APPENDIX-V

ROAD AND BRIDGE

APPENDIX V: ROAD AND BRIDGE

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V.1 Road and Bridge

V.1.1 Road List

1. Status of Infrastructure Development (Road)

1-1. Summary of Road Development (as of 2016, 2018)

Road Name	Pavement Type and Road Length				
	Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
National Road (as of 2018)	12.500	0.000	0.000	0.000	**12.500**
Provincial Road (as of 2016)	3.860	2.000	43.300	18.779	**67.939**
Municipal Street (as of 2018)	8.806	1.200	10.327	3.057	**23.390**
Barangay Road (as of 2018)	26.220	1.000	167.370	45.030	**239.620**
Total	**51.386**	**4.200**	**220.997**	**66.866**	**343.449**

1-2. Summary of Road Development (as of 2015)

Road Name	Pavement Type and Road Length				
	Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
National Road (as of 2015)	8.500	0.000	4.000	0.000	**12.500**
Provincial Road (as of 2015)	1.860	2.000	43.300	20.779	**67.939**
Municipal Street (as of 2015)	7.888	1.200	10.657	3.255	**23.000**
Barangay Road (as of 2015)	15.318	1.000	166.470	50.332	**233.120**
Total	**33.566**	**4.200**	**224.427**	**74.366**	**336.559**

2. Status of National Road

2-1. National Road (as of 2018)

	Road Name	Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
1	Cotabato-Davao National Highway	8.500				**8.500**
2	Dualing-Silik Tertiary National Highway	4.000				**4.000**
Total		**12.500**	**0.000**	**0.000**	**0.000**	**12.500**

2-2. National Road (as of 2015)

	Road Name	Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
1	Cotabato-Davao National Highway	8.500				**8.500**
2	Dualing-Silik Tertiary National Highway			4.000		**4.000**
Total		**8.500**	**0.000**	**4.000**	**0.000**	**12.500**

3. Status of Provincial Road

3-1. Provincial Road (as of 2016)

	Road Name	Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
1	Nalapaan-Tomado			1.250		**1.250**
2	Fort Pikit-Tinibtiban	0.200		0.800	0.550	**1.550**
3	New Panay-Maridagao-Pikit			10.000	3.529	**13.529**
4	Pikit-Junction-Fort Pikit	0.500		0.400		**0.900**
5	Inug-ug-Dyke-Fort Pikit			1.000	1.000	**2.000**
6	Inug-ug-Talitay-Dyke			4.500		**4.500**
7	Pikit-Paidu Pulangi	0.800	1.000	5.000	8.900	**15.700**
8	Manding-Gligli-Bulol	0.360	1.000	4.650		**6.010**
9	Ladtingan-Calawag			3.000		**3.000**
10	Tapudoc-Nalapaan			3.850	3.000	**6.850**
11	Ginatilan-Panicupan-Nalapaan Nat'l. Highway Junc.			2.050	1.800	**3.850**
12	Carmen-Maridagao			3.000		**3.000**
13	Bualan-Nalapaan Road			3.800		**3.800**
14	Fort pikit - Ladtingan	2.000				**2.000**
	Total	**3.860**	**2.000**	**43.300**	**18.779**	**67.939**

3-2. Provincial Road (as of 2015)

	Road Name	Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
1	Nalapaan-Tomado			1.250		**1.250**
2	Fort Pikit-Tinibtiban	0.200		0.800	0.550	**1.550**
3	New Panay-Maridagao-Pikit			10.000	3.529	**13.529**
4	Pikit-Junction-Fort Pikit	0.500		0.400		**0.900**
5	Inug-ug-Dyke-Fort Pikit			1.000	1.000	**2.000**
6	Inug-ug-Talitay-Dyke			4.500		**4.500**
7	Pikit-Paidu Pulangi	0.800	1.000	5.000	8.900	**15.700**
8	Manding-Gligli-Bulol	0.360	1.000	4.650		**6.010**
9	Ladtingan-Calawag			3.000		**3.000**
10	Tapudoc-Nalapaan			3.850	3.000	**6.850**
11	Ginatilan-Panicupan-Nalapaan Nat'l. Highway Junc.			2.050	1.800	**3.850**
12	Carmen-Maridagao			3.000		**3.000**
13	Bualan-Nalapaan Road			3.800		**3.800**
14	Fort pikit - Ladtingan				2.000	**2.000**
	Total	**1.860**	**2.000**	**43.300**	**20.779**	**67.939**

4. Status of Municipal Street

4-1. Municipal Street (as of 2018)

Road Name		Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
1	Colony St.	0.300	0.890			**1.190**
2	Makapendeg Andil St.			0.900		**0.900**
3	Fidel Flores St.	0.840		0.000		**0.840**
4	Rasam Afdal St.	0.200		0.375		**0.575**
5	Datu Plang Mamasalakeg St.			0.580		**0.580**
6	Maximo Abad St.			0.750		**0.750**
7	Datu Piang St.	0.370		0.230		**0.600**
8	Datu Udtog Matalam St.	0.450				**0.450**
9	Manuel L. Quezon St.	1.410				**1.410**
10	Notre Dame Drive	0.360	0.010			**0.370**
11	Ubaldo Cuevas St.	0.250		0.300		**0.550**
12	Gregorio Tocao St.		0.300	0.310		**0.610**
13	Alfonso Gokotano St.			0.430		**0.430**
14	Pedro Fernandez St.			0.370		**0.370**
15	Rufino Caballero St.	0.200		0.090		**0.290**
16	Gregorio Initan St.			0.170		**0.170**
17	Pablo Navarro St.	0.070				**0.070**
18	Vicente Nacario St.			0.330		**0.330**
19	Vidal Cabanog St.	0.070		0.230		**0.300**
20	Roque Dandan St.			0.200		**0.200**
21	Mama Manampan St.			0.325		**0.325**
22	Joaquin Ferenal St.	0.500		0.150		**0.650**
23	Cipriano Quinones St.	0.240				**0.240**
24	Datun Aminin Pucan St.	0.200		0.000		**0.200**
25	Datu Dalandag St.			0.090		**0.090**
26	Bai Matabay Plang St.	0.200		0.000		**0.200**
27	Sergio Osmena St.	0.540				**0.540**
28	Pendatun Drive	0.695		0.210		**0.905**
29	Tumindeg-Sultan Road			1.000		**1.000**
30	Lamak St.	0.100		0.040		**0.140**
31	Datu Piang St. and Gregorio Del Pilar St.	0.263				**0.263**
32	J. Ferenal Street	1.150				**1.150**
33	Town Site Parcel 2 (Batulawan)			3.057	3.057	**6.114**
34	Higway - Batulawan Es	0.198				**0.198**
35	National Highway - CFCST St.	0.200		0.190		**0.390**
	Total	**8.806**	**1.200**	**10.327**	**3.057**	**23.390**

4-2. Municipal Street (as of 2015)

Road Name		Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
1	Colony St.	0.300	0.890			**1.190**
2	Makapendeg Andil St.			0.900		**0.900**
3	Fidel Flores St.	0.840				**0.840**
4	Rasam Afdal St.	0.200		0.375		**0.575**
5	Datu Plang Mamasalakeg St.			0.580		**0.580**
6	Maximo Abad St.			0.750		**0.750**
7	Datu Piang St.	0.370		0.230		**0.600**
8	Datu Udtog Matalam St.	0.450				**0.450**
9	Manuel L. Quezon St.	1.410				**1.410**
10	Notre Dame Drive	0.360	0.010			**0.370**
11	Ubaldo Cuevas St.	0.100		0.450		**0.550**
12	Gregorio Tocao St.		0.300	0.310		**0.610**
13	Alfonso Gokotano St.			0.430		**0.430**
14	Pedro Fernandez St.			0.370		**0.370**
15	Rufino Caballero St.	0.070		0.220		**0.290**
16	Gregorio Initan St.			0.170		**0.170**
17	Pablo Navarro St.	0.070				**0.070**
18	Vicente Nacario St.			0.330		**0.330**
19	Vidal Cabanog St.	0.070		0.230		**0.300**
20	Roque Dandan St.			0.200		**0.200**
21	Mama Manampan St.			0.325		**0.325**
22	Joaquin Ferenal St.	0.500		0.150		**0.650**
23	Cipriano Quinones St.			0.240		**0.240**
24	Datun Aminin Pucan St.	0.200		0.000		**0.200**
25	Datu Dalandag St.			0.090		**0.090**
26	Bai Matabay Plang St.	0.200		0.000		**0.200**
27	Sergio Osmena St.	0.540				**0.540**
28	Pendatun Drive	0.695		0.210		**0.905**
29	Tumindeg-Sultan Road			1.000		**1.000**
30	Lamak St.	0.100		0.040		**0.140**
31	Datu Piang St. and Gregorio Del Pilar St.	0.263				**0.263**
32	J. Ferenal Street	1.150				**1.150**
33	Town Site Parcel 2 (Batulawan)			3.057	3.057	**6.114**
34	Higway - Batulawan Es				0.198	**0.198**
	Total	**7.888**	**1.200**	**10.657**	**3.255**	**23.000**

5. Status of Barangay Road

5-1. Barangay Road (as of 2018) (1/2)

	Road Name	Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
1	Inug-ug-Barongis Road	0.300		10.000	1.700	**12.000**
2	Silik-Damalasak-Katilacan Road			3.000		**3.000**
3	Poblacion-Gligli-Bulol-Kabasalan Road		1.000	11.000	3.000	**15.000**
4	Balong-Calawag Road	1.000		3.000		**4.000**
5	Tinutulan-Nabundas-Balabak Road	1.000		11.000		**12.000**
6	Galigayanan-Gligli Road			2.000		**2.000**
7	Hi-way Junc.-Takepan-Kalacacan Proper Road			2.000		**2.000**
8	Panicupan-Lagunde Road			2.000		**2.000**
9	Bulol-Bagoinged Road			2.400		**2.400**
10	Bualan- Sitio Valencia Road			6.100		**6.100**
11	Sitio Sampaguita-Brgy.Rd. Kalacacan				1.300	**1.300**
12	Balatican-Balungis Road			4.000		**4.000**
13	Batulawan Brgy. Road			1.000		**1.000**
14	Dalingaoen Brgy. Road			1.000		**1.000**
15	Dalingaoen-Panicupan Road			4.200		**4.200**
16	Hi-way-Nalapaan-Sitio Baruyan Road			2.000		**2.000**
17	Silik-San Isidro Road			2.000		**2.000**
18	Hi-way-Takepan-Sitio Idsla Road			1.500		**1.500**
19	Lagunde E/S-Sitio Edzap FMR			2.000		**2.000**
20	Lagunde-Mahad Road			1.500		**1.500**
21	Provincial Road-Tinutulan			2.000		**2.000**
22	Balatican Proper-Sitio Aleng Road			2.000		**2.000**
23	Highway Takepan-Kalacacan Brgy. Road			2.500		**2.500**
24	Balong-Macabual-Gligli Road			2.500		**2.500**
25	Manaulanan-Balong Road			2.500		**2.500**
26	Sitio Midsambal-Punol Proper Road			2.500		**2.500**
27	Manding Gligli Road			1.500		**1.500**
28	Gligli-Calawag Road			1.200		**1.200**
29	Bagoinged-Buliok-Barongis Road			4.000		**4.000**
30	Provincial Road-Nunguan ES Road			1.200		**1.200**
31	Calawag-Macabual-Gli-gli Road				3.500	**3.500**
32	Tapodok-Bualan-Nalapaan Prov'l.				3.500	**3.500**
33	Ginatilan-Balong Road	2.000		2.000	2.500	**6.500**
34	Balong-Manaulanan Road				3.500	**3.500**
35	Paidu Pulangi-Macasendeg Road				3.500	**3.500**
36	Sitio Tamanang-Punol Road				2.500	**2.500**
37	Bagoinged-Bulol Road				2.000	**2.000**
38	Silik-Katilacan Road				2.500	**2.500**
	Sub-total	**4.300**	**1.000**	**95.600**	**29.500**	**130.400**

5-1. Barangay Road (as of 2018) (2/2)

	Road Name	Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
39	Manaulanan-Pamalian Elem.Sch. Road				1.500	**1.500**
40	Nunguan-Balungis Road				5.550	**5.550**
41	Poblacion-Bualan Road				8.480	**8.480**
42	Highway Batulawan ES	0.260				**0.260**
43	Poblacion Gli-gli	0.450				**0.450**
44	Highway Takepan-Kalacacan Brgy. Road	2.000		2.000		**4.000**
45	Nabundas - Balungis Road			6.820		**6.820**
46	Takepan - Kalacacan Road			1.640		**1.640**
47	Bulod- Sitio Lebanaon Gli-Gli Road			1.600		**1.600**
48	Batulawan - Fort Pikit Road			1.620		**1.620**
49	Manaulanan - Pamalian Road			6.550		**6.550**
50	Bualan - Kolambog Road			1.650		**1.650**
51	Paidu - Pulangi - Sitio Shuk Brgy. Road Dike			1.740		**1.740**
52	Lagunde - Nalapaan Road			4.450		**4.450**
53	Nunguan - Gokotan Road			4.200		**4.200**
54	Ginatilan - Panicupan Road			4.000		**4.000**
55	Batulawan - Sitio Buguak, Kalacacan Road			3.000		**3.000**
56	Nalapaan - Bualan Road			5.800		**5.800**
57	Damalasak - Katilacan Road			4.800		**4.800**
58	Dalingaoen - Panicupan Road			4.200		**4.200**
59	Batulawan - Balungis Road			2.800		**2.800**
60	Balatikan - Balungis Road	5.000				**5.000**
61	Silik - Sitio Midsambal Road			2.000		**2.000**
62	Nalapaan - Sitio Baruyan Road			3.600		**3.600**
63	Balatikan - Balungis Road	4.200				**4.200**
64	Nalapaan - Sitio Baruyan FMR	1.760				**1.760**
65	Panicupan - Lagunde FMR	1.500				**1.500**
66	Batulawan ES FMR	1.150				**1.150**
67	Balungis - Nabundas Road			3.000		**3.000**
68	Lagunde ES- Provincial Road Junction	2.000				**2.000**
69	Tinutulan - Balabak	2.400				**2.400**
70	Nunguan - Nabundas Road	1.000				**1.000**
71	Batulawan - Dalingaoen - Malapang Road	0.200		6.300		**6.500**
	Sub-total	**21.920**	**0.000**	**71.770**	**15.530**	**109.220**
	Total	**26.220**	**1.000**	**167.370**	**45.030**	**239.620**

5-2. Barangay Road (as of 2015) (1/2)

	Road Name	Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
1	Inug-ug-Barongis Road	0.300		10.000	1.700	**12.000**
2	Silik-Damalasak-Katilacan Road			3.000		**3.000**
3	Poblacion-Gligli-Bulol-Kabasalan Road		1.000	11.000	3.000	**15.000**
4	Balong-Calawag Road	1.000		3.000		**4.000**
5	Tinutulan-Nabundas-Balabak Road	1.000		11.000		**12.000**
6	Galigayanan-Gligli Road			2.000		**2.000**
7	Hi-way Junc.-Takepan-Kalacacan Proper Road			2.000		**2.000**
8	Panicupan-Lagunde Road			2.000		**2.000**
9	Bulol-Bagoinged Road			2.400		**2.400**
10	Bualan- Sitio Valencia Road			6.100		**6.100**
11	Sitio Sampaguita-Brgy.Rd. Kalacacan				1.300	**1.300**
12	Balatican-Balungis Road			4.000		**4.000**
13	Batulawan Brgy. Road			1.000		**1.000**
14	Dalingaoen Brgy. Road			1.000		**1.000**
15	Dalingaoen-Panicupan Road			4.200		**4.200**
16	Hi-way-Nalapaan-Sitio Baruyan Road			2.000		**2.000**
17	Silik-San Isidro Road			2.000		**2.000**
18	Hi-way-Takepan-Sitio Idsla Road			1.500		**1.500**
19	Lagunde E/S-Sitio Edzap FMR			2.000		**2.000**
20	Lagunde-Mahad Road			1.500		**1.500**
21	Provincial Road-Tinutulan			2.000		**2.000**
22	Balatican Proper-Sitio Aleng Road			2.000		**2.000**
23	Highway Takepan-Kalacacan Brgy. Road			2.500		**2.500**
24	Balong-Macabual-Gligli Road			2.500		**2.500**
25	Manaulanan-Balong Road			2.500		**2.500**
26	Sitio Midsambal-Punol Proper Road			2.500		**2.500**
27	Manding Gligli Road			1.500		**1.500**
28	Gligli-Calawag Road			1.200		**1.200**
29	Bagoinged-Buliok-Barongis Road			4.000		**4.000**
30	Provincial Road-Nunguan ES Road			1.200		**1.200**
31	Calawag-Macabual-Gli-gli Road				3.500	**3.500**
32	Tapodok-Bualan-Nalapaan Prov'l.				3.500	**3.500**
33	Ginatilan-Balong Road	2.000		2.000	2.500	**6.500**
34	Balong-Manaulanan Road				3.500	**3.500**
35	Paidu Pulangi-Macasendeg Road				3.500	**3.500**
36	Sitio Tamanang-Punol Road				2.500	**2.500**
37	Bagoinged-Bulol Road				2.000	**2.000**
38	Silik-Katilacan Road				2.500	**2.500**
	Sub-total	**4.300**	**1.000**	**95.600**	**29.500**	**130.400**

5-2. Barangay Road (as of 2015) (2/2)

	Road Name	Pavement Type and Road Length				
		Concrete (km)	Asphalt (km)	Gravel (km)	Earth (km)	**Total (km)**
39	Manaulanan-Pamalian Elem.Sch. Road				1.500	**1.500**
40	Nunguan-Balungis Road				5.550	**5.550**
41	Poblacion-Bualan Road				8.480	**8.480**
42	Highway Batulawan ES	0.260				**0.260**
43	Poblacion Gli-gli	0.450				**0.450**
44	Highway Takepan-Kalacacan Brgy. Road	2.000		2.000		**4.000**
45	Nabundas - Balungis Road			6.820		**6.820**
46	Takepan - Kalacacan Road			1.640		**1.640**
47	Bulod- Sitio Lebanaon Gli-Gli Road			1.600		**1.600**
48	Batulawan - Fort Pikit Road			1.620		**1.620**
49	Manaulanan - Pamalian Road			6.550		**6.550**
50	Bualan - Kolambog Road			1.650		**1.650**
51	Paidu - Pulangi - Sitio Shuk Brgy. Road Dike			1.740		**1.740**
52	Lagunde - Nalapaan Road			4.450		**4.450**
53	Nunguan - Gokotan Road			4.200		**4.200**
54	Ginatilan - Panicupan Road			4.000		**4.000**
55	Batulawan - Sitio Buguak, Kalacacan Road			3.000		**3.000**
56	Nalapaan - Bualan Road			5.800		**5.800**
57	Damalasak - Katilacan Road			4.800		**4.800**
58	Dalingaoen - Panicupan Road			4.200		**4.200**
59	Batulawan - Balungis Road			2.800		**2.800**
60	Balatikan - Balungis Road				5.000	**5.000**
61	Silik - Sitio Midsambal Road			2.000		**2.000**
62	Nalapaan - Sitio Baruyan Road			3.600		**3.600**
63	Balatikan - Balungis Road	3.898			0.302	**4.200**
64	Nalapaan - Sitio Baruyan FMR	1.760				**1.760**
65	Panicupan - Lagunde FMR	1.500				**1.500**
66	Batulawan ES FMR	1.150				**1.150**
67	Balungis - Nabundas Road			3.000		**3.000**
68	Lagunde ES- Provincial Road Junction			2.000		**2.000**
69	Tinutulan - Balabak			2.400		**2.400**
70	Nunguan - Nabundas Road			1.000		**1.000**
	Sub-total	**11.018**	**0.000**	**70.870**	**20.832**	**102.720**
	Total	**15.318**	**1.000**	**166.470**	**50.332**	**233.120**

V.2 Bridge List

Status of Infrastructure Development (Bridge)

(1) Summary of Bridge Development (as of 2018)

Bridge Name or Name of Road Section (where bridge is located)	Bridge Type and Bridge Length (m)				
	Concrete Bridge	Steel Bridge	Timber Bridge	RC Box Culvert	**Total**
Along the National Road	16	0	0	0	**16**
Along the Provincial Road	13	0	0	0	**13**
Along the Municipal Street	0	0	0	0	**0**
Along the Barangay Road	0	0	0	24	**24**
Total	**29**	**0**	**0**	**24**	**53**

(2) Along the National Road (as of 2018)

	Bridge Name or Name of Road Section (where bridge is located)	Bridge Type and Bridge Length (m)				
		Concrete Bridge	Steel Bridge	Timber Bridge	RC Box Culvert	**Total**
1	Nalapaan Bridge	6				**6**
2	Panicupan Bridge	10				**10**
Total		**16**	**0**	**0**	**0**	**16**

(3) Along the Provincial Road (as of 2018)

	Bridge Name or Name of Road Section (where bridge is located)	Bridge Type and Bridge Length (m)				
		Concrete Bridge	Steel Bridge	Timber Bridge	RC Box Culvert	**Total**
1	Silik Bridge (Unfinished)	10				**10**
2	Paidu-Pulangi	3				**3**
Total		**13**	**0**	**0**	**0**	**13**

(4) Along the Municipal Street (as of 2018)

	Bridge Name or Name of Road Section (where bridge is located)	Bridge Type and Bridge Length (m)				
		Concrete Bridge	Steel Bridge	Timber Bridge	RC Box Culvert	**Total**
1	-					**0**
Total		**0**	**0**	**0**	**0**	**0**

(5) Barangay Road (as of 2018)

	Bridge Name or Name of Road Section (where bridge is located)	Bridge Type and Bridge Length (m)				
		Concrete Bridge	Steel Bridge	Timber Bridge	RC Box Culvert	**Total**
1	Takepan				3	**3**
2	Pamalian				6	**6**
3	Panicupan Irrigation Drainage				3	**3**
4	Bulol (Balibet)				3	**3**
5	Ginatilan - Panicupan				3	**3**
6	Lagunde				6	**6**
Total		**0**	**0**	**0**	**24**	**24**

APPENDIX-VI

FLOOD SIMULATION

APPENDIX VI: FLOOD SIMULATION

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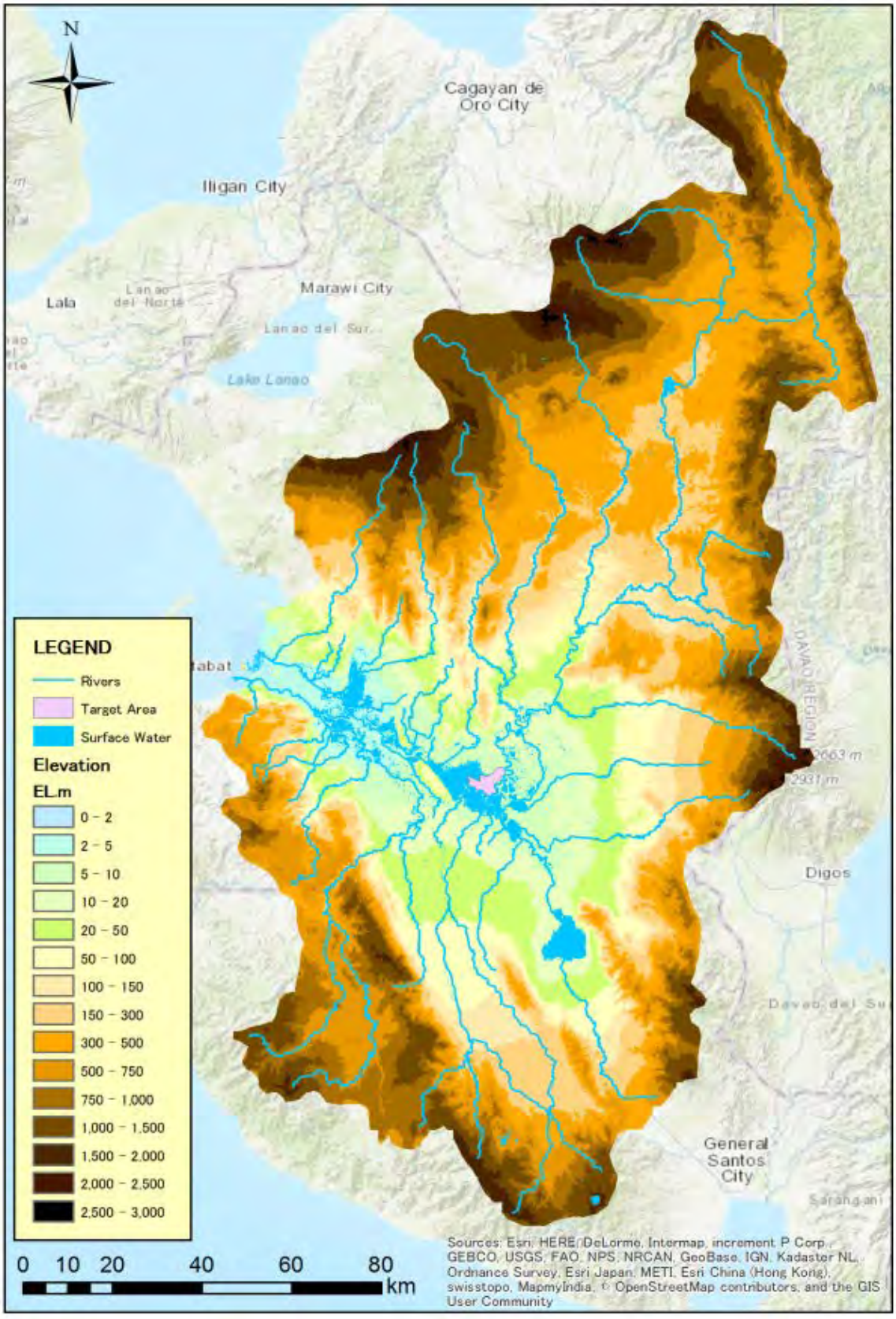
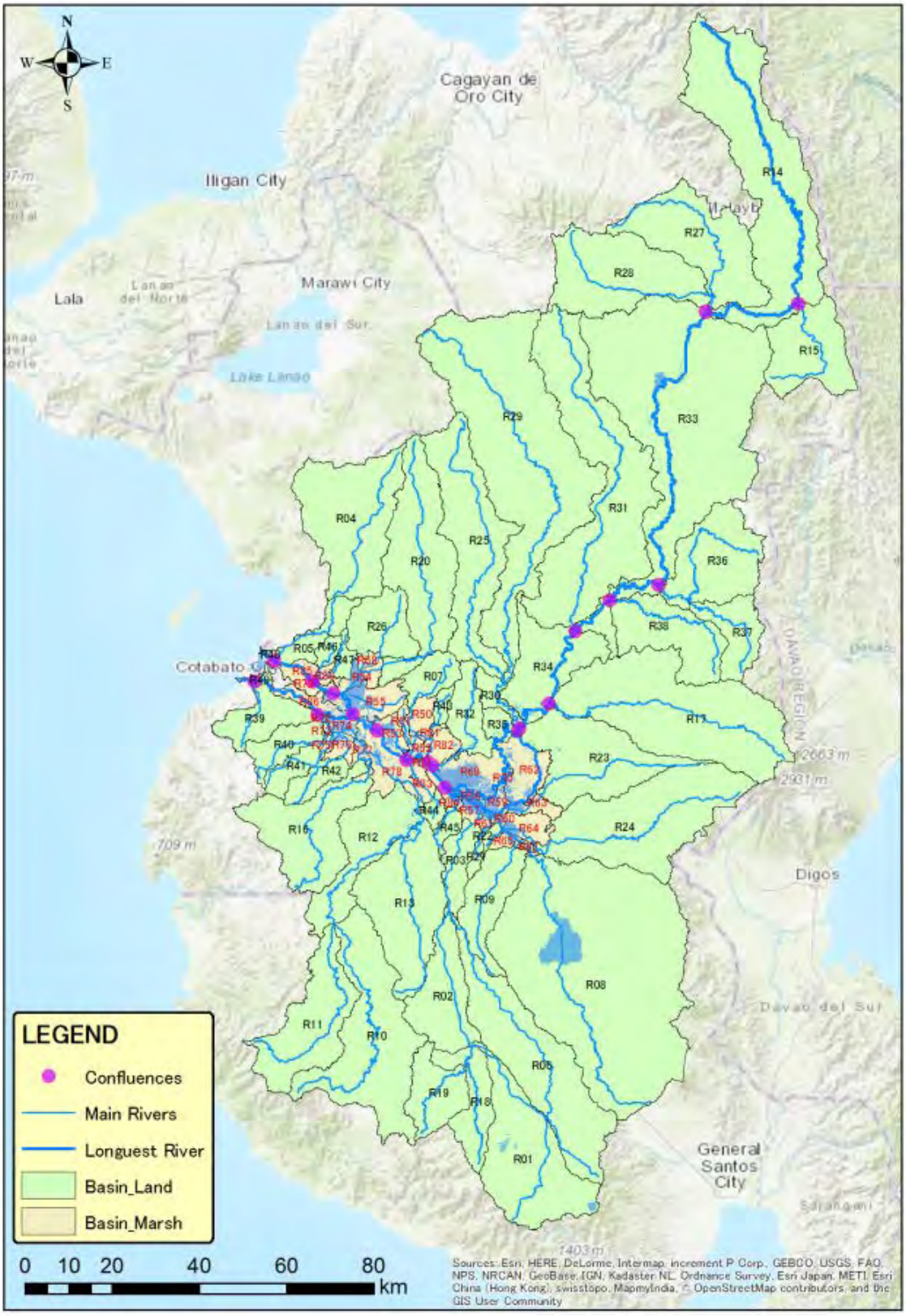
APPENDIX VI. FLOOD SIMULATION

VI.1 Elevation Distribution within the MRB



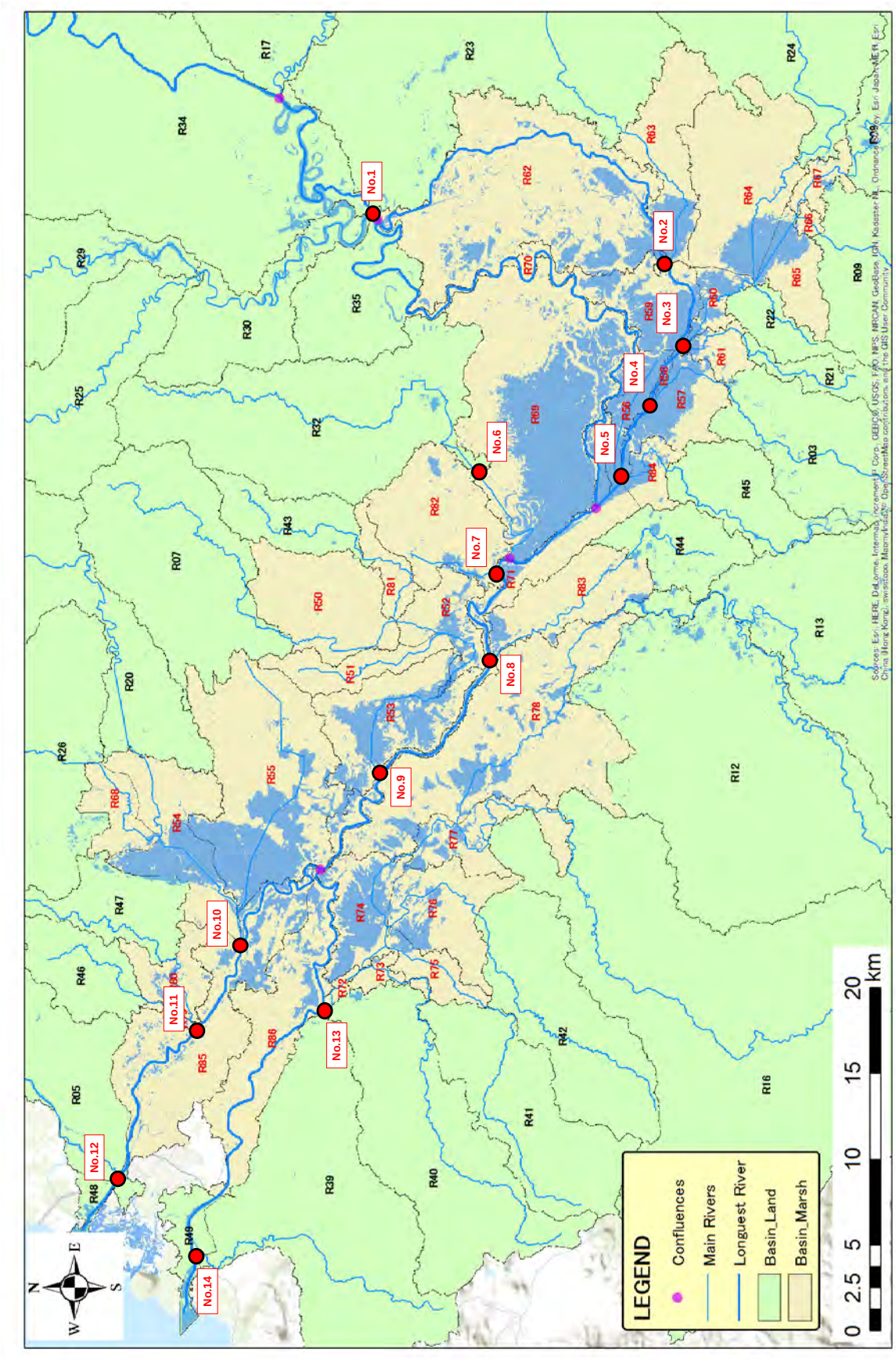
Elevation Distribution within the MRB

VI.2 River Alignments and Basin Boundaries



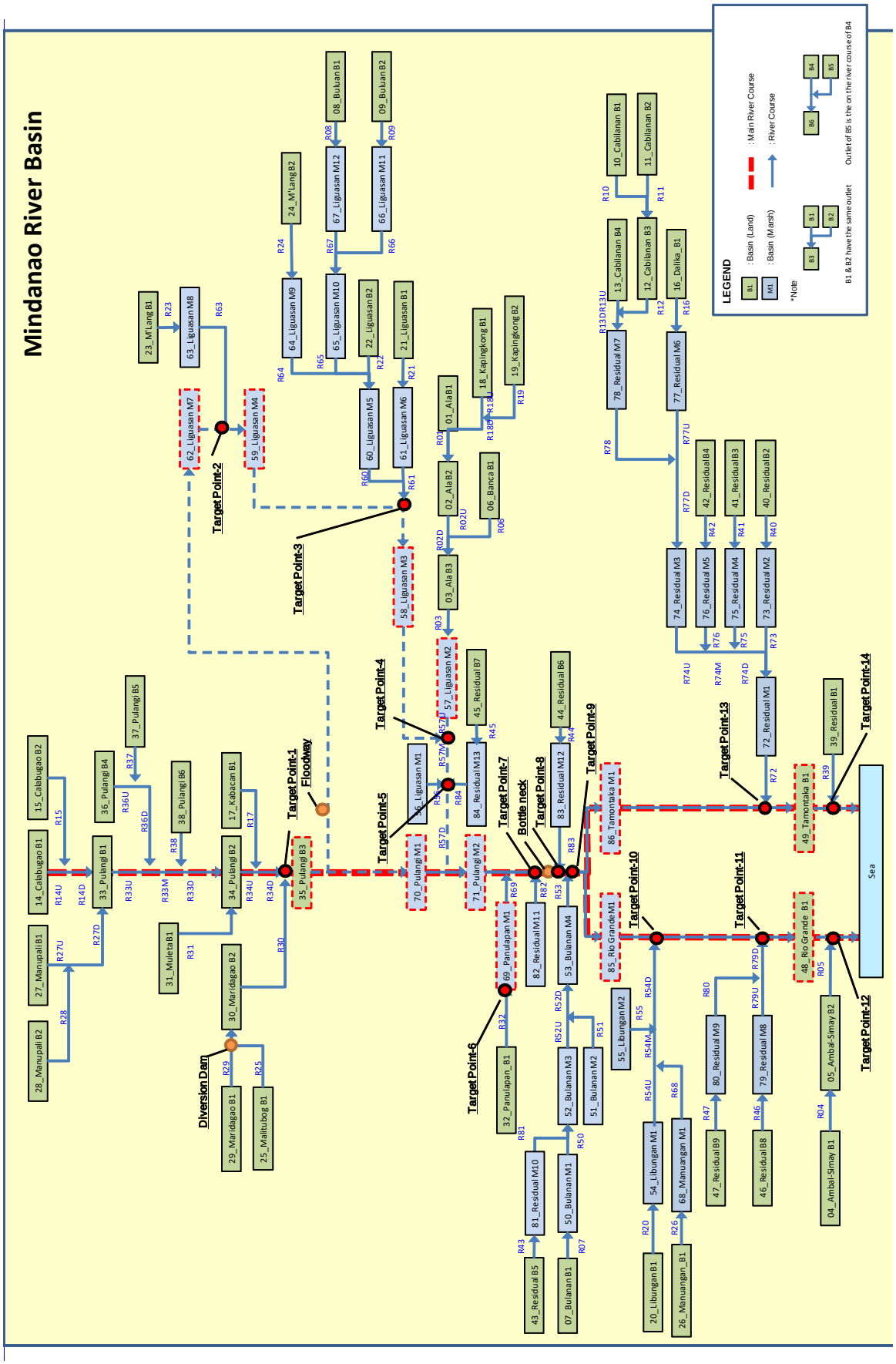
River Alignments and Basin Boundaries

VI.3 River Alignments and Basin Boundaries (Focusing on the Area from LMSA to the River Mouths)



