.Supply in 1/5-Dry Year [m3/s]=	1.30	W.Supply in 1/10-Dry Year [m3/s]=	1.29
Average W.D. [MCM/year]=	35.78	W.D. in 1/5-Dry Year [MCM/year]=	34.95	W.D. in 1/10-Dry Year [MCM/year]=	41.10
Average W.Supply Vol. [MCM/year]=	40.93	W.Supply in 1/5-Dry Year [MCM/year]=	41.10	W.Supply in 1/10-Dry Year [MCM/year]=	40.55
Provability of Deficit (1/Years)=	10.25				

Source: JICA Survey Team

Table D-286 Results of Proposed Inabanga Dam in WRR-VII (Bohol) [Case: Sediment Yield=0.553 mm/year, Dam Height=41.5m, Design Demand=20.0%] (2/3)

Unit: MCM/year

No.	Year	SW River Flow	GW Flow	SW Potential	GW Potential	SW DIW WD	GW DIW WD	SW Irrigation WD	GW Irrigation WD	SW Livestock WD	GW Livestock WD	SW Other WD	GW Other WD	SW Total W.Demand	GW Total W.Demand	SW Water Balance	GW Water Balance	Total Water Balance	SW Deficit	GW Deficit	W.Demand
1	1980	1,190.35	323.15	1,191.68	329.78	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,149.51	-170.24	979.27	0.00	-163.62	-163.62
2	1981	937.25	325.01	938.76	331.58	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	896.54	-167.04	729.51	0.00	-160.47	-160.47
3	1982	584.28	308.51	585.99	315.11	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	543.57	-183.54	360.03	0.00	-176.94	-176.94
4	1983	376.91	284.62	378.81	291.24	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	336.20	-207.43	128.78	0.00	-200.81	-200.81
5	1984	1,075.09	305.35	1,077.20	312.03	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,034.25	-188.05	846.20	0.00	-181.37	-181.37
6	1985	1,052.74	319.73	1,055.02	326.36	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	1,012.03	-172.32	839.72	0.00	-165.69	-165.69
7	1986	939.19	317.82	941.67	324.48	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	898.48	-174.22	724.26	0.00	-167.56	-167.56
8	1987	510.29	306.52	512.96	313.20	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	469.58	-185.53	284.05	0.00	-178.85	-178.85
9	1988	461.45	283.68	465.06	290.60	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	420.62	-209.72	210.90	0.00	-202.79	-202.79
10	1989	878.96	307.35	882.37	314.64	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	838.25	-184.70	653.55	0.00	-177.40	-177.40
11	1990	628.55	303.66	631.93	309.27	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	587.84	-188.39	399.45	0.00	-182.78	-182.78
12	1991	567.63	303.03	570.98	311.27	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	526.92	-189.02	337.90	0.00	-180.78	-180.78
13	1992	282.88	279.86	286.52	287.92	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	242.05	-213.54	28.51	0.00	-205.48	-205.48
14	1993	312.87	252.41	315.99	257.49	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	272.16	-239.64	32.52	0.00	-234.56	-234.56
15	1994	758.18	288.53	761.67	293.57	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	717.47	-203.51	513.95	0.00	-198.48	-198.48
16	1995	727.98	297.11	732.09	302.58	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.71	492.05	687.28	-194.94	492.33	0.00	-189.47	-189.47
17	1996	1,091.97	311.49	1,096.10	317.25	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,051.13	-181.91	869.23	0.00	-176.15	-176.15
18	1997	758.56	312.05	763.32	318.12	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	717.86	-180.00	537.86	0.00	-173.93	-173.93
19	1998	285.92	279.87	291.17	286.55	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	245.22	-212.18	33.04	0.00	-205.50	-205.50
20	1999	754.44	282.65	757.91	287.25	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	713.74	-209.40	504.34	0.00	-204.80	-204.80
21	2000	1,130.58	312.56	1,135.94	319.68	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,089.74	-180.83	908.91	0.00	-173.72	-173.72
22	2001	1,197.88	319.04	1,203.19	326.86	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	1,157.17	-173.01	984.16	0.00	-165.19	-165.19
23	2002	791.52	317.70	797.36	325.52	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	750.82	-174.35	576.47	0.00	-166.52	-166.52
24	2003	683.37	303.67	688.53	311.70	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	642.67	-188.38	454.29	0.00	-180.35	-180.35
25	2004	681.60	310.40	687.74	318.15	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	640.76	-182.99	457.77	0.00	-175.25	-175.25
26	2005	389.17	285.92	395.50	293.80	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	348.47	-206.12	142.35	0.00	-198.25	-198.25
27	2006	780.75	296.62	786.60	304.03	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	740.05	-195.42	544.63	0.00	-188.01	-188.01
28	2007	797.15	305.68	803.55	313.33	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	756.45	-186.37	570.08	0.00	-178.72	-178.72
29	2008	1,429.59	320.30	1,436.43	327.92	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,388.76	-173.10	1,215.66	0.00	-165.48	-165.48
30	2009	1,222.14	327.84	1,229.48	335.65	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	1,181.44	-164.20	1,017.23	0.00	-156.40	-156.40
31	2010	744.45	313.35	751.78	321.13	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	703.73	-178.70	525.03	0.00	-170.92	-170.92
32	2011	2,091.21	329.19	2,099.40	336.28	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	2,050.49	-162.87	1,887.63	0.00	-155.77	-155.77
33	2012	1,343.76	331.35	1,352.38	339.21	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	1,302.93	-162.05	1,140.88	0.00	-154.18	-154.18
34	2013	1,204.79	325.39	1,213.38	333.02	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,164.07	-166.66	997.41	0.00	-159.03	-159.03
35	2014	1,261.29	323.91	1,270.01	331.73	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,220.57	-168.14	1,052.43	0.00	-160.32	-160.32
36	2015	717.53	317.77	726.26	325.30	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	676.81	-174.28	502.53	0.00	-166.75	-166.75
37	2016	392.18	283.56	400.80	290.49	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	351.34	-209.84	141.50	0.00	-202.91	-202.91
38	2017	1,360.01	310.59	1,367.28	317.17	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,319.29	-181.47	1,137.83	0.00	-174.88	-174.88
39	2018	1,196.39	326.06	1,205.24	332.72	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	1,155.67	-165.99	989.68	0.00	-159.33	-159.33
40	2019	480.26	303.80	489.25	310.14	34.93	285.59	5.72	1.08	0.07	0.33	0.00	205.05	40.72	492.05	439.54	-188.26	251.28	0.00	-181.91	-181.91
41	2020	560.58	284.36	568.09	290.19	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	519.74	-209.03	310.71	0.00	-203.21	-203.21
Max.		2,091.21	331.35	2,099.40	339.21	35.03	286.37	5.74	1.08	0.07	0.33	0.00	205.61	40.84	493.40	2,050.49	-162.05	1,888.45	0.00	-154.18	-154.18
Ave.		844.68	305.89	849.89	312.79	34.96	285.80	5.71	1.08	0.07	0.33	0.00	205.20	40.74	492.41	803.93	-186.52	617.41	0.00	-179.62	-179.62
Min.		282.88	252.41	286.52	257.49	34.93	285.59	5.70	1.08	0.07	0.33	0.00	205.05	40.70	492.05	242.05	-239.64	2.41	0.00	-234.56	-234.56
Times of Deficit																					41
Provability of Deficit (%)																					100.00%
Provability of Deficit (1/Years)																					1.00

Source: JICA Survey Team

Table D-287 Results of Proposed Inabanga Dam in WRR-VII (Bohol) [Case: Sediment Yield=0.553 mm/year, Dam Height=41.5m, Design Demand=20.0%] (3/3)

Unit: MCM/year

No.	Year	Total W.Demand in Metro Cebu	W.Demand	W.Supply	Deficit
1	1980	-163.62	41.10	41.10	0.00
2	1981	-160.47	41.00	41.00	0.00
3	1982	-176.94	41.00	41.00	0.00
4	1983	-200.81	41.00	39.55	-1.45
5	1984	-181.37	41.10	41.10	0.00
6	1985	-165.69	41.00	41.00	0.00
7	1986	-167.56	41.00	41.00	0.00
8	1987	-178.85	41.00	41.00	0.00
9	1988	-202.79	41.10	41.10	0.00
10	1989	-177.40	41.00	40.64	-0.36
11	1990	-182.78	41.00	41.00	0.00
12	1991	-180.78	41.00	41.00	0.00
13	1992	-205.48	41.10	41.10	0.00
14	1993	-234.56	41.00	41.00	0.00
15	1994	-198.48	41.00	41.00	0.00
16	1995	-189.47	41.00	41.00	0.00
17	1996	-176.15	41.10	41.10	0.00
18	1997	-173.93	41.00	41.00	0.00
19	1998	-205.50	41.00	40.55	-0.44
20	1999	-204.80	41.00	41.00	0.00
21	2000	-173.72	41.10	41.10	0.00
22	2001	-165.19	41.00	41.00	0.00
23	2002	-166.52	41.00	41.00	0.00
24	2003	-180.35	41.00	41.00	0.00
25	2004	-175.25	41.10	41.10	0.00
26	2005	-198.25	41.00	41.00	0.00
27	2006	-188.01	41.00	41.00	0.00
28	2007	-178.72	41.00	41.00	0.00
29	2008	-165.48	41.10	41.10	0.00
30	2009	-156.40	41.00	41.00	0.00
31	2010	-170.92	41.00	41.00	0.00
32	2011	-155.77	41.00	41.00	0.00
33	2012	-154.18	41.10	41.10	0.00
34	2013	-159.03	41.00	41.00	0.00
35	2014	-160.32	41.00	41.00	0.00
36	2015	-166.75	41.00	41.00	0.00
37	2016	-202.91	41.10	40.98	-0.11
38	2017	-174.88	41.00	41.00	0.00
39	2018	-159.33	41.00	41.00	0.00
40	2019	-181.91	41.00	41.00	0.00
41	2020	-203.21	41.10	41.10	0.00
Max.		-154.18	41.10	41.10	0.00
Ave.		-179.62	41.02	40.96	-0.06
Min.		-234.56	41.00	39.55	-1.45
Times of Deficit					4
Provability of Deficit (%)					9.8%
Provability of Deficit (1/Years)					10.25

Source: JICA Survey Team

The results of reservoir operation study of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 0.934 mm/year and proposed maximum dam height at 41.5m is shown in following Table. As shown in Table below, reservoir sedimentation will be high due to comparatively small reservoir capacity compared with large catchment area.

It is not available to supply water from dam, if the sediment yield at 0.934 mm/year or more. The total reservoir volume at full supply water level (FSL) will be filled by sediment by 71.82 years. Thus, sediment dredging countermeasures will be required for the proposed Inabanga dam.

Table D-288 Futures of Proposed Inabanga Dam in WRR-VII (Bohol)
[Case: Sediment Yield=0.934 mm/year, Dam Height=41.5m]

Catchment Area at Dam Site [km2]	547.55	
Dam Height [m]	41.50	
Dam Bottom Elevation [El.m]	25.00	
Dam Crest Elevation [El.m]	66.50	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	65.00	
Full Supply Volume [MCM]	26.75	
Annual Sediment Yield Volume [million m3/year]	0.5112	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	9.0%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	10,327	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	0.934	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	1,307	
Mean Inflow [m3/sec]	22.36	at Dam Site
Annual Inflow Volume [km3/year]	705,280	at Dam Site
Ratio of Capacity to Annual Inflow	0.038	C/I
Trap Efficiency [%]	72.9%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	37.24	
Dead Storage Volume [MCM}	37.24	
Minimum Operation WL (MOL) [El.m]	90.50	at Dead Storage Volume
Effective Storage Capacity [MCM]	-10.49	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	71.82	at FSL

Source: JICA Survey Team

Table below shows the summary of results of reservoir operation study of proposed Inabanga dam in Bohol province, WRR-VII.

In the cases of dam height at 41.5 m, only the cases of the sediment yield at 0.55 mm/year by Khosla's Equation will be available to supply water from proposed Inabanga dam to Metro Cebu by 20.0% of demand equivalent to 10.25 MCM/year.

Other cases of sediment yield, it might be not able to supply water form proposed Inabanga dam without any countermeasures of sediment dredging.

Table D-289 Summary of Reservoir Operation Study for Proposed Inabanga Dam in WRR-VII (Bohol)

Dam Site Case No.	Unit	Inabanga			
		17	**18**	19	20
Location (Province)	-	Bohol	**Bohol**	Bohol	Bohol
Catchment Area	(km^2)	547.55	**547.55**	547.55	547.55
Proposed Dam Height	(m)	41.5	**41.5**	41.5	41.5
Annual Sediment Yield Volume	(million m3/year)	0.720	**0.303**	1.486	1.486
Annual Sediment Yield	(mm/year)	1.31	**0.55**	2.71	2.71
Annual Sediment Yield Volume	(t/km2/year)	1,840	**774**	3,800	3,800
Source of Sediment Yield	-	Joglekar's Equation (1960)	**Khosla's equation (1953)**	Average of Joglekar & Khosla Equation	Magat Dam, Sue White (1996)
Full Supply Volume	(MCM)	26.75	**26.80**	26.80	26.80
Full Supply WL (FSL)	(El.m)	65.00	**65.00**	65.00	65.00
Dead Storage Volume	(MCM)	52.44	**22.05**	37.24	108.28
Minimum Operation WL (MOL)	(El.m)	127.42	**61.02**	90.50	263.12
Effective Storage Volume	(MCM)	-25.69	**4.75**	-10.44	-81.48
Target Supply Area/City (Demand Area)	-	Metro Cebu	**Metro Cebu**	Metro Cebu	Metro Cebu
Supply Ratio for Demand	(%)	-	**20.0%**	-	-
Ave. Supply Water from Dam	(MCM//Year)	-	**40.93**	-	-
Supply Available Return Period	(Year)	-	**10.25**	-	-
Years of Full Sedimentation of Reservoir	(Year)	51.0	**121.6**	72.0	24.7
Notes	-	Need to be Sediment Dredging	Need to be Sediment Dredging	Need to be Sediment Dredging	Need to be Sediment Dredging

Notes:

Joglekar's Equation (1960)	Qs = 0.00597*(A)^(0.76)
Khosla's equation (1953)	Qs = 0.00323*(A)^(0.72)
Magat Dam, Sue White (1996)	SY = 3,800 [t/km2/year]

Source: JICA Survey Team

12.2 WRR-XI

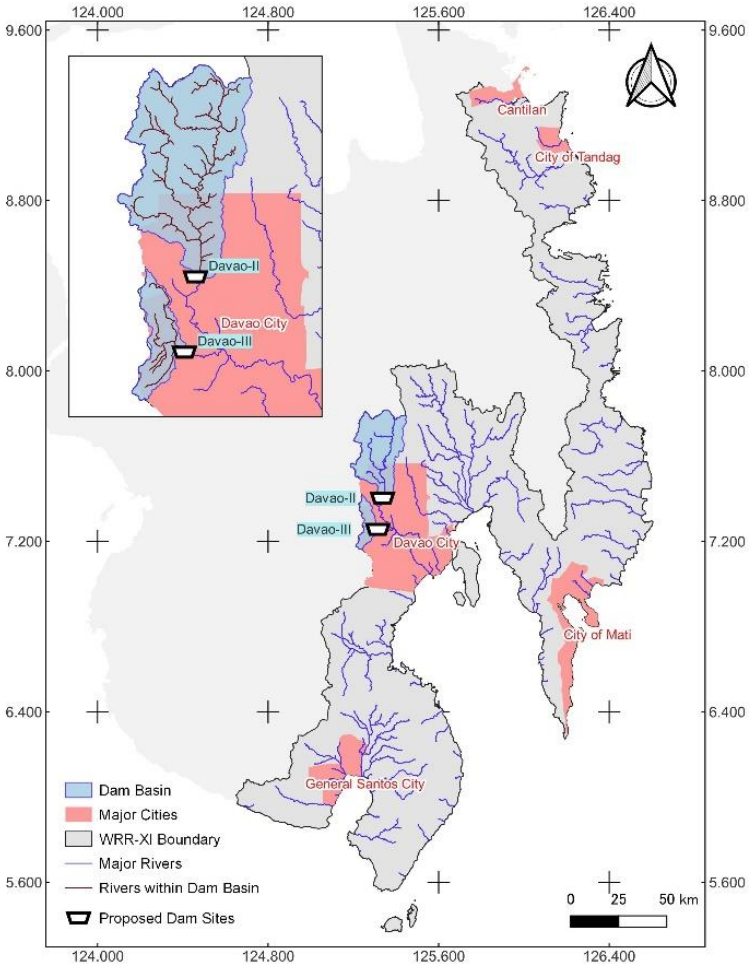
12.2.1 Location of Proposed Dams in WRR-XI

List of proposed dam sites in WRR-XI is shown in Table below. The location map of proposed dam sites in WRR-XI is shown in Figure below.

Table D-290 List of Proposed Dam Sites in WRR-XI

No.	Name	Owner	Status	Challenges
N1	Davao-II Dam	(MCWD/DPWH/NIA)	M/P	✓ Pre-F/S & F/S is not yet financed ✓ Setup of implementing organization ✓ Possibility of scale-down ✓ Possibility of multipurpose development (water supply, flood control)
N2	Davao-III Dam	(MCWD/DPWH/NIA)	M/P	✓ Pre-F/S & F/S is not yet financed ✓ Setup of implementing organization ✓ Possibility of multipurpose development (water supply, flood control) ✓ Social issues

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-512 Location Map of Proposed Dam Sites in WRR-XI

12.2.2 River Flow

Same methods were applied as WRR-VII.

12.2.3 Environmental Flow

In this study, environmental flow from proposed dams were set at 10% of 80% dependable flow which is 80% discharge of flow duration curve (FDC) as same as WRR-VII.

12.2.4 Sediment Yield

Same methods were applied as WRR-VII.

12.2.5 Trap Efficiency

Same methods were applied as WRR-VII.

12.2.6 Design Outflow and Reservoir Operation Rule Curves

Same methods were applied as WRR-VII.

12.2.7 Evaporation and Rainfall at Reservoir Water Surface

Same methods were applied as WRR-VII.

12.2.8 Preliminary Reservoir Operation Study

(1) Proposed Davao-II Dam

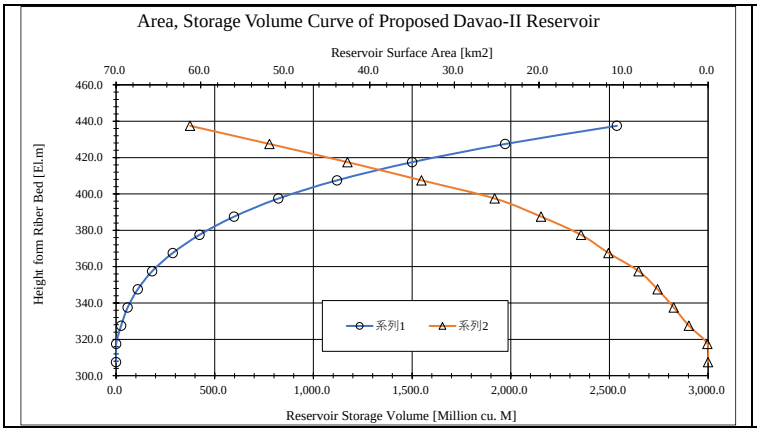
Photo of proposed Davao-II dam site is shown in Figure below.



Source: JICA Survey Team

Figure D-513 Photos of Proposed Davao-II Dam Site in WRR-XI

Reservoir area-storage curve of proposed Davao-II dam site is shown Figure below.



Reservoir Elevation	Reservoir Volume	Reservoir Area
(El.m)	(MCM)	(km2)
307.50	0.00	0.000
317.50	0.65	0.084
327.50	25.59	2.267
337.50	58.68	4.059
347.50	109.88	5.967
357.50	183.16	8.205
367.50	287.12	11.769
377.50	422.71	15.020
387.50	597.80	19.746
397.50	822.72	25.227
407.50	1,119.28	33.880
417.50	1,500.14	42.627
427.50	1,971.99	51.854
437.50	2,537.69	61.256

Source: JICA Survey Team

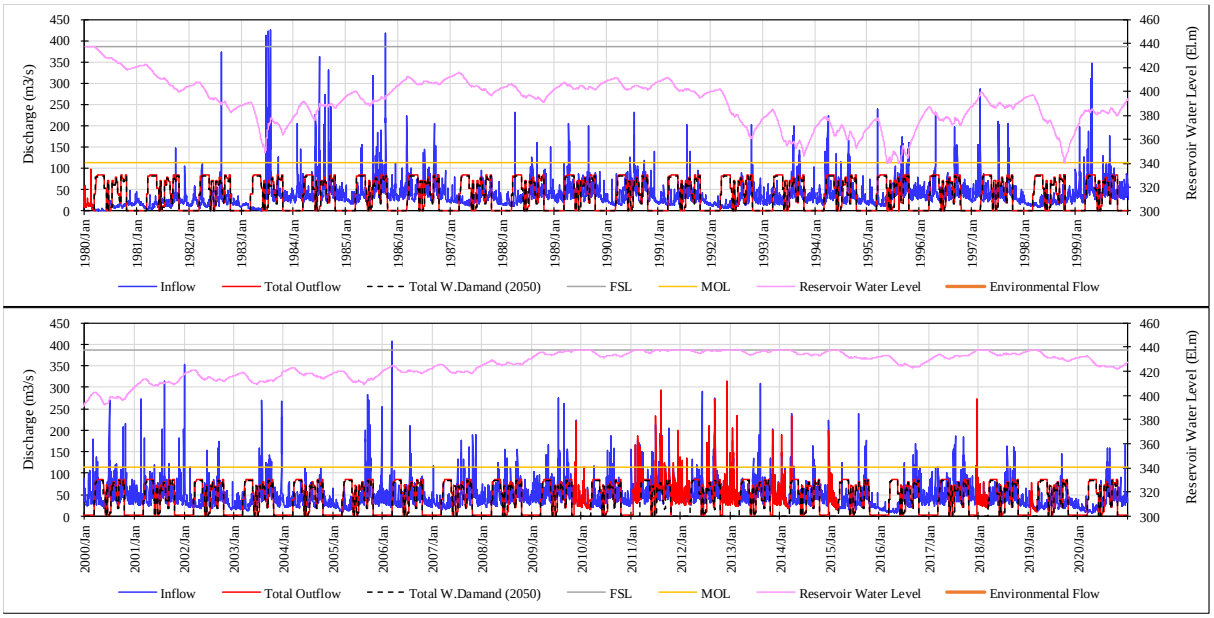
Figure D-514 Reservoir Area-Storage Curve of Proposed Davao-II Dam Site in WRR-XI

The results of reservoir operation study of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 0.845 mm/year and proposed maximum dam height at 131.5m are shown in following Tables and Figure. In this case, much reservoir volume and inflow, the available water supply ratio for water demand (deficit) in Metro Davao will be increased at 1,455% by 1/20-dry years return periods.

Table D-291 Futures of Proposed Davao-II Dam in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=131.5 m, Design Demand=1455%]

Catchment Area at Dam Site [km2]	814.04	
Dam Height [m]	131.50	
Dam Bottom Elevation [El.m]	307.50	
Dam Crest Elevation [El.m]	439.00	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	437.50	
Full Supply Volume [MCM]	2,537.69	
Annual Sediment Yield Volume [million m3/year]	0.6877	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	8.3%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	10,173	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	0.845	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	1,183	
Mean Inflow [m3/sec]	40.79	at Dam Site
Annual Inflow Volume [km3/year]	1,286,265	at Dam Site
Ratio of Capacity to Annual Inflow	1.973	C/I
Trap Efficiency [%]	105.6%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	72.63	
Dead Storage Volume [MCM}	72.63	
Minimum Operation WL (MOL) [El.m]	340.22	at Dead Storage Volume
Effective Storage Capacity [MCM]	2,465.06	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	3,494.19	at FSL

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-515 Results of Reservoir Operation Study of Proposed Davao-II Dam Site in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=131.5 m, Design Demand=1455%]

Table D-292 Results of Proposed Davao-II Dam in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=131.5 m, Design Demand=1455%] (1/3)

Dam Height (Exclude Freeboard) [m]=	130.00	Max. 130m	Province =	Davao del Sur	Province =	Davao del S
Demand Rate [%]=	1455.00%		1/5-Dry Year=	2002	1/10-Dry Year=	1987
Average W.D. [m3/s]=	36.19		W.D. in 1/5-Dry Year [m3/s]=	36.20	W.D. in 1/10-Dry Year [m3/s]=	36.25
Average W.Supply Vol. [m3/s]=	36.23		W.Supply in 1/5-Dry Year [m3/s]=	36.31	W.Supply in 1/10-Dry Year [m3/s]=	36.31
Average W.D. [MCM/year]=	1,141.15		W.D. in 1/5-Dry Year [MCM/year]=	1,141.71	W.D. in 1/10-Dry Year [MCM/year]=	1,143.05
Average W.Supply Vol. [MCM/year]=	1,142.44		W.Supply in 1/5-Dry Year [MCM/year]=	1,144.94	W.Supply in 1/10-Dry Year [MCM/year]=	1,144.94
Provability of Deficit (1/Years)=	20.50					

Source: JICA Survey Team

Table D-293 Results of Proposed Davao-II Dam in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=131.5 m, Design Demand=1455%] (2/3)