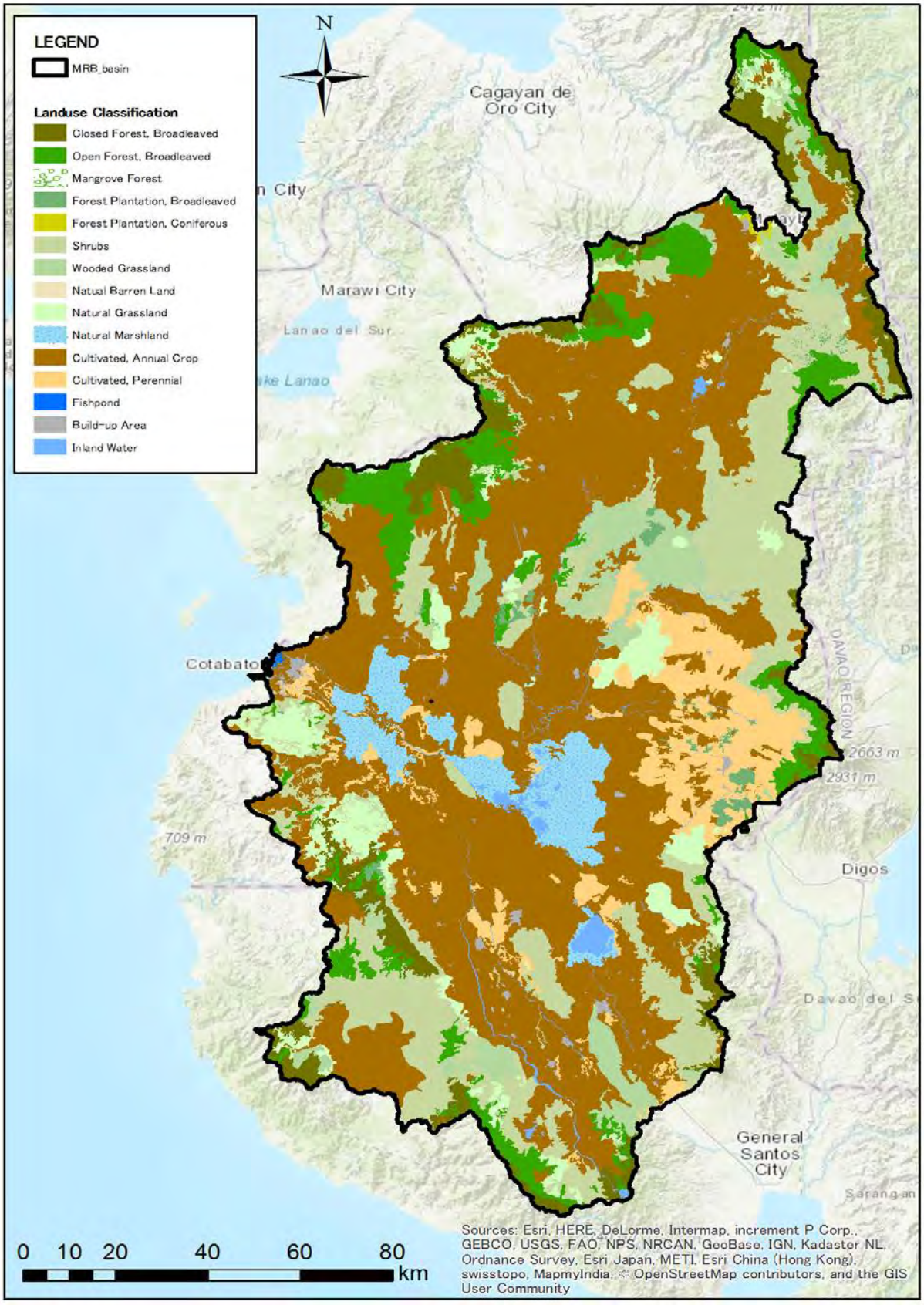
River Alignments and Basin Boundaries (focusing on the area from LMSA to the River Mouths)

VI.4 River Network Diagram in the MRB



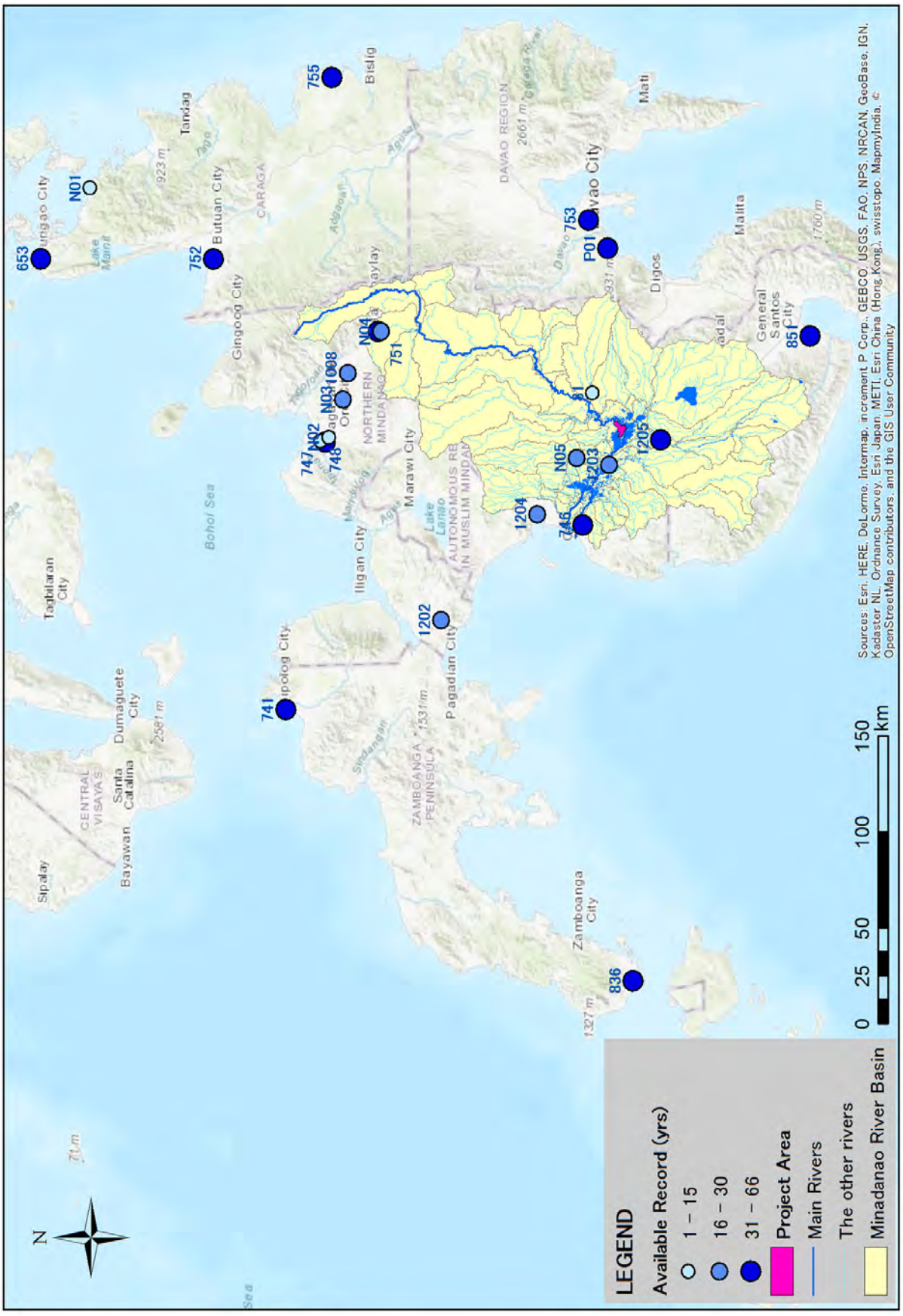
River Network Diagram in the MRB

VI.5 Land Use Map



Land Use Map

VI.6 Rainfall Gauge Stations

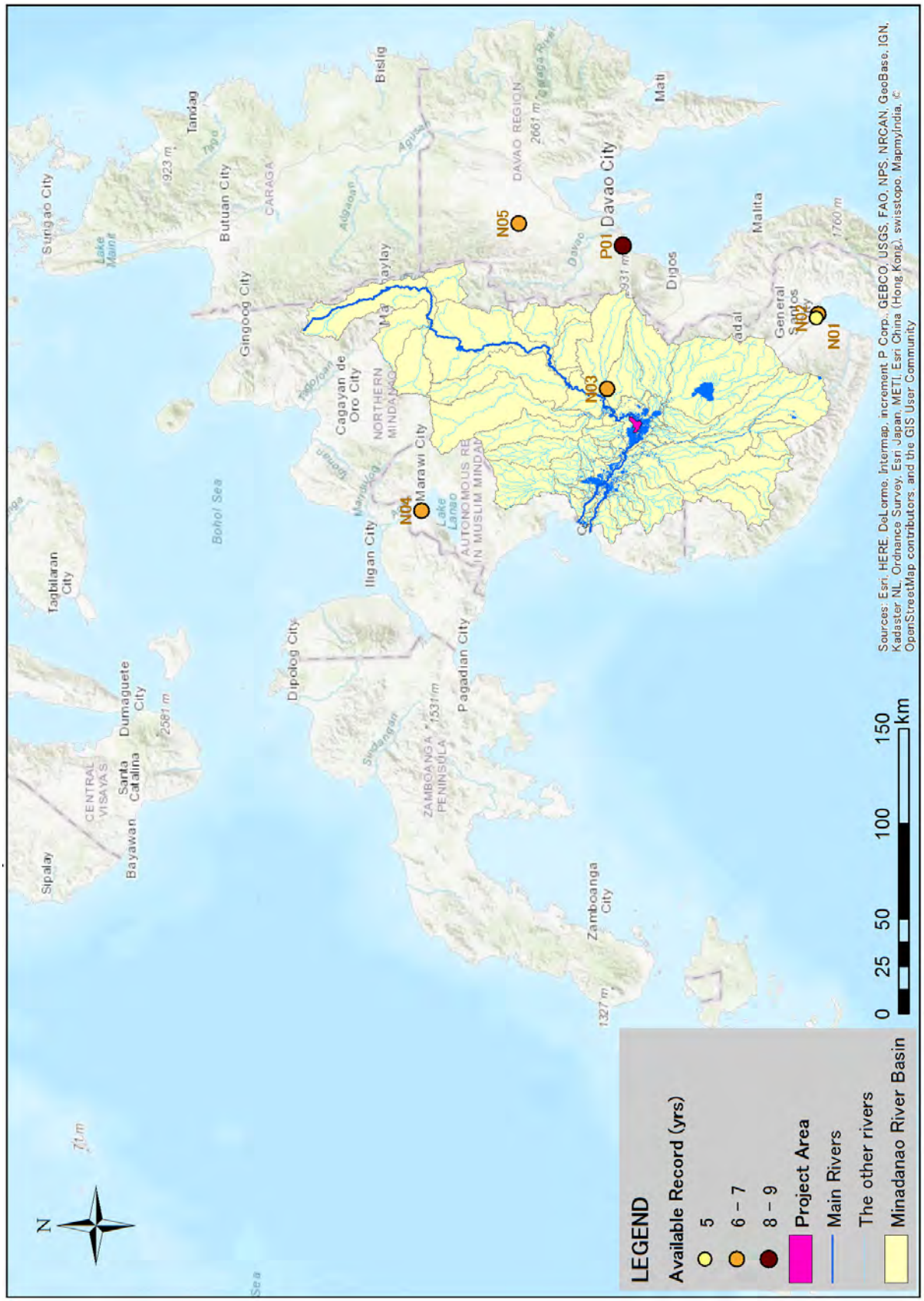


List of Rainfall Gauge Stations

Station ID	Name of Locatoin		Gauge Type*	Long. (°)	Lati. (°)	Elevation (EL.m)	Record Period	Source
81	USM	Kabacan	GR	124.839	7.114	20	1969-1985	PAGASA
653	Surigao	Surigao del norte	SYN	125.489	9.783	39	1951-1979 1984-2016	PAGASA
741	Diplog	Zamboanga del norte	SYN	123.345	8.603	4	1981-2016	PAGASA
746	Cotabato city	Maguindanao	SYN	124.215	7.162	50	1951-1960 1986-2016	PAGASA
747	Lumbia airport	Misamis oriental	SYN	124.612	8.409	182	1977-2013	PAGASA
748	El Salvador city	Misamis Oriental	SYN	124.617	8.433	9	2013-2016	PAGASA
751	Malaybalay	Bukidnon	SYN	125.134	8.151	627	1961-2016	PAGASA
752	Butuan city	Agusan del norte	SYN	125.482	8.947	18	1981-2016	PAGASA
753	Davao city	Davao del sur	SYN	125.655	7.128	17	1951-2016	PAGASA
755	Hinatuan	Surigao del sur	SYN	126.338	8.367	3	1951-2016	PAGASA
836	Zamboanga city	Zamboanga del norte	SYN	122.063	6.920	7	1951-2016	PAGASA
851	General Santos	South cotabato	SYN	125.103	6.057	132	1951-2016	PAGASA
1008	Kisolon, Sumilao	Bukidnon	CR	124.938	8.298	680	1980-2000	PAGASA
1202	Kapatagan	Lanao del Norte	-	123.767	7.850	90	1971-2000	PAGASA
1203	Datu Piang	Maguindanao	OR	124.500	7.033	9	1972-1987 1994-1998	PAGASA
1204	Parang	Maguindanao	OR	124.267	7.383	85	1972-2000	PAGASA
1205	Carmen, Tauron	Sultan Kudarat	OR	124.617	6.783	29	1960-2000	PAGASA
P01	PCA, Bago Oshiro	Davao del sur	-	125.522	7.037	-	1981-2016	PAGASA
N01	Claver	Surigao Del Norte	-	125.824	9.543	-	1980-1982	NIA
N02	Bubunawan	Bukidnon	-	124.634	8.393	-	1988-1990	NIA
N03	Camp Phillips	Bukidnon	-	124.813	8.323	-	1962-1987	NIA
N04	Malaybalay	Bukidnon	-	125.134	8.136	-	1957-1965 1968-1975	NIA
N05	Midsayap	North Cotabato	-	124.531	7.191	-	1956-1975	NIA

* SYN Synoptic Station
GR Agrometeorological Station
OR Official Rain Station
CR Cooperative Rain Station

VI.8 Location of the Pan-Evaporation Stations



Location of the Pan-Evaporation Stations

VI.9 Pan-Evaporation Stations

Pan-Evaporation Stations

Station ID	Name of Location		Long. (°)	Lati (°)	Elevation (EL.m)	Record Period	Source
N01	Bula	General Santos	125.1904	6.1094	6	1957-1973	NIA
N02	Dadiangas	General Santos	125.1726	6.1182	19	1959-1965	NIA
N03	Mindanao Institute of Technology (MIT)	Kabacan	124.8391	7.1136	30	1957-1973	NIA
N04	Mindanao State University	Malawi	124.2605	7.9984	780	1969-1984	NIA
N05	Tagum	Davao del Norte	125.6298	7.5302	35	1977-1988	NIA
P01	PCA	Davao del Sur	125.5217	7.0367	8	2007-2016	PAGASA

APPENDIX-VII

ENVIRONMENT

APPENDIX VII: ENVIRONMENT

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APPENDIX VII. ENVIRONMENT

Appendix VIII.1 Compensation Rates for Land Loss in case of Irrigation Facility Construction

Republika ng Pilipinas
DEPARTMENT OF AGRICULTURE
PAMBANSANG PANGASIWAAN NG PATUBIG
(National Irrigation Administration)
MALITUBOG-MARIDAGAO IRRIGATION PROJECT
Villarica, Midsayap, Cotabato
Tel No. 064-2298843, 064-2298184, Telefax No. 064-2298453

5/9/003
RECEIVED

April 28, 2003

The Administrator
National Irrigation Administration
EDSA, Diliman
Quezon City

Thru: Legal Department

Subject: Land Market Value Evaluation

Forwarded herewith the land market value evaluation result for the acquisition of land along the right-of-way of irrigation facilities and its appurtenants as per survey conducted by the evaluation committee. The market value was done in accordance with the Memorandum 12 s2002 dated February 28, 2002 in compliance with the Implementing Rules and Regulations (IRR) of RA 8974 of 2000

The evaluation committee recommended the maximum values for the following; a) Riceland – P10.50 per sq meter, b) Other Agricultural Products-P7.50 per sq meter

For your approval.

Very truly yours,

NOLDIN S. OYOD
OIC, Project Manager

P10.5 and P7.5 per square meter were set as compensation rates for Riceland and other agricultural land, respectively.

In 2003, a land value survey revealed that it ranges from P11.322 per square meter to P12.50. However, those were not reflected for setting compensation rates as mentioned above.

Republic of the Philippines
DEPARTMENT OF AGRICULTURE
National Irrigation Administration
Malitubog-Maridagao Irrigation Project Stage I
Midsayap, Cotabato
Telefax No. (064)2298453

ROW COMMITTEE RESOLUTION NO. 2003-01

WHEREAS, the Evaluation Committee for the acquisition of Right-of-Way was tasked to conduct an evaluation of the fair market value of the properties/improvements to be acquired by NIA Malitubog-Maridagao Irrigation Project (Annex A),

WHEREAS, the Committee conducted a survey, gathering of data and assessments on the market values of real properties in selected barangay in the Province of Cotabato and Maguindanao;

WHEREAS, the Municipalities of Pikit and Carmen of Cotabato Province and Pagalungan of Maguindanao Province do not have the following: a) approved land use or zoning ordinance, b) development cost for improving the land, c) current selling price on the records of the deed of sale in the Office of the Register of Deeds,

WHEREAS, the land covered by the right-of-way of the irrigation and drainage canals and other appurtenant structures are all classified as agricultural land (Annex B),

WHEREAS, the average result of the survey of opinion value of land result in different barangay namely; Gen Luna, Kibayao, of Carmen Municipality, Gocotan of Pikit Municipality, of the Cotabato Province and Limbalod, Pagagawan Municipality, Maguindanao Province ranges from P11.322 per sq meter to P12.50 per sq meter (Annex C),

WHEREAS, the NIA-MMIP Project Management Office (PMO) had already paid 63 lots at a cost of not more than 10.00 pesos per square meter in Maridagao Service Area prior to the approval of MC 12 s2002 dated February 28, 2002, compliance of IRR of RA 8974 of 2000 (Annex D and Annex E),

WHEREAS, the PMO used the consolidated schedule of market values of Real Properties per hectare for the Municipalities of Pikit and Carmen of Cotabato Province and Municipality of Pagalungan & Pagagawan of Maguindanao Province as basis for payment prior to the approval of MC 12 s2002 dated February 28, 2002, compliance of IRR of RA 8974 of 2000 (Annex F),

WHEREAS, as per evaluation and assessment based on the available data for the value of the land paid or to be paid by the NIA-MMIP-PMO is reasonable, acceptable and within the assessment value of the Municipality and Province,

WHEREAS, the cost estimates for the removal, demolition, and reconstruction of permanent structures shall be based on the standard local market value of the construction materials plus the calculated direct labor cost based on the rate of wages provided by the Department of Labor,

WHEREAS, THEREFORE, BE IT RESOLVED, AS IT HEREBY RESOLVED, that the recommended maximum fair market values is P10.50 per square meter for Riceland and P7.20 pesos per square meter for other agricultural land and shall be the basis in the payment for the Right of Way to be acquired by the National Irrigation Administration, Malitubog-Maridagao Irrigation Project within the Municipalities of Carmen and Pikit of the Province of Cotabato and Municipalities of Pagalungan and Pagagawan, of the Province of Maguindanao.

IN WITNESS HEREOF, we hereunto affixed our signature this 3rd day of July 2002.
Done at NIA-MMIP, Villarica, Midsayap, Cotabato.

EVALUATION COMMITTEE FOR
THE ACQUISITION OF RIGHT-OF-WAY:

MOGUIDON A. MAONGKONG
Member

SALEH P. KABUNTO
Member

ROEL C. BRIONES
Chairman

Appendix VII.2 List of Birds Identified in the Liguasan Marsh

English Name	Scientific Name	Residency Status	Survey in 1998 by *1	Survey in 2017*2	Remarks
1. Asian Glossy Starling	*Aplonis panayensis*	R	No	Yes	
2. Barn Swallow	*Hirundo rustica*	M	Yes	Yes	
3. Barred Rail	*Hypotaenidia torquata*	R	Yes	Yes	
4. Black bittern	*Dupetor flavicollis*	R	Yes	Yes	
5. Black-crowned night heron	*Nycticorax nycticorax*	M	No	Yes	
6. Black-naped Oriole	*Oriolus chinensis*	R	Yes	Yes	
7. Black-winged kite	*Elanus caeruleus*	R	Yes	Yes	
8. Black-winged Stilt	*Himantopus himantopus*	M	No	Yes	
9. Blue throated bee-eater	*Merops americanus*	E	Yes	No	
10. Blue-tailed Bee-eater	*Merops philippinus*	R	Yes	Yes	
11. Brahminy kite	*Halias turindus*	R	Yes	Yes	
12. Brown shrike	*Lanius cristatus*	M	Yes	No	Migrant population has yet to arrive
13. Brush cuckoo	*Cacomantis variolosus*	R	No	Yes	
14. Cattle egret	*Bubulcus ibis*	M/R	Yes	Yes	
15. Chestnut Munia	*Lonchura atricapilla*	R	Yes	Yes	
16. Cinnamon bittern	*Ixobrychus cinnamomeus*	R	Yes	Yes	
17. Clamorous reed warbler	*Acrocephalus stentoreus*	R	No	Yes	
18. Collared kingfisher	*Todiramphus chloris*	R	Yes	Yes	
19. Comb-crested jacana	*Irediparra gallinacean*	R	Yes	No	
20. Gull-billed Tern	*Gelochelidon nilotica*	R	No	Yes	
21. Common kingfisher	*Alcedo atthis*	R	Yes	No	
22. Common Moorhen	*Gallinula chloropus*	R	Yes	Yes	
23. Common Sandpiper	*Actitis hypoleucos*	M	Yes	Yes	
24. Common Tern	*Sterna hirundo*	R	No	Yes	
25. Cotabato little grebe	*Tachybaptus ruficollis Cotabato*	R	Yes	No	Photographed in Cagayan de Oro in Jan, 2017. Most likely still present at the marsh
26. Oriental Dollarbird	*Eurystomus orientalis*	R	Yes	No	
27. Eastern spotted dove	*Spilopelia chinensis*	R	Yes	Yes	
28. Emerald dove	*Chalcophaps indica*	R	Yes	No	
29. Eurasian tree sparrow	*Passer montanus*	I	Yes	Yes	
30. Glossy swiftlet	*Colocalia esculenta*	R	Yes	No	2017 survey did not sample swiftlets
31. Great white egret	*Ardea alba*	M	No	Yes	
32. Great-billed heron	*Ardea sumatrana*	R	Yes	No	Kennedy *et al* 2001 did not write Mindanao as part of the species' range in the country. 1998 survey could have mistaken *A. purpurea* for *A. sumatrana*
33. Greater Crested Tern	*Thalasseus bergii*	R	No	Yes	
34. Green-backed heron	*Butorides striata*	M/R	Yes	Yes	

English Name	Scientific Name	Residency Status	Survey in 1998 by *1	Survey in 2017*2	Remarks
35. Grey heron	*Ardea cinerea*	M	Yes	No	Uncommon migrant (Kennedy *et al* 2001). But locals claim that the species do arrive during migration season
36. Grey wagtail	*Motacilla cinerea*	R	Yes	No	
37. Guaiabero	*Bolbopsittacus lunulatus*	E	Yes	Yes	
38. House Swallow	*Hirundo javanica*	R	Yes	Yes	
39. Indigo-banded kingfisher	*Ceyxcyanopectus*	E	Yes	No	
40. Intermediate egret	*Ardea intermedia*	M	Yes	Yes	
41. Island collared-dove	*Streptopelia bitorquata*	R	Yes	Yes	
42. Javan pond heron	*Ardeola speciose*	R	Yes	Yes	
43. Large-billed crow	*Corvus macrorhynchos*	R	Yes	Yes	
44. Little egret	*Egretta garzetta*	M	Yes	Yes	
45. Malayan night heron	*Gorsachius melanolophus*	R	Yes	No	
46. Middendorff's Grasshopper Warbler	*Locustella ochotensis*	R	Yes	Yes	
47. Olive-backed Sunbird	*Cinnyris jugularis*	R	Yes	Yes	
48. Orange-bellied flowerpecker	*Dicaeum trigonostigma*	R	No	Yes	
49. Oriental darter	*Anhinga melanogaster*	R	Yes	Yes	
50. Oriental reed warbler	*Acrocephalus orientalis*	M	No	Yes	
51. Painted quail	*Synoicus chinensis*	R	Yes	No	
52. Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	R	No	Yes	
53. Philippine Bulbul	*Hypsipetes philippinus*	E	No	Yes	
54. Philippine coucal	*Centropus viridis*	E	Yes	No	
55. Philippine cuckoo-dove	*Macropygia tenuirostris*	E	Yes	No	
56. Philippine duck	*Anas luzonica*	E	Yes	Yes	
57. Philippine Hanging-parrot	*Loriculus philippensis*	E	No	Yes	
58. Philippine Pied Fantail	*Rhipidura nigritorquis*	E	Yes	Yes	
59. Philippine tailor bird	*Orthotomus castaneiceps*	E	Yes	No	
60. Pied harrier	*Circus melanoleucos*	M/R	No	Yes	
61. Pied triller	*Lalage nigra*	R	Yes	Yes	
62. Pink-necked green-pigeon	*Treron vernans*	R	No	Yes	
63. Plain swamphen	*Amaurornis olivacea*	E	Yes	No	
64. Purple heron	*Ardea purpurea*	R	Yes	Yes	Common, solitary or in pairs
65. Purple Swamphen	*Porphyrio porphyrio*	R	Yes	Yes	
66. Pygmy swiftlet	*Colocalia troglodytes*	E	Yes	No	2017 survey did not sample swiftlets
67. Red-keeled flowerpecker	*Dicaeum austral*	E	No	Yes	
68. Reef egret	*Egretta sacra*	R	Yes	No	Almost exclusively found on reefs, small islets, and along

English Name	Scientific Name	Residency Status	Survey in 1998 by *1	Survey in 2017*2	Remarks
					coasts (Kennedy *et al* 2001). 1998 detection could be a mis-identification
69. Ruddy-breasted Crake	*Zapornia fusca*	R	No	Yes	
70. Rufous night heron	*Nycticorax caledonicus*	R	Yes	No	
71. Slaty-breasted rail	*Lewinia striata*	R	Yes	No	
72. Slaty-legged crake	*Rallina eurizonoides*	R	Yes	No	
73. Spot-billed pelican	*Pelecanus philippensis*	Ext	Yes	No	Listed in the IUCN Red List as "extinct" in the Philippines.
74. Striated Grassbird	*Megalurus palustris*	R	Yes	Yes	
75. Tawny Grassbird	*Cincloramphus timoriensis*	R	Yes	Yes	
76. Wandering whistling duck	*Dendrocygna arcuate*	R	Yes	Yes	
77. Water cock	*Gallicrex cinerea*	R	No	Yes	
78. Whimbrel	*Numenius phaeopus*	R	Yes	No	
79. Whiskered tern	*Chlidonias hybrid*	R	Yes	No	
80. White-bellied sea eagle	*Haliaetus leucogaster*	R	Yes	No	Sea eagles not found at the Pikit marshes based on interviews
81. White-breasted Waterhen	*Amaurornis phoenicurus*	R	Yes	Yes	
82. White-breasted wood swallow	*Artamus leucorynchus*	R	Yes	Yes	
83. White-browed Crake	*Porzana cinerea*	R	Yes	Yes	
84. White-eared brown dove	*Phapitreron leucotis*	E	No	Yes	
85. White-throated kingfisher	*Halcyon gularis*	E	Yes	Yes	
86. Wood sandpiper	*Tringa glareola*	M	No	Yes	
87. Yellow bittern	*Ixobrychus sinensis*	R	Yes	Yes	
88. Yellowish bulbul	*Hypsipetes everetti*	E	Yes	No	
89. Yellow-vented Bulbul	*Pycnonotus goiavier*	R	Yes	Yes	
90. Zebra dove	*Geopelia striata*	R	Yes	Yes	
91. Zittingcisticola	*Cisticola juncidis*	R	Yes	Yes	
Total Identified Species			70	63	

Residency Status: R – Resident, M– Migratory, E – Endemic, M/R – Migrant & Resident populations,
Ext – Extirpated in the region, and I – Introduced

Sources:

*1 NEDA Region XII, 1998, The Liguasan Marsh Development Master Plan 1999-2025

*2 JICA Survey Team, 2017

APPENDIX-VIII

INDIGENOUS PEOPLE AND OTHER SOCIAL ISSUES

APPENDIX VIII: INDIGENOUS PEOPLE AND OTHER SOCIAL ISSUES

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ANNEX VIII INDIGENOUS PEOPLE AND OTHER SOCIAL ISSUES

VIII.1 Definition of Key Terminology

Table VIII.1.1 Definition of key terminology around IPs' rights

Term	Definition	Source	
		Republic Act No. 8371 IPRA	NCIP AO No. 3, 2012
Ancestral Domain	all areas generally belonging to ICCs/IPs comprising lands, inland waters, coastal areas, and natural resources therein, held under a claim of ownership, occupied or possessed by ICCs/IPs, by themselves or through their ancestors, communally or individually since time immemorial, continuously to the present except when interrupted by war, force majeure or displacement by force, deceit, stealth or as a consequence of government projects or any other voluntary dealings entered into by government and private individuals/corporations, and which are necessary to ensure their economic, social and cultural welfare. It shall include ancestral lands, forests, pasture, residential, agricultural, and other lands individually owned whether alienable and disposable or otherwise, hunting grounds, burial grounds, worship areas, bodies of water, mineral and other natural resources, and lands which may no longer be exclusively occupied by ICCs/IPs but from which they traditionally had access to for their subsistence and traditional activities, particularly the home ranges of ICCs/IPs who are still nomadic and/or shifting cultivators.	✓	
Ancestral Lands	land occupied, possessed and utilized by individuals, families and clans who are members of the ICCs/IPs since time immemorial, by themselves or through their predecessors-in-interest, under claims of individual or traditional group ownership, continuously, to the present except when interrupted by war, force majeure or displacement by force, deceit, stealth, or as a consequence of government projects and other voluntary dealings entered into by government and private individuals/corporations, including, but not limited to, residential lots, rice terraces or paddies, private forests, swidden farms and tree lots.	✓	
Certificate of Ancestral Domain Title	a title formally recognizing the rights of possession and ownership of ICCs/IPs over their ancestral domains identified and delineated in accordance with this Indigenous People's Rights Act of 1997.	✓	
Certificate of Non-Overlap (CNO)	It refers to the Certificate issued by the NCIP attesting to the fact that the area where the particular plan, program, project or activity will be done does not overlap with, or affect, any ancestral domain.		✓
Certification Precondition (CP)	It refers to the Certificate issued by the NCIP, signed by the Chairperson, attesting to the grant of FPIC by the concerned ICCs/IPs after appropriate compliance with the requirements provided for in this Guidelines.		✓
Field-Based Investigation (FBI)	It refers to the ground investigation undertaken to determine whether or not the plan, program, project or activity overlaps with, or affects an ancestral domain, the extent of the affected area, and the ICCs/IPs whose FPIC is to be obtained.		✓
Free and Prior Informed Consent (FPIC)	Consensus of all members of the ICCs/IPs to be determined in accordance with their respective customary laws and practices, free from any external manipulation, interference and coercion, and obtained after fully disclosing the intent and scope of the activity, in a language and process understandable to the community.	✓	

Term	Definition	Source	
		Republic Act No. 8371 IPRA	NCIP AO No. 3, 2012
Indigenous Cultural Communities / Indigenous Peoples	a group of people or homogenous societies identified by self-ascription and ascription by others, who have continuously lived as organized community on communally bounded and defined territory, and who have, under claims of ownership since time immemorial, occupied, possessed and utilized such territories, sharing common bonds of language, customs, traditions and other distinctive cultural traits, or who have, through resistance to political, social and cultural inroads of colonization, non-indigenous religions and cultures, became historically differentiated from the majority of Filipinos. ICCs/IPs shall likewise include peoples who are regarded as indigenous on account of their descent from the populations which inhabited the country, at the time of conquest or colonization, or at the time of inroads of nonindigenous religions and cultures, or the establishment of present state boundaries, who retain some or all of their own social, economic, cultural and political institutions, but who may have been displaced from their traditional domains or who may have resettled outside their ancestral domains.	✓	
Indigenous elder / leader	An indigenous elder/leader emerges from the dynamics of customary laws and practices; they evolve from a lifestyle of conscious assertion and practice of traditional values and beliefs. They are recognized as authority in conflict resolution and peace-building processes, on spiritual rites and ceremonies and in doing so, possess the attributes of wisdom and integrity. They lead and assist the community in decision-making process towards, the protection and promotion of their rights and the sustainable development of their ancestral domains.		✓
Time Immemorial	a period of time when as far back as memory can go, certain ICCs/IPs are known to have occupied, possessed in the concept of owner, and utilized a defined territory devolved to them, by operation of customary law or inherited from their ancestors, in accordance with their customs and traditions.	✓	