Unit: MCM/year

No.	Year	SW River Flow	GW Flow	SW Potential	GW Potential	SW DIW WD	GW DIW WD	SW Irrigation WD	GW Irrigation WD	SW Livestock WD	GW Livestock WD	SW Other WD	GW Other WD	SW Total W.Demand	GW Total W.Demand	SW Water Balance	GW Water Balance	Total Water Balance	SW Deficit	GW Deficit	W.Demand
1	1980	16,653	81.68	18,034	260.19	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	15,503	-179.89	15,323.29	0.00	-78.86	-78.86
2	1981	14,242	81.72	15,609	258.39	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	13,093	-179.14	12,914.04	0.00	-78.69	-78.69
3	1982	17,105	81.73	18,477	259.01	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	15,956	-179.13	15,777.16	0.00	-78.63	-78.63
4	1983	22,404	81.55	23,775	258.84	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	21,255	-179.30	21,075.80	0.00	-78.76	-78.76
5	1984	34,461	82.43	35,842	260.94	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	33,311	-179.14	33,131.61	0.00	-78.37	-78.37
6	1985	29,127	82.11	30,494	258.78	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	27,978	-178.75	27,799.43	0.00	-78.41	-78.41
7	1986	30,499	82.17	31,871	259.45	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	29,350	-178.68	29,171.48	0.00	-78.39	-78.39
8	1987	17,702	81.91	19,073	259.19	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	16,553	-178.95	16,374.09	0.00	-78.56	-78.56
9	1988	26,295	82.16	27,676	260.67	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	25,145	-179.41	24,965.28	0.00	-78.53	-78.53
10	1989	31,957	82.15	33,324	258.82	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	30,809	-178.70	30,630.04	0.00	-78.39	-78.39
11	1990	25,095	82.03	26,467	259.31	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	23,946	-178.83	23,767.43	0.00	-78.47	-78.47
12	1991	18,049	81.87	19,420	259.15	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	16,900	-178.98	16,720.88	0.00	-78.55	-78.55
13	1992	14,556	81.57	15,937	260.08	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	13,406	-180.00	13,225.58	0.00	-78.93	-78.93
14	1993	23,240	81.79	24,607	258.46	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	22,091	-179.07	21,912.43	0.00	-78.60	-78.60
15	1994	26,541	81.97	27,912	259.25	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	25,392	-178.89	25,213.07	0.00	-78.47	-78.47
16	1995	26,375	81.89	27,747	259.17	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	25,227	-178.96	25,047.78	0.00	-78.56	-78.56
17	1996	32,597	82.34	33,978	260.86	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	31,447	-179.23	31,267.47	0.00	-78.44	-78.44
18	1997	27,450	82.07	28,817	258.74	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	26,301	-178.79	26,122.44	0.00	-78.46	-78.46
19	1998	14,546	81.64	15,917	258.93	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	13,397	-179.21	13,217.84	0.00	-78.76	-78.76
20	1999	40,522	82.19	41,893	259.47	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	39,373	-178.66	39,194.44	0.00	-78.37	-78.37
21	2000	37,451	82.46	38,832	260.97	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	36,301	-179.11	36,121.58	0.00	-78.37	-78.37
22	2001	35,249	82.23	36,616	258.90	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	34,100	-178.62	33,921.37	0.00	-78.36	-78.36
23	2002	21,398	82.05	22,769	259.33	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	20,249	-178.81	20,070.31	0.00	-78.47	-78.47
24	2003	29,258	81.97	30,630	259.25	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	28,110	-178.89	27,930.76	0.00	-78.51	-78.51
25	2004	23,073	82.25	24,454	260.76	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	21,923	-179.32	21,743.62	0.00	-78.48	-78.48
26	2005	29,104	81.96	30,471	258.63	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	27,955	-178.90	27,776.17	0.00	-78.53	-78.53
27	2006	30,897	82.19	32,269	259.47	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	29,748	-178.67	29,569.52	0.00	-78.37	-78.37
28	2007	29,605	82.11	30,977	259.39	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	28,456	-178.75	28,277.56	0.00	-78.44	-78.44
29	2008	38,368	82.49	39,749	261.01	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	37,218	-179.08	37,038.66	0.00	-78.33	-78.33
30	2009	40,498	82.32	41,865	258.99	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	39,349	-178.54	39,170.33	0.00	-78.31	-78.31
31	2010	28,488	82.18	29,860	259.47	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	27,340	-178.67	27,160.97	0.00	-78.38	-78.38
32	2011	48,861	82.37	50,233	259.66	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	47,712	-178.48	47,533.70	0.00	-78.28	-78.28
33	2012	42,578	82.62	43,959	261.13	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	41,428	-178.95	41,248.74	0.00	-78.27	-78.27
34	2013	38,086	82.33	39,453	259.00	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	36,938	-178.52	36,759.21	0.00	-78.32	-78.32
35	2014	31,475	82.24	32,847	259.52	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	30,326	-178.61	30,147.63	0.00	-78.37	-78.37
36	2015	19,700	81.99	21,071	259.27	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	18,551	-178.86	18,372.21	0.00	-78.49	-78.49
37	2016	22,686	82.02	24,067	260.53	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	21,536	-179.55	21,355.98	0.00	-78.64	-78.64
38	2017	43,852	82.29	45,219	258.96	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	42,704	-178.56	42,525.14	0.00	-78.33	-78.33
39	2018	28,465	82.22	29,837	259.50	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	27,316	-178.64	27,137.61	0.00	-78.36	-78.36
40	2019	19,100	81.98	20,472	259.26	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	17,952	-178.87	17,772.63	0.00	-78.51	-78.51
41	2020	22,559	81.22	23,940	259.73	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	21,409	-180.35	21,228.69	0.00	-78.58	-78.58
Max.		48,861	82.62	50,233	261.13	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	47,712	-178.48	47,533.70	0.00	-78.27	-78.27
Ave.		28,053	82.06	29,426	259.52	98.36	249.92	1,045.56	0.11	5.14	0.15	0.00	10.87	1,149.06	261.05	26,904	-178.99	26,724.73	0.00	-78.49	-78.49
Min.		14,242	81.22	15,609	258.39	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	13,093	-180.35	12,912.82	0.00	-78.93	-78.93
Times of Deficit																					41
Provability of Deficit (%)																					100.00%
Provability of Deficit (1/Years)																					1.00

Source: JICA Survey Team

Table D-294 Results of Proposed Davao-II Dam in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=131.5 m, Design Demand=1455%] (3/3)

Unit: MCM/year

No.	Year	Total W.Demand in Metro Cebu	W.Demand	W.Supply	Deficit
1	1980	-78.86	1,144.94	1,144.94	0.00
2	1981	-78.69	1,144.94	1,144.94	0.00
3	1982	-78.63	1,144.94	1,144.94	0.00
4	1983	-78.76	1,144.94	1,144.94	0.00
5	1984	-78.37	1,144.94	1,144.94	0.00
6	1985	-78.41	1,144.94	1,144.94	0.00
7	1986	-78.39	1,144.94	1,144.94	0.00
8	1987	-78.56	1,144.94	1,144.94	0.00
9	1988	-78.53	1,144.94	1,144.94	0.00
10	1989	-78.39	1,144.94	1,144.94	0.00
11	1990	-78.47	1,144.94	1,144.94	0.00
12	1991	-78.55	1,144.94	1,144.94	0.00
13	1992	-78.93	1,144.94	1,144.94	0.00
14	1993	-78.60	1,144.94	1,144.94	0.00
15	1994	-78.47	1,144.94	1,144.94	0.00
16	1995	-78.56	1,144.94	1,097.56	-47.38
17	1996	-78.44	1,144.94	1,144.94	0.00
18	1997	-78.46	1,144.94	1,144.94	0.00
19	1998	-78.76	1,144.94	1,123.53	-21.41
20	1999	-78.37	1,144.94	1,144.94	0.00
21	2000	-78.37	1,144.94	1,144.94	0.00
22	2001	-78.36	1,144.94	1,144.94	0.00
23	2002	-78.47	1,144.94	1,144.94	0.00
24	2003	-78.51	1,144.94	1,144.94	0.00
25	2004	-78.48	1,144.94	1,144.94	0.00
26	2005	-78.53	1,144.94	1,144.94	0.00
27	2006	-78.37	1,144.94	1,144.94	0.00
28	2007	-78.44	1,144.94	1,144.94	0.00
29	2008	-78.33	1,144.94	1,144.94	0.00
30	2009	-78.31	1,144.94	1,144.94	0.00
31	2010	-78.38	1,144.94	1,144.94	0.00
32	2011	-78.28	1,144.94	1,144.94	0.00
33	2012	-78.27	1,144.94	1,144.94	0.00
34	2013	-78.32	1,144.94	1,144.94	0.00
35	2014	-78.37	1,144.94	1,144.94	0.00
36	2015	-78.49	1,144.94	1,144.94	0.00
37	2016	-78.64	1,144.94	1,144.94	0.00
38	2017	-78.33	1,144.94	1,144.94	0.00
39	2018	-78.36	1,144.94	1,144.94	0.00
40	2019	-78.51	1,144.94	1,144.94	0.00
41	2020	-78.58	1,144.94	1,144.94	0.00
Max.		-78.27	1,144.94	1,144.94	0.00
Ave.		-78.49	1,144.94	1,143.26	-1.68
Min.		-78.93	1,144.94	1,097.56	-47.38
Times of Deficit					2
Provability of Deficit (%)					4.9%
Provability of Deficit (1/Years)					20.50

Source: JICA Survey Team

Table below shows the summary of results of reservoir operation study of proposed Davao-II dam in WRR-XI.

In the cases of dam height at 131.5 m, will be able to supply water ratio at 1455% for the Metro Davao water demand (deficit) from proposed Davao-II dam.

If water supply ratio at 600% for the Metro Davao water demand (deficit) from proposed Davao-II dam, the dam height will be able to reduce at 56.5 m.

Table D-295 Summary of Reservoir Operation Study for Proposed Davao-II and Davao-III Dam in WRR-XI

Dam Site	Unit	Davao-II (High Dam Case)				Davao-II (Low Dam Case)			
Case No.		1	2	**3**	4	5	6	**7**	8
Location (Province)	-	Davao City	Davao City	**Davao City**	Davao City	Davao City	Davao City	**Davao City**	Davao City
Catchment Area	(km^2)	814.04	814.04	**814.04**	814.04	814.04	814.04	**814.04**	814.04
Proposed Dam Height	(m)	131.5	131.5	**131.5**	131.5	56.5	56.5	**56.5**	56.5
Annual Sediment Yield Volume	(million m3/year)	0.973	0.403	**0.688**	2.210	0.973	0.403	**0.688**	2.210
Annual Sediment Yield	(mm/year)	1.20	0.49	**0.84**	2.71	1.20	0.49	**0.84**	2.71
Annual Sediment Yield Volume	(t/km2/year)	1,673	692	**1,183**	3,800	1,673	692	**1,183**	3,800
Source of Sediment Yield	-	Joglekar's Equation (1960)	Khosla's equation (1953)	**Average of Joglekar & Khosla Equation**	Magat Dam, Sue White (1996)	Joglekar's Equation (1960)	Khosla's equation (1953)	**Average of Joglekar & Khosla Equation**	Magat Dam, Sue White (1996)
Full Supply Volume	(MCM)	2,537.69	2,537.69	**2,537.69**	2,537.69	235.14	235.14	**235.14**	235.14
Full Supply WL (FSL)	(El.m)	437.50	437.50	**437.50**	437.50	362.50	362.50	**362.50**	362.50
Dead Storage Volume	(MCM)	102.74	42.51	**72.63**	233.33	88.70	36.71	**62.71**	201.45
Minimum Operation WL (MOL)	(El.m)	346.10	332.62	**340.22**	362.33	343.36	330.86	**338.29**	359.26
Effective Storage Volume	(MCM)	2,434.95	2,495.17	**2,465.06**	2,304.36	146.44	198.44	**172.44**	33.69
Target Supply Area/City (Demand Area)	-	Metro Davao	Metro Davao	**Metro Davao**	Metro Davao	Metro Davao	Metro Davao	**Metro Davao**	Metro Davao
Supply Ratio for Demand	(%)	1450.0%	1460.0%	**1455.0%**	1445.0%	500.0%	620.0%	**600.0%**	200.0%
Ave. Supply Water from Dam	(MCM//Year)	1,139.61	1,145.31	**1,142.44**	1,133.92	389.55	483.01	**466.57**	155.78
Supply Available Return Period	(Year)	20.50	20.50	**20.50**	20.50	20.50	20.50	**20.50**	20.50
Years of Full Sedimentation of Reservoir	(Year)	2,470.1	5,969.1	**3,494.2**	1,087.6	265.1	640.6	**375.0**	116.7
Notes	-								

Joglekar's Equation (1960) Qs = 0.00597*(A)^(0.76)
Khosla's equation (1953) Qs = 0.00323*(A)^(0.72)
Magat Dam, Sue White (1996) SY = 3,800 [t/km2/year]

Source: JICA Survey Team

(2) Proposed Davao-III Dam

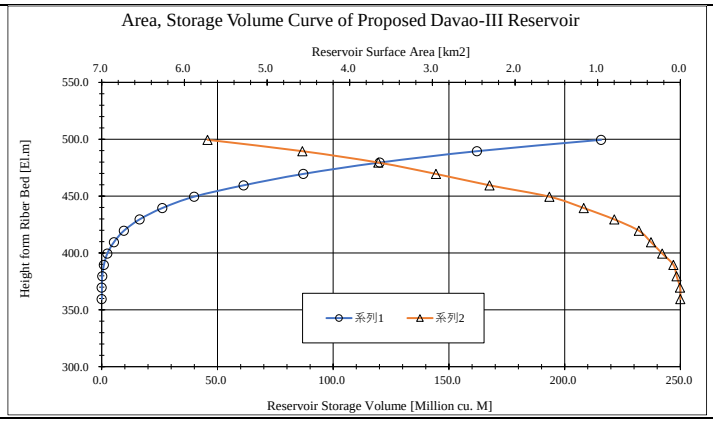
Photo of proposed Davao-III dam site is shown in Figure below.



Source: JICA Survey Team

Figure D-516 Photo of A Few kilometers from Davao-III Dam Site in WRR-XI

Reservoir area-storage curve of proposed Davao-III dam site is shown Figure below.



Reservoir Elevation	Reservoir Volume	Reservoir Area
(El.m)	(MCM)	(km2)
359.50	0.00	0.000
369.50	0.01	0.004
379.50	0.23	0.045
389.50	0.96	0.084
399.50	2.43	0.220
409.50	5.28	0.355
419.50	9.57	0.501
429.50	16.35	0.799
439.50	26.20	1.169
449.50	39.94	1.585
459.50	61.34	2.309
469.50	87.09	2.956
479.50	120.10	3.655
489.50	162.13	4.572
499.50	215.79	5.719

Source: JICA Survey Team

Figure D-517 Reservoir Area-Storage Curve of Proposed Davao-III Dam Site in WRR-XI

The result of futures of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 1.219 mm/year and proposed maximum dam height at 64.5m considering of social impacts is shown in following Table. In this case, the reservoir capacity at full supply water level (FSL) will be filled by sedimentation around 78.6 years. Thus, the countermeasures of sediment dredging will be required for the case of dam height at 64.5 m.