Source: Republic Act No. 8371 The Indigenous Peoples' Rights Act of 1997

VIII.2 Organization Chart of the NCIP Regional Office of Region XII

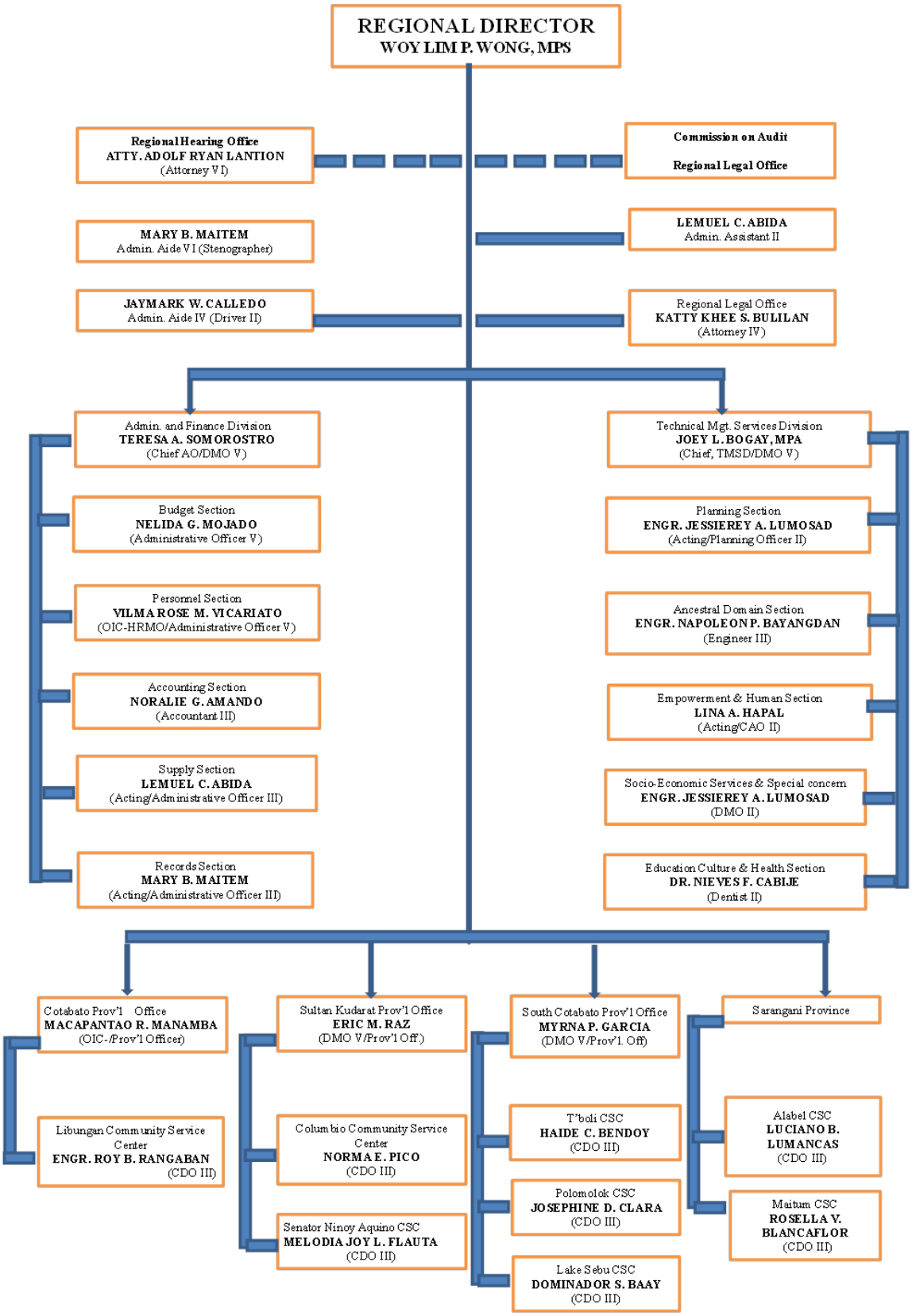


Figure VIII.1.1 Organizational Structure of the NCIP Regional Office XII

Source: NCIP Regional Office XII

VIII.1.3 FBI Report

Republic of the Philippines
OFFICE OF THE PRESIDENT
NATIONAL COMMISSION ON INDIGENOUS PEOPLES
Region XII
LIBUNGAN COMMUNITY SERVICE CENTER
Corotan Bldg., Poblacion, Libungan, Cotabato
(064) 521-6304 Email: libunganec@gmail.com

FOR : WOY LIM P. WONG, MPS
Regional Director
NCIP-12
Koronadal City

THRU : JOEY L. BOGAY, MPA
Chief, TMSD

MACAPANTAO R. MANAMBA, MMPA
Provincial Officer

FROM : THE FBI TEAM

SUBJECT : FIELD-BASED INVESTIAGATION (FBI) REPORT AND SECONDARY DATA ASSESSMENT ON THE MALITUBOG MARIDAGAO IRRIGATION PROJECT (PAHSE-II) IN BARANGAYS BAGUINGED, BARUNGIS, BULIOK, BULOD, BULOL, KABASALAN, RAJAH MUDA AND TALITAY ALL THE MUNICIPALITY OF PIKIT PROVINCE OF COTABATO

DATE : JULY 3, 2017

1. NAME AND ADDRESS OF THE APPLICANT : Suiyu Consultants, Inc
Al Nor Hotel and Conference Center, Cotabato City, Mindanao

2. ENDORSING REGULATORY AGENCY

3. DATE OF ENDORSEMENT

4. DATE OF FBI : July 3, 2017

5. LOCATION OF THE APPLICATION : Brgys. Baguinged, Barungis, Buliok, Bulod, Bulol, Kabasalan, Rajah Muda and Talitay all in the

Municipality of Pikit, Cotaabato

6. NATURE OF THE APPLICATION : Irrigation System Project

7. TOTAL AREA APPLIED :

8. NAME & DESIGNATION OF AUTHORIZED FBI TEAM : Engr. Roy B. Rangaban
EDO III/FBI Team Leader

Martino M. Insing
TAA II/FBI Member

Frederick Allan Sangarna
TAA I/FBI Member

Timuey Eleno Pendaupan
CADT Gawasan Representative

Timuey Lintuangan T. Mangod
CADT LAMP Representative

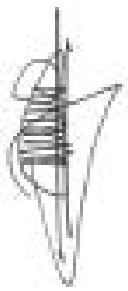
9. SPECIFIC OBJECTIVES/PURPOSE OF FBI:

a. To determine whether or not the plan, program, project or activity overlaps with, or affects, an ancestral domain, the extent of the affected area, and the ICCs/IPs whose FPIC is to be obtained.

b. To consult with the AD representatives if applicable.

c. To identify the elders/leaders and determine presence of disputes/conflicts with adjacent ancestral domain/s.

d. On site preparation of the WFP needed for the conduct of FPIC to be signed by AD representative.



e. To gather secondary data (maps, barangay/area profile and other relevant data).

10.SPECIFIC PLACES ACTUALLY VISITED:

a. Office of the Mayor-Municipal Hall, Poblacion Pikit, Cotabato

b. Training Center- Poblacion Pikit, Cotabato

c. Proposed Project Site

(1.NAMES AND POSITIONS OF PERSONS ACTUALLY INTERVIPWED:

a. Silson M. Mameid -Brgy. Kagawad of Bulod, Pikit, Cotabato
b. Mohamad D. Salik -representative of Brgy. Bulok, Pikit, Cot.
c. Motin M. Kalatoogan -representative/treasurer of Brgy. Rajah Muda, Pikit, Cotabato
d. Taimi P. Ayong -resident of Brgy. Bulol, Pikit, Cotabato
e. Mama B. Uba -resident of Brgy. Kabasalan, Pikit, Cotabato
f. Bising K. Aalam -resident of Brgy. Barungis, Pikit, Cotabato
g. Ibrahim K. Hamer -Brgy. Kagawad, Bagunged, Pikit, Cotabato
h. Timuey Elena Pendaupan -CADT Guwasan reptesentative
i. Timuey Limuongan T. Mangod-CADT LAMP representative

12.SECONDARY DATA GATHERED - Municipal Socio-Economic Profile (See attached @ Tab M)

13.DISCUSSION/s:

NCIP Libungan CSC office received a Memorandum Order No. 176 Series of 2017 issued by Wov Lim P. Wong, MPS, NCIP-12 Regional Director dated May 29, 2017 with subject: Conduct Secondary Data Assessment and Field-Based Investigation re: CP APPLICATION OF MALITUBOG-MARIDAGAO IRRIGATION PROJECT-II (MMIP-II) PREPARATORY SURVEY LOCATED IN THE MUNICIPALITIES OF PAGALUNGAN AND DATU MONTAWAL PROVINCE OF MAGUINDANAO AND MUNICIPALITIES OF PIKIT, CARMEN AND ALEOSAN OF COTABATO PROVINCE with the constituted Field-Based Investigation (FBI)Team namely: Engr. Roy B. Ringuban-Team Leader, Martino M. Insing-Member and Frederick Allan Sangansa-Member.

On June 2, 2017 Marie Lyn O. Cayunda, a representative of Sanyu Consultancy Inc. came to NCIP Libungan CSC office for a preparatory meeting to present the Auto-CADD map of the proposed MMIP-II Project located on the aforesaid Municipalities.

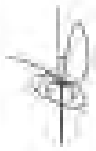
The Ancestral Domains of the Erumanen Menuvu Indigenous Cultural Communities (ICCs) are already delineated and issued with NCIP En Banc Resolutions approving the application of Certificate of Ancestral Domain Titles covering Municipalities of Carmen, Aleosan, portions of Pikit, Midsayap, Libungan, Pigcawayan all in the Province of Cotabato and the undersigned advised Ms. Cayunda that it would be technically practical to overlay first the MMIP-II project sites with that of the CADT areas to ascertain if it is within or outside Ancestral Domain areas for ready reference of the FBI Team. The undersigned FBI team leader referred Ms. Cayunda to Engr. Napoleon

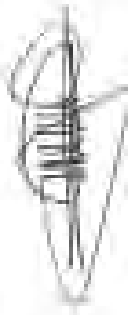
Buyangdan Engineer III/ADO in charge of NCIP-Regional Office for the overlay/projection of MMIP-II map with the AD maps.

On June 21, the undersigned team leader received a projection or overlaid map showing the relative position of the proposed MMIP-II project sites with the CADT LAMP map covering Municipalities of Libungan, Alamada, Midsayap and Pikit all in Province of Cotabato with an explanation/steps taken in overlaying the 2 maps.

On June 27, 2017 Ms. Cayunda went back to NCIP-Libungan CSC to personally talk to the undersigned FBI Team Leader about the overlaid map and it was suggested to overlay also the CADT Gawasan map with the MMIP-II projects considering that the said CADT is also covering Municipalities of Carmen and Aleosan all in the Province of Cotabato to further ascertain if MMIP-II project overlaps with the said CADT.

The FBI Team together with NIA, Sanyu Consultancy, Inc. representatives and CADT representatives conducted the Pre FBI Conference last June 29, 2017 held at NCIP Libungan CSC office. During the Pre FBI conference, the FBI Team discussed the process, secondary data needed and the purpose of Field-Based Investigation. Engr Reynaldo Sarigumba-Manager of NIA MMIP Engineering presented the map of the MMIP-I and discussed the on-going project activities and the proposed MMIP-II project. He also discussed the activities to be conducted and the areas subject to the MMIP projects. In addition, Engr. Henrieta Quinto of Sanyu Consultants, Inc. also discussed the future rehabilitation activities to be undertaken in the MMIP-I, on-going constructions and the proposed MMIP-II project. After the presentation of Engineers Sarigumba and Quinto, the undersigned FBI team leader raised clarifications to NIA and Sanyu Consultants, Inc on the specific areas/or Barangays subject to Field-Based Investigation of NCIP. As per instruction according to Ms. Marie Lyn O. Cayunda of Sanyu Consultancy, the specific areas subject to FBI to be conducted by NCIP are the areas under Stage II Study (JICA) of Lower Malitubog S. covering Brgys. Bagolinged, Barangis, Bulatok, Bulod, Bulol, Kabasalan, Rajah Muda and Talitay all in the Municipality of Pikit, Cotabato. The CADT representatives commented that the said Barangays are publicly known as areas of Muslims and it is outside of the Ancestral Domain of the Indigenous Peoples particularly the Erumanen Menuvu ICCs. The next activity was the review of the draft Work and Financial Plan (WFP) of the expenses incurred during the FBI activities.





On July 5, 2016, the undersigned FBI Team conducted the Field-Based Investigation and Gathering of Secondary Data together with representatives from NIA, Sanyu Consultants, Inc. and the CADT representatives of CADT Gawasan and LAMP. We proceeded to the office of Mayor Sumulong Sultan of the Municipality of Pikit for a courtesy call and personally inform him about our activity to be conducted and at the same time requested a copy of the Municipal Socio-Economic Profile.

After the courtesy call, we proceeded to Training Center at Poblacion Pikit, Cotabato for the conduct of interviews to the Barangay Officials and residents of the above-mentioned Barangays. After the conduct of interviews, the team proceeded to the proposed project sites located at Brgy. Bulod and Bulol for inspection and photo documentations.

Based on the above cited activities, the FBI Team come up with following findings and observations:

1. The proposed project sites under MMIP-II traversing Brgys Bagumged, Barungis, Bulok, Bulol, Bulol, Kabasalan, Rajah Muda and Talitay all in the Municipality of Pikit, Cotabato are outside Ancestral Domain of Indigenous Cultural Communities/Indigenous Peoples as per projection with the CADT maps and actual site inspection together with CADT representatives.

2. There are no Indigenous Cultural Communities/Indigenous Peoples present in the aforesaid areas that will be affected during the implementation of the said project;

3. The said Barangays are patently Bangsamoro territory;

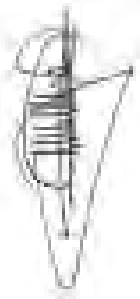
4. The said Barangays are very suitable for rice production and it is highly recommended that an irrigation system will be implemented in the area;

5. The Barangay Official/Representatives expressed full support and cooperation on the role of concerned Barangay Officials and members of the community for the realization of the Malitubog-Maridagao Irrigation Project-II that will surely addressed the food security in the area and in the Region as a whole.

Based on the above premises, the FBI Team strongly recommends for the issuance of Certificate of Non-Overlap (CNO) to application of Sanyu Consultants, Inc. to the proposed Malitubog-Maridagao Irrigation Project-II (MMIP-II) located at Brgys. Bagumged, Barungis, Bulok, Bulol, Bulol, Kabasalan, Rajah Muda and Talitay all in the Municipality of Pikit, Cotabato.

14.PERTINENT ATTACHMENTS

Projection/Overlay of the Proposed Project Site with the map of CADT Gawasan and LAMP (see attached @ Tab N)



Prepared by:

EMILIO ROY B. BANGAHAN, CE
CIDO IMEBI Team Leader

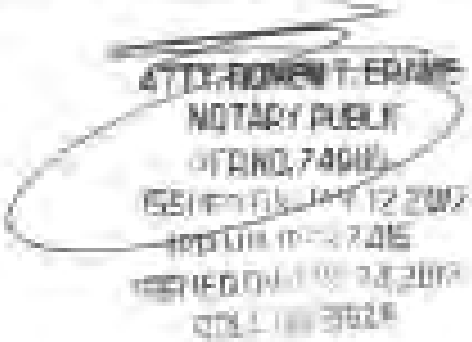
MARTINO M. TARING
TAA IMEBI Member

FREDERICK MILAN B. SANGAMA
TAA IMEBI Member

EMILEY ELENO PENDAUPAN
CADT Dewasan Representative

TIMLEY LINTUANGAN T. MANGOD
CADT LAMP Representative

SUBSCRIBED AND SWORN TO before me this 11 2017 Municipal Circuit



APPENDIX-IX

COST ESTIMATION

APPENDIX IX: COST ESTIMATION

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APPENDIX IX. COST ESTIMATION

IX.1 Project Cost of MMIP II

IX.1.1 Summary of Project Cost (Case-1)

(1) PHP Version

Particulars				Original Total Cost (PHP Version)	2019	2020	2021	2022	Total
Direct Cost	**CY2019 ODA Program**								
	Irrigation and Drainage Development	1-1.	Construction of the MC-2	254,988,800	38,248,320	101,995,520	89,246,080	25,498,880	254,988,800
		1-2.	Construction of the Lateral under MC-2	206,940,800	31,041,120	82,776,320	72,429,280	20,694,080	206,940,800
		1-3.	Construction of the Main Drainage (MDC)	35,270,400	5,290,560	14,108,160	12,344,640	3,527,040	35,270,400
		1-4.	Construction of the Main Drainage (LDC)	14,713,600	2,207,040	5,885,440	5,149,760	1,471,360	14,713,600
		1-5.	Construction of FAÇADE DRAIN	169,628,800	25,444,320	67,851,520	59,370,080	16,962,880	169,628,800
		1-6.	Flood Protection Works (Canal Slope Protection, Concrete Flume Introduction and Sluice Gates Introduction along the Pulangui River etc.)	0	0	0	0	0	0
		1-7.	Urgent Works for MMIP I Area						
			(1) Supply and delivery of steel gates	5,720,000	858,000	2,288,000	2,002,000	572,000	5,720,000
			(2) Drainage Structures	3,361,600	504,240	1,344,640	1,176,560	336,160	3,361,600
			Sub-total of Direct Cost (a)	**690,624,000**	**103,593,600**	**276,249,600**	**241,718,400**	**69,062,400**	**690,624,000**
	Distribution Infrastructure Improvement	2-1.	Access Road (Intra-site Road) Construction	114,664,000	17,199,600	45,865,600	40,132,400	11,466,400	114,664,000
		2-2.	Bridge Construction (along Access Road)	124,784,000	18,717,600	49,913,600	43,674,400	12,478,400	124,784,000
			Sub-total of Direct Cost (b)	**239,448,000**	**35,917,200**	**95,779,200**	**83,806,800**	**23,944,800**	**239,448,000**
	Agriculture & Extension Development	3-1.	Technical Assistance for Irrigated Rice Production	69,134,472	10,370,171	27,653,789	24,197,065	6,913,447	69,134,472
		3-2.	Enhancement of Agriculture Extension Services at Municipality Level	5,235,215	785,282	2,094,086	1,832,325	523,522	5,235,215
		3-3.	Development of Seed Production	4,326,058	648,909	1,730,423	1,514,120	432,606	4,326,058
			Sub-total of Direct Cost (c)	**78,695,745**	**11,804,362**	**31,478,298**	**27,543,511**	**7,869,575**	**78,695,745**
	Other Related Activities	4-1.	Parcellary Mapping/ Survey						
			(1) Parcellary Survey	1,355,200	203,280	542,080	474,320	135,520	1,355,200
			(2) Construction Survey	1,760,000	264,000	704,000	616,000	176,000	1,760,000
		4-2.	Institutional Development Program (IA establishment)						
			(1) On-Farm Development	3,256,000	488,400	1,302,400	1,139,600	325,600	3,256,000
			(2) IA Strengthening/Organizing	2,525,600	378,840	1,010,240	883,960	252,560	2,525,600
		4-3.	Field Support for Supervision and Monitoring	12,179,200	1,826,880	4,871,680	4,262,720	1,217,920	12,179,200
		4-4.	Project Service Facilities	1,003,200	150,480	401,280	351,120	100,320	1,003,200
		4-5.	Detailed Engineering	20,116,219	3,017,433	8,046,488	7,040,677	2,011,622	20,116,219
		4-6.	Other Administrative Works	30,174,328	4,526,149	12,069,731	10,561,015	3,017,433	30,174,328
			Sub-total of Direct Cost (d)	**72,369,747**	**10,855,462**	**28,947,899**	**25,329,412**	**7,236,975**	**72,369,747**
	Total of Direct Cost (A) = (a) + (b) + (c) + (d)			**1,081,137,492**	**162,170,624**	**432,454,997**	**378,398,122**	**108,113,749**	**1,081,137,492**
Indirect Cost	Land Acquisition	(1)	Irrigation and Drainage Development	7,410,000	3,705,000	3,705,000	0	0	7,410,000
		(2)	Distribution Infrastructure Improvement (Access Road)	3,710,000	1,855,000	1,855,000	0	0	3,710,000
			Total of Land Acquisition (e)	**11,120,000**	**5,560,000**	**5,560,000**	**0**	**0**	**11,120,000**
	VAT	(1)	Direct Cost	143,084,565	21,462,685	57,233,826	50,079,598	14,308,457	143,084,565
		(2)	Land Acquisition	0	0	0	0	0	0
			Total of Land VAT (f)	**143,084,565**	**21,462,685**	**57,233,826**	**50,079,598**	**14,308,457**	**143,084,565**
	Price Escalation	(1)	Direct Cost	-	3,081,242	16,606,272	21,984,931	8,454,495	50,126,940
		(2)	Land Acquisition	-	105,640	213,504	0	0	319,144
			Total of Land Price Escalation (g)	**-**	**3,186,882**	**16,819,776**	**21,984,931**	**8,454,495**	**50,446,084**
	Physical Contingency	(1)	Direct Cost	-	0	0	0	63,717,450	63,717,450
		(2)	Land Acquisition	-	0	0	0	571,957	571,957
			Total of Physical Contingency (h)	**-**	**0**	**0**	**0**	**64,289,407**	**64,289,407**
	Total of Indirect Cost (B) = (e) + (f) + (g) + (h)			**-**	**30,209,567**	**79,613,602**	**72,064,529**	**87,052,359**	**268,940,056**
Grand Total = (A) + (B)				**-**	**192,380,190**	**512,068,599**	**450,462,651**	**195,166,108**	**1,350,077,549**

(2) JPY Version

Particulars				Original Total Cost (JPY Version)	2019	2020	2021	2022	Total
Direct Cost	**CY2019 ODA Program**								
	Irrigation and Drainage Development	1-1.	Construction of the MC-2	527,826,816	79,174,022	211,130,726	184,739,386	52,782,682	527,826,816
		1-2.	Construction of the Lateral under MC-2	428,367,456	64,255,118	171,346,982	149,928,610	42,836,746	428,367,456
		1-3.	Construction of the Main Drainage (MDC)	73,009,728	10,951,459	29,203,891	25,553,405	7,300,973	73,009,728
		1-4.	Construction of the Main Drainage (LDC)	30,457,152	4,568,573	12,182,861	10,660,003	3,045,715	30,457,152
		1-5.	Construction of FAÇADE DRAIN	351,131,616	52,669,742	140,452,646	122,896,066	35,113,162	351,131,616
		1-6.	Flood Protection Works (Canal Slope Protection, Concrete Flume Introduction and Sluice Gates Introduction along the Pulangui River etc.)	0	0	0	0	0	0
		1-7.	Urgent Works for MMIP I Area						
			(1) Supply and delivery of steel gates	11,840,400	1,776,060	4,736,160	4,144,140	1,184,040	11,840,400
			(2) Drainage Structures	6,958,512	1,043,777	2,783,405	2,435,479	695,851	6,958,512
			Sub-total of Direct Cost (a)	**1,429,591,680**	**214,438,752**	**571,836,672**	**500,357,088**	**142,959,168**	**1,429,591,680**
	Distribution Infrastructure Improvement	2-1.	Access Road (Intra-site Road) Construction	237,354,480	35,603,172	94,941,792	83,074,068	23,735,448	237,354,480
		2-2.	Bridge Construction (along Access Road)	258,302,880	38,745,432	103,321,152	90,406,008	25,830,288	258,302,880
			Sub-total of Direct Cost (b)	**495,657,360**	**74,348,604**	**198,262,944**	**173,480,076**	**49,565,736**	**495,657,360**
	Agriculture & Extension Development	3-1.	Technical Assistance for Irrigated Rice Production	143,108,357	21,466,254	57,243,343	50,087,925	14,310,836	143,108,357
		3-2.	Enhancement of Agriculture Extension Services at Municipality Level	10,836,895	1,625,534	4,334,758	3,792,913	1,083,690	10,836,895
		3-3.	Development of Seed Production	8,954,940	1,343,241	3,581,976	3,134,229	895,494	8,954,940
			Sub-total of Direct Cost (c)	**162,900,192**	**24,435,029**	**65,160,077**	**57,015,067**	**16,290,019**	**162,900,192**
	Other Related Activities	4-1.	Parcellary Mapping/ Survey						
			(1) Parcellary Survey	2,805,264	420,790	1,122,106	981,842	280,526	2,805,264
			(2) Construction Survey	3,643,200	546,480	1,457,280	1,275,120	364,320	3,643,200
		4-2.	Institutional Development Program (IA establishment)						
			(1) On-Farm Development	6,739,920	1,010,988	2,695,968	2,358,972	673,992	6,739,920
			(2) IA Strengthening/Organizing	5,227,992	784,199	2,091,197	1,829,797	522,799	5,227,992
		4-3.	Field Support for Supervision and Monitoring	25,210,944	3,781,642	10,084,378	8,823,830	2,521,094	25,210,944
		4-4.	Project Service Facilities	2,076,624	311,494	830,650	726,818	207,662	2,076,624
		4-5.	Detailed Engineering	41,640,573	6,246,086	16,656,229	14,574,201	4,164,057	41,640,573
		4-6.	Other Administrative Works	62,460,860	9,369,129	24,984,344	21,861,301	6,246,086	62,460,860
			Sub-total of Direct Cost (d)	**149,805,377**	**22,470,807**	**59,922,151**	**52,431,882**	**14,980,538**	**149,805,377**
	Total of Direct Cost (A) = (a) + (b) + (c) + (d)			**2,237,954,609**	**335,693,191**	**895,181,844**	**783,284,113**	**223,795,461**	**2,237,954,609**
Indirect Cost	Land Acquisition	(1)	Irrigation and Drainage Development	15,338,700	7,669,350	7,669,350	0	0	15,338,700
		(2)	Distribution Infrastructure Improvement (Access Road)	7,679,700	3,839,850	3,839,850	0	0	7,679,700
			Total of Land Acquisition (e)	**23,018,400**	**11,509,200**	**11,509,200**	**0**	**0**	**23,018,400**
	VAT	(1)	Direct Cost	296,185,050	44,427,758	118,474,020	103,664,768	29,618,505	296,185,050
		(2)	Land Acquisition	0	0	0	0	0	0
			Total of Land VAT (f)	**296,185,050**	**44,427,758**	**118,474,020**	**103,664,768**	**29,618,505**	**296,185,050**
	Price Escalation	(1)	Direct Cost	-	6,378,171	34,374,983	45,508,807	17,500,805	103,762,765
		(2)	Land Acquisition	-	218,675	441,953	0	0	660,628
			Total of Land Price Escalation (g)	**-**	**6,596,845**	**34,816,936**	**45,508,807**	**17,500,805**	**104,423,394**
	Physical Contingency	(1)	Direct Cost		0	0	0	131,895,121	131,895,121
		(2)	Land Acquisition		0	0	0	1,183,951	1,183,951
			Total of Physical Contingency (h)	**-**	**0**	**0**	**0**	**133,079,073**	**133,079,073**
	Total of Indirect Cost (B) = (e) + (f) + (g) + (h)			**-**	**62,533,803**	**164,800,156**	**149,173,575**	**180,198,383**	**556,705,916**
Grand Total = (A) + (B)				**-**	**398,226,994**	**1,059,982,000**	**932,457,688**	**403,993,844**	**2,794,660,525**

IX.1.2 Summary of Project Cost (Case-2)

(1) PHP Version

Particulars				Original Total Cost (PHP Version)	2019	2020	2021	2022	Total
Direct Cost	**CY2019 ODA Program**								
	Irrigation and Drainage Development	1-1.	Construction of the MC-2	680,961,600	102,144,240	272,384,640	238,336,560	68,096,160	680,961,600
		1-2.	Construction of the Lateral under MC-2	274,507,200	41,176,080	109,802,880	96,077,520	27,450,720	274,507,200
		1-3.	Construction of the Main Drainage (MDC)	35,270,400	5,290,560	14,108,160	12,344,640	3,527,040	35,270,400
		1-4.	Construction of the Main Drainage (LDC)	14,713,600	2,207,040	5,885,440	5,149,760	1,471,360	14,713,600
		1-5.	Construction of FAÇADE DRAIN	169,628,800	25,444,320	67,851,520	59,370,080	16,962,880	169,628,800
		1-6.	Flood Protection Works (Canal Slope Protection, Concrete Flume Introduction and Sluice Gates Introduction along the Pulangui River etc.)	269,649,600	40,447,440	107,859,840	94,377,360	26,964,960	269,649,600
		1-7.	Urgent Works for MMIP I Area						
			(1) Supply and delivery of steel gates	5,720,000	858,000	2,288,000	2,002,000	572,000	5,720,000
			(2) Drainage Structures	3,361,600	504,240	1,344,640	1,176,560	336,160	3,361,600
			Sub-total of Direct Cost (a)	**1,453,812,800**	**218,071,920**	**581,525,120**	**508,834,480**	**145,381,280**	**1,453,812,800**
	Distribution Infrastructure Improvement	2-1.	Access Road (Intra-site Road) Construction	141,504,000	21,225,600	56,601,600	49,526,400	14,150,400	141,504,000
		2-2.	Bridge Construction (along Access Road)	146,344,000	21,951,600	58,537,600	51,220,400	14,634,400	146,344,000
			Sub-total of Direct Cost (b)	**287,848,000**	**43,177,200**	**115,139,200**	**100,746,800**	**28,784,800**	**287,848,000**
	Agriculture & Extension Development	3-1.	Technical Assistance for Irrigated Rice Production	69,134,472	10,370,171	27,653,789	24,197,065	6,913,447	69,134,472
		3-2.	Enhancement of Agriculture Extension Services at Municipality Level	5,235,215	785,282	2,094,086	1,832,325	523,522	5,235,215
		3-3.	Development of Seed Production	4,326,058	648,909	1,730,423	1,514,120	432,606	4,326,058
			Sub-total of Direct Cost (c)	**78,695,745**	**11,804,362**	**31,478,298**	**27,543,511**	**7,869,575**	**78,695,745**
	Other Related Activities	4-1.	Parcellary Mapping/ Survey						
			(1) Parcellary Survey	2,640,000	396,000	1,056,000	924,000	264,000	2,640,000
			(2) Construction Survey	3,423,200	513,480	1,369,280	1,198,120	342,320	3,423,200
		4-2.	Institutional Development Program (IA establishment)						
			(1) On-Farm Development	6,732,000	1,009,800	2,692,800	2,356,200	673,200	6,732,000
			(2) IA Strengthening/Organizing	5,218,400	782,760	2,087,360	1,826,440	521,840	5,218,400
		4-3.	Field Support for Supervision and Monitoring	23,707,200	3,556,080	9,482,880	8,297,520	2,370,720	23,707,200
		4-4.	Project Service Facilities	1,944,800	291,720	777,920	680,680	194,480	1,944,800
		4-5.	Detailed Engineering	34,036,411	5,105,462	13,614,564	11,912,744	3,403,641	34,036,411
		4-6.	Other Administrative Works	51,054,616	7,658,192	20,421,847	17,869,116	5,105,462	51,054,616
			Sub-total of Direct Cost (d)	**128,756,627**	**19,313,494**	**51,502,651**	**45,064,820**	**12,875,663**	**128,756,627**
	Total of Direct Cost (A) = (a) + (b) + (c) + (d)			**1,949,113,172**	**292,366,976**	**779,645,269**	**682,189,610**	**194,911,317**	**1,949,113,172**
Indirect Cost	Land Acquisition	(1)	Irrigation and Drainage Development	14,380,000	7,190,000	7,190,000	0	0	14,380,000
		(2)	Distribution Infrastructure Improvement (Access Road)	4,624,000	2,312,000	2,312,000	0	0	4,624,000
			Total of Land Acquisition (e)	**19,004,000**	**9,502,000**	**9,502,000**	**0**	**0**	**19,004,000**
	VAT	(1)	Direct Cost	258,439,389	38,765,908	103,375,756	90,453,786	25,843,939	258,439,389
		(2)	Land Acquisition	0	0	0	0	0	0
			Total of Land VAT (f)	**258,439,389**	**38,765,908**	**103,375,756**	**90,453,786**	**25,843,939**	**258,439,389**
	Price Escalation	(1)	Direct Cost	-	5,554,973	29,938,378	39,635,216	15,242,065	90,370,632
		(2)	Land Acquisition	-	180,538	364,877	0	0	545,415
			Total of Land Price Escalation (g)	**-**	**5,735,511**	**30,303,255**	**39,635,216**	**15,242,065**	**90,916,047**
	Physical Contingency	(1)	Direct Cost	-	0	0	0	114,896,160	114,896,160
		(2)	Land Acquisition	-	0	0	0	977,471	977,471
			Total of Physical Contingency (h)	**-**	**0**	**0**	**0**	**115,873,630**	**115,873,630**
	Total of Indirect Cost (B) = (e) + (f) + (g) + (h)			-	**54,003,419**	**143,181,011**	**130,089,003**	**156,959,634**	**484,233,067**
Grand Total = (A) + (B)				-	**346,370,395**	**922,826,280**	**812,278,613**	**351,870,952**	**2,433,346,239**

(2) JPY Version

Particulars				Original Total Cost (JPY Version)	2019	2020	2021	2022	Total
Direct Cost	**CY2019 ODA Program**								
	Irrigation and Drainage Development	1-1.	Construction of the MC-2	1,409,590,512	211,438,577	563,836,205	493,356,679	140,959,051	1,409,590,512
		1-2.	Construction of the Lateral under MC-2	568,229,904	85,234,486	227,291,962	198,880,466	56,822,990	568,229,904
		1-3.	Construction of the Main Drainage (MDC)	73,009,728	10,951,459	29,203,891	25,553,405	7,300,973	73,009,728
		1-4.	Construction of the Main Drainage (LDC)	30,457,152	4,568,573	12,182,861	10,660,003	3,045,715	30,457,152
		1-5.	Construction of FAÇADE DRAIN	351,131,616	52,669,742	140,452,646	122,896,066	35,113,162	351,131,616
		1-6.	Flood Protection Works (Canal Slope Protection, Concrete Flume Introduction and Sluice Gates Introduction along the Pulangui River etc.)	558,174,672	83,726,201	223,269,869	195,361,135	55,817,467	558,174,672
		1-7.	Urgent Works for MMIP I Area						
			(1) Supply and delivery of steel gates	11,840,400	1,776,060	4,736,160	4,144,140	1,184,040	11,840,400
			(2) Drainage Structures	6,958,512	1,043,777	2,783,405	2,435,479	695,851	6,958,512
			Sub-total of Direct Cost (a)	**3,009,392,496**	**451,408,874**	**1,203,756,998**	**1,053,287,374**	**300,939,250**	**3,009,392,496**
	Distribution Infrastructure Improvement	2-1.	Access Road (Intra-site Road) Construction	292,913,280	43,936,992	117,165,312	102,519,648	29,291,328	292,913,280
		2-2.	Bridge Construction (along Access Road)	302,932,080	45,439,812	121,172,832	106,026,228	30,293,208	302,932,080
			Sub-total of Direct Cost (b)	**595,845,360**	**89,376,804**	**238,338,144**	**208,545,876**	**59,584,536**	**595,845,360**
	Agriculture & Extension Development	3-1.	Technical Assistance for Irrigated Rice Production	143,108,357	21,466,254	57,243,343	50,087,925	14,310,836	143,108,357
		3-2.	Enhancement of Agriculture Extension Services at Municipality Level	10,836,895	1,625,534	4,334,758	3,792,913	1,083,690	10,836,895
		3-3.	Development of Seed Production	8,954,940	1,343,241	3,581,976	3,134,229	895,494	8,954,940
			Sub-total of Direct Cost (c)	**162,900,192**	**24,435,029**	**65,160,077**	**57,015,067**	**16,290,019**	**162,900,192**
	Other Related Activities	4-1.	Parcellary Mapping/ Survey						
			(1) Parcellary Survey	5,464,800	819,720	2,185,920	1,912,680	546,480	5,464,800
			(2) Construction Survey	7,086,024	1,062,904	2,834,410	2,480,108	708,602	7,086,024
		4-2.	Institutional Development Program (IA establishment)						
			(1) On-Farm Development	13,935,240	2,090,286	5,574,096	4,877,334	1,393,524	13,935,240
			(2) IA Strengthening/Organizing	10,802,088	1,620,313	4,320,835	3,780,731	1,080,209	10,802,088
		4-3.	Field Support for Supervision and Monitoring	49,073,904	7,361,086	19,629,562	17,175,866	4,907,390	49,073,904
		4-4.	Project Service Facilities	4,025,736	603,860	1,610,294	1,409,008	402,574	4,025,736
		4-5.	Detailed Engineering	70,455,371	10,568,306	28,182,148	24,659,380	7,045,537	70,455,371
		4-6.	Other Administrative Works	105,683,056	15,852,458	42,273,222	36,989,070	10,568,306	105,683,056
			Sub-total of Direct Cost (d)	**266,526,218**	**39,978,933**	**106,610,487**	**93,284,176**	**26,652,622**	**266,526,218**
	Total of Direct Cost (A) = (a) + (b) + (c) + (d)			**4,034,664,267**	**605,199,640**	**1,613,865,707**	**1,412,132,493**	**403,466,427**	**4,034,664,267**
Indirect Cost	Land Acquisition	(1)	Irrigation and Drainage Development	29,766,600	14,883,300	14,883,300	0	0	29,766,600
		(2)	Distribution Infrastructure Improvement (Access Road)	9,571,680	4,785,840	4,785,840	0	0	9,571,680
			Total of Land Acquisition (e)	**39,338,280**	**19,669,140**	**19,669,140**	**0**	**0**	**39,338,280**
	VAT	(1)	Direct Cost	534,969,536	80,245,430	213,987,814	187,239,338	53,496,954	534,969,536
		(2)	Land Acquisition	0	0	0	0	0	0
			Total of Land VAT (f)	**534,969,536**	**80,245,430**	**213,987,814**	**187,239,338**	**53,496,954**	**534,969,536**
	Price Escalation	(1)	Direct Cost	-	11,498,793	61,972,443	82,044,898	31,551,075	187,067,209
		(2)	Land Acquisition	-	373,714	755,295	0	0	1,129,009
			Total of Land Price Escalation (g)	**-**	**11,872,507**	**62,727,738**	**82,044,898**	**31,551,075**	**188,196,217**
	Physical Contingency	(1)	Direct Cost		0	0	0	237,835,051	237,835,051
		(2)	Land Acquisition		0	0	0	2,023,364	2,023,364
			Total of Physical Contingency (h)	**-**	**0**	**0**	**0**	**239,858,415**	**239,858,415**
	Total of Indirect Cost (B) = (e) + (f) + (g) + (h)			**-**	**111,787,077**	**296,384,692**	**269,284,235**	**324,906,443**	**1,002,362,448**
Grand Total = (A) + (B)				**-**	**716,986,717**	**1,910,250,399**	**1,681,416,729**	**728,372,870**	**5,037,026,715**

IX.1.3 Summary of Project Cost (Same Condition as NIA's Estimation)

For the sake of comparison between NIA's estimation and JICA Team's estimation for remaining civil works of MMIP II project area, the cost of "Distribution Infrastructure Improvement", "Agriculture & Extension Development" and "Price Escalation" were excluded from the JICA Team's estimation. The result of these estimations have been referred

(1) Case-1 (PHP Version)

Particulars				Original Total Cost (PHP Version)	2019	2020	2021	2022	Total
Direct Cost	**CY2019 ODA Program**								
	Irrigation and Drainage Development	1-1.	Construction of the MC-2	254,988,800	38,248,320	101,995,520	89,246,080	25,498,880	254,988,800
		1-2.	Construction of the Lateral under MC-2	206,940,800	31,041,120	82,776,320	72,429,280	20,694,080	206,940,800
		1-3.	Construction of the Main Drainage (MDC)	35,270,400	5,290,560	14,108,160	12,344,640	3,527,040	35,270,400
		1-4.	Construction of the Main Drainage (LDC)	14,713,600	2,207,040	5,885,440	5,149,760	1,471,360	14,713,600
		1-5.	Construction of FAÇADE DRAIN	169,628,800	25,444,320	67,851,520	59,370,080	16,962,880	169,628,800
		1-6.	Flood Protection Works (Canal Slope Protection, Concrete Flume Introduction and Sluice Gates Introduction along the Pulangui River etc.)	0	0	0	0	0	0
		1-7.	Urgent Works for MMIP I Area						
			(1) Supply and delivery of steel gates	5,720,000	858,000	2,288,000	2,002,000	572,000	5,720,000
			(2) Drainage Structures	3,361,600	504,240	1,344,640	1,176,560	336,160	3,361,600
			Sub-total of Direct Cost (a)	**690,624,000**	**103,593,600**	**276,249,600**	**241,718,400**	**69,062,400**	**690,624,000**
	Distribution Infrastructure Improvement	2-1.	Access Road (Intra-site Road) Construction	0	0	0	0	0	0
		2-2.	Bridge Construction (along Access Road)	0	0	0	0	0	0
			Sub-total of Direct Cost (b)	**0**	**0**	**0**	**0**	**0**	**0**
	Agriculture & Extension Development	3-1.	Technical Assistance for Irrigated Rice Production	0	0	0	0	0	0
		3-2.	Enhancement of Agriculture Extension Services at Municipality Level	0	0	0	0	0	0
		3-3.	Development of Seed Production	0	0	0	0	0	0
			Sub-total of Direct Cost (c)	**0**	**0**	**0**	**0**	**0**	**0**
	Other Related Activities	4-1.	Parcellary Mapping/ Survey						
			(1) Parcellary Survey	1,355,200	203,280	542,080	474,320	135,520	1,355,200
			(2) Construction Survey	1,760,000	264,000	704,000	616,000	176,000	1,760,000
		4-2.	Institutional Development Program (IA establishment)						
			(1) On-Farm Development	3,256,000	488,400	1,302,400	1,139,600	325,600	3,256,000
			(2) IA Strengthening/Organizing	2,525,600	378,840	1,010,240	883,960	252,560	2,525,600
		4-3.	Field Support for Supervision and Monitoring	12,179,200	1,826,880	4,871,680	4,262,720	1,217,920	12,179,200
		4-4.	Project Service Facilities	1,003,200	150,480	401,280	351,120	100,320	1,003,200
		4-5.	Detailed Engineering	13,753,344	2,063,002	5,501,338	4,813,670	1,375,334	13,753,344
		4-6.	Other Administrative Works	20,630,016	3,094,502	8,252,006	7,220,506	2,063,002	20,630,016
			Sub-total of Direct Cost (b)	**56,462,560**	**8,469,384**	**22,585,024**	**19,761,896**	**5,646,256**	**56,462,560**
			Total of Direct Cost (A) = (a) + (b)	**747,086,560**	**112,062,984**	**298,834,624**	**261,480,296**	**74,708,656**	**747,086,560**
Indirect Cost	Land Acquisition	(1)	Irrigation and Drainage Development	7,410,000	3,705,000	3,705,000	0	0	7,410,000
			Total of Land Acquisition (c)	**7,410,000**	**3,705,000**	**3,705,000**	**0**	**0**	**7,410,000**
	VAT	(1)	Direct Cost	98,905,968	14,835,895	39,562,387	34,617,089	9,890,597	98,905,968
		(2)	Land Acquisition	0	0	0	0	0	0
			Total of Land VAT (d)	**98,905,968**	**14,835,895**	**39,562,387**	**34,617,089**	**9,890,597**	**98,905,968**
	Physical Contingency	(1)	Direct Cost	-	0	0	0	42,299,626	42,299,626
		(2)	Land Acquisition	-	0	0	0	370,500	370,500
			Total of Physical Contingency (e)	**-**	**0**	**0**	**0**	**42,670,126**	**42,670,126**
			Total of Indirect Cost (B) = (c) + (d) + (e)	**-**	**18,540,895**	**43,267,387**	**34,617,089**	**52,560,723**	**148,986,094**
			Grand Total = (A) + (B)	**-**	**130,603,879**	**342,102,011**	**296,097,385**	**127,269,379**	**896,072,654**

(2) Case-2 (PHP Version)

Particulars				Original Total Cost (PHP Version)	2019	2020	2021	2022	Total
Direct Cost	**CY2019 ODA Program**								
	Irrigation and Drainage Development	1-1.	Construction of the MC-2	680,961,600	102,144,240	272,384,640	238,336,560	68,096,160	680,961,600
		1-2.	Construction of the Lateral under MC-2	274,507,200	41,176,080	109,802,880	96,077,520	27,450,720	274,507,200
		1-3.	Construction of the Main Drainage (MDC)	35,270,400	5,290,560	14,108,160	12,344,640	3,527,040	35,270,400
		1-4.	Construction of the Main Drainage (LDC)	14,713,600	2,207,040	5,885,440	5,149,760	1,471,360	14,713,600
		1-5.	Construction of FAÇADE DRAIN	169,628,800	25,444,320	67,851,520	59,370,080	16,962,880	169,628,800
		1-6.	Flood Protection Works (Canal Slope Protection, Concrete Flume Introduction and Sluice Gates Introduction along the Pulangui River etc.)	269,649,600	40,447,440	107,859,840	94,377,360	26,964,960	269,649,600
		1-7.	Urgent Works for MMIP I Area						
			(1) Supply and delivery of steel gates	5,720,000	858,000	2,288,000	2,002,000	572,000	5,720,000
			(2) Drainage Structures	3,361,600	504,240	1,344,640	1,176,560	336,160	3,361,600
			Sub-total of Direct Cost (a)	**1,453,812,800**	**218,071,920**	**581,525,120**	**508,834,480**	**145,381,280**	**1,453,812,800**
	Distribution Infrastructure Improvement	2-1.	Access Road (Intra-site Road) Construction	0	0	0	0	0	0
		2-2.	Bridge Construction (along Access Road)	0	0	0	0	0	0
			Sub-total of Direct Cost (b)	**0**	**0**	**0**	**0**	**0**	**0**
	Agriculture & Extension Development	3-1.	Technical Assistance for Irrigated Rice Production	0	0	0	0	0	0
		3-2.	Enhancement of Agriculture Extension Services at Municipality Level	0	0	0	0	0	0
		3-3.	Development of Seed Production	0	0	0	0	0	0
			Sub-total of Direct Cost (c)	**0**	**0**	**0**	**0**	**0**	**0**
	Other Related Activities	4-1.	Parcellary Mapping/ Survey						
			(1) Parcellary Survey	2,640,000	396,000	1,056,000	924,000	264,000	2,640,000
			(2) Construction Survey	3,423,200	513,480	1,369,280	1,198,120	342,320	3,423,200
		4-2.	Institutional Development Program (IA establishment)						
			(1) On-Farm Development	6,732,000	1,009,800	2,692,800	2,356,200	673,200	6,732,000
			(2) IA Strengthening/Organizing	5,218,400	782,760	2,087,360	1,826,440	521,840	5,218,400
		4-3.	Field Support for Supervision and Monitoring	23,707,200	3,556,080	9,482,880	8,297,520	2,370,720	23,707,200
		4-4.	Project Service Facilities	1,944,800	291,720	777,920	680,680	194,480	1,944,800
		4-5.	Detailed Engineering	26,705,536	4,005,830	10,682,214	9,346,938	2,670,554	26,705,536
		4-6.	Other Administrative Works	40,058,304	6,008,746	16,023,322	14,020,406	4,005,830	40,058,304
			Sub-total of Direct Cost (b)	**110,429,440**	**16,564,416**	**44,171,776**	**38,650,304**	**11,042,944**	**110,429,440**
	Total of Direct Cost (A) = (a) + (b)			**1,564,242,240**	**234,636,336**	**625,696,896**	**547,484,784**	**156,424,224**	**1,564,242,240**
Indirect Cost	Land Acquisition	(1)	Irrigation and Drainage Development	14,380,000	7,190,000	7,190,000	0	0	14,380,000
			Total of Land Acquisition (c)	**14,380,000**	**7,190,000**	**7,190,000**	**0**	**0**	**14,380,000**
	VAT	(1)	Direct Cost	207,539,792	31,130,969	83,015,917	72,638,927	20,753,979	207,539,792
		(2)	Land Acquisition	0	0	0	0	0	0
			Total of Land VAT (d)	**207,539,792**	**31,130,969**	**83,015,917**	**72,638,927**	**20,753,979**	**207,539,792**
	Physical Contingency	(1)	Direct Cost	-	0	0	0	88,589,102	88,589,102
		(2)	Land Acquisition	-	0	0	0	719,000	719,000
			Total of Physical Contingency (e)	**-**	**0**	**0**	**0**	**89,308,102**	**89,308,102**
	Total of Indirect Cost (B) = (c) + (d) + (e)			**-**	**38,320,969**	**90,205,917**	**72,638,927**	**110,062,081**	**311,227,894**
Grand Total = (A) + (B)				**-**	**272,957,305**	**715,902,813**	**620,123,711**	**266,486,305**	**1,875,470,134**

IX.2 Project Cost of MMIP III

IX.2.1 Summary of Project Cost for MMIP III

(1) PHP Version

Particulars				Original Total Cost (PHP Version)	Project Cost (million PHP)				
					1st Year	2nd Year	3rd Year	4th Year	Total
MMIP III Project	Direct Cost	III-1	Rehabilitation of MMIP I Area (MSA & UMSA)	149,600,000	22,440,000	59,840,000	52,360,000	14,960,000	149,600,000
		III-2	Improvement of MMIP II Area (UMSA, LMSA and PESA)	101,490,400	15,223,560	40,596,160	35,521,640	10,149,040	101,490,400
		III-3	Procurement of Machineries (for Maintenance)	126,425,121	18,963,768	50,570,048	44,248,792	12,642,512	126,425,121
			Sub-total of Direct Cost (A)	**377,515,521**	**56,627,328**	**151,006,208**	**132,130,432**	**37,751,552**	**377,515,521**
	Indirect Cost		VAT	34,239,600	5,135,940	13,695,840	11,983,860	3,423,960	34,239,600
			Physical Contingency	18,875,776	2,831,366	7,550,310	6,606,522	1,887,578	18,875,776
			Administration Cost	19,819,565	2,972,935	7,927,826	6,936,848	1,981,956	19,819,565
			Sub-total of Indirect Cost (B)	**72,934,941**	**10,940,241**	**29,173,976**	**25,527,229**	**7,293,494**	**72,934,941**
Grand Total = (A) + (B)				**450,450,462**	**67,567,569**	**180,180,185**	**157,657,662**	**45,045,046**	**450,450,462**

(2) JPY Version

Particulars				Original Total Cost (JPY Version)	Project Cost (million JPY)				
					1st Year	2nd Year	3rd Year	4th Year	Total
MMIP III Project	Direct Cost	III-1	Rehabilitation of MMIP I Area (MSA & UMSA)	309,672,000	46,450,800	123,868,800	108,385,200	30,967,200	309,672,000
		III-2	Improvement of MMIP II Area (UMSA, LMSA and PESA)	210,085,128	31,512,769	84,034,051	73,529,795	21,008,513	210,085,128
		III-3	Procurement of Machineries (for Maintenance)	261,700,000	39,255,000	104,680,000	91,595,000	26,170,000	261,700,000
			Sub-total of Direct Cost (A)	**781,457,128**	**117,218,569**	**312,582,851**	**273,509,995**	**78,145,713**	**781,457,128**
	Indirect Cost		VAT	70,875,972	10,631,396	28,350,389	24,806,590	7,087,597	70,875,972
			Physical Contingency	39,072,856	5,860,928	15,629,143	13,675,500	3,907,286	39,072,856
			Administration Cost	41,026,499	6,153,975	16,410,600	14,359,275	4,102,650	41,026,499
			Sub-total of Indirect Cost (B)	**150,975,328**	**22,646,299**	**60,390,131**	**52,841,365**	**15,097,533**	**150,975,328**
Grand Total = (A) + (B)				**932,432,456**	**139,864,868**	**372,972,982**	**326,351,360**	**93,243,246**	**932,432,456**

IX.2.2 List and Direct Cost of Maintenance Machineries

No.	Equipment Name	Specification	Nos.	Unit Cost (JPY)	Cost (JPY)	Remark
1. Maintenance Machineries						
1-1. Maintenance Machineries (NIA's Request)						
(1)	Dump Truck	332HP(246kW), Loading Capa. 10 ton	6	13,000,000	78,000,000	NIA's Request
(2)	Hydraulic Excavator	Bucket 0.8m3(0.6m3), 20 ton	1	13,300,000	13,300,000	NIA's Request
(3)	Long Armed Hydraulic Excavator	Bucket 0.4m3(0.3m3), 22 ton	1	15,200,000	15,200,000	NIA's Request
(4)	Motor Grader	120 HP (89kW), 10 ton	1	9,840,000	9,840,000	NIA's Request
(5)	Wheel Loader (Front-End Loader)	Bucket 1.3~1.4m3, 6.9 ton	1	6,900,000	6,900,000	NIA's Request
(6)	Compactor (Tamping Roller)	10 ton, Vibratory	1	1,360,000	1,360,000	NIA's Request
(7)	Service Vehicle		1	3,500,000	3,500,000	NIA's Request
				Sub-total (a)	**128,100,000**	
1-2. Maintenance Machineries (JICA Propose)						
(1)	Track Dozer	90HP (67kW), 10 ton	1	8,590,000	8,590,000	Additional Plan
(2)	Hydraulic Excavator	Bucket 0.28m3(0.20m3), 7 ton	4	5,330,000	21,320,000	Additional Plan
(3)	Steel Wheel Static Roller	76HP (56kW), 3 Wheels, 10~12t	1	7,630,000	7,630,000	Additional Plan
(4)	Vibratory Roller	Hand Guide, 12HP (9kW), 0.6t	2	1,200,000	2,400,000	Additional Plan
(5)	Vibratory Plate Compactor	4HP (3kW), 0.06t	2	300,000	600,000	Additional Plan
(6)	Forklift	41HP(30kW), Loading Capa. 2.0 ton	1	1,700,000	1,700,000	Additional Plan
(7)	Generator Set	20 kVA	2	1,440,000	2,880,000	Additional Plan
(8)	Concrete Mixer	HP10 (7.5kW), 0.35m3	1	2,660,000	2,660,000	Additional Plan
(9)	Concrete Mixer	HP15 (11kW), 0.20m3	1	1,590,000	1,590,000	Additional Plan
(10)	Jeep	4 Wheel Drive	2	3,000,000	6,000,000	Additional Plan
(11)	Pick-up	2t	2	3,000,000	6,000,000	Additional Plan
(12)	Farm Tractor	HP24 (718kW), Crawler (Rear Wheel)	1	3,000,000	3,000,000	Additional Plan
				Sub-total (a)	**64,370,000**	
				Sub-total (c) = (a)+(b)	**192,470,000**	
2. Spare Parts						
(1)	Spare Parts (for all Equipment)	10% of Equipment Price	1 lot	19,200,000	19,200,000	
				Sub-total (d)	**19,200,000**	
3. transportation and Training						
(1)	Ocean Freight, Inland Transportation, Insurance, Training for Equipment etc.		1 lot	50,000,000	50,000,000	
				Sub-total (e)	**50,000,000**	
				Total (c)+(d)+(e)	**261,670,000**	

(261.7 million JPY)

(115.8 million PHP)

APPENDIX-X

PROJECT EVALUATION

APPENDIX X: PROJECT EVALUATION

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APPENDIX X. PROJECT EVALUATION

X.1 Economic Analysis of Initially Proposed Options

To identify efficient options among initially proposed plans, economic analysis was conducted as of July 2017, at the time of 1st Interim Report submission. In summary, the result showed that the option that considers foundation treatment in addition to extra-banking was not economically feasible because the cost was too high. Firstly, following shows how evaluation cases established.

On engineering perspective, four alternative are considered regarding dyke construction, e.g., 1) original design by NIA-PMO (that is called "alternative-3" in the evaluation), 2) an alternative which extra banking is considered to cope with consolidation settlement ("alternative-2"), and 3) an alternative which foundation treatment is considered in addition to the extra embankment ("alternative-1"). Alternative-1 has the largest beneficial areas with highest project cost followed by Alternative-2. While Alternative-3 has smallest beneficial areas with lowest project cost. In terms of cost-efficiency, the superiority or inferiority among the alternatives are qualitatively uncertain and should be determined quantitatively. Economic Internal Rate of Return (EIRR) is applied as the indicator of the comparison.

However, most economically efficient option does not necessary mean that the option is economically feasible. To evaluate whether the proposed plans are economically feasible or not, the EIRR shall be judged by comparing with Social Discount Ratio in the Philippines. Although the Social Discount Ratio in the Philippines is not established yet, according to NEDA, 10% is applied with practices of similar project in the irrigation/agriculture sector in the country. Therefore, the EIRR should be more than 10% otherwise the possible plans cannot be justified.

One problem is that the results may change depending on the definition and scope of "the project". As the feasibility study of Japanese Yen-Loan project, "The project" shall cover only the target area once planned to be financed by ODA loan (2,133 ha of south-eastern part of Lower Malitubog Service Area). In that case, the economic efficiency should be judged based on the costs and benefits to be occurred in ODA target area. While on the standpoint of NIA project, not only ODA target areas but also other areas of LMSA total 6,590 ha shall be taken into consideration. The analysis applied basically former definition, namely, it covers only the costs and benefits to be occurred in ODA target area (cases notified with "OD"). For reference purpose, analysis which included other part of LMSA were also conducted (cases notified with "LM").

Incidentally, the construction in LMSA launched at 2015 and still on-going. Looking at 2018 fiscal year (beginning of detail design), the costs from 2015 to 2017 have already been incurred and cannot be recovered. It is so-called sunk cost and generally not count in project evaluation (cases notified with "SC"). However, one might think that the EIRR could be overestimated if the items expensed 2015-2017 would benefit for the proposed projects and the benefits are inseparable with each other. For example, construction of irrigation canals on upstream service area could benefit future construction in downstream. Therefore, EIRRs, which counted 2015- 2017 expenses as if they were part of the component of "the project", were calculated for reference cases (cases notified with "NS").

Based on above concepts, total 12 cases were established, summarized in Table X.1.1;

- ✓ S.N 1-3 are the cases in which cost invested by NIA till year 2017 is taken as sunk cost, while S.N 4-6 count all the cost for LMSA since the construction commencement year of 2015.
- ✓ S.N 1-6 deals with whole LMSA while S.N 7-9 deals only with the possible ODA loan financing area, the most eastern part of the LMSA.
- ✓ S.N 10-12 consider NO dykes are to be constructed, in that irrigable area will be reduced through cost will be also be reduced.

Table X.1.1 the Cases for Project Evaluation

SN	Case	Dike Construction	Dike Budget	Construction of Dike	Target Area	Project Cost Included in the Evaluation (Base Year)
1	1-1-LM-SC	With Dike	Yen-Loan	Alternative-3	LMSA Total	Only the Budget Between 2018 -2024 (2018 Base Year)
2	1-2-LM-SC	With Dike	Ditto	Alternative-2	LMSA Total	Ditto
3	1-3-LM-SC	With Dike	Ditto	Alternative-1	LMSA Total	Ditto
4	1-1-LM-NC	With Dike	Ditto	Alternative-3	LMSA Total	Including all Budget Between 2015 - 2024(2015 Base Year)
5	1-2-LM-NC	With Dike	Ditto	Alternative-2	LMSA Total	Ditto
6	1-3-LM-NC	With Dike	Ditto	Alternative-1	LMSA Total	Ditto
7	1-1-OD-SC	With Dike	Ditto	Alternative-3	Only ODA Target Area	Only the Budget During 2018 -2024 (2018 Base Year)
8	1-2-OD-SC	With Dike	Ditto	Alternative-2	Only ODA Target Area	Ditto
9	1-3-OD-SC	With Dike	Ditto	Alternative-1	Only ODA Target Area	Ditto
10	2-0-LM-SC	Without Dike	N.A	N.A	LMSA Total	Only the Budget During 2018 -2024 (2018 Base Year)
11	2-0-LM-NC	Without Dike	N.A	N.A	LMSA Total	Including all Budget Between 2015 - 2024(2015 Base Year)
12	2-0-OD-SC	Without Dike	N.A	N.A	Only ODA Target Area	Only the Budget During 2018 -2024 (2018 Base Year)

Source: JICA Survey Team

Regarding the costs that has already expensed (2015-2017), should be evaluated at current price level, otherwise, the expenses are underestimated. Hence, all expensed cost were converted into May 2017 price level, by using construction materials wholesale price index. Table X.1.2 shows financial and economic costs by evaluation case at current price and at May 2017 price level.

Table X.1.2 Financial and Economic Cost by Evaluation Case (At 2017 Price Level) , Million Php

Case	Financial Cost			Economic Cost		
	FC	LC	Total	FC	LC	Total
1-1-LM-SC	101.7	4,401.1	4,502.8	83.6	3,557.4	3,641.0
1-2-LM-SC	116.1	4,804.4	4,920.5	95.6	3,884.6	3,980.2
1-3-LM-SC	156.7	10,168.9	10,325.7	119.5	8,227.8	8,347.3
1-1-LM-NC	101.7	5,658.7	5,760.4	83.6	4,557.5	4,641.2
1-2-LM-NC	116.1	6,062.4	6,178.5	95.6	4,885.2	4,980.7
1-3-LM-NC	156.7	11,426.5	11,583.2	119.5	9,228.0	9,347.5
1-1-OD-SC	94.5	2,175.3	2,269.8	79.6	1,772.1	1,851.7
1-2-OD-SC	94.8	2,299.8	2,394.7	79.6	1,872.9	1,952.5
1-3-OD-SC	130.7	4,066.6	4,197.3	107.5	3,304.7	3,412.2
2-0-LM-SC	46.6	1,826.3	1,873.0	39.8	1,470.4	1,510.2
2-0-LM-NC	46.6	3,026.5	3,073.1	39.8	2,425.0	2,464.8
2-0-OD-SC	46.6	871.9	918.5	39.8	711.3	751.1

Source: JICA Survey Team

Table X.1.3 summarizes current and target irrigable area by evaluation case. The estimated planted areas on present (without) condition are shown in 2^{n} – 5^{th} columns of the Table. For instance, the current cultivated area of maize at rainy season was 415 ha in ODA covered area, and 1,087 ha in LMSA overall.

The planted areas on future (with) condition are shown in 6^{th} – 9^{th} columns of same table. With the project, thanks to the construction of protection dike, the arable lands are expected to be fully irrigated aside from minor portion of perennial crops and tree plantation areas. Then, the irrigable area will expand to 2,133ha and 6,590 in ODA covered area and in LMSA respectively. On the other hand, in

the case of without protection dike, the target irrigable area shrunk but still it can irrigate 1,001 ha in ODA covered areas and 3,688 ha in LMSA.

Table X.1.3 Current and Target Irrigable Area by Evaluation Case and by with/without Dike

Case	Rainy Season, Current		Dry Season, Current		Plan with Dykes		Plan Without Dykes	
	Paddy, ha	Maize, ha	Paddy, ha	Maize, ha	RS Paddy, ha	DS Paddy, ha	RS Paddy, ha	DS Paddy, ha
1-1-LM-SC	367	1,087	457	795	6,590	6,590	-	-
1-2-LM-SC	367	1,087	457	795	6,590	6,590	-	-
1-3-LM-SC	367	1,087	457	795	6,590	6,590	-	-
1-1-LM-NC	367	1,087	457	795	6,590	6,590	-	-
1-2-LM-NC	367	1,087	457	795	6,590	6,590	-	-
1-3-LM-NC	367	1,087	457	795	6,590	6,590	-	-
1-1-OD-SC	131	415	154	303	2,133	2,133	-	-
1-2-OD-SC	131	415	154	303	2,133	2,133	-	-
1-3-OD-SC	131	415	154	303	2,133	2,133	-	-
2-0-LM-SC	367	1,087	457	795	-	-	3,688	3,688
2-0-LM-NC	367	1,087	457	795	-	-	3,688	3,688
2-0-OD-SC	131	415	154	303	-	-	1,001	1,001

Source: JICA Survey Team.

The result of economic analysis is summarized in Table X.1.4.

- ✓ Construction costs which include foundation treatment were very huge and respective EIRR were very low, namely, 2.3% for 1-3-LM-SC, 0.1% for 1-3-LM-NC, and -4.0% for 1-3-OD-SC.
- ✓ The EIRR performs well if expense items from 2015 to 2017 can be regarded as sunk cost (18.2% in 1-1-LM-SC, 16.2% in 1-2-LM-SC, and 12.5% in 2-0-LM-SC). For other cases (notified with "LM"), it was not feasible.
- ✓ When it comes to ODA target area, the Case 1-1-OD-SC marked 6.3% in EIRR (no extra banking and no foundation treatment), Case1-2-OD-SC marked 5.6% (only extra banking), and Case 1-3-OD-SC marked -1.5% (extra banking and foundation treatment). Another option made by excluding protection dike from the cases that is equivalent to Case 2-0-OD-SC. It marked 5.9% in EIRR.

Table X.1.4 Summary of Annual Net Benefit, EIRR, NPV, and B/C

SN	Case	Annual Benefit (Million Php)	IRR (%)	NPV (Million Php)	B/C
1	1-1-LM-SC	595.1	12.7%	645	1.18
2	1-2-LM-SC	595.1	11.4%	340	1.09
3	1-3-LM-SC	595.1	1.4%	-3,551	0.54
4	1-1-LM-NC	595.1	9.9%	-28	0.99
5	1-2-LM-NC	595.1	9.0%	-333	0.94
6	1-3-LM-NC	595.1	0.8%	-4,224	0.53
7	1-1-OD-SC	190.4	6.3%	-355	0.79
8	1-2-OD-SC	190.4	5.6%	-304	0.75
9	1-3-OD-SC	190.4	-1.5%	-1,193	0.43
10	2-0-LM-SC	310.8	12.5%	347	1.22
11	2-0-LM-NC	310.8	7.9%	-445	0.85
12	2-0-OD –SC	79.5	5.9%	-191	0.74

Source: JICA Survey Team Net Present Value is calculated with 10% of Social Discount Ratio

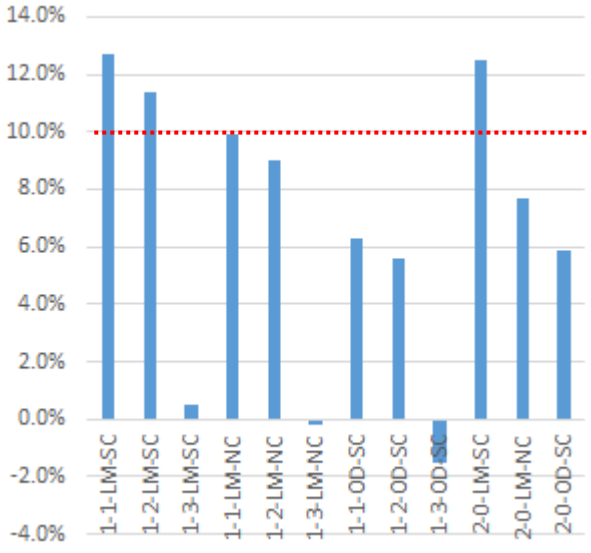


Figure X.1.1 Comparison of EIRR by Evaluation Case
Source: JICA Survey Team

As the feasibility study of yen-loan project, it is better to focus on ODA target area (notified with "OD"). According to the results, the EIRRs were below of social discount ratio in this country (10%). Particularly, the cases of which foundation treatment is included in the project cost (Case 1-3-LM-SC, Case 1-3-LM-NC and Case 1-3-D-SC), were too high to be viable, and in fact, EIRR marked almost zero or negative value. Hence, it is concluded that these plans were difficult to be implemented.

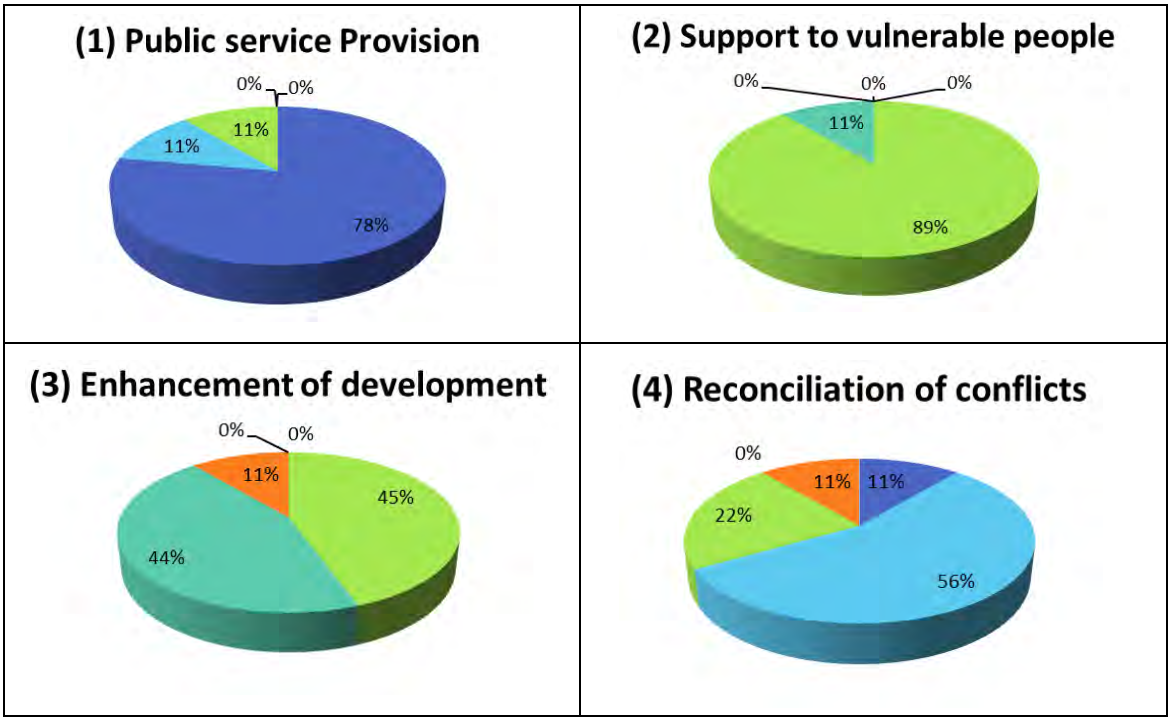
X.2 Qualitative Benefit to Peace and Order Condition

As already mentioned in the Main Report, there may be a difficulty of finding out direct relationship between the MMIP I and peace and order establishment in the area. However, there may be a possibility that the MMIP I has contributed to sustain peace and order once, for example, cessation of hostilities were agreed upon.

According to SAPROF report (May 2007), it is said that with the implementation of MMIP I and the continued commitment of the Government to effort peace and development in the region, the peace and order condition were drastically improved. The project area was declared a zone of peace and therefore, the implementation of MMIP I was regarded by some as a development project that promoted the building of a community of peace.