Table D-296 Futures of Proposed Davao-III Dam in WRR-XI [Case: Sediment Yield=9.06 mm/year, Dam Height=61.5m, Design Demand=2.0%]

Catchment Area at Dam Site [km2]	151.11	
Dam Height [m]	64.50	
Dam Bottom Elevation [El.m]	358.00	
Dam Crest Elevation [El.m]	422.50	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	421.00	
Full Supply Volume [MCM]	11.60	
Annual Sediment Yield Volume [million m3/year]	0.1952	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	11.9%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	10,845	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	1.291	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	1,808	
Mean Inflow [m3/sec]	7.96	at Dam Site
Annual Inflow Volume [km3/year]	251,053	at Dam Site
Ratio of Capacity to Annual Inflow	0.046	C/I
Trap Efficiency [%]	75.7%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	14.77	
Dead Storage Volume [MCM}	14.77	
Minimum Operation WL (MOL) [El.m]	425.66	at Dead Storage Volume
Effective Storage Capacity [MCM]	-3.16	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	78.58	at FSL

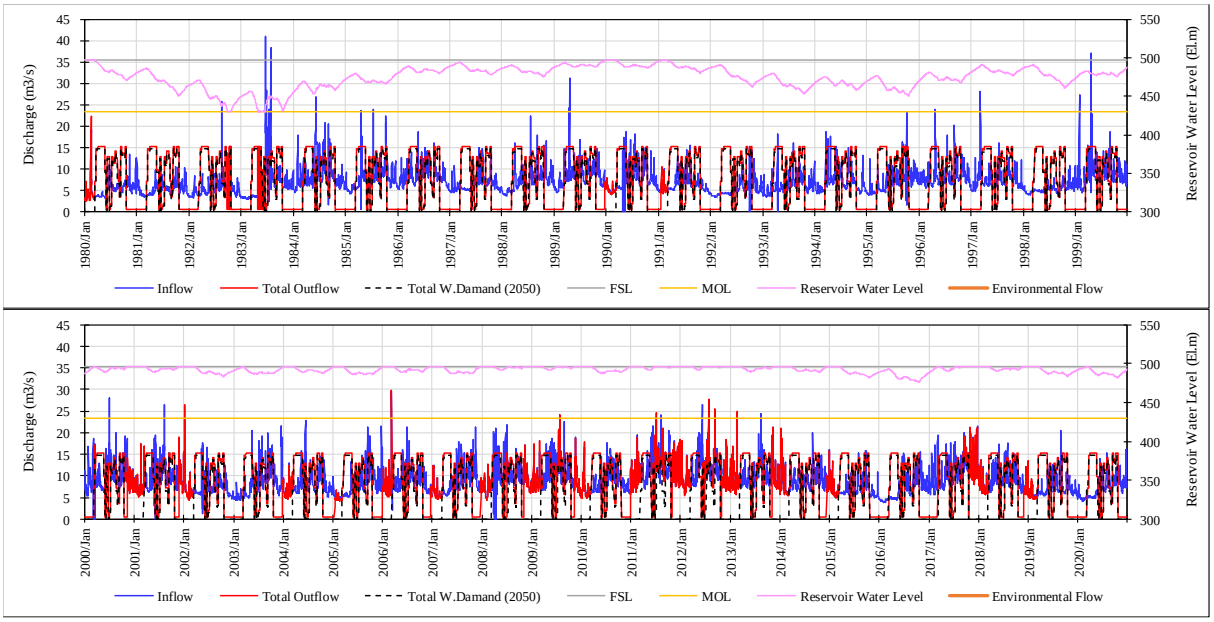
Source: JICA Survey Team

The results of reservoir operation study of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 1.291 mm/year and proposed maximum dam height at 141.5m are shown in following Tables and Figure. In this case, much reservoir volume and inflow, the available water supply ratio for water demand (deficit) in Metro Davao will be increased at 260% by 1/20-dry years return periods.

Table D-297 Futures of Proposed Davao-III Dam in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=141.5 m, Design Demand=260%]

Catchment Area at Dam Site [km2]	151.11	
Dam Height [m]	141.50	
Dam Bottom Elevation [El.m]	356.50	
Dam Crest Elevation [El.m]	498.00	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	496.50	
Full Supply Volume [MCM]	215.79	
Annual Sediment Yield Volume [million m3/year]	0.1952	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	11.9%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	10,845	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	1.291	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	1,808	
Mean Inflow [m3/sec]	7.96	at Dam Site
Annual Inflow Volume [km3/year]	251,053	at Dam Site
Ratio of Capacity to Annual Inflow	0.860	C/I
Trap Efficiency [%]	100.6%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	19.62	
Dead Storage Volume [MCM}	19.62	
Minimum Operation WL (MOL) [El.m]	429.82	at Dead Storage Volume
Effective Storage Capacity [MCM]	196.16	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	1,099.57	at FSL

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-518 Results of Reservoir Operation Study of Proposed Davao-III Dam in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=141.5 m, Design Demand=260%]

Table D-298 Results of Proposed Davao-III Dam in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=141.5 m, Design Demand=260%] (1/3)

Dam Height (Exclude Freeboard) [m]=	140.00
Demand Rate [%]=	260.00%
Average W.D. [m3/s]=	6.47
Average W.Supply Vol. [m3/s]=	6.44
Average W.D. [MCM/year]=	203.92
Average W.Supply Vol. [MCM/year]=	203.20
Provability of Deficit (1/Years)=	20.50

Province =	Davao del Sur
1/5-Dry Year=	2002
W.D. in 1/5-Dry Year [m3/s]=	6.47
W.Supply in 1/5-Dry Year [m3/s]=	6.49
W.D. in 1/5-Dry Year [MCM/year]=	204.02
W.Supply in 1/5-Dry Year [MCM/year]=	204.59

Province =	Davao del Su
1/10-Dry Year=	1987
W.D. in 1/10-Dry Year [m3/s]=	6.48
W.Supply in 1/10-Dry Year [m3/s]=	6.49
W.D. in 1/10-Dry Year [MCM/year]=	204.26
W.Supply in 1/10-Dry Year [MCM/year]=	204.59

Source: JICA Survey Team

Table D-299 Results of Proposed Davao-III Dam in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=141.5 m, Design Demand=260%] (2/3)

Unit: MCM/year

No.	Year	SW River Flow	GW Flow	SW Potential	GW Potential	SW DIW WD	GW DIW WD	SW Irrigation WD	GW Irrigation WD	SW Livestock WD	GW Livestock WD	SW Other WD	GW Other WD	SW Total W.Demand	GW Total W.Demand	SW Water Balance	GW Water Balance	Total Water Balance	SW Deficit	GW Deficit	W.Demand
1	1980	16,653	81.68	18,034	260.19	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	15,503	-179.89	15,323.29	0.00	-78.86	-78.86
2	1981	14,242	81.72	15,609	258.39	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	13,093	-179.14	12,914.04	0.00	-78.69	-78.69
3	1982	17,105	81.73	18,477	259.01	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	15,956	-179.13	15,777.16	0.00	-78.63	-78.63
4	1983	22,404	81.55	23,775	258.84	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	21,255	-179.30	21,075.80	0.00	-78.76	-78.76
5	1984	34,461	82.43	35,842	260.94	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	33,311	-179.14	33,131.61	0.00	-78.37	-78.37
6	1985	29,127	82.11	30,494	258.78	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	27,978	-178.75	27,799.43	0.00	-78.41	-78.41
7	1986	30,499	82.17	31,871	259.45	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	29,350	-178.68	29,171.48	0.00	-78.39	-78.39
8	1987	17,702	81.91	19,073	259.19	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	16,553	-178.95	16,374.09	0.00	-78.56	-78.56
9	1988	26,295	82.16	27,676	260.67	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	25,145	-179.41	24,965.28	0.00	-78.53	-78.53
10	1989	31,957	82.15	33,324	258.82	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	30,809	-178.70	30,630.04	0.00	-78.39	-78.39
11	1990	25,095	82.03	26,467	259.31	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	23,946	-178.83	23,767.43	0.00	-78.47	-78.47
12	1991	18,049	81.87	19,420	259.15	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	16,900	-178.98	16,720.88	0.00	-78.55	-78.55
13	1992	14,556	81.57	15,937	260.08	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	13,406	-180.00	13,225.58	0.00	-78.93	-78.93
14	1993	23,240	81.79	24,607	258.46	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	22,091	-179.07	21,912.43	0.00	-78.60	-78.60
15	1994	26,541	81.97	27,912	259.25	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	25,392	-178.89	25,213.07	0.00	-78.47	-78.47
16	1995	26,375	81.89	27,747	259.17	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	25,227	-178.96	25,047.78	0.00	-78.56	-78.56
17	1996	32,597	82.34	33,978	260.86	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	31,447	-179.23	31,267.47	0.00	-78.44	-78.44
18	1997	27,450	82.07	28,817	258.74	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	26,301	-178.79	26,122.44	0.00	-78.46	-78.46
19	1998	14,546	81.64	15,917	258.93	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	13,397	-179.21	13,217.84	0.00	-78.76	-78.76
20	1999	40,522	82.19	41,893	259.47	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	39,373	-178.66	39,194.44	0.00	-78.37	-78.37
21	2000	37,451	82.46	38,832	260.97	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	36,301	-179.11	36,121.58	0.00	-78.37	-78.37
22	2001	35,249	82.23	36,616	258.90	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	34,100	-178.62	33,921.37	0.00	-78.36	-78.36
23	2002	21,398	82.05	22,769	259.33	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	20,249	-178.81	20,070.31	0.00	-78.47	-78.47
24	2003	29,258	81.97	30,630	259.25	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	28,110	-178.89	27,930.76	0.00	-78.51	-78.51
25	2004	23,073	82.25	24,454	260.76	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	21,923	-179.32	21,743.62	0.00	-78.48	-78.48
26	2005	29,104	81.96	30,471	258.63	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	27,955	-178.90	27,776.17	0.00	-78.53	-78.53
27	2006	30,897	82.19	32,269	259.47	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	29,748	-178.67	29,569.52	0.00	-78.37	-78.37
28	2007	29,605	82.11	30,977	259.39	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	28,456	-178.75	28,277.56	0.00	-78.44	-78.44
29	2008	38,368	82.49	39,749	261.01	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	37,218	-179.08	37,038.66	0.00	-78.33	-78.33
30	2009	40,498	82.32	41,865	258.99	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	39,349	-178.54	39,170.33	0.00	-78.31	-78.31
31	2010	28,488	82.18	29,860	259.47	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	27,340	-178.67	27,160.97	0.00	-78.38	-78.38
32	2011	48,861	82.37	50,233	259.66	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	47,712	-178.48	47,533.70	0.00	-78.28	-78.28
33	2012	42,578	82.62	43,959	261.13	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	41,428	-178.95	41,248.74	0.00	-78.27	-78.27
34	2013	38,086	82.33	39,453	259.00	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	36,938	-178.52	36,759.21	0.00	-78.32	-78.32
35	2014	31,475	82.24	32,847	259.52	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	30,326	-178.61	30,147.63	0.00	-78.37	-78.37
36	2015	19,700	81.99	21,071	259.27	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	18,551	-178.86	18,372.21	0.00	-78.49	-78.49
37	2016	22,686	82.02	24,067	260.53	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	21,536	-179.55	21,355.98	0.00	-78.64	-78.64
38	2017	43,852	82.29	45,219	258.96	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	42,704	-178.56	42,525.14	0.00	-78.33	-78.33
39	2018	28,465	82.22	29,837	259.50	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	27,316	-178.64	27,137.61	0.00	-78.36	-78.36
40	2019	19,100	81.98	20,472	259.26	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	17,952	-178.87	17,772.63	0.00	-78.51	-78.51
41	2020	22,559	81.22	23,940	259.73	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	21,409	-180.35	21,228.69	0.00	-78.58	-78.58
Max.		48,861	82.62	50,233	261.13	98.56	250.42	1,046.45	0.11	5.15	0.15	0.00	10.89	1,150.15	261.57	47,712	-178.48	47,533.70	0.00	-78.27	-78.27
Ave.		28,053	82.06	29,426	259.52	98.36	249.92	1,045.56	0.11	5.14	0.15	0.00	10.87	1,149.06	261.05	26,904	-178.99	26,724.73	0.00	-78.49	-78.49
Min.		14,242	81.22	15,609	258.39	98.29	249.74	1,045.24	0.11	5.13	0.15	0.00	10.86	1,148.66	260.86	13,093	-180.35	12,912.82	0.00	-78.93	-78.93
Times of Deficit																					41
Provability of Deficit (%)																					100.00%
Provability of Deficit (1/Years)																					1.00

Source: JICA Survey Team

Table D-300 Results of Proposed Davao-III Dam in WRR-XI [Case: Sediment Yield=0.845 mm/year, Dam Height=141.5 m, Design Demand=260%] (3/3)

Unit: MCM/year

No.	Year	Total W.Demand in Metro Cebu	W.Demand	W.Supply	Deficit
1	1980	-78.86	204.59	204.59	0.00
2	1981	-78.69	204.59	204.59	0.00
3	1982	-78.63	204.59	189.21	-15.39
4	1983	-78.76	204.59	169.86	-34.73
5	1984	-78.37	204.59	204.59	0.00
6	1985	-78.41	204.59	204.59	0.00
7	1986	-78.39	204.59	204.59	0.00
8	1987	-78.56	204.59	204.59	0.00
9	1988	-78.53	204.59	204.59	0.00
10	1989	-78.39	204.59	204.59	0.00
11	1990	-78.47	204.59	204.59	0.00
12	1991	-78.55	204.59	204.59	0.00
13	1992	-78.93	204.59	204.59	0.00
14	1993	-78.60	204.59	204.59	0.00
15	1994	-78.47	204.59	204.59	0.00
16	1995	-78.56	204.59	204.59	0.00
17	1996	-78.44	204.59	204.59	0.00
18	1997	-78.46	204.59	204.59	0.00
19	1998	-78.76	204.59	204.59	0.00
20	1999	-78.37	204.59	204.59	0.00
21	2000	-78.37	204.59	204.59	0.00
22	2001	-78.36	204.59	204.59	0.00
23	2002	-78.47	204.59	204.59	0.00
24	2003	-78.51	204.59	204.59	0.00
25	2004	-78.48	204.59	204.59	0.00
26	2005	-78.53	204.59	204.59	0.00
27	2006	-78.37	204.59	204.59	0.00
28	2007	-78.44	204.59	204.59	0.00
29	2008	-78.33	204.59	204.59	0.00
30	2009	-78.31	204.59	204.59	0.00
31	2010	-78.38	204.59	204.59	0.00
32	2011	-78.28	204.59	204.59	0.00
33	2012	-78.27	204.59	204.59	0.00
34	2013	-78.32	204.59	204.59	0.00
35	2014	-78.37	204.59	204.59	0.00
36	2015	-78.49	204.59	204.59	0.00
37	2016	-78.64	204.59	204.59	0.00
38	2017	-78.33	204.59	204.59	0.00
39	2018	-78.36	204.59	204.59	0.00
40	2019	-78.51	204.59	204.59	0.00
41	2020	-78.58	204.59	204.59	0.00
Max.		-78.27	204.59	204.59	0.00
Ave.		-78.49	204.59	203.37	-1.22
Min.		-78.93	204.59	169.86	-34.73
Times of Deficit					2
Provability of Deficit (%)					4.9%
Provability of Deficit (1/Years)					20.50

Source: JICA Survey Team

Table below shows the summary of results of reservoir operation study of proposed Davao-III dam in WRR-XI.

Table D-301 Summary of Reservoir Operation Study for Proposed Kotkot Dam in WRR-VII (Cebu)

Dam Site	Unit	Davao-III (Low Dam Case)				Davao-III (High Dam Case)			
Case No.		9	**10**	11	12	13	14	**15**	16
Location (Province)	-	Davao City	**Davao City**	Davao City	Davao City	Davao City	Davao City	**Davao City**	Davao City
Catchment Area	(km^2)	151.11	**151.11**	151.11	151.11	151.11	151.11	**151.11**	151.11
Proposed Dam Height	(m)	63.5	**63.5**	63.5	63.5	141.5	141.5	**141.5**	141.5
Annual Sediment Yield Volume	(million m3/year)	0.271	**0.120**	0.195	0.410	0.271	0.120	**0.195**	0.410
Annual Sediment Yield	(mm/year)	1.79	**0.79**	1.29	2.71	1.79	0.79	**1.29**	2.71
Annual Sediment Yield Volume	(t/km2/year)	2,507	**1,110**	1,808	3,800	2,507	1,110	**1,808**	3,800
Source of Sediment Yield	-	Joglekar's Equation (1960)	**Khosla's equation (1953)**	Average of Joglekar & Khosla Equation	Magat Dam, Sue White (1996)	Joglekar's Equation (1960)	Khosla's equation (1953)	**Average of Joglekar & Khosla Equation**	Magat Dam, Sue White (1996)
Full Supply Volume	(MCM)	11.60	**11.60**	11.60	11.60	215.79	215.79	**215.79**	215.79
Full Supply WL (FSL)	(El.m)	421.00	**421.00**	421.00	421.00	496.50	496.50	**496.50**	496.50
Dead Storage Volume	(MCM)	20.47	**9.06**	14.77	31.04	27.21	12.04	**19.62**	41.25
Minimum Operation WL (MOL)	(El.m)	432.18	**416.82**	425.66	441.52	437.23	420.15	**429.82**	447.11
Effective Storage Volume	(MCM)	-8.87	**2.54**	-3.16	-19.43	188.58	203.74	**196.16**	174.54
Target Supply Area/City (Demand Area)	-	Metro Davao	**Metro Davao**	Metro Davao	Metro Davao	Metro Davao	Metro Davao	**Metro Davao**	Metro Davao
Supply Ratio for Demand	(%)	-	**80.0%**	-	-	260.0%	260.0%	**260.0%**	260.0%
Ave. Supply Water from Dam	(MCM//Year)	-	**62.59**	-	-	202.99	203.40	**203.20**	202.65
Supply Available Return Period	(Year)	-	**10.25**	-	-	20.50	20.50	**20.50**	20.50
Years of Full Sedimentation of Reservoir	(Year)	56.7	**128.1**	78.6	37.4	793.1	1,791.8	**1,099.6**	523.2
Notes	-	Need to be Sediment Dredging	Need to be Sediment Dredging	Need to be Sediment Dredging	Need to be Sediment Dredging				

Joglekar's Equation (1960) Qs = 0.00597*(A)^(0.76)
Khosla's equation (1953) Qs = 0.00323*(A)^(0.72)
Magat Dam, Sue White (1996) SY = 3,800 [t/km2/year]

Source: JICA Survey Team

In the cases of dam height at 63.5 m, only the sediment yield at 0.79 mm/year by Khosla's equation will be available to supply water for Metro Davao water demand (deficit) in 2050 from proposed Davao-III dam.

If the cases of proposed dam height at 141.5 m, all cases of sediment yield are available to supply water form proposed Davao-III dam at 260% of water demands that is equivalent of 20.5 MCM/year at 20.5-years return period in 2050 demands.

12.3 WRR-V

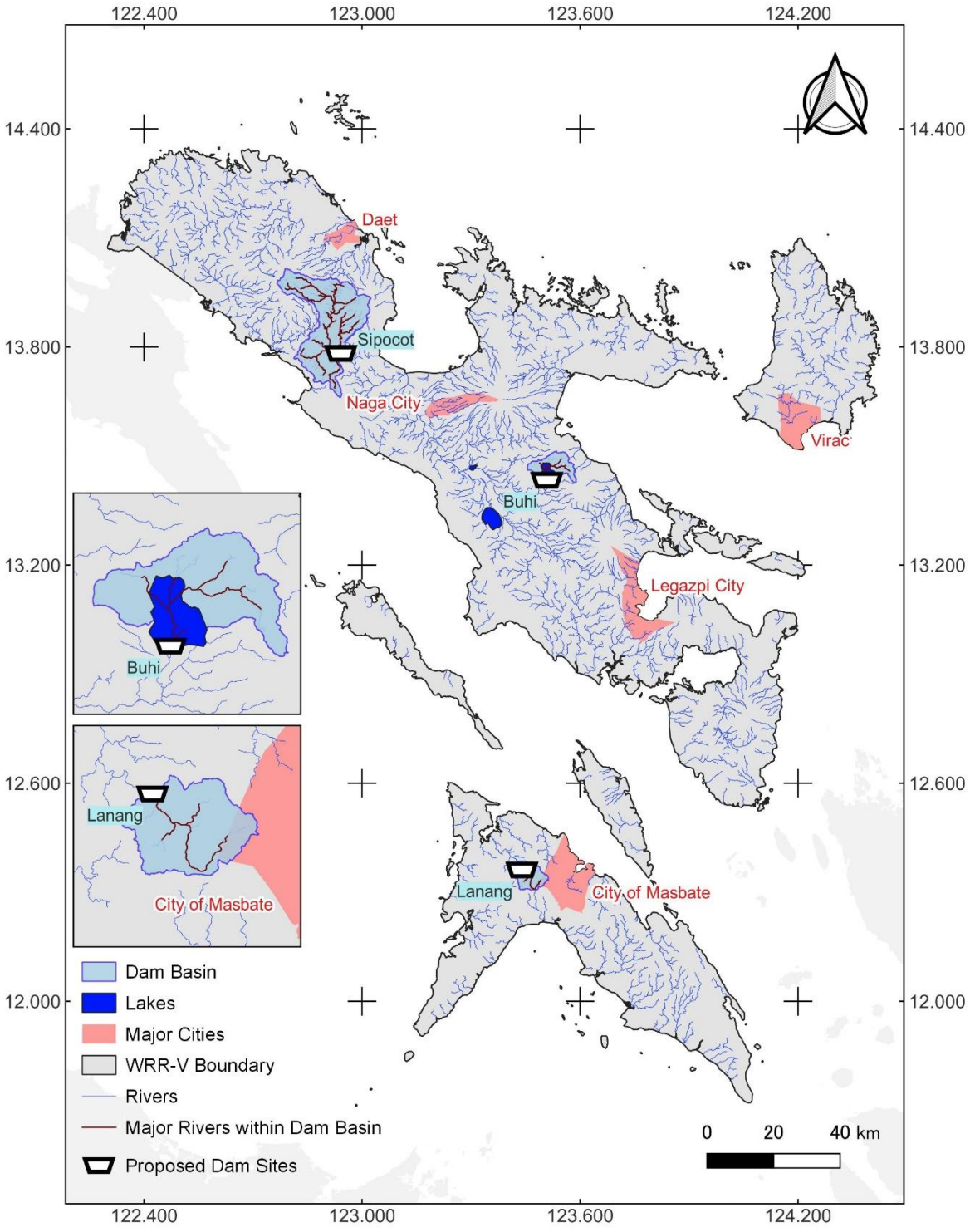
12.3.1 Location of Proposed Dams in WRR-V

List of proposed dam sites in WRR-V is shown in Table below. The location map of proposed dam sites in WRR-V is shown in Figure below.

Table D-302 List of Proposed Dam Sites in WRR-V

No.	Name	Owner	Status	Challenges
N1	Sipocot Dam	(MCWD/DPWH/NIA)	M/P	✓ Pre-F/S & F/S is not yet financed ✓ Setup of implementing organization ✓ Possibility of scale-down ✓ Possibility of multipurpose development (water supply, flood control) ✓ Social issues
N2	Lanang Dam	(MCWD/DPWH/NIA)	M/P	✓ Pre-F/S & F/S is not yet financed ✓ Setup of implementing organization ✓ Possibility of multipurpose development (water supply, flood control) ✓ Social issues
N3	Lake Buhi	(NIA)	M/P	✓ Pre-F/S & F/S is not yet financed ✓ Setup of implementing organization ✓ Social issues

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-519 Location Map of Proposed Dam Sites in WRR-V

12.3.2 River Flow

Same methods were applied as WRR-VII.

12.3.3 Environmental Flow

In this study, environmental flow from proposed dams were set at 10% of 80% dependable flow which is 80% discharge of flow duration curve (FDC) as same as WRR-VII.

12.3.4 Sediment Yield

Same methods were applied as WRR-VII.

12.3.5 Trap Efficiency

Same methods were applied as WRR-VII.

12.3.6 Design Outflow and Reservoir Operation Rule Curves

Same methods were applied as WRR-VII.

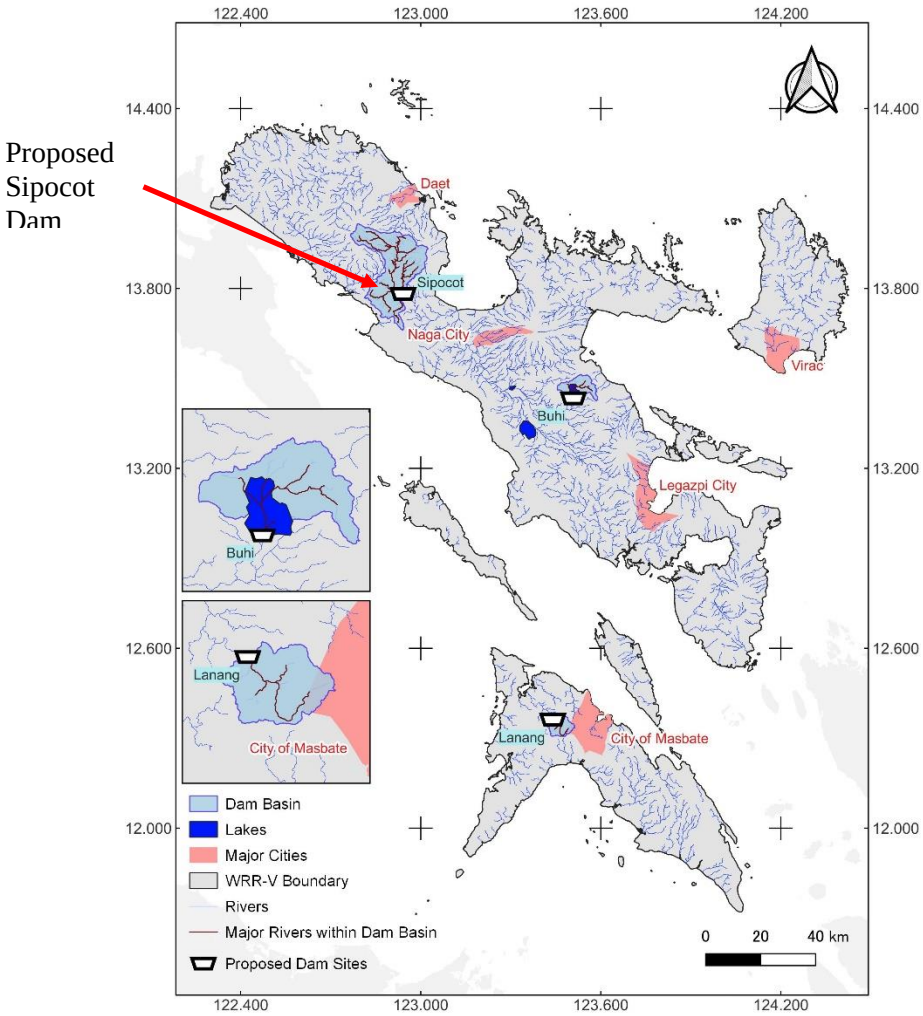
12.3.7 Evaporation and Rainfall at Reservoir Water Surface

Same methods were applied as WRR-VII.

12.3.8 Preliminary Reservoir Operation Study

(1) Proposed Sipocot Dam (Camarines Sur)

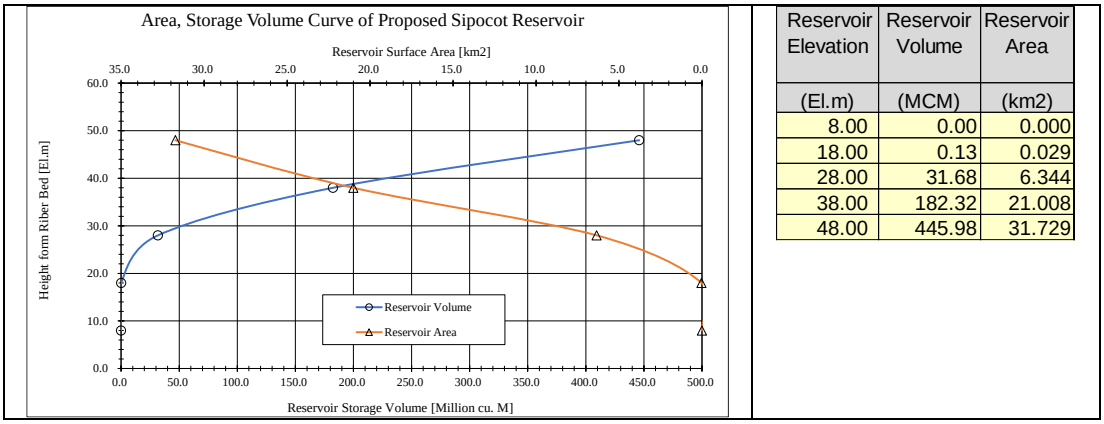
Location map of proposed Sipocot dam site is shown Figure below.