The members of MNLE and MILF are basically such people who engaged themselves in fighting once ordered or once incident takes place, however otherwise they engage themselves in raising their own livelihood. It means that when the cessation of hostilities is agreed upon, they may tend to return to their livelihood, which is basically farming. The last major conflict recorded between MILF and AFP in and around the project site was in 2003. The delivery of irrigation water by MMIP I, according to NIA-PMO, served as turning point for several MILF members who had returned and resumed the livelihood, farming.

Figure X.2.1 shows evaluation of government functions by focal groups gathered each of selected Barangays. 2 Barangays out of the 3 Barangays from the MMIP I area affirmed that their trust on the Government has increased after the completion of MMIP I, as they saw significant improvement on the items (3) Enhancement of development, (4) Reconciliation of Conflicts and (5) Provision of law and order.



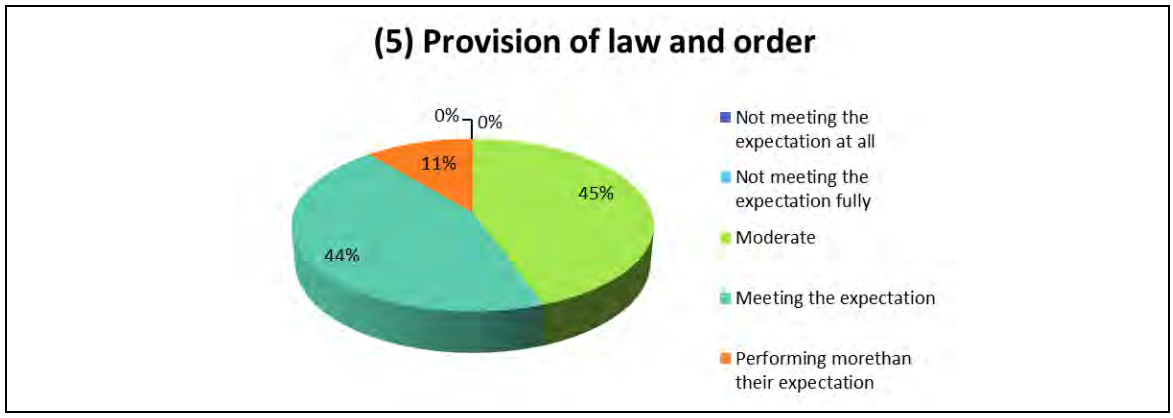


Figure X.2.1 Evaluation of Government Functions by Barangays

Source: JICA Study Team

X.3 Tables and Figures in Project Evaluation

In this chapter, supplementary information that could not be included in the main report are provided.

(1) Operation and Maintenance Fee

For the operation and maintenance cost calculation, one (1) percentages for Case-1 and two (2) percentage for Case-2 of the total costs are applied. The work items of operation and maintenance fee are supposed to include personal service, maintenance operation and other expenses. Estimated annual OM fees by evaluation cases are shown at the fifth column from bottom, which close to 1% and 2%.

Table X.3.1 Current and Target Irrigable Area by Evaluation Case and by with/without Dike

Work Item		Case-1 (million PHP)				Case-2 (million PHP)			
		MMIP II Area		LMSA		MMIP II Area		LMSA	
Personal Services (PS)	Salary and Wages	14.00	(30%)	8.00	(29%)	20.00	(18%)	12.00	(16%)
	Other Compensations	4.00	(9%)	2.50	(9%)	8.00	(7%)	4.50	(6%)
	Retirement/ Personnel Benefits etc.	2.50	(5%)	1.50	(5%)	5.50	(5%)	3.50	(5%)
	Sub-total of PS (A)	**20.50**	**(44%)**	**12.00**	**(44%)**	**33.50**	**(30%)**	**20.00**	**(27%)**
Maintenance Operation and Other Expenses (MOOE)	Office Supplies and Materials *1	1.50	(3%)	1.00	(4%)	2.50	(2%)	1.50	(2%)
	Utility Expenses *2	1.50	(3%)	1.00	(4%)	2.50	(2%)	1.50	(2%)
	Professional Services *3	2.00	(4%)	1.50	(5%)	6.00	(5%)	3.50	(5%)
	Repair and Maintenance for Office *4	1.50	(3%)	1.00	(4%)	3.00	(3%)	2.00	(3%)
	Extraordinary and Miscellaneous Expenses	1.00	(2%)	0.50	(2%)	3.00	(3%)	2.00	(3%)
	Construction Materials and Labor *5	10.00	(22%)	5.00	(18%)	27.00	(24%)	20.00	(27%)
	Operation Cost of Construction Equipment *6	5.00	(11%)	3.00	(11%)	20.00	(18%)	15.00	(21%)
	Provision of Additional MOOE	2.00	(4%)	1.50	(5%)	9.00	(8%)	5.00	(7%)
	Other Expense	1.50	(3%)	1.00	(4%)	5.00	(4%)	2.50	(3%)
	Sub-total of MOOE (B)	**26.00**	**(56%)**	**15.50**	**(56%)**	**78.00**	**(70%)**	**53.00**	**(73%)**
Total (C) = (A) + (B)		**46.50**	**(100%)**	**27.50**	**(100%)**	**111.50**	**(100%)**	**73.00**	**(100%)**
Project Cost (D) *7		**4,660.90**		**2,748.40**		**5,564.10**		**3,651.70**	
Ratio of O & M Cost (C / D)		**1.00%**		**1.00%**		**2.00%**		**2.00%**	
Target Area (ha) (E)		**7,634**		**3,688**		**10,356**		**6,590**	
Cost of O & M per ha (PHP/ha) (C / E)		**6,100**		**7,500**		**10,800**		**11,100**	

*1: Office supplies/ gasoline, oil and lubricant/ textbook and instructional materials/ drugs and medicines etc.
*2: Water and electricity etc.
*3: Legal services/ auditing services/ environment & sanitary services/ canal cleanings & maintenance/ IA remuneration etc.
*4: Office equipment, furniture, IT equipment & software etc.
*5: Construction materials (embankment materials, cement, sand, gravel etc.) and labor for rehabilitation of irrigation & drainage facilities, road and bridge etc.
*6: Diesel fee/ rental fee/ maintenance fee/ spare parts/ wage of operator etc.
*7: Source: JICA Survey Team; the Cost Includes irrigation canals, drainage, and agriculture extension works.
Note: The costs that has already expensed by 2018 are converted into current price level by using CMWPI .

(2) Conversion Factors

All cost and benefit are calculated in Philippines Peso (Php), adopting the level of June 2018 price which are standardized by using consumer price index (CPI) and construction materials wholesale price index (CMWPI).

Table X.3.2 summarizes CPI and CMWPI from 2000 to June 2018 (June 2018 = 100). As right part of Figure X.3.1 indicating, the two indicator show similar tendency in the long run, especially in recent years. However, CMWPI is better to apply for construction costs since annual inflation rate of construction material sometimes significantly deviates from other ordinary goods and service as shown in left part of the figure. Comparing the two indicator, CMWPI is always lower than CPI since 2015. It means that project cost becomes higher when one applies CMWPI instead of CPI, and the EIRRs would be evaluated conservatively.

Table X.3.2 Consumer Price Index and Construction Material Wholesale Price Index from 2000 to June 2018

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CPI	50.78	53.49	54.95	56.21	58.92	62.76	66.2	68.12	73.75	76.86
CMWPI	39.75	42.05	42.49	44.40	49.09	57.00	64.63	66.57	73.69	74.60
	2010	2011	2012	2013	2014	2015	2016	2017	Current	
CPI	79.78	83.48	86.13	88.71	92.36	93.68	95.34	98.38	100	
CMWPI	77.5	83.39	86.49	88.08	89.75	89.11	90.34	93.28	100	

Source: Philippines Statistic Authority edited by JICA Survey Team.

Note: Current means June 2018

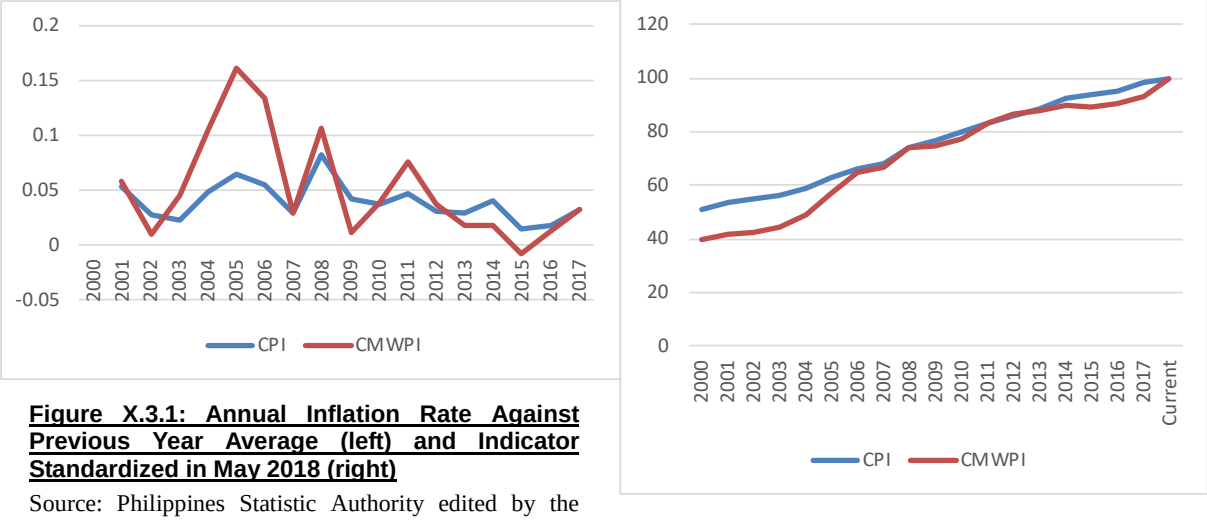


Figure X.3.1: Annual Inflation Rate Against Previous Year Average (left) and Indicator Standardized in May 2018 (right)

Source: Philippines Statistic Authority edited by the Survey Team

As already mentioned in the main report, Standard Conversion Factor (SCF) which was employed in "Philippine Rural Development Project"; World Bank, 2014, is applied in this economic evaluation

Table X.3.3 Applied Conversion Factors

Particulars	Factor	Reference
Standard Conversion Factor (SCF)	0.90	Philippine Rural Development Project, World Bank, 2014
Skilled Labor	1.00	Assumed placed under competitive market
Unskilled Labor/ Family Labor	0.60	Philippine Rural Development Project, World Bank, 2014

Source: JICA Survey Team

Farmgate prices, yields, gross profit, and farming cost per ha were surveyed by the Team thorough household questionnaire survey on June – July 2017. Farmgate price and farming cost were converted to July 2018 price level by CPI (Table X.3.4) except for paddy farmgate price which applies average four municipalities sourced from Philippines National Statistic Authority, Kotabato Province June 2018.

Table X.3.4 Farm Cost- Benefit Indicators Applied in the Evaluation (June 2018 Price Level)

Crop Type	Hectare	Unit Price	Yield per ha	Gross Profit (Php/Year)	Total Cost (Php/Year)	Net Profit (Php/Year)	Net Profit Ratio (%) (Php/Year)
Rice Irrigated (Financial)	1.00	20.4	3.4	68,988	36,320	32,668	47.4%
Rice Non-Irrigated (Financial)	1.00	17.2	1.7	29,274	10,225	19,049	65.1%
Corn (Financial)	1.00	11.1	2.1	23,614	13,180	10,434	44.2%
Rice Irrigated (Economic)	1.00	18.3	3.4	62,089	27,728	34,361	55.3%
Rice Non-Irrigated (Economic)	1.00	15.5	1.7	26,347	8,787	17,560	66.6%
Corn (Economic)	1.00	10.0	2.1	21,252	10,361	10,892	51.2%

Source: JICA Survey Team, based on Farmer Household Survey on June – July 2017

Note: PSA for national and provincial data is applied for farmgate price of paddy.

(3) Detail Calculation of Project Benefit

Table X.3.5 Planted Areas and Evaluation Cases for LMSA Area

Case	Crop	Dry Season			Wet Season			Total Production (ton)
		Planted Area (ha)	Yield (ton/ha)	Production (ton)	Planted Area (ha)	Yield (ton/ha)	Production (ton)	
-	**Without Project**							
-	Rice (rain-fed)	457	1.7	777	367	1.7	624	1,401
-	Corn	795	2.1	1,670	1,087	2.1	2,283	3,953
C1	**With Project (Case-1)**							
C1-LM-D00	Rice (Irrigated)	3,688	4.7	17,334	2,810	4.7	13,207	30,541
C1-LM-D30	30% reduction	3,688	4.7	17,334	870	4.7	4,089	27,631
					1,940	3.2	6,208	
C1-LM-D50	50% reduction	3,688	4.7	17,334	870	4.7	4,089	25,885
					1,940	2.3	4,462	
C1-LM-D80	80% reduction	3,688	4.7	17,334	870	4.7	4,089	23,169
					1,940	0.9	1,746	
C2	**With Project (Case-2)**							
C2-LM-D00	Rice (irrigated)	6,590	4.7	30,973	3,810	4.7	17,907	48,880
C2-LM-D30	30% reduction	6,590	4.7	30,973	870	4.7	4,089	44,470
					2,940	3.2	9,408	
C2-LM-D50	50% reduction	6,590	4.7	30,973	870	4.7	4,089	41,824
					2,940	2.3	6,762	
C2-LM-D80	80% reduction	6,590	4.7	30,973	870	4.7	4,089	37,708
					2,940	0.9	2,646	

Source: JICA Survey Team

Table X.3.6 Planted Areas and Evaluation Cases for all MMIP II Area

Case	Crop	Dry Season			Wet Season			Total Production (ton)
		Planted Area (ha)	Yield (ton/ha)	Production (ton)	Planted Area (ha)	Yield (ton/ha)	Production (ton)	
-	**Without Project**							
-	Rice (rain-fed)	731	1.7	1,242	587	1.7	997	2,240
-	Corn	1,271	2.1	2,669	1,738	2.1	3,650	6,319
C1	**With Project (Case-1)**							
C1-M2-D00	Rice (Irrigated)	7,634	4.7	35,880	6,756	4.7	31,753	67,633
C1-M2-D30	30% reduction	7,634	4.7	35,880	4,816	4.7	22,635	64,723
					1,940	3.2	6,208	
C1-M2-D50	50% reduction	7,634	4.7	35,880	4,816	4.7	22,635	62,977
					1,940	2.3	4,462	
C1-M2-D80	80% reduction	7,634	4.7	35,880	4,816	4.7	22,635	60,261
					1,940	0.9	1,746	
C2	**With Project (Case-2)**							
C2-M2-D00	Rice (irrigated)	10,536	4.7	49,519	7,756	4.7	36,453	85,972
C2-M2-D30	30% reduction	10,536	4.7	49,519	4,816	4.7	22,635	81,562
					2,940	3.2	9,408	
C2-M2-D50	50% reduction	10,536	4.7	49,519	4,816	4.7	22,635	78,916
					2,940	2.3	6,762	
C2-M2-D80	80% reduction	10,536	4.7	49,519	4,816	4.7	22,635	74,800
					2,940	0.9	2,646	

Source: JICA Survey Team

Table X.3.7 Annual Benefit Calculation (C1-LM-D00)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	367.0	457.0	1,087.0	795.0	870.0	3,688.0	1,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	4.7	
Production, ton	623.9	776.9	2,282.7	1,669.5	4,089.0	17,333.6	9,118.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	7.0	8.7	11.2	8.2	34.1	144.6	76.1	
Net Economic Profit per season, million peso	6.4	8.0	11.7	8.5	37.3	158.3	83.3	
Total Financial Profit, million peso	35.1				178.7		76.1	
Total Economic Profit, million peso	34.7				195.7		83.3	
Annual Financial Benefit, million peso							219.7	
Annual Economic Benefit, million peso							244.2	

Source: JICA Survey Team.

Table X.3.8 Annual Benefit Calculation (C1-LM-D30)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	367.0	457.0	1,087.0	795.0	870.0	3,688.0	1,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	3.2	
Production, ton	623.9	776.9	2,282.7	1,669.5	4,089.0	17,333.6	6,208.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	7.0	8.7	11.2	8.2	34.1	144.6	51.8	
Net Economic Profit per season, million peso	6.4	8.0	11.7	8.5	37.3	158.3	56.7	
Total Financial Profit, million peso	35.1				178.7		51.8	
Total Economic Profit, million peso	34.7				195.7		56.7	
Annual Financial Benefit, million peso							195.4	
Annual Economic Benefit, million peso							217.7	

Source: JICA Survey Team.

Table X.3.9 Annual Benefit Calculation (C1-LM-D50)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	367.0	457.0	1,087.0	795.0	870.0	3,688.0	1,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	2.3	
Production, ton	623.9	776.9	2,282.7	1,669.5	4,089.0	17,333.6	4,462.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	7.0	8.7	11.2	8.2	34.1	144.6	37.2	
Net Economic Profit per season, million peso	6.4	8.0	11.7	8.5	37.3	158.3	40.8	
Total Financial Profit, million peso	35.1				178.7		37.2	
Total Economic Profit, million peso	34.7				195.7		40.8	
Annual Financial Benefit, million peso							180.9	
Annual Economic Benefit, million peso							201.7	

Source: JICA Survey Team.

Table X.3.10 Annual Benefit Calculation (C1-LM-D80)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	367.0	457.0	1,087.0	795.0	870.0	3,688.0	1,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	0.9	
Production, ton	623.9	776.9	2,282.7	1,669.5	4,089.0	17,333.6	1,746.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	7.0	8.7	11.2	8.2	34.1	144.6	14.6	
Net Economic Profit per season, million peso	6.4	8.0	11.7	8.5	37.3	158.3	15.9	
Total Financial Profit, million peso	35.1				178.7		14.6	
Total Economic Profit, million peso	34.7				195.7		15.9	
Annual Financial Benefit, million peso							158.2	
Annual Economic Benefit, million peso							176.9	

Source: JICA Survey Team.

Table X.3.11 Annual Benefit Calculation (C2-LM-D00)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	367.0	457.0	1,087.0	795.0	870.0	6,590.0	2,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.6	4.6	4.6	
Production, ton	623.9	776.9	2,282.7	1,669.5	4,002.0	30,314.0	13,524.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	7.0	8.7	11.2	8.2	33.4	252.9	112.8	
Net Economic Profit per season, million peso	6.4	8.0	11.7	8.5	36.6	276.9	123.5	
Total Financial Profit, million peso	35.1				286.2		112.8	
Total Economic Profit, million peso	34.7				313.4		123.5	
Annual Financial Benefit, million peso							364.0	
Annual Economic Benefit, million peso							402.2	

Source: JICA Survey Team.

Table X.3.12 Annual Benefit Calculation (C2-LM-D30)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	367.0	457.0	1,087.0	795.0	870.0	6,590.0	2,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.6	4.6	3.2	
Production, ton	623.9	776.9	2,282.7	1,669.5	4,002.0	30,314.0	9,408.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	7.0	8.7	11.2	8.2	33.4	252.9	78.5	
Net Economic Profit per season, million peso	6.4	8.0	11.7	8.5	36.6	276.9	85.9	
Total Financial Profit, million peso	35.1				286.2		78.5	
Total Economic Profit, million peso	34.7				313.4		85.9	
Annual Financial Benefit, million peso							329.7	
Annual Economic Benefit, million peso							364.6	

Source: JICA Survey Team.

Table X.3.13 Annual Benefit Calculation (C2-LM-D50)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	367.0	457.0	1,087.0	795.0	870.0	6,590.0	2,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.6	4.6	2.3	
Production, ton	623.9	776.9	2,282.7	1,669.5	4,002.0	30,314.0	6,762.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	7.0	8.7	11.2	8.2	33.4	252.9	56.4	
Net Economic Profit per season, million peso	6.4	8.0	11.7	8.5	36.6	276.9	61.8	
Total Financial Profit, million peso	35.1				286.2		56.4	
Total Economic Profit, million peso	34.7				313.4		61.8	
Annual Financial Benefit, million peso							307.6	
Annual Economic Benefit, million peso							340.5	

Source: JICA Survey Team.

Table X.3.14 Annual Benefit Calculation (C2-LM-D80)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	367.0	457.0	1,087.0	795.0	870.0	6,590.0	2,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.6	4.6	0.9	
Production, ton	623.9	776.9	2,282.7	1,669.5	4,002.0	30,314.0	2,646.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	7.0	8.7	11.2	8.2	33.4	252.9	22.1	
Net Economic Profit per season, million peso	6.4	8.0	11.7	8.5	36.6	276.9	24.2	
Total Financial Profit, million peso	35.1				286.2		22.1	
Total Economic Profit, million peso	34.7				313.4		24.2	
Annual Financial Benefit, million peso							273.3	
Annual Economic Benefit, million peso							302.9	

Source: JICA Survey Team.

Table X.3.15 Annual Benefit Calculation (C1-M2-D00)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	586.8	730.6	1,737.9	1,271.0	4,816.0	7,634.0	1,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	4.7	
Production, ton	997.5	1,242.1	3,649.5	2,669.2	22,635.2	35,879.8	9,118.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	11.2	13.9	17.9	13.1	188.8	299.3	76.1	
Net Economic Profit per season, million peso	10.3	12.8	18.7	13.7	206.7	327.7	83.3	
Total Financial Profit, million peso	56.1				488.1		76.1	
Total Economic Profit, million peso	55.5				534.4		83.3	
Annual Financial Benefit, million peso							508.1	
Annual Economic Benefit, million peso							562.2	

Source: JICA Survey Team.

Table X.3.16 Annual Benefit Calculation (C1-M2-D30)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	586.8	730.6	1,737.9	1,271.0	4,816.0	7,634.0	1,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	3.2	
Production, ton	997.5	1,242.1	3,649.5	2,669.2	22,635.2	35,879.8	6,208.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	11.2	13.9	17.9	13.1	188.8	299.3	51.8	
Net Economic Profit per season, million peso	10.3	12.8	18.7	13.7	206.7	327.7	56.7	
Total Financial Profit, million peso	56.1				488.1		51.8	
Total Economic Profit, million peso	55.5				534.4		56.7	
Annual Financial Benefit, million peso							483.8	
Annual Economic Benefit, million peso							535.7	

Source: JICA Survey Team.

Table X.3.17 Annual Benefit Calculation (C1-M2-D50)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	586.8	730.6	1,737.9	1,271.0	4,816.0	7,634.0	1,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	2.3	
Production, ton	997.5	1,242.1	3,649.5	2,669.2	22,635.2	35,879.8	4,462.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	11.2	13.9	17.9	13.1	188.8	299.3	37.2	
Net Economic Profit per season, million peso	10.3	12.8	18.7	13.7	206.7	327.7	40.8	
Total Financial Profit, million peso	56.1				488.1		37.2	
Total Economic Profit, million peso	55.5				534.4		40.8	
Annual Financial Benefit, million peso							469.3	
Annual Economic Benefit, million peso							519.7	

Source: JICA Survey Team.

Table X.3.18 Annual Benefit Calculation (C1-M2-D80)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	586.8	730.6	1,737.9	1,271.0	4,816.0	7,634.0	1,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	0.9	
Production, ton	997.5	1,242.1	3,649.5	2,669.2	22,635.2	35,879.8	1,746.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	11.2	13.9	17.9	13.1	188.8	299.3	14.6	
Net Economic Profit per season, million peso	10.3	12.8	18.7	13.7	206.7	327.7	15.9	
Total Financial Profit, million peso	56.1				488.1		14.6	
Total Economic Profit, million peso	55.5				534.4		15.9	
Annual Financial Benefit, million peso							446.6	
Annual Economic Benefit, million peso							494.9	

Source: JICA Survey Team.

Table X.3.19 Annual Benefit Calculation (C2-M2-D00)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	586.8	730.6	1,737.9	1,271.0	4,816.0	10,536.0	2,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	4.7	
Production, ton	997.5	1,242.1	3,649.5	2,669.2	22,635.2	49,519.2	13,818.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	11.2	13.9	17.9	13.1	188.8	413.1	115.3	
Net Economic Profit per season, million peso	10.3	12.8	18.7	13.7	206.7	452.3	126.2	
Total Financial Profit, million peso	56.1				601.9		115.3	
Total Economic Profit, million peso	55.5				659.0		126.2	
Annual Financial Benefit, million peso							661.1	
Annual Economic Benefit, million peso							729.7	

Source: JICA Survey Team.

Table X.3.20 Annual Benefit Calculation (C2-M2-D30)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	586.8	730.6	1,737.9	1,271.0	4,816.0	10,536.0	2,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	3.2	
Production, ton	997.5	1,242.1	3,649.5	2,669.2	22,635.2	49,519.2	9,408.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	11.2	13.9	17.9	13.1	188.8	413.1	78.5	
Net Economic Profit per season, million peso	10.3	12.8	18.7	13.7	206.7	452.3	85.9	
Total Financial Profit, million peso	56.1				601.9		78.5	
Total Economic Profit, million peso	55.5				659.0		85.9	
Annual Financial Benefit, million peso							624.3	
Annual Economic Benefit, million peso							689.5	

Source: JICA Survey Team.

Table X.3.21 Annual Benefit Calculation (C2-M2-D50)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	586.8	730.6	1,737.9	1,271.0	4,816.0	10,536.0	2,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	2.3	
Production, ton	997.5	1,242.1	3,649.5	2,669.2	22,635.2	49,519.2	6,762.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	11.2	13.9	17.9	13.1	188.8	413.1	56.4	
Net Economic Profit per season, million peso	10.3	12.8	18.7	13.7	206.7	452.3	61.8	
Total Financial Profit, million peso	56.1				601.9		56.4	
Total Economic Profit, million peso	55.5				659.0		61.8	
Annual Financial Benefit, million peso							602.2	
Annual Economic Benefit, million peso							665.3	

Source: JICA Survey Team.

Table X.3.22 Annual Benefit Calculation (C2-M2-D80)

Title	Without				With (Target Area, unflooded)		With (Target Area, flooded)	
	Paddy Rainfed		Corn		Paddy Irrigated		Paddy Irrigated	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Cultivated Area, ha	586.8	730.6	1,737.9	1,271.0	4,816.0	10,536.0	2,940.0	Integrated in "With (Target area, Unflooded)"
Yield, ton/ha	1.7	1.7	2.1	2.1	4.7	4.7	0.9	
Production, ton	997.5	1,242.1	3,649.5	2,669.2	22,635.2	49,519.2	2,646.0	
Financial Price, peso/kg	17.2	17.2	11.1	11.1	20.4	20.4	20.4	
Economic Price, peso/kg	15.5	15.5	10.0	10.0	18.3	18.3	18.3	
Profit Ratio, Financial (%)	0.65	0.65	0.44	0.44	0.41	0.41	0.41	
Profit Ratio, Economic (%)	0.67	0.67	0.51	0.51	0.50	0.50	0.50	
Net Financial Profit per season, million peso	11.2	13.9	17.9	13.1	188.8	413.1	22.1	
Net Economic Profit per season, million peso	10.3	12.8	18.7	13.7	206.7	452.3	24.2	
Total Financial Profit, million peso	56.1				601.9		22.1	
Total Economic Profit, million peso	55.5				659.0		24.2	
Annual Financial Benefit, million peso							567.9	
Annual Economic Benefit, million peso							627.7	

Source: JICA Survey Team.

(4) Detail Calculation of Project Cost for the Evaluation

Table X.3.23 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case1), current price level

	2011	2012	2013	2014	2015	2016
Construction Cost	0.0	0.0	0.0	0.0	122,747,865.0	220,947,152.0
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	0.0	0.0	0.0	0.0
Land Acquisition	0.0	0.0	0.0	0.0	10,024,940.0	19,766,895.0
Administration Fee	0.0	0.0	0.0	0.0	7,475,558.0	13,542,160.0
VAT	0.0	0.0	0.0	0.0	16,738,345.0	30,129,157.0
Total	0.0	0.0	0.0	0.0	156,986,708.0	284,385,364.0

Source: JICA Survey Team.

Table X.3.23 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case1), current price level; Continued

	2017	2018	2019	2020	2021	2022
Construction Cost	246,171,163.0	561,950,806.0	368,837,585.0	402,081,897.0	272,698,172.0	70,974,640.0
Price Escalation	0.0	0.0	8,923,689.0	18,116,161.0	18,886,247.0	9,460,871.0
Physical Contingency	0.0	29,168,214.0	37,332,518.0	9,828,512.0	13,358,581.0	35,490,400.0
Land Acquisition	19,571,442.0	14,245,450.0	8,110,963.0	3,695,000.0	0.0	0.0
Administration Fee	14,965,569.0	34,298,580.0	23,929,579.0	24,494,559.0	17,197,537.0	6,522,194.0
VAT	33,568,796.0	80,607,140.0	55,386,834.0	56,169,602.0	39,007,740.0	14,517,960.0
Total	314,276,970.0	720,270,190.0	502,521,168.0	514,385,731.0	361,148,277.0	136,966,065.0

Source: JICA Survey Team

Table X.3.24 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case1), June 2018 price level

	2011	2012	2013	2014	2015	2016
Construction Cost	0	0	0	0	137,748,698	244,572,894
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	0.0	0.0	0.0	0.0
Land Acquisition	0.0	0.0	0.0	0.0	11,250,072.9	21,880,556.8
Administration Fee	0.0	0.0	0.0	0.0	7,449,939.1	13,322,672.3
VAT	0.0	0.0	0.0	0.0	18,783,913.1	33,350,849.0
Total	0.0	0.0	0.0	0.0	175,232,623.4	313,126,971.6

Source: JICA Survey Team

Note: Administration Fee is deducted to exclude VAT and Price Escalation portions

Table X.3.24 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case1),June 2018 price level; Continued

	2017	2018	2019	2020	2021	2022
Construction Cost	263,905,621	561,950,806	368,837,585.0	402,081,897.0	272,698,172.0	70,974,640.0
Price Escalation	0.0	0.0	8,923,689.0	18,116,161.0	18,886,247.0	9,460,871.0
Physical Contingency	0.0	29,168,214.0	37,332,518.0	9,828,512.0	13,358,581.0	35,490,400.0
Land Acquisition	20,981,391.5	14,245,450.0	8,110,963.0	3,695,000.0	0.0	0.0
Administration Fee	14,244,349.6	30,268,223.1	20,714,052.9	20,780,270.8	14,302,837.7	5,323,252.4
VAT	35,987,131.2	80,607,140.0	55,386,834.0	56,169,602.0	39,007,740.0	14,517,960.0
Total	335,118,493.1	716,239,833.1	499,305,641.9	510,671,442.8	358,253,577.7	135,767,123.4

Source: JICA Survey Team

Note: Administration Fee is deducted to exclude VAT and Price Escalation portions

Table X.3.25 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case2), current price level

	2011	2012	2013	2014	2015	2016
Construction Cost	0.0	0.0	0.0	0.0	122,747,865.0	221,871,052.0
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	0.0	0.0	0.0	0.0
Land Acquisition	0.0	0.0	0.0	0.0	10,024,940.0	20,133,509.0
Administration Fee	0.0	0.0	0.0	0.0	7,475,558.0	13,612,985.0
VAT	0.0	0.0	0.0	0.0	16,738,345.0	30,255,143.0
Total	0.0	0.0	0.0	0.0	156,986,708.0	285,872,689.0

Source: JICA Survey Team

Table X.3.25 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case2), current price level; Continued

	2017	2018	2019	2020	2021	2022
Construction Cost	269,337,080.0	619,107,082.0	512,183,990.0	681,508,642.0	506,916,772.0	137,894,240.0
Price Escalation	0.0	0.0	12,115,407.0	30,595,398.0	34,349,997.0	18,380,754.0
Physical Contingency	0.0	29,168,214.0	38,737,435.0	13,308,680.0	13,358,581.0	68,948,000.0
Land Acquisition	23,418,569.0	17,725,963.0	11,605,963.0	7,190,000.0	0.0	0.0
Administration Fee	16,474,171.0	37,720,121.0	32,488,422.0	41,367,527.0	31,278,600.0	12,671,438.0
VAT	36,727,783.0	88,401,178.0	75,125,649.0	94,747,817.0	70,946,640.0	28,205,760.0
Total	345,957,603.0	792,122,558.0	682,256,866.0	868,718,064.0	656,850,590.0	266,100,192.0

Source: JICA Survey Team

Table X.3.26 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case2),June 2018 price level

	2011	2012	2013	2014	2015	2016
Construction Cost	0	0	0	0	137,748,698	245,595,586
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	0.0	0.0	0.0	0.0
Land Acquisition	0.0	0.0	0.0	0.0	11,250,072.9	22,286,372.6
Administration Fee	0.0	0.0	0.0	0.0	7,449,939.1	13,394,097.7
VAT	0.0	0.0	0.0	0.0	18,783,913.1	33,490,306.6
Total	0.0	0.0	0.0	0.0	175,232,623.4	314,766,362.5

Source: JICA Survey Team

Note: Administration Fee is deducted to exclude VAT and Price Escalation portions

Table X.3.26 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case2),June 2018 price level; Continued

	2017	2018	2019	2020	2021	2022
Construction Cost	288,740,437	619,107,082	512,183,990.0	681,508,642.0	506,916,772.0	137,894,240.0
Price Escalation	0.0	0.0	12,115,407.0	30,595,398.0	34,349,997.0	18,380,754.0
Physical Contingency	0.0	29,168,214.0	38,737,435.0	13,308,680.0	13,358,581.0	68,948,000.0
Land Acquisition	25,105,670.0	17,725,963.0	11,605,963.0	7,190,000.0	0.0	0.0
Administration Fee	15,692,304.8	33,300,062.2	28,126,369.2	35,100,366.2	26,013,768.1	10,342,112.2
VAT	39,373,695.3	88,401,178.0	75,125,649.0	94,747,817.0	70,946,640.0	28,205,760.0
Total	368,912,107.5	787,702,499.2	677,894,813.2	862,450,903.2	651,585,758.1	263,770,866.2

Source: JICA Survey Team

Note: Administration Fee is deducted to exclude VAT and Price Escalation portions

Table X.3.27 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case2), Current price level

	2011	2012	2013	2014	2015	2016
Construction Cost	14,483,520.9	135,004,504.4	197,079,162.0	606,224,411.0	332,669,755.6	356,664,975.6
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	2,682,242.0	1,133,087.0	0.0	0.0
Land Acquisition	5,772,902.5	10,425,981.5	9,105,670.0	9,673,695.5	22,847,457.0	27,734,921.5
Administration Fee	1,111,572.5	8,192,009.6	11,805,363.3	34,992,633.5	20,044,063.5	21,651,801.5
VAT	1,975,025.7	18,409,706.0	27,240,191.6	82,821,477.0	45,364,057.8	48,636,133.4
Total	23,343,021.6	172,032,201.5	247,912,628.9	734,845,304.0	420,925,333.9	454,687,832.0

Source: JICA Survey Team

Table X.3.27 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case2), Current price level; Continued

	2017	2018	2019	2020	2021	2022
Construction Cost	344,317,186.2	774,075,983.7	543,163,369.8	685,574,489.6	506,916,772.4	137,894,240.0
Price Escalation	0.0	0.0	13,097,197.7	30,830,986.0	34,349,997.8	18,380,753.6
Physical Contingency	0.0	39,640,204.0	53,230,433.0	14,641,738.0	13,358,581.0	68,948,000.0
Land Acquisition	23,418,569.0	17,725,963.0	11,605,963.0	7,190,000.0	0.0	0.0
Administration Fee	20,734,405.0	47,120,172.5	35,121,169.6	41,686,062.3	31,278,599.5	12,671,437.7
VAT	46,952,343.8	110,961,299.7	81,326,427.8	95,484,031.8	70,946,639.5	28,205,760.0
Total	435,422,504.0	989,523,622.8	737,544,560.8	875,407,307.6	656,850,590.2	266,100,191.3

Source: JICA Survey Team

Table X.3.28 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case2),June 2018 price level

	2011	2012	2013	2014	2015	2016
Construction Cost	17,368,415	156,092,617	223,750,184	675,458,954	373,324,829	394,802,940
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	3,045,233.9	1,262,492.5	0.0	0.0
Land Acquisition	6,922,775.5	12,054,551.4	10,337,954.1	10,778,490.8	25,639,610.6	30,700,599.4
Administration Fee	1,214,559.5	8,407,358.4	11,856,668.6	34,374,996.8	19,948,222.0	21,275,176.9
VAT	2,368,420.3	21,285,357.8	30,926,648.0	92,280,197.2	50,907,931.5	53,836,764.9
Total	27,874,169.9	197,839,884.6	279,916,688.6	814,155,131.1	469,820,593.6	500,615,480.7

Source: JICA Survey Team

Note: Administration Fee is deducted to exclude VAT and Price Escalation portions

Table X.3.28 Annual Expense for Irrigation and Drainage Rehabilitation (LMSA, Case2),June 2018 price level: Continued

	2017	2018	2019	2020	2021	2022
Construction Cost	369,122,198	774,075,984	543,163,369.8	685,574,489.6	506,916,772.4	137,894,240.0
Price Escalation	0.0	0.0	13,097,197.7	30,830,986.0	34,349,997.8	18,380,753.6
Physical Contingency	0.0	39,640,204.0	53,230,433.0	14,641,738.0	13,358,581.0	68,948,000.0
Land Acquisition	25,105,670.0	17,725,963.0	11,605,963.0	7,190,000.0	0.0	0.0
Administration Fee	19,711,393.4	41,572,107.5	30,399,988.3	35,370,311.4	26,013,767.7	10,342,112.0
VAT	50,334,845.4	110,961,299.7	81,326,427.8	95,484,031.8	70,946,639.5	28,205,760.0
Total	464,274,106.7	983,975,557.8	732,823,379.6	869,091,556.7	651,585,758.4	263,770,865.6

Source: JICA Survey Team

Note: Administration Fee is deducted to exclude VAT and Price Escalation portions

Table X.3.29 Annual Expense for Irrigation and Drainage Rehabilitation (MMIP2, Case1), current price level

	2011	2012	2013	2014	2015	2016
Construction Cost	14,483,521.0	135,004,504.0	197,079,162.0	606,224,411.0	332,669,756.0	355,741,076.0
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	2,682,242.0	1,133,087.0	0.0	0.0
Land Acquisition	5,772,903.0	10,425,982.0	9,105,670.0	9,673,696.0	22,847,458.0	27,368,308.0
Administration Fee	1,111,572.0	8,192,009.0	11,805,364.0	34,992,633.0	20,044,064.0	21,580,977.0
VAT	1,975,026.0	18,409,706.0	27,240,191.0	82,821,477.0	45,364,059.0	48,510,147.0
Total	23,343,022.0	172,032,201.0	247,912,629.0	734,845,304.0	420,925,337.0	453,200,508.0

Source: JICA Survey Team.