Source: JICA Survey Team

Figure D-520 Location Map of Proposed Sipocot Dam Site in WRR-V (Camarines Sur)

Reservoir area-storage curve of proposed Sipocot dam site is shown Figure below.



Reservoir Elevation	Reservoir Volume	Reservoir Area
(El.m)	(MCM)	(km2)
8.00	0.00	0.000
18.00	0.13	0.029
28.00	31.68	6.344
38.00	182.32	21.008
48.00	445.98	31.729

Source: JICA Survey Team

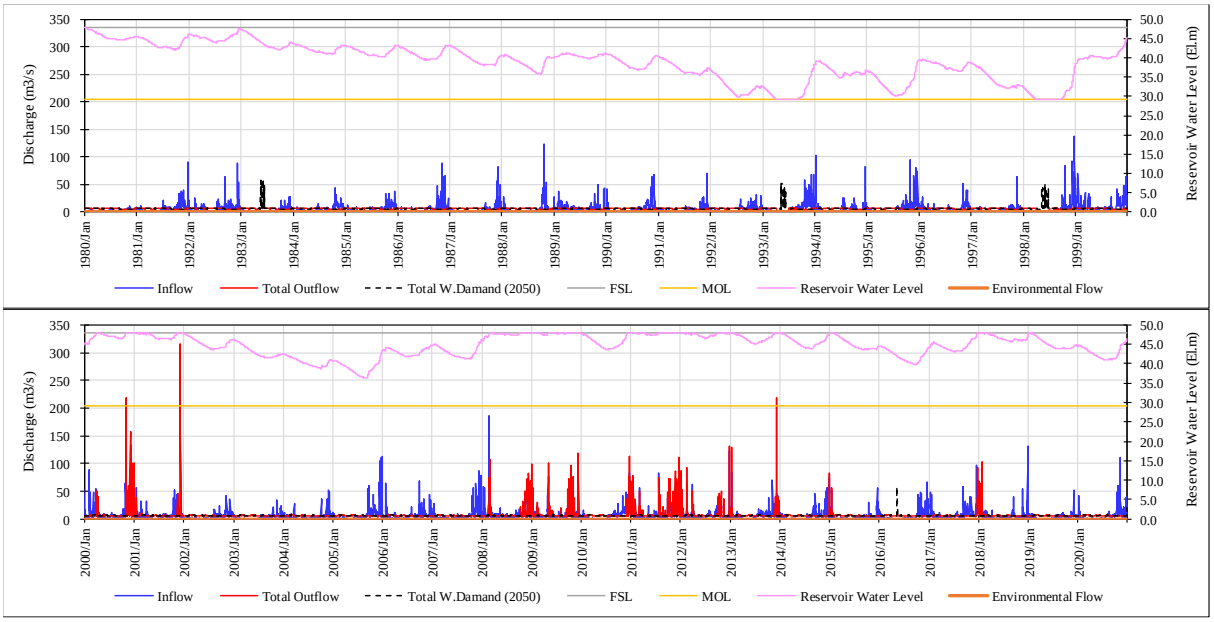
Figure D-521 Reservoir Area-Storage Curve of Proposed Sipocot Dam Site in WRR-V (Camarines Sur)

The results of reservoir operation study of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 0.97 mm/year and proposed maximum dam height at 41.5m are shown in following Tables and Figure.

Table D-303 Futures of Proposed Sipocot Dam Site in WRR-V (Camarines Sur) [Case: Sediment Yield=0.97 mm/year, Dam Height=41.5m, Design Demand=780%]

Catchment Area at Dam Site [km2]	469.87	
Dam Height [m]	41.50	
Dam Bottom Elevation [El.m]	8.00	
Dam Crest Elevation [El.m]	49.50	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	48.00	
Full Supply Volume [MCM]	445.98	
Annual Sediment Yield Volume [million m3/year]	0.4559	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	9.3%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	10,387	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	0.970	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	1,358	
Mean Inflow [m3/sec]	5.64	at Dam Site
Annual Inflow Volume [km3/year]	177,897	at Dam Site
Ratio of Capacity to Annual Inflow	2.507	C/I
Trap Efficiency [%]	107.1%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	48.80	
Dead Storage Volume [MCM]	48.80	
Minimum Operation WL (MOL) [El.m]	29.14	at Dead Storage Volume
Effective Storage Capacity [MCM]	397.18	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	913.83	at FSL

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-522 Results of Reservoir Operation Study of Proposed Sipocot Dam Site in WRR-V (Camarines Sur) [Case: Sediment Yield=0.97 mm/year, Dam Height=41.5m, Design Demand=780%]

Table D-304 Results of Proposed Sipocot Dam Site in WRR-V (Camarines Sur) [Case: Sediment Yield=0.97 mm/year, Dam Height=41.5m, Design Demand=780%] (1/3)

Dam Height (Exclude Freeboard) [m]=	40.00	Province =	Camarines Sur	Province =	Camarines S
Demand Rate [%]=	780.00%	1/5-Dry Year=	2002	1/10-Dry Year=	2015
Average W.D. [m3/s]=	6.28	W.D. in 1/5-Dry Year [m3/s]=	6.14	W.D. in 1/10-Dry Year [m3/s]=	6.14
Average W.Supply Vol. [m3/s]=	6.03	W.Supply in 1/5-Dry Year [m3/s]=	6.14	W.Supply in 1/10-Dry Year [m3/s]=	6.14
Average W.D. [MCM/year]=	197.99	W.D. in 1/5-Dry Year [MCM/year]=	193.75	W.D. in 1/10-Dry Year [MCM/year]=	193.75
Average W.Supply Vol. [MCM/year]=	190.29	W.Supply in 1/5-Dry Year [MCM/year]=	193.72	W.Supply in 1/10-Dry Year [MCM/year]=	193.72
Provability of Deficit (1/Years)=	20.50				

Source: JICA Survey Team

Table D-305 Results of Proposed Sipocot Dam Site in WRR-V (Camarines Sur) [Case: Sediment Yield=0.97 mm/year, Dam Height=41.5m, Design Demand=780%] (2/3)

Unit: MCM/year

No.	Year	SW River Flow	GW Flow	SW Potential	GW Potential	SW DIW WD	GW DIW WD	SW Irrigation WD	GW Irrigation WD	SW Livestock WD	GW Livestock WD	SW Other WD	GW Other WD	SW Total W.Demand	GW Total W.Demand	SW Water Balance	GW Water Balance	Total Water Balance	SW Deficit	GW Deficit	W.Demand
1	1980	2,079	0.05	2,143	1.52	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	1,932	-26.38	1,906.11	0.00	-24.90	-24.90
2	1981	3,396	0.05	3,460	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,249	-26.31	3,223.07	0.00	-24.84	-24.84
3	1982	3,121	0.05	3,185	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,974	-26.31	2,947.90	0.00	-24.84	-24.84
4	1983	2,339	0.05	2,403	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,193	-26.31	2,166.29	5.99	-24.84	-18.85
5	1984	3,043	0.05	3,107	1.52	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	2,896	-26.38	2,869.74	0.00	-24.90	-24.90
6	1985	3,248	0.05	3,312	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,102	-26.31	3,075.27	0.00	-24.84	-24.84
7	1986	3,068	0.05	3,131	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,921	-26.31	2,894.61	0.00	-24.84	-24.84
8	1987	2,479	0.05	2,542	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,332	-26.31	2,305.77	0.00	-24.84	-24.84
9	1988	3,122	0.05	3,186	1.52	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	2,975	-26.38	2,948.48	0.00	-24.90	-24.90
10	1989	3,897	0.05	3,961	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,751	-26.31	3,724.24	0.00	-24.84	-24.84
11	1990	2,877	0.05	2,941	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,730	-26.31	2,703.91	0.00	-24.84	-24.84
12	1991	2,492	0.05	2,556	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,345	-26.31	2,319.15	0.00	-24.84	-24.84
13	1992	2,159	0.05	2,222	1.52	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	2,012	-26.38	1,985.32	0.00	-24.90	-24.90
14	1993	3,327	0.05	3,391	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,181	-26.31	3,154.34	13.05	-24.84	-11.79
15	1994	3,479	0.05	3,543	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,332	-26.31	3,306.15	0.00	-24.84	-24.84
16	1995	4,591	0.05	4,654	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	4,444	-26.31	4,417.86	0.00	-24.84	-24.84
17	1996	3,809	0.05	3,873	1.52	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	3,662	-26.38	3,635.61	0.00	-24.90	-24.90
18	1997	2,054	0.05	2,118	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	1,908	-26.31	1,881.39	0.00	-24.84	-24.84
19	1998	3,103	0.05	3,166	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,956	-26.31	2,929.82	9.99	-24.84	-14.85
20	1999	5,428	0.05	5,492	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	5,282	-26.31	5,255.29	0.00	-24.84	-24.84
21	2000	5,581	0.05	5,645	1.53	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	5,434	-26.38	5,407.75	0.00	-24.90	-24.90
22	2001	4,166	0.05	4,230	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	4,019	-26.31	3,992.91	0.00	-24.84	-24.84
23	2002	2,642	0.05	2,705	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,495	-26.31	2,468.84	0.00	-24.84	-24.84
24	2003	2,170	0.05	2,234	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,023	-26.31	1,996.96	0.00	-24.84	-24.84
25	2004	2,940	0.05	3,004	1.52	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	2,793	-26.38	2,766.46	0.00	-24.90	-24.90
26	2005	4,087	0.05	4,151	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,941	-26.31	3,914.39	0.00	-24.84	-24.84
27	2006	4,191	0.05	4,255	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	4,045	-26.31	4,018.37	0.00	-24.84	-24.84
28	2007	4,028	0.05	4,091	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,881	-26.31	3,854.59	0.00	-24.84	-24.84
29	2008	5,668	0.05	5,731	1.53	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	5,521	-26.38	5,494.30	0.00	-24.90	-24.90
30	2009	5,607	0.05	5,671	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	5,460	-26.31	5,433.94	0.00	-24.84	-24.84
31	2010	3,537	0.05	3,601	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,390	-26.31	3,364.07	0.00	-24.84	-24.84
32	2011	6,753	0.05	6,817	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	6,606	-26.31	6,580.07	0.00	-24.84	-24.84
33	2012	4,841	0.05	4,905	1.53	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	4,694	-26.38	4,667.74	0.00	-24.90	-24.90
34	2013	4,313	0.05	4,377	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	4,166	-26.31	4,139.86	0.00	-24.84	-24.84
35	2014	3,614	0.05	3,677	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,467	-26.31	3,440.69	0.00	-24.84	-24.84
36	2015	2,279	0.05	2,343	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,132	-26.31	2,105.91	0.00	-24.84	-24.84
37	2016	2,902	0.05	2,966	1.52	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	2,755	-26.38	2,728.44	0.71	-24.90	-24.19
38	2017	4,589	0.05	4,653	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	4,443	-26.31	4,416.23	0.00	-24.84	-24.84
39	2018	3,778	0.05	3,842	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	3,632	-26.31	3,605.25	0.00	-24.84	-24.84
40	2019	2,509	0.05	2,573	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	2,363	-26.31	2,336.20	0.00	-24.84	-24.84
41	2020	3,710	0.05	3,773	1.52	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	3,563	-26.38	3,536.17	1.08	-24.90	-23.83
Max.		6,753	0.05	6,817	1.53	0.19	22.56	146.50	3.61	0.30	0.23	0.00	0.03	147.00	26.43	6,606	-26.31	6,580.07	13.05	-24.84	-11.79
Ave.		3,586	0.05	3,649	1.52	0.19	22.52	146.31	3.61	0.30	0.23	0.00	0.03	146.81	26.38	3,439	-26.33	3,412.67	0.75	-24.86	-24.10
Min.		2,054	0.05	2,118	1.52	0.19	22.50	146.24	3.61	0.30	0.23	0.00	0.03	146.74	26.36	1,908	-26.38	1,881.32	0.00	-24.90	-24.90
Times of Deficit																					41
Provability of Deficit (%)																					100.00%
Provability of Deficit (1/Years)																					1.00

Source: JICA Survey Team

Table D-306 Results of Proposed Sipocot Dam Site in WRR-V (Camarines Sur) [Case: Sediment Yield=0.97 mm/year, Dam Height=41.5m, Design Demand=780%] (3/3)

Unit: MCM/year

No.	Year	Total W.Demand in Metro Cebu	W.Demand	W.Supply	Deficit
1	1980	-24.90	194.33	194.33	0.00
2	1981	-24.84	193.72	193.72	0.00
3	1982	-24.84	193.72	193.72	0.00
4	1983	-18.85	193.72	193.72	0.00
5	1984	-24.90	194.33	194.33	0.00
6	1985	-24.84	193.72	193.72	0.00
7	1986	-24.84	193.72	193.72	0.00
8	1987	-24.84	193.72	193.72	0.00
9	1988	-24.90	194.33	194.33	0.00
10	1989	-24.84	193.72	193.72	0.00
11	1990	-24.84	193.72	193.72	0.00
12	1991	-24.84	193.72	193.72	0.00
13	1992	-24.90	194.33	194.33	0.00
14	1993	-11.79	193.72	137.90	-55.82
15	1994	-24.84	193.72	193.72	0.00
16	1995	-24.84	193.72	193.72	0.00
17	1996	-24.90	194.33	194.33	0.00
18	1997	-24.84	193.72	193.72	0.00
19	1998	-14.85	193.72	111.50	-82.23
20	1999	-24.84	193.72	193.72	0.00
21	2000	-24.90	194.33	194.33	0.00
22	2001	-24.84	193.72	193.72	0.00
23	2002	-24.84	193.72	193.72	0.00
24	2003	-24.84	193.72	193.72	0.00
25	2004	-24.90	194.33	194.33	0.00
26	2005	-24.84	193.72	193.72	0.00
27	2006	-24.84	193.72	193.72	0.00
28	2007	-24.84	193.72	193.72	0.00
29	2008	-24.90	194.33	194.33	0.00
30	2009	-24.84	193.72	193.72	0.00
31	2010	-24.84	193.72	193.72	0.00
32	2011	-24.84	193.72	193.72	0.00
33	2012	-24.90	194.33	194.33	0.00
34	2013	-24.84	193.72	193.72	0.00
35	2014	-24.84	193.72	193.72	0.00
36	2015	-24.84	193.72	193.72	0.00
37	2016	-24.19	194.33	194.33	0.00
38	2017	-24.84	193.72	193.72	0.00
39	2018	-24.84	193.72	193.72	0.00
40	2019	-24.84	193.72	193.72	0.00
41	2020	-23.83	194.33	194.33	0.00
Max.		-11.79	194.33	194.33	0.00
Ave.		-24.10	193.89	190.52	-3.37
Min.		-24.90	193.72	111.50	-82.23
Times of Deficit					2
Provability of Deficit (%)					4.9%
Provability of Deficit (1/Years)					20.50

Source: JICA Survey Team

Table below shows the summary of results of reservoir operation study of proposed Sipocot dam in WRR-V.

Table D-307 Summary of Reservoir Operation Study for Proposed Sipocot Dam Site in WRR-V (Camarines Sur)

Dam Site Case No.	Unit	Sipocot (High Dam Case)				Sipocot (Low Dam Case)			
		1	2	**3**	4	5	6	7	8
Location (Province)	-	Camarines Sur	Camarines Sur	**Camarines Sur**	Camarines Sur	Camarines Sur	Camarines Sur	Camarines Sur	Camarines Sur
Catchment Area	(km^2)	469.87	469.87	**469.87**	469.87	469.87	469.87	469.87	469.87
Proposed Dam Height	(m)	41.5	41.5	**41.5**	41.5	30.0	30.0	30.0	30.0
Annual Sediment Yield Volume	(million m3/year)	0.641	0.271	**0.456**	1.275	0.641	0.271	0.456	1.275
Annual Sediment Yield	(mm/year)	1.36	0.58	**0.97**	2.71	1.36	0.58	0.97	2.71
Annual Sediment Yield Volume	(t/km2/year)	1,909	808	**1,358**	3,800	1,909	808	1,358	3,800
Source of Sediment Yield	-	Joglekar's Equation (1960)	Khosla's equation (1953)	**Average of Joglekar & Khosla Equation**	Magat Dam, Sue White (1996)	Joglekar's Equation (1960)	Khosla's equation (1953)	Average of Joglekar & Khosla Equation	Magat Dam, Sue White (1996)
Full Supply Volume	(MCM)	445.98	445.98	**445.98**	445.98	159.72	159.72	159.72	159.72
Full Supply WL (FSL)	(El.m)	48.00	48.00	**48.00**	48.00	36.50	36.50	36.50	36.50
Dead Storage Volume	(MCM)	68.59	29.02	**48.80**	136.53	64.60	27.33	45.97	128.59
Minimum Operation WL (MOL)	(El.m)	30.45	27.16	**29.14**	34.96	30.19	26.62	28.95	34.43
Effective Storage Volume	(MCM)	377.39	416.97	**397.18**	309.45	95.12	132.39	113.76	31.13
Target Supply Area/City (Demand Area)	-	Naga City and Others	Naga City and Others	**Naga City and Others**	Naga City and Others	Naga City and Others	Naga City and Others	Naga City and Others	Naga City and Others
Supply Ratio for Demand	(%)	770.0%	780.0%	**780.0%**	750.0%	500.0%	580.0%	535.0%	170.0%
Ave. Supply Water from Dam	(MCM//Year)	189.00	190.39	**190.29**	185.41	123.41	143.43	132.29	42.15
Supply Available Return Period	(Year)	20.50	20.50	**20.50**	20.50	20.50	20.50	20.50	20.50
Years of Full Sedimentation of Reservoir	(Year)	650.2	1,537.1	**913.8**	326.7	247.2	584.5	347.5	124.2
Notes	-								

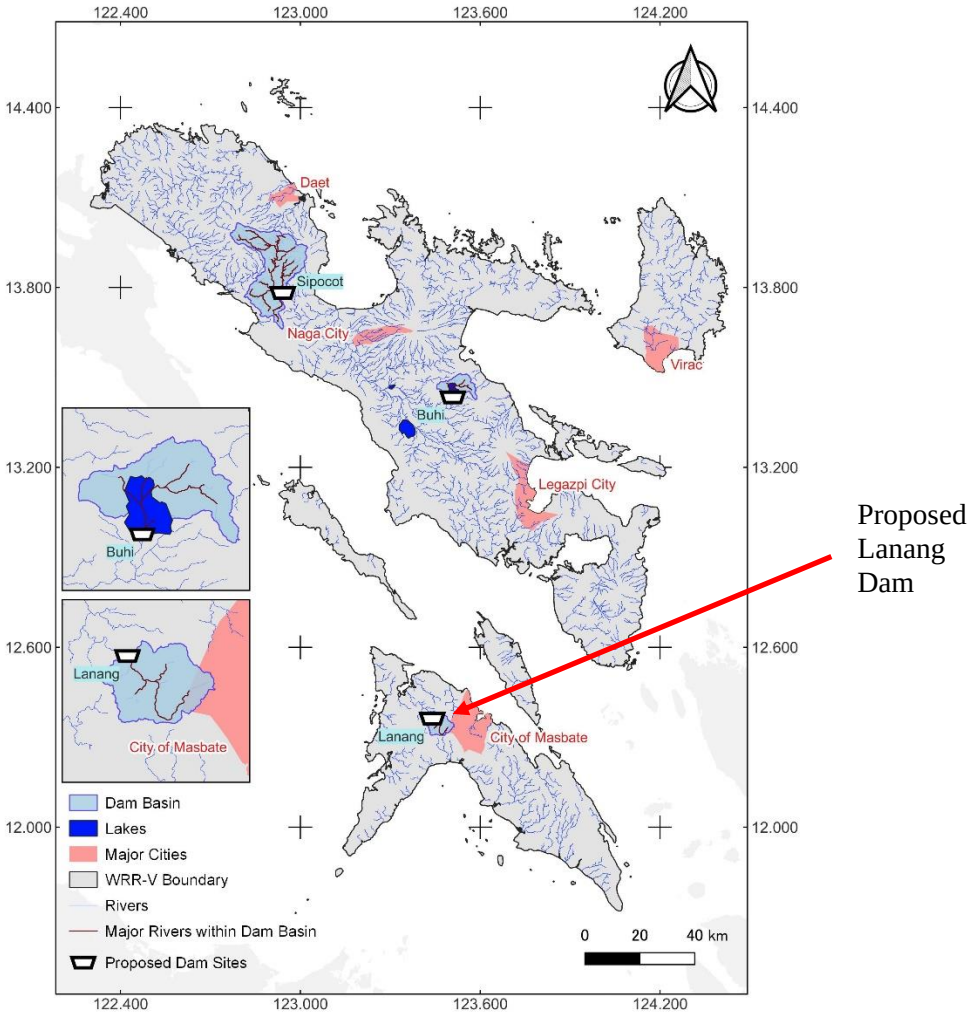
Joglekar's Equation (1960) Qs = 0.00597*(A)^(0.76)
Khosla's equation (1953) Qs = 0.00323*(A)^(0.72)
Magat Dam, Sue White (1996) SY = 3,800 [t/km2/year]

Source: JICA Survey Team

If the sediment yield of average of Joglekar's equation and Khosla's equation at 0.97 mm/year, it will be available to reduce dam height at 30.0 m for the Naga city and other areas at water supply ratio of 530% equivalent to 143.4 MCM/year in 1/20-dry year return period. The estimated futures of reduced dam height are shown in Table below.

(2) Proposed Lanang Dam (Masbate)

Location map of proposed Lanang dam site is shown Figure below.



Source: JICA Survey Team

Figure D-523 Location Map of Proposed Lanang Dam Site in WRR-V (Masbate)

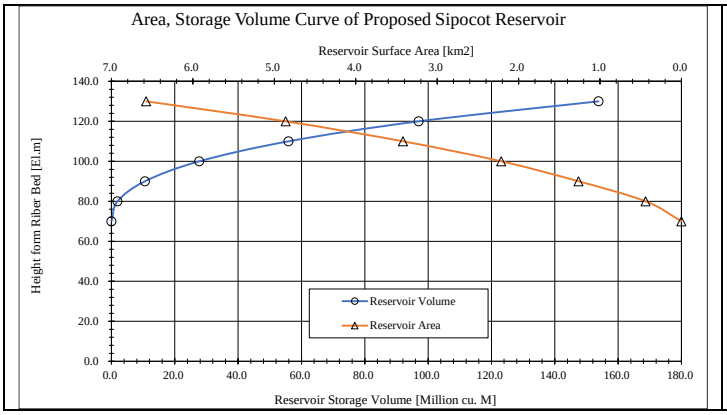
Photos of proposed Lanang dam site are shown in Figure below.



Source: JICA Survey Team

Figure D-524 Photos of Proposed Lanang Dam Site in WRR-V (Masbate)

Reservoir area-storage curve of proposed Lanang dam site is shown in Figure below.



Reservoir Elevation	Reservoir Volume	Reservoir Area
(El.m)	(MCM)	(km2)
70.00	0.00	0.000
80.00	1.90	0.441
90.00	10.55	1.263
100.00	27.73	2.213
110.00	55.90	3.420
120.00	97.00	4.861
130.00	153.81	6.573

Source: JICA Survey Team

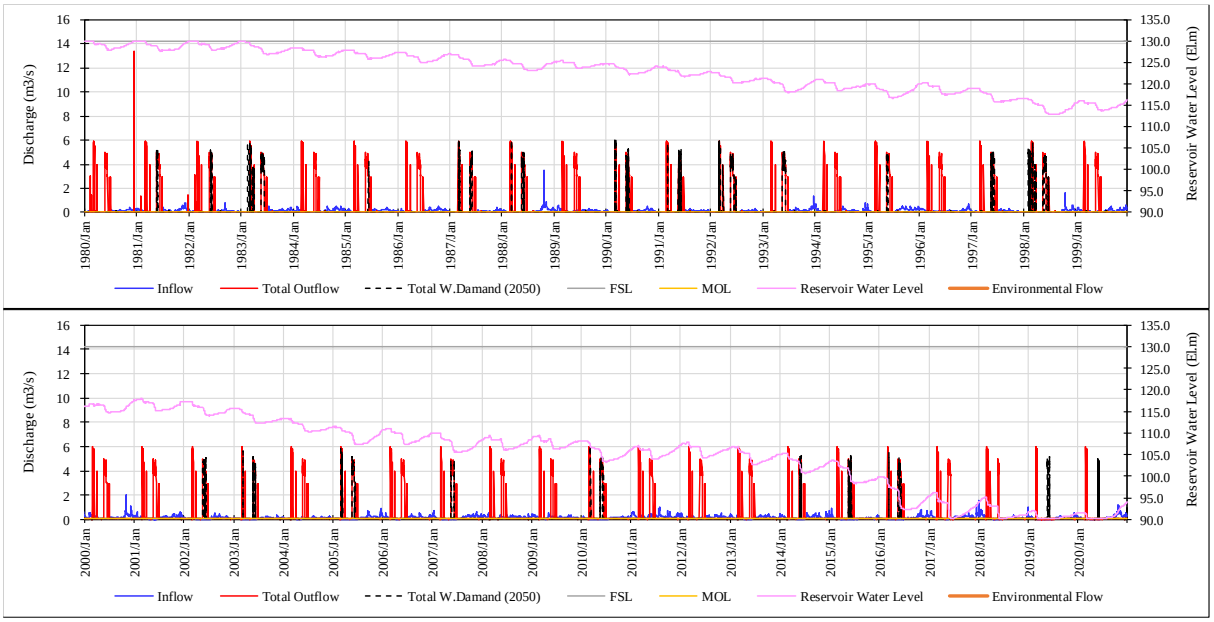
Figure D-525 Reservoir Area-Storage Curve of Proposed Lanang Dam Site in WRR-V (Masbate)

The results of reservoir operation study of the case of sediment yield by average of Joglekar's equation and Khosla's equation at 1.694 mm/year and proposed maximum dam height at 61.5m are shown in following Tables and Figure.