Table X.3.29 Annual Expense for Irrigation and Drainage Rehabilitation (MMIP2, Case1), current price level; continued

	2017	2018	2019	2020	2021	2022
Construction Cost	321,151,270.0	716,919,708.0	399,816,965.0	406,147,745.0	272,698,172.0	70,974,640.0
Price Escalation	0.0	0.0	9,905,479.0	18,351,749.0	18,886,247.0	9,460,871.0
Physical Contingency	0.0	39,640,204.0	51,825,516.0	11,161,570.0	13,358,581.0	35,490,400.0
Land Acquisition	19,571,442.0	14,245,450.0	8,110,963.0	3,695,000.0	0.0	0.0
Administration Fee	19,225,803.0	43,698,630.0	26,562,327.0	24,813,094.0	17,197,537.0	6,522,194.0
VAT	43,793,356.0	103,167,263.0	61,587,612.0	56,905,817.0	39,007,740.0	14,517,960.0
Total	403,741,871.0	917,671,255.0	557,808,862.0	521,074,975.0	361,148,277.0	136,966,065.0

Source: JICA Survey Team.

Table X.3.30 Annual Expense for Irrigation and Drainage Rehabilitation (MMIP2, Case1) , June 2018 price level

	2011	2012	2013	2014	2015	2016
Construction Cost	17,368,415	156,092,616	223,750,184	675,458,954	373,324,830	393,780,248
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	3,045,233.9	1,262,492.5	0.0	0.0
Land Acquisition	6,922,776.1	12,054,552.0	10,337,954.1	10,778,491.4	25,639,611.7	30,294,784.1
Administration Fee	1,214,559.0	8,407,357.8	11,856,669.3	34,374,996.3	19,948,222.4	21,203,752.0
VAT	2,368,420.7	21,285,357.8	30,926,647.4	92,280,197.2	50,907,932.9	53,697,306.8
Total	27,874,170.5	197,839,884.1	279,916,688.7	814,155,131.2	469,820,597.0	498,976,091.0

Source: JICA Survey Team.

Note: Administration Fee is deducted to exclude VAT and Price Escalation portions

Table X.3.30 Annual Expense for Irrigation and Drainage Rehabilitation (MMIP2, Case1), June 2018 price level; continued

	2017	2018	2019	2020	2021	2022
Construction Cost	344,287,382	716,919,708	399,816,965.0	406,147,745.0	272,698,172.0	70,974,640.0
Price Escalation	0.0	0.0	9,905,479.0	18,351,749.0	18,886,247.0	9,460,871.0
Physical Contingency	0.0	39,640,204.0	51,825,516.0	11,161,570.0	13,358,581.0	35,490,400.0
Land Acquisition	20,981,391.5	14,245,450.0	8,110,963.0	3,695,000.0	0.0	0.0
Administration Fee	18,263,438.3	38,540,267.0	22,987,672.4	21,050,215.7	14,302,837.7	5,323,252.4
VAT	46,948,280.4	103,167,263.0	61,587,612.0	56,905,817.0	39,007,740.0	14,517,960.0
Total	430,480,492.3	912,512,892.0	554,234,207.4	517,312,096.7	358,253,577.7	135,767,123.4

Source: JICA Survey Team.

Note: Administration Fee is deducted to exclude VAT and Price Escalation portion

Table X.3.31 Annual Expense for Irrigation and Drainage Rehabilitation (MMIP2, Case2), current price level

	2011	2012	2013	2014	2015	2016
Construction Cost	14,483,520.9	135,004,504.4	197,079,162.0	606,224,411.0	332,669,755.6	356,664,975.6
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	2,682,242.0	1,133,087.0	0.0	0.0
Land Acquisition	5,772,902.5	10,425,981.5	9,105,670.0	9,673,695.5	22,847,457.0	27,734,921.5
Administration Fee	1,111,572.5	8,192,009.6	11,805,363.3	34,992,633.5	20,044,063.5	21,651,801.5
VAT	1,975,025.7	18,409,706.0	27,240,191.6	82,821,477.0	45,364,057.8	48,636,133.4
Total	23,343,021.6	172,032,201.5	247,912,628.9	734,845,304.0	420,925,333.9	454,687,832.0
Check	23,343,021.6	172,032,201.5	247,912,628.9	734,845,304.0	420,925,333.9	454,687,832.0

Source: JICA Survey Team.

Table X.3.31 Annual Expense for Irrigation and Drainage Rehabilitation (MMIP2, Case2), current price level; continued

	2017	2018	2019	2020	2021	2022
Construction Cost	344,317,186.2	774,075,983.7	543,163,369.8	685,574,489.6	506,916,772.4	137,894,240.0
Price Escalation	0.0	0.0	13,097,197.7	30,830,986.0	34,349,997.8	18,380,753.6
Physical Contingency	0.0	39,640,204.0	53,230,433.0	14,641,738.0	13,358,581.0	68,948,000.0
Land Acquisition	23,418,569.0	17,725,963.0	11,605,963.0	7,190,000.0	0.0	0.0
Administration Fee	20,734,405.0	47,120,172.5	35,121,169.6	41,686,062.3	31,278,599.5	12,671,437.7
VAT	46,952,343.8	110,961,299.7	81,326,427.8	95,484,031.8	70,946,639.5	28,205,760.0
Total	435,422,504.0	989,523,622.8	737,544,560.8	875,407,307.6	656,850,590.2	266,100,191.3

Source: JICA Survey Team.

Table X.3.32 Annual Expense for Irrigation and Drainage Rehabilitation (MMIP2, Case2), June 2018 price level

	2011	2012	2013	2014	2015	2016
Construction Cost	17,368,415	156,092,617	223,750,184	675,458,954	373,324,829	394,802,940
Price Escalation	0.0	0.0	0.0	0.0	0.0	0.0
Physical Contingency	0.0	0.0	3,045,233.9	1,262,492.5	0.0	0.0
Land Acquisition	6,922,775.5	12,054,551.4	10,337,954.1	10,778,490.8	25,639,610.6	30,700,599.4
Administration Fee	1,214,559.5	8,407,358.4	11,856,668.6	34,374,996.8	19,948,222.0	21,275,176.9
VAT	2,368,420.3	21,285,357.8	30,926,648.0	92,280,197.2	50,907,931.5	53,836,764.9
Total	27,874,169.9	197,839,884.6	279,916,688.6	814,155,131.1	469,820,593.6	500,615,480.7

Source: JICA Survey Team

Table X.3.32 Annual Expense for Irrigation and Drainage Rehabilitation (MMIP2, Case2), June 2018 price level; Continued

	2017	2018	2019	2020	2021	2022
Construction Cost	369,122,198	774,075,984	543,163,369.8	685,574,489.6	506,916,772.4	137,894,240.0
Price Escalation	0.0	0.0	13,097,197.7	30,830,986.0	34,349,997.8	18,380,753.6
Physical Contingency	0.0	39,640,204.0	53,230,433.0	14,641,738.0	13,358,581.0	68,948,000.0
Land Acquisition	25,105,670.0	17,725,963.0	11,605,963.0	7,190,000.0	0.0	0.0
Administration Fee	19,711,393.4	41,572,107.5	30,399,988.3	35,370,311.4	26,013,767.7	10,342,112.0
VAT	50,334,845.4	110,961,299.7	81,326,427.8	95,484,031.8	70,946,639.5	28,205,760.0
Total	464,274,106.7	983,975,557.8	732,823,379.6	869,091,556.7	651,585,758.4	263,770,865.6

Source: JICA Survey Team

Table X.3.33 Annual Expense for Farm Extension

	1st YEAR (2020 Dry and Wet)	2nd YEAR (2021 Dry and Wet)	3rd YEAR (2022 Dry and Wet)	Total
Construction Cost	0	0	0	0
skilled labor	16,209,600	14,083,100	14,212,775	44,505,475
unskilled labor	547,000	259,350	272,318	1,078,668
other material	18,955,600	9,430,200	11,348,700	39,734,500
Land Acquisition	0	0	0	0
Consultant Fee	0	0	0	0
Administration Fee	1,356,065	1,221,330	1,530,945	4,108,340
Total	37,068,265	24,993,980	27,364,738	89,426,983
Physical Contingency	1,853,413	1,249,699	1,368,237	4,471,349

Source: JICA Survey Team.

Note: Administration Fee is deducted to exclude VAT and Price Escalation portion

Table X.3.34 Economic Conversion of Project Cost for Irrigation and Drainage Rehabilitation (LMSA, Case1) (million Php)

Component	Financial Cost			Economic Cost		
	FC	LC	Total	FC	LC	Total
Construction Cost	929.1	1,393.7	2,322.8	929.1	1,254.3	2,183.4
Other Material	882.7	975.6	1,858.2	882.7	878.0	1,760.7
Skilled Labor	23.2	209.0	232.3	23.2	209.0	232.3
Unskilled Labor	23.2	209.0	232.3	23.2	139.4	162.6
Land Acquisition	32.1	48.1	80.2	32.1	43.3	75.4
Consultant Fee	0.0	0.0	0.0	0.0	0.0	0.0
Administration Fee	50.6	75.8	126.4	50.6	68.3	118.8
Base Cost	**1,012**	**1,517.6**	**2,529.3**	**1,011.7**	**1,365.8**	**2,377.6**
Physical Contingency	50.1	75.1	125.2	50.1	68.3	118.4
BC+PhC	**1,062**	**1,592.7**	**2,654.5**	**1,061.8**	**1,434.1**	**2,495.9**

Source: JICA Survey Team.

Table X.3.35 Economic Conversion of Project Cost for Irrigation and Drainage Rehabilitation (LMSA, Case2) (million Php)

Component	Financial Cost			Economic Cost		
	FC	LC	Total	FC	LC	Total
Construction Cost	1,943.0	2,914.5	4,857.5	1,943.0	2,623.1	4,566.1
Other Material	1,845.9	2,040.2	3,886.0	1,845.9	1,836.2	3,682.0
Skilled Labor	48.6	437.2	485.8	48.6	437.2	485.8
Unskilled Labor	48.6	437.2	485.8	48.6	291.5	340.0
Land Acquisition	63.2	94.8	158.1	63.2	85.4	148.6
Consultant Fee	0.0	0.0	0.0	0.0	0.0	0.0
Administration Fee	104.2	156.3	260.5	104.2	140.7	244.9
Base Cost	**2,110**	**3,165.7**	**5,276.1**	**2,110.4**	**2,849.1**	**4,959.5**
Physical Contingency	77.7	116.5	194.1	77.7	142.5	220.1
BC+PhC	**2,188**	**3,282.1**	**5,470.2**	**2,188.1**	**2,991.5**	**5,179.6**

Source: JICA Survey Team.

Table X.3.36 Economic Conversion of Project Cost for Irrigation and Drainage Rehabilitation (MMIP2, Case1) (million Php)

Component	Financial Cost			Economic Cost		
	FC	LC	Total	FC	LC	Total
Construction Cost	1,620.2	2,430.4	4,050.6	1,620.2	2,187.3	3,807.6
Other Material	1,539.2	1,701.3	3,240.5	1,539.2	1,531.1	3,070.4
Skilled Labor	40.5	364.6	405.1	40.5	364.6	405.1
Unskilled Labor	40.5	364.6	405.1	40.5	243.0	283.5
Land Acquisition	57.2	85.8	143.1	57.2	77.3	134.5
Consultant Fee	0.0	0.0	0.0	0.0	0.0	0.0
Administration Fee	87.0	130.5	217.5	87.0	117.4	204.4
Base Cost	**1,764**	**2,646.7**	**4,411.2**	**1,764.5**	**2,382.0**	**4,146.5**
Physical Contingency	62.3	93.5	155.8	62.3	119.1	181.4
BC+PhC	**1,827**	**2,740.2**	**4,566.9**	**1,826.8**	**2,501.1**	**4,327.9**

Source: JICA Survey Team.

Table X.3.37 Economic Conversion of Project Cost for Irrigation and Drainage Rehabilitation (MMIP2, Case2) (million Php)

Component	Financial Cost			Economic Cost		
	FC	LC	Total	FC	LC	Total
Construction Cost	1,943.0	2,914.5	4,857.5	1,943.0	2,623.1	4,566.1
Other Material	1,845.9	2,040.2	3,886.0	1,845.9	1,836.2	3,682.0
Skilled Labor	48.6	437.2	485.8	48.6	437.2	485.8
Unskilled Labor	48.6	437.2	485.8	48.6	291.5	340.0
Land Acquisition	63.2	94.8	158.1	63.2	85.4	148.6
Consultant Fee	0.0	0.0	0.0	0.0	0.0	0.0
Administration Fee	104.2	156.3	260.5	104.2	140.7	244.9
Base Cost	**2,110**	**3,165.7**	**5,276.1**	**2,110.4**	**2,849.1**	**4,959.5**
Physical Contingency	77.7	116.5	194.1	77.7	142.5	220.1
BC+PhC	**2,188**	**3,282.1**	**5,470.2**	**2,188.1**	**2,991.5**	**5,179.6**

Source: JICA Survey Team.

Table X.3.38 Economic Conversion of Project Cost for Agriculture Extension (for all Cases) (million Php)

Component	Financial Cost			Economic Cost		
	FC	LC	Total	FC	LC	Total
Construction Cost	34.1	51.2	85.3	34.1	46.1	80.2
Other Material	15.9	23.8	39.7	15.9	21.5	37.4
Skilled Labor	17.8	26.7	44.5	17.8	26.7	44.5
Unskilled Labor	0.4	0.6	1.1	0.4	0.6	1.1
Land Acquisition	0.0	0.0	0.0	0.0	0.0	0.0
Consultant Fee	0	0	0.0	0.0	0.0	0.0
Administration Cost	1.6	2.5	4.1	1.6	2.2	3.9
Base Cost	**35.8**	**53.7**	**89.4**	**35.8**	**48.3**	**84.1**
Physical Contingency	1.8	2.7	4.5	1.8	2.4	4.2
BC+PhC	**37.6**	**56.4**	**93.9**	**37.6**	**50.7**	**88.3**

Source: JICA Survey Team.

Table X.3.39 Cash Flow Sheet of Case C1-LM-D00

EIRR	6.57%		B/C
NPV	-787.6		0.74
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.8	0.0	144.8	0.0	0.0	-144.8	0.7	-211.9	211.9	0.0
2016	257.1	1.4	258.5	0.0	0.0	-258.5	0.8	-344.1	344.1	0.0
2017	274.6	4.0	278.6	8.7	0.0	-269.9	0.8	-326.5	337.1	10.5
2018	586.5	6.8	593.3	47.9	0.0	-545.4	0.9	-600.0	652.6	52.7
2019	409.3	12.6	422.0	97.2	0.0	-324.8	1.0	-324.8	422.0	97.2
2020	455.9	16.7	472.7	140.9	0.0	-331.8	1.1	-301.6	429.7	128.1
2021	319.1	21.3	340.4	163.0	0.0	-177.4	1.2	-146.6	281.3	134.7
2022	136.8	24.5	161.3	175.3	0.0	14.0	1.3	10.5	121.2	131.7
2023	0.0	25.8	25.8	197.2	0.0	171.4	1.5	117.0	17.7	134.7
2024	0.0	25.8	25.8	224.2	0.0	198.4	1.6	123.2	16.0	139.2
2025	0.0	25.8	25.8	242.6	0.0	216.8	1.8	122.4	14.6	136.9
2026	0.0	25.8	25.8	244.2	0.0	218.4	1.9	112.1	13.3	125.3
2027	0.0	25.8	25.8	244.2	0.0	218.4	2.1	101.9	12.1	113.9
2028	0.0	25.8	25.8	244.2	0.0	218.4	2.4	92.6	11.0	103.6
2029	0.0	25.8	25.8	244.2	0.0	218.4	2.6	84.2	10.0	94.1
2030	0.0	25.8	25.8	244.2	0.0	218.4	2.9	76.5	9.1	85.6
2031	0.0	25.8	25.8	244.2	0.0	218.4	3.1	69.6	8.2	77.8
2032	0.0	25.8	25.8	244.2	0.0	218.4	3.5	63.3	7.5	70.7
2033	0.0	25.8	25.8	244.2	0.0	218.4	3.8	57.5	6.8	64.3
2034	0.0	25.8	25.8	244.2	0.0	218.4	4.2	52.3	6.2	58.5
2035	0.0	25.8	25.8	244.2	0.0	218.4	4.6	47.5	5.6	53.1
2036	0.0	25.8	25.8	244.2	0.0	218.4	5.1	43.2	5.1	48.3
2037	0.0	25.8	25.8	244.2	0.0	218.4	5.6	39.3	4.6	43.9
2038	0.0	25.8	25.8	244.2	0.0	218.4	6.1	35.7	4.2	39.9
2039	0.0	25.8	25.8	244.2	0.0	218.4	6.7	32.5	3.8	36.3
2040	0.0	25.8	25.8	244.2	0.0	218.4	7.4	29.5	3.5	33.0
2041	0.0	25.8	25.8	244.2	0.0	218.4	8.1	26.8	3.2	30.0
2042	0.0	25.8	25.8	244.2	0.0	218.4	9.0	24.4	2.9	27.3
2043	0.0	25.8	25.8	244.2	0.0	218.4	9.8	22.2	2.6	24.8
2044	0.0	25.8	25.8	244.2	0.0	218.4	10.8	20.2	2.4	22.5
2045	0.0	25.8	25.8	244.2	0.0	218.4	11.9	18.3	2.2	20.5
2046	0.0	25.8	25.8	244.2	0.0	218.4	13.1	16.7	2.0	18.6
2047	0.0	25.8	25.8	244.2	0.0	218.4	14.4	15.1	1.8	16.9
2048	0.0	25.8	25.8	244.2	0.0	218.4	15.9	13.8	1.6	15.4
Total	2,584.2	759.2	3,343.4	6,913.6	0.0	3,570.2	169.8	-787.6	2,977.8	2,190.3

Source: JICA Survey Team.

Table X.3.40 Cash Flow Sheet of Case C1-LM-D30

EIRR	5.40%		B/C
NPV	-1030.6		0.65
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.8	0.0	144.8	0.0	0.0	-144.8	0.7	-211.9	211.9	0.0
2016	257.1	1.4	258.5	0.0	0.0	-258.5	0.8	-344.1	344.1	0.0
2017	274.6	4.0	278.6	7.6	0.0	-271.0	0.8	-327.9	337.1	9.2
2018	586.5	6.8	593.3	41.8	0.0	-551.5	0.9	-606.7	652.6	46.0
2019	409.3	12.6	422.0	85.3	0.0	-336.7	1.0	-336.7	422.0	85.3
2020	455.9	16.7	472.7	124.3	0.0	-348.4	1.1	-316.7	429.7	113.0
2021	319.1	21.3	340.4	144.6	0.0	-195.8	1.2	-161.8	281.3	119.5
2022	136.8	24.5	161.3	156.1	0.0	-5.2	1.3	-3.9	121.2	117.3
2023	0.0	25.8	25.8	175.7	0.0	149.9	1.5	102.4	17.7	120.0
2024	0.0	25.8	25.8	199.6	0.0	173.8	1.6	107.9	16.0	123.9
2025	0.0	25.8	25.8	216.0	0.0	190.2	1.8	107.3	14.6	121.9
2026	0.0	25.8	25.8	217.6	0.0	191.8	1.9	98.4	13.3	111.7
2027	0.0	25.8	25.8	217.6	0.0	191.8	2.1	89.5	12.1	101.5
2028	0.0	25.8	25.8	217.6	0.0	191.8	2.4	81.3	11.0	92.3
2029	0.0	25.8	25.8	217.6	0.0	191.8	2.6	73.9	10.0	83.9
2030	0.0	25.8	25.8	217.6	0.0	191.8	2.9	67.2	9.1	76.3
2031	0.0	25.8	25.8	217.6	0.0	191.8	3.1	61.1	8.2	69.3
2032	0.0	25.8	25.8	217.6	0.0	191.8	3.5	55.5	7.5	63.0
2033	0.0	25.8	25.8	217.6	0.0	191.8	3.8	50.5	6.8	57.3
2034	0.0	25.8	25.8	217.6	0.0	191.8	4.2	45.9	6.2	52.1
2035	0.0	25.8	25.8	217.6	0.0	191.8	4.6	41.7	5.6	47.4
2036	0.0	25.8	25.8	217.6	0.0	191.8	5.1	37.9	5.1	43.1
2037	0.0	25.8	25.8	217.6	0.0	191.8	5.6	34.5	4.6	39.1
2038	0.0	25.8	25.8	217.6	0.0	191.8	6.1	31.4	4.2	35.6
2039	0.0	25.8	25.8	217.6	0.0	191.8	6.7	28.5	3.8	32.3
2040	0.0	25.8	25.8	217.6	0.0	191.8	7.4	25.9	3.5	29.4
2041	0.0	25.8	25.8	217.6	0.0	191.8	8.1	23.6	3.2	26.7
2042	0.0	25.8	25.8	217.6	0.0	191.8	9.0	21.4	2.9	24.3
2043	0.0	25.8	25.8	217.6	0.0	191.8	9.8	19.5	2.6	22.1
2044	0.0	25.8	25.8	217.6	0.0	191.8	10.8	17.7	2.4	20.1
2045	0.0	25.8	25.8	217.6	0.0	191.8	11.9	16.1	2.2	18.3
2046	0.0	25.8	25.8	217.6	0.0	191.8	13.1	14.6	2.0	16.6
2047	0.0	25.8	25.8	217.6	0.0	191.8	14.4	13.3	1.8	15.1
2048	0.0	25.8	25.8	217.6	0.0	191.8	15.9	12.1	1.6	13.7
Total	2,584.2	759.2	3,343.4	6,155.8	0.0	2,812.4	169.8	-1,030.6	2,977.8	1,947.2

Source: JICA Survey Team.

Table X.3.41 Cash Flow Sheet of Case C1-LM-D50

EIRR	4.66%		B/C
NPV	-1175.8		0.61
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.8	0.0	144.8	0.0	0.0	-144.8	0.7	-211.9	211.9	0.0
2016	257.1	1.4	258.5	0.0	0.0	-258.5	0.8	-344.1	344.1	0.0
2017	274.6	4.0	278.6	6.9	0.0	-271.7	0.8	-328.7	337.1	8.3
2018	586.5	6.8	593.3	38.2	0.0	-555.1	0.9	-610.6	652.6	42.0
2019	409.3	12.6	422.0	78.1	0.0	-343.9	1.0	-343.9	422.0	78.1
2020	455.9	16.7	472.7	114.4	0.0	-358.3	1.1	-325.7	429.7	104.0
2021	319.1	21.3	340.4	133.6	0.0	-206.8	1.2	-170.9	281.3	110.4
2022	136.8	24.5	161.3	144.7	0.0	-16.6	1.3	-12.5	121.2	108.7
2023	0.0	25.8	25.8	162.9	0.0	137.1	1.5	93.6	17.7	111.3
2024	0.0	25.8	25.8	184.9	0.0	159.1	1.6	98.8	16.0	114.8
2025	0.0	25.8	25.8	200.1	0.0	174.3	1.8	98.4	14.6	113.0
2026	0.0	25.8	25.8	201.7	0.0	175.9	1.9	90.2	13.3	103.5
2027	0.0	25.8	25.8	201.7	0.0	175.9	2.1	82.0	12.1	94.1
2028	0.0	25.8	25.8	201.7	0.0	175.9	2.4	74.6	11.0	85.5
2029	0.0	25.8	25.8	201.7	0.0	175.9	2.6	67.8	10.0	77.8
2030	0.0	25.8	25.8	201.7	0.0	175.9	2.9	61.6	9.1	70.7
2031	0.0	25.8	25.8	201.7	0.0	175.9	3.1	56.0	8.2	64.3
2032	0.0	25.8	25.8	201.7	0.0	175.9	3.5	50.9	7.5	58.4
2033	0.0	25.8	25.8	201.7	0.0	175.9	3.8	46.3	6.8	53.1
2034	0.0	25.8	25.8	201.7	0.0	175.9	4.2	42.1	6.2	48.3
2035	0.0	25.8	25.8	201.7	0.0	175.9	4.6	38.3	5.6	43.9
2036	0.0	25.8	25.8	201.7	0.0	175.9	5.1	34.8	5.1	39.9
2037	0.0	25.8	25.8	201.7	0.0	175.9	5.6	31.6	4.6	36.3
2038	0.0	25.8	25.8	201.7	0.0	175.9	6.1	28.8	4.2	33.0
2039	0.0	25.8	25.8	201.7	0.0	175.9	6.7	26.1	3.8	30.0
2040	0.0	25.8	25.8	201.7	0.0	175.9	7.4	23.8	3.5	27.3
2041	0.0	25.8	25.8	201.7	0.0	175.9	8.1	21.6	3.2	24.8
2042	0.0	25.8	25.8	201.7	0.0	175.9	9.0	19.6	2.9	22.5
2043	0.0	25.8	25.8	201.7	0.0	175.9	9.8	17.9	2.6	20.5
2044	0.0	25.8	25.8	201.7	0.0	175.9	10.8	16.2	2.4	18.6
2045	0.0	25.8	25.8	201.7	0.0	175.9	11.9	14.8	2.2	16.9
2046	0.0	25.8	25.8	201.7	0.0	175.9	13.1	13.4	2.0	15.4
2047	0.0	25.8	25.8	201.7	0.0	175.9	14.4	12.2	1.8	14.0
2048	0.0	25.8	25.8	201.7	0.0	175.9	15.9	11.1	1.6	12.7
Total	2,584.2	759.2	3,343.4	5,702.9	0.0	2,359.5	169.8	-1,175.8	2,977.8	1,802.0

Source: JICA Survey Team.

Table X.3.42 Cash Flow Sheet of Case C1-LM-D80

EIRR	3.43%	B/C	
NPV	-1402.6		0.53
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.8	0.0	144.8	0.0	0.0	-144.8	0.7	-211.9	211.9	0.0
2016	257.1	1.4	258.5	0.0	0.0	-258.5	0.8	-344.1	344.1	0.0
2017	274.6	4.0	278.6	5.8	0.0	-272.8	0.8	-330.1	337.1	7.0
2018	586.5	6.8	593.3	32.5	0.0	-560.8	0.9	-616.9	652.6	35.8
2019	409.3	12.6	422.0	67.0	0.0	-355.0	1.0	-355.0	422.0	67.0
2020	455.9	16.7	472.7	98.9	0.0	-373.8	1.1	-339.8	429.7	89.9
2021	319.1	21.3	340.4	116.4	0.0	-224.0	1.2	-185.1	281.3	96.2
2022	136.8	24.5	161.3	126.8	0.0	-34.5	1.3	-25.9	121.2	95.3
2023	0.0	25.8	25.8	142.8	0.0	117.0	1.5	79.9	17.7	97.5
2024	0.0	25.8	25.8	162.0	0.0	136.2	1.6	84.5	16.0	100.6
2025	0.0	25.8	25.8	175.3	0.0	149.5	1.8	84.4	14.6	99.0
2026	0.0	25.8	25.8	176.9	0.0	151.1	1.9	77.5	13.3	90.8
2027	0.0	25.8	25.8	176.9	0.0	151.1	2.1	70.5	12.1	82.5
2028	0.0	25.8	25.8	176.9	0.0	151.1	2.4	64.1	11.0	75.0
2029	0.0	25.8	25.8	176.9	0.0	151.1	2.6	58.2	10.0	68.2
2030	0.0	25.8	25.8	176.9	0.0	151.1	2.9	52.9	9.1	62.0
2031	0.0	25.8	25.8	176.9	0.0	151.1	3.1	48.1	8.2	56.4
2032	0.0	25.8	25.8	176.9	0.0	151.1	3.5	43.8	7.5	51.2
2033	0.0	25.8	25.8	176.9	0.0	151.1	3.8	39.8	6.8	46.6
2034	0.0	25.8	25.8	176.9	0.0	151.1	4.2	36.2	6.2	42.3
2035	0.0	25.8	25.8	176.9	0.0	151.1	4.6	32.9	5.6	38.5
2036	0.0	25.8	25.8	176.9	0.0	151.1	5.1	29.9	5.1	35.0
2037	0.0	25.8	25.8	176.9	0.0	151.1	5.6	27.2	4.6	31.8
2038	0.0	25.8	25.8	176.9	0.0	151.1	6.1	24.7	4.2	28.9
2039	0.0	25.8	25.8	176.9	0.0	151.1	6.7	22.5	3.8	26.3
2040	0.0	25.8	25.8	176.9	0.0	151.1	7.4	20.4	3.5	23.9
2041	0.0	25.8	25.8	176.9	0.0	151.1	8.1	18.6	3.2	21.7
2042	0.0	25.8	25.8	176.9	0.0	151.1	9.0	16.9	2.9	19.8
2043	0.0	25.8	25.8	176.9	0.0	151.1	9.8	15.3	2.6	18.0
2044	0.0	25.8	25.8	176.9	0.0	151.1	10.8	13.9	2.4	16.3
2045	0.0	25.8	25.8	176.9	0.0	151.1	11.9	12.7	2.2	14.8
2046	0.0	25.8	25.8	176.9	0.0	151.1	13.1	11.5	2.0	13.5
2047	0.0	25.8	25.8	176.9	0.0	151.1	14.4	10.5	1.8	12.3
2048	0.0	25.8	25.8	176.9	0.0	151.1	15.9	9.5	1.6	11.2
Total	2,584.2	759.2	3,343.4	4,996.2	0.0	1,652.8	169.8	-1,402.6	2,977.8	1,575.3

Source: JICA Survey Team.

Table X.3.43 Cash Flow Sheet of Case C2-LM-D00

EIRR	8.19%		B/C
NPV	-533.6		0.87
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.0	0.0	144.0	0.0	0.0	-144.0	0.7	-210.8	210.8	0.0
2016	257.8	2.9	260.7	0.0	0.0	-260.7	0.8	-346.9	346.9	0.0
2017	301.3	8.0	309.3	14.4	0.0	-294.9	0.8	-356.9	374.3	17.4
2018	642.8	14.1	656.8	80.0	0.0	-576.8	0.9	-634.5	722.5	88.0
2019	552.4	26.9	579.3	161.8	0.0	-417.5	1.0	-417.5	579.3	161.8
2020	739.6	38.0	777.6	233.6	0.0	-544.0	1.1	-494.5	706.9	212.4
2021	556.9	52.8	609.7	269.3	0.0	-340.4	1.2	-281.3	503.9	222.6
2022	241.3	63.9	305.2	288.8	0.0	-16.4	1.3	-12.3	229.3	217.0
2023	0.0	68.7	68.7	324.7	0.0	256.0	1.5	174.8	46.9	221.8
2024	0.0	68.7	68.7	369.4	0.0	300.7	1.6	186.7	42.7	229.4
2025	0.0	68.7	68.7	399.7	0.0	331.0	1.8	186.8	38.8	225.6
2026	0.0	68.7	68.7	402.3	0.0	333.6	1.9	171.2	35.3	206.4
2027	0.0	68.7	68.7	402.3	0.0	333.6	2.1	155.6	32.1	187.7
2028	0.0	68.7	68.7	402.3	0.0	333.6	2.4	141.5	29.1	170.6
2029	0.0	68.7	68.7	402.3	0.0	333.6	2.6	128.6	26.5	155.1
2030	0.0	68.7	68.7	402.3	0.0	333.6	2.9	116.9	24.1	141.0
2031	0.0	68.7	68.7	402.3	0.0	333.6	3.1	106.3	21.9	128.2
2032	0.0	68.7	68.7	402.3	0.0	333.6	3.5	96.6	19.9	116.5
2033	0.0	68.7	68.7	402.3	0.0	333.6	3.8	87.8	18.1	105.9
2034	0.0	68.7	68.7	402.3	0.0	333.6	4.2	79.9	16.5	96.3
2035	0.0	68.7	68.7	402.3	0.0	333.6	4.6	72.6	15.0	87.6
2036	0.0	68.7	68.7	402.3	0.0	333.6	5.1	66.0	13.6	79.6
2037	0.0	68.7	68.7	402.3	0.0	333.6	5.6	60.0	12.4	72.4
2038	0.0	68.7	68.7	402.3	0.0	333.6	6.1	54.5	11.2	65.8
2039	0.0	68.7	68.7	402.3	0.0	333.6	6.7	49.6	10.2	59.8
2040	0.0	68.7	68.7	402.3	0.0	333.6	7.4	45.1	9.3	54.4
2041	0.0	68.7	68.7	402.3	0.0	333.6	8.1	41.0	8.4	49.4
2042	0.0	68.7	68.7	402.3	0.0	333.6	9.0	37.3	7.7	44.9
2043	0.0	68.7	68.7	402.3	0.0	333.6	9.8	33.9	7.0	40.8
2044	0.0	68.7	68.7	402.3	0.0	333.6	10.8	30.8	6.3	37.1
2045	0.0	68.7	68.7	402.3	0.0	333.6	11.9	28.0	5.8	33.8
2046	0.0	68.7	68.7	402.3	0.0	333.6	13.1	25.4	5.2	30.7
2047	0.0	68.7	68.7	402.3	0.0	333.6	14.4	23.1	4.8	27.9
2048	0.0	68.7	68.7	402.3	0.0	333.6	15.9	21.0	4.3	25.4
Total	3,435.9	1,993.2	5,429.1	11,394.6	0.0	5,965.5	169.8	-533.6	4,146.7	3,613.2

Source: JICA Survey Team.