Table D-308 Futures of Proposed Lanang Dam in WRR-V (Masbate) [Case: Sediment Yield=1.694 mm/year, Dam Height=61.5m, Design Demand=34.1%]

Catchment Area at Dam Site [km2]	51.63	
Dam Height [m]	61.50	
Dam Bottom Elevation [El.m]	70.00	
Dam Crest Elevation [El.m]	131.50	
Free Board [m]	1.50	
Full Supply WL (FSL) [El.m]	130.00	
Full Supply Volume [MCM]	153.8	
Annual Sediment Yield Volume [million m3/year]	0.0874	Average of Joglekar & Khosla Equation Qs = average(0.00597*(A)^(0.76), 0.00323*(A)^(0.72))
Sediment Delivery Ratio (SDR) [%]	15.0%	ASCE (1975)
Annual Mean Soil Loss [m3/km2/year]	11,303	SY =SYR / SDR / CA
Annual Sediment Yield [mm/year]	1.694	
Reservoir Sediment Bulk Density [kg/m3]	1,400	H. Samadi Boroujeni, et.al.(2009)
Annual Sediment Yield [t/km2/year]	2,371	
Mean Inflow [m3/sec]	0.12	at Dam Site
Annual Inflow Volume [km3/year]	3,935	at Dam Site
Ratio of Capacity to Annual Inflow	39.088	C/I
Trap Efficiency [%]	123.7%	Brune (1953) Curve
Sediment Volume at 100-years [MCM]	10.82	
Dead Storage Volume [MCM}	10.82	
Minimum Operation WL (MOL) [El.m]	90.15	at Dead Storage Volume
Effective Storage Capacity [MCM]	143.00	FSL.Vol. - MOL.Vol.
Years of Full Sedimentation [years]	1,421.90	at FSL

Source: JICA Survey Team



Source: JICA Survey Team

Figure D-526 Results of Reservoir Operation Study of Proposed Lanang Dam Site in WRR-V (Masbate) [Case: Sediment Yield=1.694 mm/year, Dam Height=61.5m, Design Demand=34.1%]

Table D-309 Results of Proposed Lanang Dam in WRR-V (Masbate) [Case: Sediment Yield=1.694 mm/year, Dam Height=61.5m, Design Demand=34.1%] (1/3)

Dam Height (Exclude Freeboard) [m]=	60.00	Province =	Masbate	Province =	Masbate
Demand Rate [%]=	34.10%	1/5-Dry Year=	1991	1/10-Dry Year=	2019
Average W.D. [m3/s]=	0.16	W.D. in 1/5-Dry Year [m3/s]=	0.21	W.D. in 1/10-Dry Year [m3/s]=	0.27
Average W.Supply Vol. [m3/s]=	0.40	W.Supply in 1/5-Dry Year [m3/s]=	0.41	W.Supply in 1/10-Dry Year [m3/s]=	0.13
Average W.D. [MCM/year]=	5.14	W.D. in 1/5-Dry Year [MCM/year]=	6.60	W.D. in 1/10-Dry Year [MCM/year]=	8.65
Average W.Supply Vol. [MCM/year]=	12.49	W.Supply in 1/5-Dry Year [MCM/year]=	12.84	W.Supply in 1/10-Dry Year [MCM/year]=	3.96
Provability of Deficit (1/Years)=	10.25				

Source: JICA Survey Team

Table D-310 Results of Proposed Lanang Dam in WRR-V (Masbate) [Case: Sediment Yield=1.694 mm/year, Dam Height=61.5m, Design Demand=34.1%] (2/3)

Unit: MCM/year

No.	Year	SW River Flow	GW Flow	SW Potential	GW Potential	SW DIW WD	GW DIW WD	SW Irrigation WD	GW Irrigation WD	SW Livestock WD	GW Livestock WD	SW Other WD	GW Other WD	SW Total W.Demand	GW Total W.Demand	SW Water Balance	GW Water Balance	Total Water Balance	SW Deficit	GW Deficit	W.Demand
1	1980	2,437	12.09	2,492	13.50	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	2,202	-5.57	2,196.33	0.00	-4.15	-4.15
2	1981	2,782	12.07	2,836	13.49	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,547	-5.54	2,541.38	3.96	-4.12	-0.16
3	1982	1,572	12.04	1,626	13.45	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,337	-5.57	1,331.46	5.16	-4.16	1.00
4	1983	1,722	11.87	1,776	13.28	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,487	-5.74	1,481.48	43.34	-4.33	39.01
5	1984	2,903	12.11	2,957	13.53	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	2,668	-5.55	2,662.16	0.00	-4.13	-4.13
6	1985	2,260	12.07	2,314	13.49	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,025	-5.54	2,019.41	1.09	-4.13	-3.03
7	1986	2,347	12.06	2,401	13.48	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,112	-5.55	2,106.46	0.00	-4.14	-4.14
8	1987	1,268	11.89	1,322	13.31	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,033	-5.72	1,027.46	24.81	-4.31	20.50
9	1988	2,613	11.93	2,668	13.34	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	2,378	-5.73	2,372.60	17.37	-4.31	13.06
10	1989	2,710	12.11	2,764	13.53	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,475	-5.50	2,469.59	0.00	-4.09	-4.09
11	1990	1,697	11.93	1,752	13.34	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,463	-5.69	1,456.91	23.42	-4.28	19.14
12	1991	1,440	11.90	1,494	13.31	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,205	-5.71	1,199.44	15.47	-4.30	11.17
13	1992	1,200	11.64	1,254	13.05	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	965	-6.02	958.71	34.18	-4.61	29.57
14	1993	2,175	11.21	2,230	12.63	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,941	-6.40	1,934.15	21.28	-4.98	16.30
15	1994	2,559	11.45	2,613	12.86	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,324	-6.17	2,317.87	0.00	-4.75	-4.75
16	1995	2,904	11.44	2,958	12.85	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,669	-6.17	2,663.20	7.21	-4.76	2.45
17	1996	2,732	11.55	2,787	12.97	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	2,497	-6.10	2,491.01	0.00	-4.69	-4.69
18	1997	1,404	11.42	1,458	12.83	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,169	-6.20	1,162.85	19.27	-4.78	14.49
19	1998	1,597	11.08	1,651	12.50	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,362	-6.53	1,355.39	45.98	-5.12	40.86
20	1999	3,258	11.08	3,312	12.49	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	3,023	-6.53	3,016.46	0.00	-5.12	-5.12
21	2000	3,763	11.11	3,818	12.53	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	3,528	-6.55	3,521.63	0.00	-5.13	-5.13
22	2001	3,073	11.08	3,127	12.49	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,838	-6.54	2,831.64	0.00	-5.12	-5.12
23	2002	1,648	10.99	1,702	12.40	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,413	-6.63	1,406.33	21.16	-5.22	15.95
24	2003	1,494	10.93	1,548	12.34	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,259	-6.68	1,252.31	17.64	-5.27	12.36
25	2004	1,724	10.96	1,778	12.38	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	1,489	-6.69	1,481.91	0.00	-5.28	-5.28
26	2005	2,408	10.86	2,462	12.28	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,173	-6.75	2,166.51	32.82	-5.34	27.49
27	2006	2,879	11.04	2,934	12.45	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,645	-6.57	2,638.02	0.00	-5.16	-5.16
28	2007	2,947	11.02	3,001	12.43	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,712	-6.59	2,705.68	2.51	-5.18	-2.67
29	2008	3,800	11.14	3,855	12.55	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	3,565	-6.52	3,558.51	0.00	-5.10	-5.10
30	2009	3,213	11.07	3,268	12.49	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,978	-6.54	2,971.92	0.00	-5.13	-5.13
31	2010	1,786	10.94	1,840	12.35	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,551	-6.67	1,544.74	23.13	-5.26	17.87
32	2011	4,978	11.13	5,033	12.54	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	4,744	-6.48	4,737.15	0.00	-5.07	-5.07
33	2012	3,279	11.13	3,333	12.55	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	3,044	-6.53	3,037.33	0.00	-5.11	-5.11
34	2013	2,704	11.05	2,759	12.46	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,470	-6.56	2,463.19	0.00	-5.15	-5.15
35	2014	2,845	11.06	2,899	12.47	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,610	-6.56	2,603.47	6.44	-5.15	1.30
36	2015	1,446	10.99	1,501	12.40	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,212	-6.62	1,205.11	16.38	-5.21	11.17
37	2016	1,983	10.86	2,037	12.27	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	1,748	-6.80	1,740.71	20.53	-5.39	15.14
38	2017	3,386	11.04	3,441	12.46	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	3,151	-6.57	3,144.91	0.00	-5.15	-5.15
39	2018	2,630	11.03	2,685	12.45	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	2,396	-6.58	2,389.24	0.00	-5.17	-5.17
40	2019	1,533	10.90	1,587	12.31	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	1,298	-6.71	1,291.72	20.77	-5.30	15.47
41	2020	2,794	10.81	2,849	12.22	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	2,559	-6.85	2,552.34	10.08	-5.43	4.65
Max.		4,978	12.11	5,033	13.53	38.93	13.97	195.02	3.46	1.04	0.22	0.00	0.00	235.00	17.66	4,744	-5.50	4,738.13	45.98	-4.09	40.86
Ave.		2,436	11.37	2,491	12.78	38.86	13.95	194.86	3.46	1.04	0.22	0.00	0.00	234.76	17.62	2,202	-6.26	2,195.33	10.59	-4.84	5.74
Min.		1,200	10.81	1,254	12.22	38.83	13.94	194.80	3.46	1.04	0.22	0.00	0.00	234.67	17.61	965	-6.85	957.88	0.00	-5.43	-5.28
Times of Deficit																					21
Provability of Deficit (%)																					51.22%
Provability of Deficit (1/Years)																					1.95

Source: JICA Survey Team

Table D-311 Results of Proposed Lanang Dam in WRR-V (Masbate) [Case: Sediment Yield=1.694 mm/year, Dam Height=61.5m, Design Demand=34.1%] (3/3)

Unit: MCM/year

No.	Year	Total W.Demand in Metro Cebu	W.Demand	W.Supply	Deficit
1	1980	-4.15	12.84	12.84	0.00
2	1981	-0.16	12.84	12.84	0.00
3	1982	1.00	12.84	12.84	0.00
4	1983	39.01	12.84	12.84	0.00
5	1984	-4.13	12.84	12.84	0.00
6	1985	-3.03	12.84	12.84	0.00
7	1986	-4.14	12.84	12.84	0.00
8	1987	20.50	12.84	12.84	0.00
9	1988	13.06	12.84	12.84	0.00
10	1989	-4.09	12.84	12.84	0.00
11	1990	19.14	12.84	12.84	0.00
12	1991	11.17	12.84	12.84	0.00
13	1992	29.57	12.84	12.84	0.00
14	1993	16.30	12.84	12.84	0.00
15	1994	-4.75	12.84	12.84	0.00
16	1995	2.45	12.84	12.84	0.00
17	1996	-4.69	12.84	12.84	0.00
18	1997	14.49	12.84	12.84	0.00
19	1998	40.86	12.84	12.84	0.00
20	1999	-5.12	12.84	12.84	0.00
21	2000	-5.13	12.84	12.84	0.00
22	2001	-5.12	12.84	12.84	0.00
23	2002	15.95	12.84	12.84	0.00
24	2003	12.36	12.84	12.84	0.00
25	2004	-5.28	12.84	12.84	0.00
26	2005	27.49	12.84	12.84	0.00
27	2006	-5.16	12.84	12.84	0.00
28	2007	-2.67	12.84	12.84	0.00
29	2008	-5.10	12.84	12.84	0.00
30	2009	-5.13	12.84	12.84	0.00
31	2010	17.87	12.84	12.84	0.00
32	2011	-5.07	12.84	12.84	0.00
33	2012	-5.11	12.84	12.84	0.00
34	2013	-5.15	12.84	12.84	0.00
35	2014	1.30	12.84	12.84	0.00
36	2015	11.17	12.84	12.84	0.00
37	2016	15.14	12.84	12.84	0.00
38	2017	-5.15	12.84	11.46	-1.38
39	2018	-5.17	12.84	9.70	-3.14
40	2019	15.47	12.84	3.96	-8.87
41	2020	4.65	12.84	3.29	-9.55
Max.		40.86	12.84	12.84	0.00
Ave.		5.74	12.84	12.28	-0.56
Min.		-5.28	12.84	3.29	-9.55
Times of Deficit					4
Provability of Deficit (%)					9.8%
Provability of Deficit (1/Years)					10.25

Source: JICA Survey Team

Table below shows the summary of results of reservoir operation study of proposed Lanang dam in Bohol province, WRR-VII.

If the case of sediment yields by average of Joglekar's equation and Khosla's equation at 1.69 mm/year and proposed maximum dam height at 61.5m, water supply ratio for Masbate will be at 34.1% equivalent to 10.25 MCM/year for the water demands in 2050 at Naga city and other areas.

Table D-312 Summary of Reservoir Operation Study for Proposed Lanang Dam in WRR-V (Masbate)

Dam Site / Case No.	Unit	Lanang			
		9	10	**11**	11
Location (Province)	-	Masbate	Masbate	**Masbate**	Masbate
Catchment Area	(km^2)	51.63	51.63	**51.63**	51.63
Proposed Dam Height	(m)	61.5	61.5	**61.5**	61.5
Annual Sediment Yield Volume	(million m3/year)	0.120	0.055	**0.087**	0.140
Annual Sediment Yield	(mm/year)	2.32	1.07	**1.69**	2.71
Annual Sediment Yield Volume	(t/km2/year)	3,243	1,499	**2,371**	3,800
Source of Sediment Yield	-	Joglekar's Equation (1960)	Khosla's equation (1953)	**Average of Joglekar & Khosla Equation**	Magat Dam, Sue White (1996)
Full Supply Volume	(MCM)	153.81	153.81	**153.81**	153.81
Full Supply WL (FSL)	(El.m)	130.00	130.00	**130.00**	130.00
Dead Storage Volume	(MCM)	14.80	6.84	**10.82**	17.34
Minimum Operation WL (MOL)	(El.m)	92.47	85.70	**90.15**	93.95
Effective Storage Volume	(MCM)	139.02	146.98	**143.00**	136.48
Target Supply Area/City (Demand Area)	-	Masbate	Masbate	**Masbate**	Masbate
Supply Ratio for Demand	(%)	34.0%	34.2%	**34.1%**	34.0%
Ave. Supply Water from Dam	(MCM//Year)	12.49	12.49	**12.49**	12.43
Supply Available Return Period	(Year)	10.25	10.25	**10.25**	10.25
Years of Full Sedimentation of Reservoir	(Year)	1,039.5	2,249.6	**1,421.9**	887.2
Notes	-				

Joglekar's Equation (1960) Qs = 0.00597*(A)^(0.76)
Khosla's equation (1953) Qs = 0.00323*(A)^(0.72)
Magat Dam, Sue White (1996) SY = 3,800 [t/km2/year]

Source: JICA Survey Team