Table X.3.44 Cash Flow Sheet of Case C2-LM-D30

EIRR	6.96%		B/C
NPV	-876.9		0.79
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.0	0.0	144.0	0.0	0.0	-144.0	0.7	-210.8	210.8	0.0
2016	257.8	2.9	260.7	0.0	0.0	-260.7	0.8	-346.9	346.9	0.0
2017	301.3	8.0	309.3	12.9	0.0	-296.4	0.8	-358.7	374.3	15.6
2018	642.8	14.1	656.8	71.4	0.0	-585.4	0.9	-644.0	722.5	78.5
2019	552.4	26.9	579.3	144.9	0.0	-434.4	1.0	-434.4	579.3	144.9
2020	739.6	38.0	777.6	210.1	0.0	-567.5	1.1	-515.9	706.9	191.0
2021	556.9	52.8	609.7	243.3	0.0	-366.4	1.2	-302.8	503.9	201.1
2022	241.3	63.9	305.2	261.8	0.0	-43.4	1.3	-32.6	229.3	196.7
2023	0.0	68.7	68.7	294.4	0.0	225.7	1.5	154.1	46.9	201.1
2024	0.0	68.7	68.7	334.7	0.0	266.0	1.6	165.2	42.7	207.8
2025	0.0	68.7	68.7	362.1	0.0	293.4	1.8	165.6	38.8	204.4
2026	0.0	68.7	68.7	364.7	0.0	296.0	1.9	151.9	35.3	187.1
2027	0.0	68.7	68.7	364.7	0.0	296.0	2.1	138.1	32.1	170.1
2028	0.0	68.7	68.7	364.7	0.0	296.0	2.4	125.5	29.1	154.7
2029	0.0	68.7	68.7	364.7	0.0	296.0	2.6	114.1	26.5	140.6
2030	0.0	68.7	68.7	364.7	0.0	296.0	2.9	103.7	24.1	127.8
2031	0.0	68.7	68.7	364.7	0.0	296.0	3.1	94.3	21.9	116.2
2032	0.0	68.7	68.7	364.7	0.0	296.0	3.5	85.7	19.9	105.6
2033	0.0	68.7	68.7	364.7	0.0	296.0	3.8	77.9	18.1	96.0
2034	0.0	68.7	68.7	364.7	0.0	296.0	4.2	70.9	16.5	87.3
2035	0.0	68.7	68.7	364.7	0.0	296.0	4.6	64.4	15.0	79.4
2036	0.0	68.7	68.7	364.7	0.0	296.0	5.1	58.6	13.6	72.2
2037	0.0	68.7	68.7	364.7	0.0	296.0	5.6	53.2	12.4	65.6
2038	0.0	68.7	68.7	364.7	0.0	296.0	6.1	48.4	11.2	59.6
2039	0.0	68.7	68.7	364.7	0.0	296.0	6.7	44.0	10.2	54.2
2040	0.0	68.7	68.7	364.7	0.0	296.0	7.4	40.0	9.3	49.3
2041	0.0	68.7	68.7	364.7	0.0	296.0	8.1	36.4	8.4	44.8
2042	0.0	68.7	68.7	364.7	0.0	296.0	9.0	33.1	7.7	40.7
2043	0.0	68.7	68.7	364.7	0.0	296.0	9.8	30.0	7.0	37.0
2044	0.0	68.7	68.7	364.7	0.0	296.0	10.8	27.3	6.3	33.7
2045	0.0	68.7	68.7	364.7	0.0	296.0	11.9	24.8	5.8	30.6
2046	0.0	68.7	68.7	364.7	0.0	296.0	13.1	22.6	5.2	27.8
2047	0.0	68.7	68.7	364.7	0.0	296.0	14.4	20.5	4.8	25.3
2048	0.0	68.7	68.7	364.7	0.0	296.0	15.9	18.7	4.3	23.0
Total	3,435.9	1,993.2	5,429.1	10,323.7	0.0	4,894.6	169.8	-876.9	4,146.7	3,269.8

Source: JICA Survey Team.

Table X.3.45 Cash Flow Sheet of Case C2-LM-D50

EIRR	6.14%		B/C
NPV	-1097.9		0.74
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.0	0.0	144.0	0.0	0.0	-144.0	0.7	-210.8	210.8	0.0
2016	257.8	2.9	260.7	0.0	0.0	-260.7	0.8	-346.9	346.9	0.0
2017	301.3	8.0	309.3	11.8	0.0	-297.5	0.8	-360.0	374.3	14.3
2018	642.8	14.1	656.8	65.8	0.0	-591.0	0.9	-650.1	722.5	72.4
2019	552.4	26.9	579.3	134.1	0.0	-445.2	1.0	-445.2	579.3	134.1
2020	739.6	38.0	777.6	195.1	0.0	-582.5	1.1	-529.5	706.9	177.4
2021	556.9	52.8	609.7	226.6	0.0	-383.1	1.2	-316.6	503.9	187.3
2022	241.3	63.9	305.2	244.3	0.0	-60.9	1.3	-45.7	229.3	183.5
2023	0.0	68.7	68.7	274.9	0.0	206.2	1.5	140.8	46.9	187.8
2024	0.0	68.7	68.7	312.4	0.0	243.7	1.6	151.3	42.7	194.0
2025	0.0	68.7	68.7	337.9	0.0	269.2	1.8	151.9	38.8	190.7
2026	0.0	68.7	68.7	340.5	0.0	271.8	1.9	139.5	35.3	174.7
2027	0.0	68.7	68.7	340.5	0.0	271.8	2.1	126.8	32.1	158.8
2028	0.0	68.7	68.7	340.5	0.0	271.8	2.4	115.3	29.1	144.4
2029	0.0	68.7	68.7	340.5	0.0	271.8	2.6	104.8	26.5	131.3
2030	0.0	68.7	68.7	340.5	0.0	271.8	2.9	95.3	24.1	119.3
2031	0.0	68.7	68.7	340.5	0.0	271.8	3.1	86.6	21.9	108.5
2032	0.0	68.7	68.7	340.5	0.0	271.8	3.5	78.7	19.9	98.6
2033	0.0	68.7	68.7	340.5	0.0	271.8	3.8	71.6	18.1	89.7
2034	0.0	68.7	68.7	340.5	0.0	271.8	4.2	65.1	16.5	81.5
2035	0.0	68.7	68.7	340.5	0.0	271.8	4.6	59.1	15.0	74.1
2036	0.0	68.7	68.7	340.5	0.0	271.8	5.1	53.8	13.6	67.4
2037	0.0	68.7	68.7	340.5	0.0	271.8	5.6	48.9	12.4	61.2
2038	0.0	68.7	68.7	340.5	0.0	271.8	6.1	44.4	11.2	55.7
2039	0.0	68.7	68.7	340.5	0.0	271.8	6.7	40.4	10.2	50.6
2040	0.0	68.7	68.7	340.5	0.0	271.8	7.4	36.7	9.3	46.0
2041	0.0	68.7	68.7	340.5	0.0	271.8	8.1	33.4	8.4	41.8
2042	0.0	68.7	68.7	340.5	0.0	271.8	9.0	30.4	7.7	38.0
2043	0.0	68.7	68.7	340.5	0.0	271.8	9.8	27.6	7.0	34.6
2044	0.0	68.7	68.7	340.5	0.0	271.8	10.8	25.1	6.3	31.4
2045	0.0	68.7	68.7	340.5	0.0	271.8	11.9	22.8	5.8	28.6
2046	0.0	68.7	68.7	340.5	0.0	271.8	13.1	20.7	5.2	26.0
2047	0.0	68.7	68.7	340.5	0.0	271.8	14.4	18.8	4.8	23.6
2048	0.0	68.7	68.7	340.5	0.0	271.8	15.9	17.1	4.3	21.5
Total	3,435.9	1,993.2	5,429.1	9,634.4	0.0	4,205.3	169.8	-1,097.9	4,146.7	3,048.8

Source: JICA Survey Team.

Table X.3.46 Cash Flow Sheet of Case C2-LM-D80

EIRR	4.79%		B/C
NPV	-1441.4		0.65
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.0	0.0	144.0	0.0	0.0	-144.0	0.7	-210.8	210.8	0.0
2016	257.8	2.9	260.7	0.0	0.0	-260.7	0.8	-346.9	346.9	0.0
2017	301.3	8.0	309.3	10.3	0.0	-299.0	0.8	-361.8	374.3	12.5
2018	642.8	14.1	656.8	57.2	0.0	-599.6	0.9	-659.6	722.5	62.9
2019	552.4	26.9	579.3	117.2	0.0	-462.1	1.0	-462.1	579.3	117.2
2020	739.6	38.0	777.6	171.6	0.0	-606.0	1.1	-550.9	706.9	156.0
2021	556.9	52.8	609.7	200.6	0.0	-409.1	1.2	-338.1	503.9	165.8
2022	241.3	63.9	305.2	217.2	0.0	-88.0	1.3	-66.1	229.3	163.2
2023	0.0	68.7	68.7	244.5	0.0	175.8	1.5	120.1	46.9	167.0
2024	0.0	68.7	68.7	277.7	0.0	209.0	1.6	129.8	42.7	172.4
2025	0.0	68.7	68.7	300.3	0.0	231.6	1.8	130.7	38.8	169.5
2026	0.0	68.7	68.7	302.9	0.0	234.2	1.9	120.2	35.3	155.4
2027	0.0	68.7	68.7	302.9	0.0	234.2	2.1	109.2	32.1	141.3
2028	0.0	68.7	68.7	302.9	0.0	234.2	2.4	99.3	29.1	128.5
2029	0.0	68.7	68.7	302.9	0.0	234.2	2.6	90.3	26.5	116.8
2030	0.0	68.7	68.7	302.9	0.0	234.2	2.9	82.1	24.1	106.2
2031	0.0	68.7	68.7	302.9	0.0	234.2	3.1	74.6	21.9	96.5
2032	0.0	68.7	68.7	302.9	0.0	234.2	3.5	67.8	19.9	87.7
2033	0.0	68.7	68.7	302.9	0.0	234.2	3.8	61.7	18.1	79.8
2034	0.0	68.7	68.7	302.9	0.0	234.2	4.2	56.1	16.5	72.5
2035	0.0	68.7	68.7	302.9	0.0	234.2	4.6	51.0	15.0	65.9
2036	0.0	68.7	68.7	302.9	0.0	234.2	5.1	46.3	13.6	59.9
2037	0.0	68.7	68.7	302.9	0.0	234.2	5.6	42.1	12.4	54.5
2038	0.0	68.7	68.7	302.9	0.0	234.2	6.1	38.3	11.2	49.5
2039	0.0	68.7	68.7	302.9	0.0	234.2	6.7	34.8	10.2	45.0
2040	0.0	68.7	68.7	302.9	0.0	234.2	7.4	31.6	9.3	40.9
2041	0.0	68.7	68.7	302.9	0.0	234.2	8.1	28.8	8.4	37.2
2042	0.0	68.7	68.7	302.9	0.0	234.2	9.0	26.2	7.7	33.8
2043	0.0	68.7	68.7	302.9	0.0	234.2	9.8	23.8	7.0	30.8
2044	0.0	68.7	68.7	302.9	0.0	234.2	10.8	21.6	6.3	28.0
2045	0.0	68.7	68.7	302.9	0.0	234.2	11.9	19.6	5.8	25.4
2046	0.0	68.7	68.7	302.9	0.0	234.2	13.1	17.9	5.2	23.1
2047	0.0	68.7	68.7	302.9	0.0	234.2	14.4	16.2	4.8	21.0
2048	0.0	68.7	68.7	302.9	0.0	234.2	15.9	14.8	4.3	19.1
Total	3,435.9	1,993.2	5,429.1	8,563.3	0.0	3,134.2	169.8	-1,441.4	4,146.7	2,705.3

Source: JICA Survey Team.

Table X.3.47 Cash Flow Sheet of Case C1-M2-D00

EIRR	10.90%		B/C
NPV	423.6		1.07
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	21.6	0.0	21.6	0.0	0.0	-21.6	0.5	-46.4	46.4	0.0
2012	164.5	0.2	164.7	31.6	0.0	-133.1	0.5	-259.3	320.9	61.6
2013	233.7	1.9	235.6	63.1	0.0	-172.5	0.6	-305.5	417.3	111.8
2014	679.5	4.2	683.7	94.7	0.0	-589.0	0.6	-948.6	1,101.1	152.5
2015	389.5	11.0	400.5	126.3	0.0	-274.2	0.7	-401.5	586.4	184.9
2016	415.5	14.9	430.4	175.4	0.0	-255.0	0.8	-339.4	572.8	233.5
2017	359.2	19.0	378.3	202.4	0.0	-175.9	0.8	-212.8	457.7	244.9
2018	761.7	22.6	784.3	261.4	0.0	-522.9	0.9	-575.2	862.8	287.5
2019	463.1	30.3	493.3	336.5	0.0	-156.8	1.0	-156.8	493.3	336.5
2020	469.4	34.9	504.3	402.8	0.0	-101.5	1.1	-92.3	458.5	366.2
2021	323.2	39.6	362.8	437.8	0.0	75.0	1.2	62.0	299.9	361.8
2022	143.9	42.8	186.7	457.9	0.0	271.2	1.3	203.8	140.2	344.0
2023	0.0	44.2	44.2	491.1	0.0	446.9	1.5	305.2	30.2	335.4
2024	0.0	44.2	44.2	531.5	0.0	487.3	1.6	302.5	27.5	330.0
2025	0.0	44.2	44.2	559.2	0.0	515.0	1.8	290.7	25.0	315.7
2026	0.0	44.2	44.2	562.2	0.0	518.0	1.9	265.8	22.7	288.5
2027	0.0	44.2	44.2	562.2	0.0	518.0	2.1	241.6	20.6	262.3
2028	0.0	44.2	44.2	562.2	0.0	518.0	2.4	219.7	18.8	238.4
2029	0.0	44.2	44.2	562.2	0.0	518.0	2.6	199.7	17.1	216.8
2030	0.0	44.2	44.2	562.2	0.0	518.0	2.9	181.5	15.5	197.0
2031	0.0	44.2	44.2	562.2	0.0	518.0	3.1	165.0	14.1	179.1
2032	0.0	44.2	44.2	562.2	0.0	518.0	3.5	150.0	12.8	162.8
2033	0.0	44.2	44.2	562.2	0.0	518.0	3.8	136.4	11.7	148.0
2034	0.0	44.2	44.2	562.2	0.0	518.0	4.2	124.0	10.6	134.6
2035	0.0	44.2	44.2	562.2	0.0	518.0	4.6	112.7	9.6	122.4
2036	0.0	44.2	44.2	562.2	0.0	518.0	5.1	102.5	8.8	111.2
2037	0.0	44.2	44.2	562.2	0.0	518.0	5.6	93.2	8.0	101.1
2038	0.0	44.2	44.2	562.2	0.0	518.0	6.1	84.7	7.2	91.9
2039	0.0	44.2	44.2	562.2	0.0	518.0	6.7	77.0	6.6	83.6
2040	0.0	44.2	44.2	562.2	0.0	518.0	7.4	70.0	6.0	76.0
2041	0.0	44.2	44.2	562.2	0.0	518.0	8.1	63.6	5.4	69.1
2042	0.0	44.2	44.2	562.2	0.0	518.0	9.0	57.8	4.9	62.8
2043	0.0	44.2	44.2	562.2	0.0	518.0	9.8	52.6	4.5	57.1
2044	0.0	44.2	44.2	562.2	0.0	518.0	10.8	47.8	4.1	51.9
2045	0.0	44.2	44.2	562.2	0.0	518.0	11.9	43.5	3.7	47.2
2046	0.0	44.2	44.2	562.2	0.0	518.0	13.1	39.5	3.4	42.9
2047	0.0	44.2	44.2	562.2	0.0	518.0	14.4	35.9	3.1	39.0
2048	0.0	44.2	44.2	562.2	0.0	518.0	15.9	32.7	2.8	35.4
Total	4,424.8	1,371.8	5,796.6	17,102.3	0.0	11,305.7	169.8	423.6	6,061.8	6,485.4

Source: JICA Survey Team.

Table X.3.48 Cash Flow Sheet of Case C1-M2-D30

EIRR	10.07%		B/C
NPV	35.1		1.01
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	21.6	0.0	21.6	0.0	0.0	-21.6	0.5	-46.4	46.4	0.0
2012	164.5	0.2	164.7	24.3	0.0	-140.4	0.5	-273.6	320.9	47.4
2013	233.7	1.9	235.6	51.1	0.0	-184.5	0.6	-326.8	417.3	90.5
2014	679.5	4.2	683.7	81.1	0.0	-602.6	0.6	-970.5	1,101.1	130.6
2015	389.5	11.0	400.5	111.2	0.0	-289.3	0.7	-423.6	586.4	162.8
2016	415.5	14.9	430.4	154.8	0.0	-275.6	0.8	-366.8	572.8	206.0
2017	359.2	19.0	378.3	187.4	0.0	-190.9	0.8	-230.9	457.7	226.8
2018	761.7	22.6	784.3	248.2	0.0	-536.1	0.9	-589.8	862.8	273.0
2019	463.1	30.3	493.3	319.5	0.0	-173.8	1.0	-173.8	493.3	319.5
2020	469.4	34.9	504.3	382.8	0.0	-121.5	1.1	-110.5	458.5	348.0
2021	323.2	39.6	362.8	416.6	0.0	53.8	1.2	44.4	299.9	344.3
2022	143.9	42.8	186.7	436.2	0.0	249.5	1.3	187.5	140.2	327.7
2023	0.0	44.2	44.2	467.9	0.0	423.7	1.5	289.4	30.2	319.6
2024	0.0	44.2	44.2	506.3	0.0	462.1	1.6	286.9	27.5	314.4
2025	0.0	44.2	44.2	532.6	0.0	488.4	1.8	275.7	25.0	300.6
2026	0.0	44.2	44.2	535.6	0.0	491.4	1.9	252.1	22.7	274.8
2027	0.0	44.2	44.2	535.6	0.0	491.4	2.1	229.2	20.6	249.9
2028	0.0	44.2	44.2	535.6	0.0	491.4	2.4	208.4	18.8	227.1
2029	0.0	44.2	44.2	535.6	0.0	491.4	2.6	189.4	17.1	206.5
2030	0.0	44.2	44.2	535.6	0.0	491.4	2.9	172.2	15.5	187.7
2031	0.0	44.2	44.2	535.6	0.0	491.4	3.1	156.6	14.1	170.7
2032	0.0	44.2	44.2	535.6	0.0	491.4	3.5	142.3	12.8	155.1
2033	0.0	44.2	44.2	535.6	0.0	491.4	3.8	129.4	11.7	141.0
2034	0.0	44.2	44.2	535.6	0.0	491.4	4.2	117.6	10.6	128.2
2035	0.0	44.2	44.2	535.6	0.0	491.4	4.6	106.9	9.6	116.6
2036	0.0	44.2	44.2	535.6	0.0	491.4	5.1	97.2	8.8	106.0
2037	0.0	44.2	44.2	535.6	0.0	491.4	5.6	88.4	8.0	96.3
2038	0.0	44.2	44.2	535.6	0.0	491.4	6.1	80.3	7.2	87.6
2039	0.0	44.2	44.2	535.6	0.0	491.4	6.7	73.0	6.6	79.6
2040	0.0	44.2	44.2	535.6	0.0	491.4	7.4	66.4	6.0	72.4
2041	0.0	44.2	44.2	535.6	0.0	491.4	8.1	60.4	5.4	65.8
2042	0.0	44.2	44.2	535.6	0.0	491.4	9.0	54.9	4.9	59.8
2043	0.0	44.2	44.2	535.6	0.0	491.4	9.8	49.9	4.5	54.4
2044	0.0	44.2	44.2	535.6	0.0	491.4	10.8	45.3	4.1	49.4
2045	0.0	44.2	44.2	535.6	0.0	491.4	11.9	41.2	3.7	44.9
2046	0.0	44.2	44.2	535.6	0.0	491.4	13.1	37.5	3.4	40.9
2047	0.0	44.2	44.2	535.6	0.0	491.4	14.4	34.1	3.1	37.1
2048	0.0	44.2	44.2	535.6	0.0	491.4	15.9	31.0	2.8	33.8
Total	4,424.8	1,371.8	5,796.6	16,238.8	0.0	10,442.2	169.8	35.1	6,061.8	6,096.9

Source: JICA Survey Team.

Table X.3.49 Cash Flow Sheet of Case C1-M2-D50

EIRR	9.68%		B/C
NPV	-150.8		0.98
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	21.6	0.0	21.6	0.0	0.0	-21.6	0.5	-46.4	46.4	0.0
2012	164.5	0.2	164.7	23.4	0.0	-141.3	0.5	-275.3	320.9	45.6
2013	233.7	1.9	235.6	49.3	0.0	-186.3	0.6	-330.0	417.3	87.3
2014	679.5	4.2	683.7	78.4	0.0	-605.3	0.6	-974.8	1,101.1	126.3
2015	389.5	11.0	400.5	107.6	0.0	-292.9	0.7	-428.8	586.4	157.5
2016	415.5	14.9	430.4	149.8	0.0	-280.6	0.8	-373.4	572.8	199.4
2017	359.2	19.0	378.3	181.5	0.0	-196.8	0.8	-238.1	457.7	219.6
2018	761.7	22.6	784.3	240.4	0.0	-543.9	0.9	-598.3	862.8	264.4
2019	463.1	30.3	493.3	309.3	0.0	-184.0	1.0	-184.0	493.3	309.3
2020	469.4	34.9	504.3	370.8	0.0	-133.5	1.1	-121.4	458.5	337.1
2021	323.2	39.6	362.8	403.9	0.0	41.1	1.2	33.9	299.9	333.8
2022	143.9	42.8	186.7	423.2	0.0	236.5	1.3	177.7	140.2	318.0
2023	0.0	44.2	44.2	453.9	0.0	409.7	1.5	279.8	30.2	310.0
2024	0.0	44.2	44.2	491.2	0.0	447.0	1.6	277.5	27.5	305.0
2025	0.0	44.2	44.2	516.7	0.0	472.5	1.8	266.7	25.0	291.7
2026	0.0	44.2	44.2	519.7	0.0	475.5	1.9	244.0	22.7	266.7
2027	0.0	44.2	44.2	519.7	0.0	475.5	2.1	221.8	20.6	242.4
2028	0.0	44.2	44.2	519.7	0.0	475.5	2.4	201.6	18.8	220.4
2029	0.0	44.2	44.2	519.7	0.0	475.5	2.6	183.3	17.1	200.4
2030	0.0	44.2	44.2	519.7	0.0	475.5	2.9	166.6	15.5	182.2
2031	0.0	44.2	44.2	519.7	0.0	475.5	3.1	151.5	14.1	165.6
2032	0.0	44.2	44.2	519.7	0.0	475.5	3.5	137.7	12.8	150.5
2033	0.0	44.2	44.2	519.7	0.0	475.5	3.8	125.2	11.7	136.9
2034	0.0	44.2	44.2	519.7	0.0	475.5	4.2	113.8	10.6	124.4
2035	0.0	44.2	44.2	519.7	0.0	475.5	4.6	103.5	9.6	113.1
2036	0.0	44.2	44.2	519.7	0.0	475.5	5.1	94.1	8.8	102.8
2037	0.0	44.2	44.2	519.7	0.0	475.5	5.6	85.5	8.0	93.5
2038	0.0	44.2	44.2	519.7	0.0	475.5	6.1	77.7	7.2	85.0
2039	0.0	44.2	44.2	519.7	0.0	475.5	6.7	70.7	6.6	77.3
2040	0.0	44.2	44.2	519.7	0.0	475.5	7.4	64.2	6.0	70.2
2041	0.0	44.2	44.2	519.7	0.0	475.5	8.1	58.4	5.4	63.8
2042	0.0	44.2	44.2	519.7	0.0	475.5	9.0	53.1	4.9	58.0
2043	0.0	44.2	44.2	519.7	0.0	475.5	9.8	48.3	4.5	52.8
2044	0.0	44.2	44.2	519.7	0.0	475.5	10.8	43.9	4.1	48.0
2045	0.0	44.2	44.2	519.7	0.0	475.5	11.9	39.9	3.7	43.6
2046	0.0	44.2	44.2	519.7	0.0	475.5	13.1	36.3	3.4	39.6
2047	0.0	44.2	44.2	519.7	0.0	475.5	14.4	33.0	3.1	36.0
2048	0.0	44.2	44.2	519.7	0.0	475.5	15.9	30.0	2.8	32.8
Total	4,424.8	1,371.8	5,796.6	15,752.5	0.0	9,955.9	169.8	-150.8	6,061.8	5,911.0

Source: JICA Survey Team.

Table X.3.50 Cash Flow Sheet of Case C1-M2-D80

EIRR	9.07%		B/C
NPV	-440.3		0.93
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	21.6	0.0	21.6	0.0	0.0	-21.6	0.5	-46.4	46.4	0.0
2012	164.5	0.2	164.7	22.0	0.0	-142.7	0.5	-278.0	320.9	42.9
2013	233.7	1.9	235.6	46.5	0.0	-189.1	0.6	-334.9	417.3	82.4
2014	679.5	4.2	683.7	74.3	0.0	-609.4	0.6	-981.4	1,101.1	119.7
2015	389.5	11.0	400.5	102.1	0.0	-298.4	0.7	-436.9	586.4	149.5
2016	415.5	14.9	430.4	142.1	0.0	-288.3	0.8	-383.7	572.8	189.1
2017	359.2	19.0	378.3	172.3	0.0	-206.0	0.8	-249.2	457.7	208.5
2018	761.7	22.6	784.3	228.1	0.0	-556.2	0.9	-611.9	862.8	250.9
2019	463.1	30.3	493.3	293.5	0.0	-199.8	1.0	-199.8	493.3	293.5
2020	469.4	34.9	504.3	352.1	0.0	-152.2	1.1	-138.4	458.5	320.1
2021	323.2	39.6	362.8	384.1	0.0	21.3	1.2	17.6	299.9	317.4
2022	143.9	42.8	186.7	402.9	0.0	216.2	1.3	162.5	140.2	302.7
2023	0.0	44.2	44.2	432.3	0.0	388.1	1.5	265.0	30.2	295.3
2024	0.0	44.2	44.2	467.6	0.0	423.4	1.6	262.9	27.5	290.3
2025	0.0	44.2	44.2	491.9	0.0	447.7	1.8	252.7	25.0	277.7
2026	0.0	44.2	44.2	494.9	0.0	450.7	1.9	231.3	22.7	254.0
2027	0.0	44.2	44.2	494.9	0.0	450.7	2.1	210.2	20.6	230.9
2028	0.0	44.2	44.2	494.9	0.0	450.7	2.4	191.1	18.8	209.9
2029	0.0	44.2	44.2	494.9	0.0	450.7	2.6	173.7	17.1	190.8
2030	0.0	44.2	44.2	494.9	0.0	450.7	2.9	158.0	15.5	173.5
2031	0.0	44.2	44.2	494.9	0.0	450.7	3.1	143.6	14.1	157.7
2032	0.0	44.2	44.2	494.9	0.0	450.7	3.5	130.5	12.8	143.4
2033	0.0	44.2	44.2	494.9	0.0	450.7	3.8	118.7	11.7	130.3
2034	0.0	44.2	44.2	494.9	0.0	450.7	4.2	107.9	10.6	118.5
2035	0.0	44.2	44.2	494.9	0.0	450.7	4.6	98.1	9.6	107.7
2036	0.0	44.2	44.2	494.9	0.0	450.7	5.1	89.2	8.8	97.9
2037	0.0	44.2	44.2	494.9	0.0	450.7	5.6	81.1	8.0	89.0
2038	0.0	44.2	44.2	494.9	0.0	450.7	6.1	73.7	7.2	80.9
2039	0.0	44.2	44.2	494.9	0.0	450.7	6.7	67.0	6.6	73.6
2040	0.0	44.2	44.2	494.9	0.0	450.7	7.4	60.9	6.0	66.9
2041	0.0	44.2	44.2	494.9	0.0	450.7	8.1	55.4	5.4	60.8
2042	0.0	44.2	44.2	494.9	0.0	450.7	9.0	50.3	4.9	55.3
2043	0.0	44.2	44.2	494.9	0.0	450.7	9.8	45.8	4.5	50.2
2044	0.0	44.2	44.2	494.9	0.0	450.7	10.8	41.6	4.1	45.7
2045	0.0	44.2	44.2	494.9	0.0	450.7	11.9	37.8	3.7	41.5
2046	0.0	44.2	44.2	494.9	0.0	450.7	13.1	34.4	3.4	37.7
2047	0.0	44.2	44.2	494.9	0.0	450.7	14.4	31.2	3.1	34.3
2048	0.0	44.2	44.2	494.9	0.0	450.7	15.9	28.4	2.8	31.2
Total	4,424.8	1,371.8	5,796.6	14,994.5	0.0	9,197.9	169.8	-440.3	6,061.8	5,621.5

Source: JICA Survey Team.

Table X.3.51 Cash Flow Sheet of Case C2-M2-D00

EIRR	8.19%		B/C
NPV	-533.6		0.87
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.0	0.0	144.0	0.0	0.0	-144.0	0.7	-210.8	210.8	0.0
2016	257.8	2.9	260.7	0.0	0.0	-260.7	0.8	-346.9	346.9	0.0
2017	301.3	8.0	309.3	14.4	0.0	-294.9	0.8	-356.9	374.3	17.4
2018	642.8	14.1	656.8	80.0	0.0	-576.8	0.9	-634.5	722.5	88.0
2019	552.4	26.9	579.3	161.8	0.0	-417.5	1.0	-417.5	579.3	161.8
2020	739.6	38.0	777.6	233.6	0.0	-544.0	1.1	-494.5	706.9	212.4
2021	556.9	52.8	609.7	269.3	0.0	-340.4	1.2	-281.3	503.9	222.6
2022	241.3	63.9	305.2	288.8	0.0	-16.4	1.3	-12.3	229.3	217.0
2023	0.0	68.7	68.7	324.7	0.0	256.0	1.5	174.8	46.9	221.8
2024	0.0	68.7	68.7	369.4	0.0	300.7	1.6	186.7	42.7	229.4
2025	0.0	68.7	68.7	399.7	0.0	331.0	1.8	186.8	38.8	225.6
2026	0.0	68.7	68.7	402.3	0.0	333.6	1.9	171.2	35.3	206.4
2027	0.0	68.7	68.7	402.3	0.0	333.6	2.1	155.6	32.1	187.7
2028	0.0	68.7	68.7	402.3	0.0	333.6	2.4	141.5	29.1	170.6
2029	0.0	68.7	68.7	402.3	0.0	333.6	2.6	128.6	26.5	155.1
2030	0.0	68.7	68.7	402.3	0.0	333.6	2.9	116.9	24.1	141.0
2031	0.0	68.7	68.7	402.3	0.0	333.6	3.1	106.3	21.9	128.2
2032	0.0	68.7	68.7	402.3	0.0	333.6	3.5	96.6	19.9	116.5
2033	0.0	68.7	68.7	402.3	0.0	333.6	3.8	87.8	18.1	105.9
2034	0.0	68.7	68.7	402.3	0.0	333.6	4.2	79.9	16.5	96.3
2035	0.0	68.7	68.7	402.3	0.0	333.6	4.6	72.6	15.0	87.6
2036	0.0	68.7	68.7	402.3	0.0	333.6	5.1	66.0	13.6	79.6
2037	0.0	68.7	68.7	402.3	0.0	333.6	5.6	60.0	12.4	72.4
2038	0.0	68.7	68.7	402.3	0.0	333.6	6.1	54.5	11.2	65.8
2039	0.0	68.7	68.7	402.3	0.0	333.6	6.7	49.6	10.2	59.8
2040	0.0	68.7	68.7	402.3	0.0	333.6	7.4	45.1	9.3	54.4
2041	0.0	68.7	68.7	402.3	0.0	333.6	8.1	41.0	8.4	49.4
2042	0.0	68.7	68.7	402.3	0.0	333.6	9.0	37.3	7.7	44.9
2043	0.0	68.7	68.7	402.3	0.0	333.6	9.8	33.9	7.0	40.8
2044	0.0	68.7	68.7	402.3	0.0	333.6	10.8	30.8	6.3	37.1
2045	0.0	68.7	68.7	402.3	0.0	333.6	11.9	28.0	5.8	33.8
2046	0.0	68.7	68.7	402.3	0.0	333.6	13.1	25.4	5.2	30.7
2047	0.0	68.7	68.7	402.3	0.0	333.6	14.4	23.1	4.8	27.9
2048	0.0	68.7	68.7	402.3	0.0	333.6	15.9	21.0	4.3	25.4
Total	3,435.9	1,993.2	5,429.1	11,394.6	0.0	5,965.5	169.8	-533.6	4,146.7	3,613.2

Source: JICA Survey Team.

Table X.3.52 Cash Flow Sheet of Case C2-M2-D30

EIRR	6.96%		B/C
NPV	-876.9		0.79
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.0	0.0	144.0	0.0	0.0	-144.0	0.7	-210.8	210.8	0.0
2016	257.8	2.9	260.7	0.0	0.0	-260.7	0.8	-346.9	346.9	0.0
2017	301.3	8.0	309.3	12.9	0.0	-296.4	0.8	-358.7	374.3	15.6
2018	642.8	14.1	656.8	71.4	0.0	-585.4	0.9	-644.0	722.5	78.5
2019	552.4	26.9	579.3	144.9	0.0	-434.4	1.0	-434.4	579.3	144.9
2020	739.6	38.0	777.6	210.1	0.0	-567.5	1.1	-515.9	706.9	191.0
2021	556.9	52.8	609.7	243.3	0.0	-366.4	1.2	-302.8	503.9	201.1
2022	241.3	63.9	305.2	261.8	0.0	-43.4	1.3	-32.6	229.3	196.7
2023	0.0	68.7	68.7	294.4	0.0	225.7	1.5	154.1	46.9	201.1
2024	0.0	68.7	68.7	334.7	0.0	266.0	1.6	165.2	42.7	207.8
2025	0.0	68.7	68.7	362.1	0.0	293.4	1.8	165.6	38.8	204.4
2026	0.0	68.7	68.7	364.7	0.0	296.0	1.9	151.9	35.3	187.1
2027	0.0	68.7	68.7	364.7	0.0	296.0	2.1	138.1	32.1	170.1
2028	0.0	68.7	68.7	364.7	0.0	296.0	2.4	125.5	29.1	154.7
2029	0.0	68.7	68.7	364.7	0.0	296.0	2.6	114.1	26.5	140.6
2030	0.0	68.7	68.7	364.7	0.0	296.0	2.9	103.7	24.1	127.8
2031	0.0	68.7	68.7	364.7	0.0	296.0	3.1	94.3	21.9	116.2
2032	0.0	68.7	68.7	364.7	0.0	296.0	3.5	85.7	19.9	105.6
2033	0.0	68.7	68.7	364.7	0.0	296.0	3.8	77.9	18.1	96.0
2034	0.0	68.7	68.7	364.7	0.0	296.0	4.2	70.9	16.5	87.3
2035	0.0	68.7	68.7	364.7	0.0	296.0	4.6	64.4	15.0	79.4
2036	0.0	68.7	68.7	364.7	0.0	296.0	5.1	58.6	13.6	72.2
2037	0.0	68.7	68.7	364.7	0.0	296.0	5.6	53.2	12.4	65.6
2038	0.0	68.7	68.7	364.7	0.0	296.0	6.1	48.4	11.2	59.6
2039	0.0	68.7	68.7	364.7	0.0	296.0	6.7	44.0	10.2	54.2
2040	0.0	68.7	68.7	364.7	0.0	296.0	7.4	40.0	9.3	49.3
2041	0.0	68.7	68.7	364.7	0.0	296.0	8.1	36.4	8.4	44.8
2042	0.0	68.7	68.7	364.7	0.0	296.0	9.0	33.1	7.7	40.7
2043	0.0	68.7	68.7	364.7	0.0	296.0	9.8	30.0	7.0	37.0
2044	0.0	68.7	68.7	364.7	0.0	296.0	10.8	27.3	6.3	33.7
2045	0.0	68.7	68.7	364.7	0.0	296.0	11.9	24.8	5.8	30.6
2046	0.0	68.7	68.7	364.7	0.0	296.0	13.1	22.6	5.2	27.8
2047	0.0	68.7	68.7	364.7	0.0	296.0	14.4	20.5	4.8	25.3
2048	0.0	68.7	68.7	364.7	0.0	296.0	15.9	18.7	4.3	23.0
Total	3,435.9	1,993.2	5,429.1	10,323.7	0.0	4,894.6	169.8	-876.9	4,146.7	3,269.8

Source: JICA Survey Team.

Table X.3.53 Cash Flow Sheet of Case C2-M2-D50

EIRR	6.14%		B/C
NPV	-1097.9		0.74
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.0	0.0	144.0	0.0	0.0	-144.0	0.7	-210.8	210.8	0.0
2016	257.8	2.9	260.7	0.0	0.0	-260.7	0.8	-346.9	346.9	0.0
2017	301.3	8.0	309.3	11.8	0.0	-297.5	0.8	-360.0	374.3	14.3
2018	642.8	14.1	656.8	65.8	0.0	-591.0	0.9	-650.1	722.5	72.4
2019	552.4	26.9	579.3	134.1	0.0	-445.2	1.0	-445.2	579.3	134.1
2020	739.6	38.0	777.6	195.1	0.0	-582.5	1.1	-529.5	706.9	177.4
2021	556.9	52.8	609.7	226.6	0.0	-383.1	1.2	-316.6	503.9	187.3
2022	241.3	63.9	305.2	244.3	0.0	-60.9	1.3	-45.7	229.3	183.5
2023	0.0	68.7	68.7	274.9	0.0	206.2	1.5	140.8	46.9	187.8
2024	0.0	68.7	68.7	312.4	0.0	243.7	1.6	151.3	42.7	194.0
2025	0.0	68.7	68.7	337.9	0.0	269.2	1.8	151.9	38.8	190.7
2026	0.0	68.7	68.7	340.5	0.0	271.8	1.9	139.5	35.3	174.7
2027	0.0	68.7	68.7	340.5	0.0	271.8	2.1	126.8	32.1	158.8
2028	0.0	68.7	68.7	340.5	0.0	271.8	2.4	115.3	29.1	144.4
2029	0.0	68.7	68.7	340.5	0.0	271.8	2.6	104.8	26.5	131.3
2030	0.0	68.7	68.7	340.5	0.0	271.8	2.9	95.3	24.1	119.3
2031	0.0	68.7	68.7	340.5	0.0	271.8	3.1	86.6	21.9	108.5
2032	0.0	68.7	68.7	340.5	0.0	271.8	3.5	78.7	19.9	98.6
2033	0.0	68.7	68.7	340.5	0.0	271.8	3.8	71.6	18.1	89.7
2034	0.0	68.7	68.7	340.5	0.0	271.8	4.2	65.1	16.5	81.5
2035	0.0	68.7	68.7	340.5	0.0	271.8	4.6	59.1	15.0	74.1
2036	0.0	68.7	68.7	340.5	0.0	271.8	5.1	53.8	13.6	67.4
2037	0.0	68.7	68.7	340.5	0.0	271.8	5.6	48.9	12.4	61.2
2038	0.0	68.7	68.7	340.5	0.0	271.8	6.1	44.4	11.2	55.7
2039	0.0	68.7	68.7	340.5	0.0	271.8	6.7	40.4	10.2	50.6
2040	0.0	68.7	68.7	340.5	0.0	271.8	7.4	36.7	9.3	46.0
2041	0.0	68.7	68.7	340.5	0.0	271.8	8.1	33.4	8.4	41.8
2042	0.0	68.7	68.7	340.5	0.0	271.8	9.0	30.4	7.7	38.0
2043	0.0	68.7	68.7	340.5	0.0	271.8	9.8	27.6	7.0	34.6
2044	0.0	68.7	68.7	340.5	0.0	271.8	10.8	25.1	6.3	31.4
2045	0.0	68.7	68.7	340.5	0.0	271.8	11.9	22.8	5.8	28.6
2046	0.0	68.7	68.7	340.5	0.0	271.8	13.1	20.7	5.2	26.0
2047	0.0	68.7	68.7	340.5	0.0	271.8	14.4	18.8	4.8	23.6
2048	0.0	68.7	68.7	340.5	0.0	271.8	15.9	17.1	4.3	21.5
Total	3,435.9	1,993.2	5,429.1	9,634.4	0.0	4,205.3	169.8	-1,097.9	4,146.7	3,048.8

Source: JICA Survey Team.

Table X.3.54 Cash Flow Sheet of Case C2-M2-D80

EIRR	4.79%	B/C	
NPV	-1441.4		0.65
OCC	10.00%		

Year	Const'on Cost	O & M Cost	Total Cost	Benefit	Opportunity Cost	Net Benefit	Discount Rate	Present Value	Discounted Cost	Discounted Benefit
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
2015	144.0	0.0	144.0	0.0	0.0	-144.0	0.7	-210.8	210.8	0.0
2016	257.8	2.9	260.7	0.0	0.0	-260.7	0.8	-346.9	346.9	0.0
2017	301.3	8.0	309.3	10.3	0.0	-299.0	0.8	-361.8	374.3	12.5
2018	642.8	14.1	656.8	57.2	0.0	-599.6	0.9	-659.6	722.5	62.9
2019	552.4	26.9	579.3	117.2	0.0	-462.1	1.0	-462.1	579.3	117.2
2020	739.6	38.0	777.6	171.6	0.0	-606.0	1.1	-550.9	706.9	156.0
2021	556.9	52.8	609.7	200.6	0.0	-409.1	1.2	-338.1	503.9	165.8
2022	241.3	63.9	305.2	217.2	0.0	-88.0	1.3	-66.1	229.3	163.2
2023	0.0	68.7	68.7	244.5	0.0	175.8	1.5	120.1	46.9	167.0
2024	0.0	68.7	68.7	277.7	0.0	209.0	1.6	129.8	42.7	172.4
2025	0.0	68.7	68.7	300.3	0.0	231.6	1.8	130.7	38.8	169.5
2026	0.0	68.7	68.7	302.9	0.0	234.2	1.9	120.2	35.3	155.4
2027	0.0	68.7	68.7	302.9	0.0	234.2	2.1	109.2	32.1	141.3
2028	0.0	68.7	68.7	302.9	0.0	234.2	2.4	99.3	29.1	128.5
2029	0.0	68.7	68.7	302.9	0.0	234.2	2.6	90.3	26.5	116.8
2030	0.0	68.7	68.7	302.9	0.0	234.2	2.9	82.1	24.1	106.2
2031	0.0	68.7	68.7	302.9	0.0	234.2	3.1	74.6	21.9	96.5
2032	0.0	68.7	68.7	302.9	0.0	234.2	3.5	67.8	19.9	87.7
2033	0.0	68.7	68.7	302.9	0.0	234.2	3.8	61.7	18.1	79.8
2034	0.0	68.7	68.7	302.9	0.0	234.2	4.2	56.1	16.5	72.5
2035	0.0	68.7	68.7	302.9	0.0	234.2	4.6	51.0	15.0	65.9
2036	0.0	68.7	68.7	302.9	0.0	234.2	5.1	46.3	13.6	59.9
2037	0.0	68.7	68.7	302.9	0.0	234.2	5.6	42.1	12.4	54.5
2038	0.0	68.7	68.7	302.9	0.0	234.2	6.1	38.3	11.2	49.5
2039	0.0	68.7	68.7	302.9	0.0	234.2	6.7	34.8	10.2	45.0
2040	0.0	68.7	68.7	302.9	0.0	234.2	7.4	31.6	9.3	40.9
2041	0.0	68.7	68.7	302.9	0.0	234.2	8.1	28.8	8.4	37.2
2042	0.0	68.7	68.7	302.9	0.0	234.2	9.0	26.2	7.7	33.8
2043	0.0	68.7	68.7	302.9	0.0	234.2	9.8	23.8	7.0	30.8
2044	0.0	68.7	68.7	302.9	0.0	234.2	10.8	21.6	6.3	28.0
2045	0.0	68.7	68.7	302.9	0.0	234.2	11.9	19.6	5.8	25.4
2046	0.0	68.7	68.7	302.9	0.0	234.2	13.1	17.9	5.2	23.1
2047	0.0	68.7	68.7	302.9	0.0	234.2	14.4	16.2	4.8	21.0
2048	0.0	68.7	68.7	302.9	0.0	234.2	15.9	14.8	4.3	19.1
Total	3,435.9	1,993.2	5,429.1	8,563.3	0.0	3,134.2	169.8	-1,441.4	4,146.7	2,705.3

Source: JICA Survey Team.

APPENDIX-XI

SATELLITE IMAGE ANALYSIS

APPENDIX XI: SATELLITE IMAGE ANALYSIS

LIST OF TABLES:

LIST OF FIGURES

CHAPTER 1 LANDCOVER AND SURFACE WATER DISTRIBUTION OF LIGUASAN MARSH

XI.1 Land cover classification for Liguasan marsh

XI.1.1 General

The project area borders the northern margin of Liguasan marsh (280,000 ha) and Pulangi river. Inferring from the river topography and the flood extent obtained from satellite image analysis, the river is often connected to marsh area in the flood event. With this hydrological circumstance, Liguasan marsh and its adjacent area have the close relation and likely have their environmental tie with the Project area. The river flow condition (physical habitats including seasonality, recurrence and artificial structure etc.) therefore is directly reflected in their distribution, diversity, and quantity of living things in the area.

In the Project, the river bank is planned in the marsh area and its construction has concern to cause hydraulic cut-off of river stream and consequently affects water quantity and quality. As environmental issues, the impact on birds and fishes is one of the major subjects in the Project.

XI.1.2 Objective

In this survey, the field survey is planned to be carried out for evaluating environmental condition in relation to hydrological and biological aspect at this timing of the Project. However, because of limited survey points and lines solely in the rainy season, the spatial variation and temporal changes of the Area cannot be grasped throughout whole project area. Thus, for giving additional information on these surveys, the remote sensing using with latest images was applied simultaneously. To understand spatial and time series background of hydrology and environment, the land cover type and the surface water distribution were mapped in/around the Project area. Besides the mapping, floodwater extent, river channels' network, vegetation and marsh composition represented by water, soil, and vegetation were analyzed.

XI.1.3 Survey Area (Area of Interest for Analysis)

Survey area i.e. Area of Interest (AOI) for this satellite image analysis is located in Liguasan marsh and its bordering area. It is largest marshy area in Philippines. Its size is reported to be 220,000 ha to 288,000 ha with 40 km length and 20 km width along Pulangi River (or Mindanao River / Rio Grande). It spans the provinces of Sultan Kudarat and North Cotabato in the Central Mindanao and Maguindanao in the Autonomous Region in Muslim Mindanao (ARMM).

In view of hydro-geomorphology, this large area is divided into three adjoining marshes as shown in Figure XI.1.1; namely, 1) Liguasan marsh, 2) Libungan marsh and 3) Ebpanan marsh by taking into account their water sources and dominant tributaries as follows:

1) Liguasan Marsh constitutes the upper arc of Mindanao river system basin (so-called Cotabato basin) and its surface water is supplied from main course of Pulangi river and its tributaries of Maridagao, Kabacan, Allah rivers, and so on. The area covers the municipalities of Pikit, Pagalungan, Datu Montawal, Kabacan, Matalam, M'lang, upper Cotabato that Tulunan, Datu Paglas, Datu Paglat, Sultan sa Barongis, Rajah Buayan, Mamasapano, Datu Salibo and Datu Piang.

2) Libungan Marsh occupies the middle section of Cotabato basin and has own water body supplied by Libungan river as well as Pulangi river, which includes the municipalities of Pigcauayan, Libungan, Midsayap, Upper Kabuntalan and Talayan.

3) Ebpanan Marsh is located at the lower part of Cotabato basin stretching from the lower reach of

Allah river and adjoining small streams and covers the areas of Lower Kabuntalan, Dinaig, Sultan Kudarat and Cotabato city.

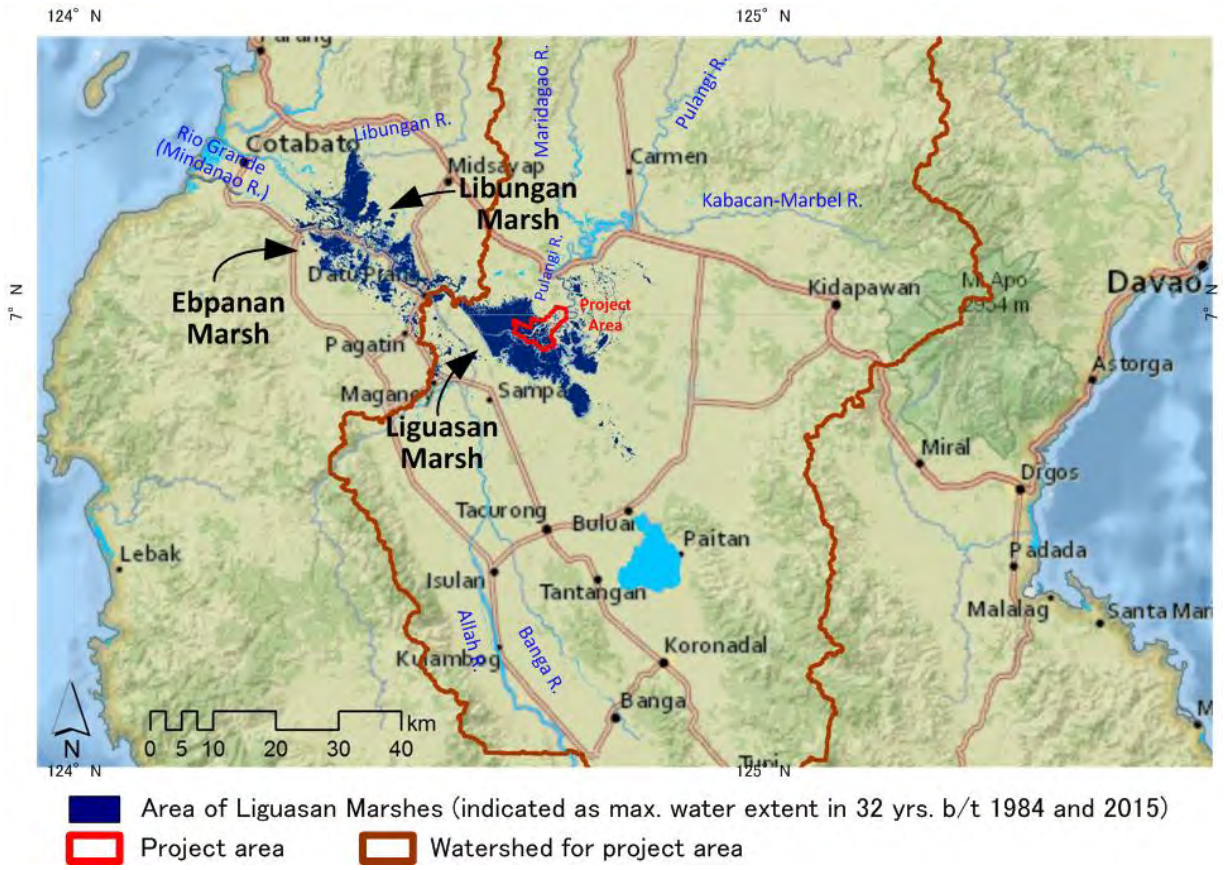


Figure XI.1.1 Marsh area in Mindanao basin

Source: JICA Survey Team

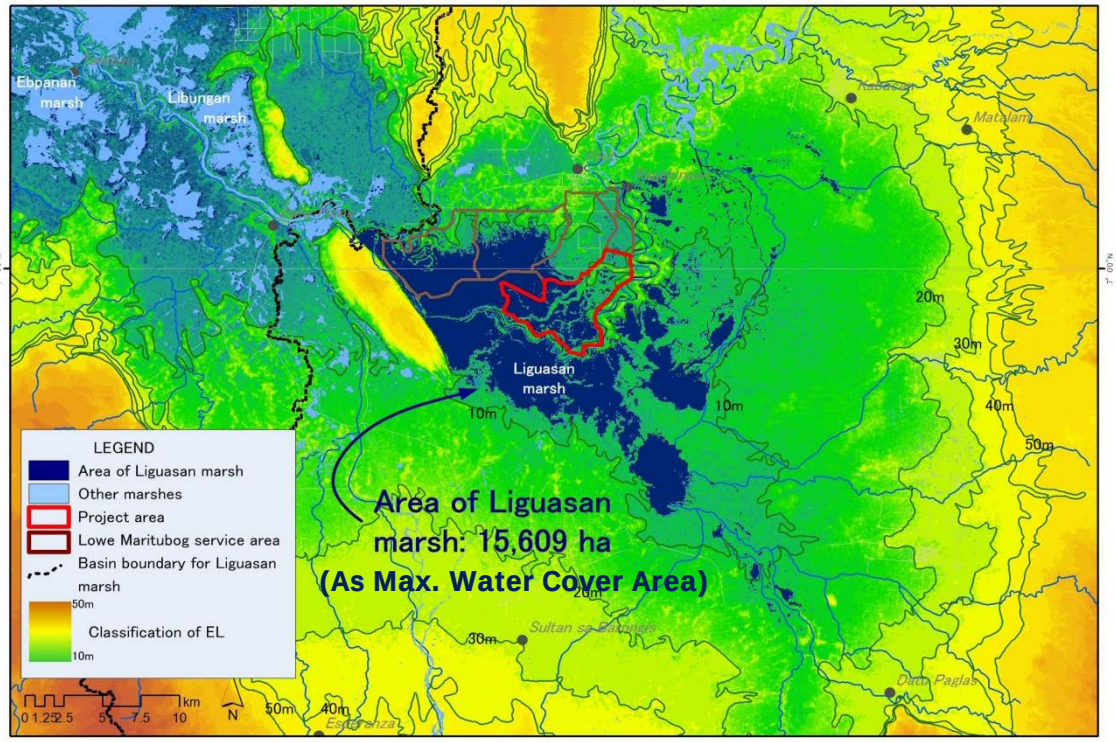


Figure XI.1.2 Location and size of Liguasan marsh (as max. extent of water cover)

Source: JICA Survey Team

The three said marshes naturally catch flooding waters when the major Pulangi river is swollen due to heavy rains as much 3,200 mm/year as an average area rainfall in the catchment. From Datu Piang located at Ebpanan marsh, all tributaries turn into single channel i.e. Pulangi river or Mindanao river which then diverts river flow again at the upper Cotabato City into two rivers; namely Mindanao River and Tamontaka River, and finally the two rivers flow out their water to the Illana bay.

As for the historical change around the marsh, the unpredictable water extent of Liguasan marsh is traceable with temporal satellite data by defining on-time extents. In Figure XI.1.2, the maximum water extent in 32 years from 1984 to 2015 is illustrated as composite image of historical extents. The maximum surface water area of Liguasan marsh is estimated at 15,609 ha, which is less than 7 % of the reported whole marsh area i.e. 220,000 to 280,000 ha. The extent of surface water will be regarded as an influencing area to the MMIP II area, especially Lower Malitubog Service Area, and its related facilities construction. This area shall be subject to the Survey area (AOI: Area of Intent) for satellite image analysis.

XI.1.4 Current condition

The Project area is located at a middle part of Liguasan marsh which is connected with a narrow channel to Libungan marsh especially in dry season. In common river stage, it has served as natural filters and controlling river water for the plains of Cotabato[1] including Cotabato city. However, in the event of flooding, marsh water is dammed-up due to the narrow channel and not able to flow into the downstream. Thus the raised water spreads over or back into the marsh area. The inundated water is then gradually discharged into the downstream and Libungan marsh, and further into Ebpanan marsh in long time period.

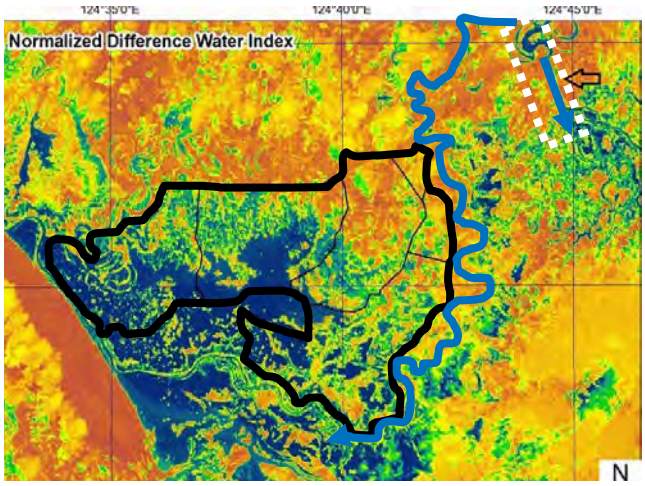


Figure XI.1.3 Diversion channel and the Project area

Source: JICA Survey Team

On the other hand, among the surrounding area of the marsh, forests had been cleared without much provisions of reforestation. Logging had welcomed the settlers and remaining forests were further cut for the reclamation of agricultural lands. In addition, a man-made channel from Pulangi and Kabacan river to Liguasan Marsh was constructed in Tungol in early 1980s and it redirected the river water into new agriculture land which was developed at the foreland of the original marshy area (see Figure XI.1.3).

XI.2 Method

The analysis for land type classification was conducted with calculation of indices of vegetation, soil, and water by use of satellite imageries acquired from both of rainy and dry season of 2015 to 2016. By applying qualified five (5) images, better quality parts were selected and mosaiced to make cloud free images. The mosaicked image was then processed for mapping land type classification by following algorism.

XI.2.1 Algorism

The survey area is located in marsh area where vegetation, soil and water coexist. Therefore, to

[1] 4th National Report to the Convention on Biological Diversity 2009

emphasize respective property for those three (3) components, Normalized Deference Vegetation Index (NDVI), Normalized Deference Soil Index (NDSI), Normalized Deference Water Index (NDWI) were calculated for AOI. After confirming their quality and eliminating error values, three (3) indices are merged into one mixed pixel with a consideration of their inter-relation. In Figure XI.1.4, procedure of analysis is shown as flowchart (algorism) of land type classification for Liguasan marsh.

In the process of analysis, following work steps were carried out: a) acquisition of satellite image (SENTINEL 2a product), b) pre-processing/mosaic with could mask, c) calculation of indices (NDVI, NDSI, and NDWI), d) creation of mix-pixel, e) determination of land cover type and mapping. In the following subsections, contents of each work steps are described.

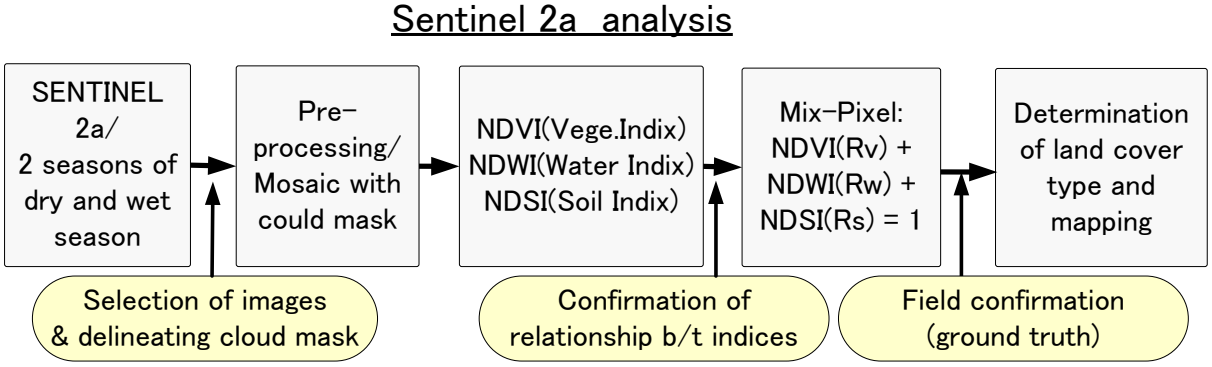


Figure XI.1.4 Algorism of land type classification for Liguasan marsh

XI.2.2 Satellite image applied

The satellite image applied for the analysis is Sentinal-2a products with 10 m resolution, which has operated by European Space Research Organization (ESRO) since June 2015. In the period of operation (from June 2015 to the end of 2016), 28 images were nominated. Five (5) images were then selected based on the better quality with less cloud condition. Satellite image list is show in Table XI.1.1.

Table XI.1.1 List of Sentinal-2a products used for the analysis

No	Image Identification No.	Date	Selected
1	S2A_OPER_MSI_L1C_TL_SGS__20151204T085823_A002345_T51NXH_N02.00_TOA	2015/12/04	○
2	S2A_OPER_MSI_L1C_TL_SGS__20160103T090156_A002774_T51NXH_N02.01_TOA	2016/01/03	△ mosaic
3	S2A_OPER_MSI_L1C_TL_SGS__20160303T091002_A003632_T51NXH_N02.01_TOA	2016/03/03	△
4	S2A_OPER_MSI_L1C_TL_SGS__20160402T090144_A004061_T51NXH_N02.01_TOA	2016/04.21	cloudy
5	S2A_OPER_MSI_L1C_TL_MTI__20160525T142036_A004776_T51NXH_N02.02_TOA	2016/05/25	-do-
6	S2A_OPER_MSI_L1C_TL_SGS__20160611T071318_A005062_T51NXH_N02.02_TOA	2016/06/11	△
7	S2A_OPER_MSI_L1C_TL_SGS__20160721T071240_A005634_T51NXH_N02.04_TOA	2016/07/21	○ mosaic
8	S2A_OPER_MSI_L1C_TL_EPA__20161225T035809_A002059_T51NXH_N02.04_TOA	2016/12/25	cloudy
9	S2A_OPER_PRD_MSIL1C_PDMC_20160212T093840_R060_V20160212T021534_20160212T021534	2016/02/12	-do-
10	S2A_OPER_PRD_MSIL1C_PDMC_20160303T110033_R060_V20160303T021338_20160303T021338	2016/03/03	-do-
11	S2A_OPER_PRD_MSIL1C_PDMC_20160403T080556_R060_V20160402T021340_20160402T021340	2016/004/3	-do-
12	S2A_OPER_PRD_MSIL1C_PDMC_20160413T090127_R060_V20160412T021537_20160412T021537	2016/04/03	-do-
13	S2A_OPER_PRD_MSIL1C_PDMC_20160422T085414_R060_V20160422T021540_20160422T021540	2016/04/22	-do-
14	S2A_OPER_PRD_MSIL1C_PDMC_20160502T113331_R060_V20160502T021347_20160502T021347	2016/050/2	-do-
15	S2A_OPER_PRD_MSIL1C_PDMC_20160525T171118_R060_V20160522T021350_20160522T021350	2106/05/25	-do-
16	S2A_OPER_PRD_MSIL1C_PDMC_20160611T090949_R060_V20160611T021348_20160611T021348	2016/06/11	-do-
17	S2A_OPER_PRD_MSIL1C_PDMC_20161130T002707_R060_V20161128T021342_20161128T021342	2016/11/30	-do-
18	S2A_OPER_PRD_MSIL1C_PDMC_20160811T030825_R060_V20160810T021352_20160810T021348	2016/08/11	-do-
19	S2A_OPER_PRD_MSIL1C_PDMC_20160830T204424_R060_V20160830T021342_20160830T021345	2016/08/30	-do-
20	S2A_OPER_PRD_MSIL1C_PDMC_20161009T092546_R060_V20161009T021342_20161009T021340	2016/10/09	-do-
21	S2A_OPER_PRD_MSIL1C_PDMC_20161029T123214_R060_V20161029T021342_20161029T021342	2016/10/29	-do-
22	S2A_OPER_PRD_MSIL1C_PDMC_20161225T045244_R060_V20151114T021342_20151114T021342	2016/12/25	-do-
23	S2A_MSIL1C_20161208T021342_N0204_R060_T51NXH_20161208T021446	2016/12/08	-do-
24	S2A_MSIL1C_20170417T021341_N0204_R060_T51NXH_20170417T021431	2017/12/08	-do-
25	S2A_MSIL1C_20161228T021342_N0204_R060_T51NYH_20161228T021505	2017/04/17	-do-
26	S2A_MSIL1C_20161228T021342_N0204_R060_T51NXH_20161228T021505	2016/12/28	-do-
27	S2A_MSIL1C_20161208T021342_N0204_R060_T51NYH_20161208T021446	2016/12/28	-do-
28	S2A_OPER_PRD_MSIL1C_PDMC_20160726T183304_R060_V20160721T021352_20160721T021348	2016/07/26	-do-

XI.2.3 Mosaic processing applied for satellite images

Using five (5) satellite images, two (2) timings of rainy and dry season were subjected to be mapped and were preliminary prepared by mosaicking them. As for dry season, image acquired on 2015/12/04 was applied to base layer and its cloud parts were replaced by images of 2016/01/03 and 2016/03/03. For rain season, the image of 2016/07/21 was used as base layer and its cloud ranges were removed by being replaced with the image of 2016/06/11. The two processed data were then given to calculate indices to be considered as indication factors.

XI.2.4 Indices (NDVI, NSDI, and NDWI)

Index ratios are typically used to classify a particular material or feature, and are dictated by the difference in reflectance values between the used bands. In the survey, vegetation, soil, and water were primarily focused as normalized index ratios because they are easy to be identified by the difference in reflectance values between the 0.665μ(R), 0.705μ(NIR) and 0.842μ(SWIR) channels.

Launched sensors, namely SENTINEL 2a MSI have 13 channels to cover from visible and near-infrared (VNIR) to short wave infrared (SWIR) which is sensitive or effective to detect water condition on the land surface. In the survey, a set of normalized indices including normalized difference vegetation index (NDVI), normalized difference soil index (NDSI), and normalized difference water index (NDWI) were employed. Ratios used for preparing land cover mapping in the Survey are listed in Table XI.1.2.

Table XI.1.2 Index ratios applied for land cover mapping in the Survey

Index Ratio	Purpose
Normalized Difference Vegetation index (NDVI)	Identify areas of vegetation and determine the growth activity of each vegetation class.
Normalized Difference Soil Index (NDSI)	Identify areas where soils is the dominant background or foreground material
Normalized Difference Water Index (NDWI)	Identify areas of standing water in size greater than one pixel

1) NDVI

$$\mathrm{NDVI} = \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + \rho_{red}}$$

Red band is used to represent the low level of reflectance from vegetation and broad NIR band is employed to represent the higher reflectance values from vegetation. The red band stays at lower reflectance levels than NIR band. NDVI provides the suitable measure for seasonal and inter-annual changes in vegetation growth and can distinguish vegetation from soil cover. Though NDVI deduces topographic effects, it does not eliminated atmospheric effect, is influenced by back ground soil, and shows non-linear changes as amount of vegetation.

2) NDSI

$$\mathrm{NDSI} = \frac{\rho_{swir} - \rho_{nir}}{\rho_{swir} + \rho_{nir}}$$

NDSI is more sensitive to canopy structure because it identifies areas where soil is the dominant background or foreground material. NDSI uses SWIR and NIR-bands, where SWIR represents the difference in reflectance values between soil areas. Thus, NDSI is the proper indicator for separating areas of vegetation from areas of soil.

3) NDWI

$$\mathrm{NDWI} = \frac{\rho_{red} - \rho_{swir}}{\rho_{red} + \rho_{swir}}$$

NDWI using NIR and SWIR reflectance values is proposed for remote sensing of the liquid water content of vegetation canopies. It reflects surface canopy moisture and forest humidity. NDWI has been used for monitoring water stress, and for mapping burnt areas in boreal forest. Thus, the changing pattern of NDWI with the seasons could distinguish areas of natural vegetation, farmland, and soil, in relation to moisture.

XI.2.5 Indices value

NDVI was calculated and resulted in the range from -0.48 to 0.88. It indicated that high value could be seen in the fringe of the Project area where palm trees are planted and in aquatic zone. On the other hand, inside the Project area and on water surface, the value is relatively lower than those because of being under construction and disable land caused by inundation.

NDSI showed the range from -0.88 to 0.50 and higher value is located in the border area of surface water, in city area, and along roads. As for NDWI, its range was obtained from -0.74 to 0.90 and highest area is concentrated in the center of marsh and river channels. The result of calculation is shown in Figure XI.1.5.

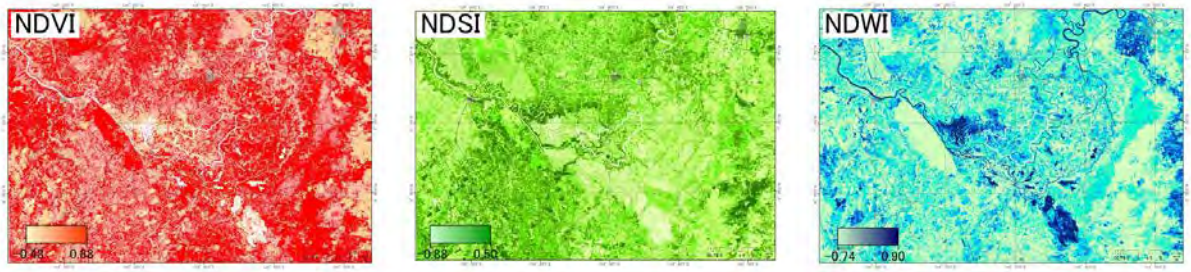


Figure XI.1.5 Indices value in rainy season (21/July/2016)

XI.2.6 Sectional profile of indices

Along horizontal and vertical profile passing through the Project area, sectional profiles were delineated to confirm the variation of indices' values (see Figure XI.1.6). Although the values are sensitively fluctuated due to surface condition, NDVI is plotted in the highest zone among three (3) indices, and its higher peaks are found at palm trees, orchards, and aquatic plants. As for others, NDSI in general indicated relatively higher level than NDWI particularly in land area.

The local variation of indices is also found in NDVI and NDSI. They have sharp peaks which is larger than 0.5 at vegetation points patched with agricultural area. On the other hand, its range of NDWI is rather narrow and the value is constant along the profiles. In the water section, NDWI is larger than those of NDVI and NDSI.

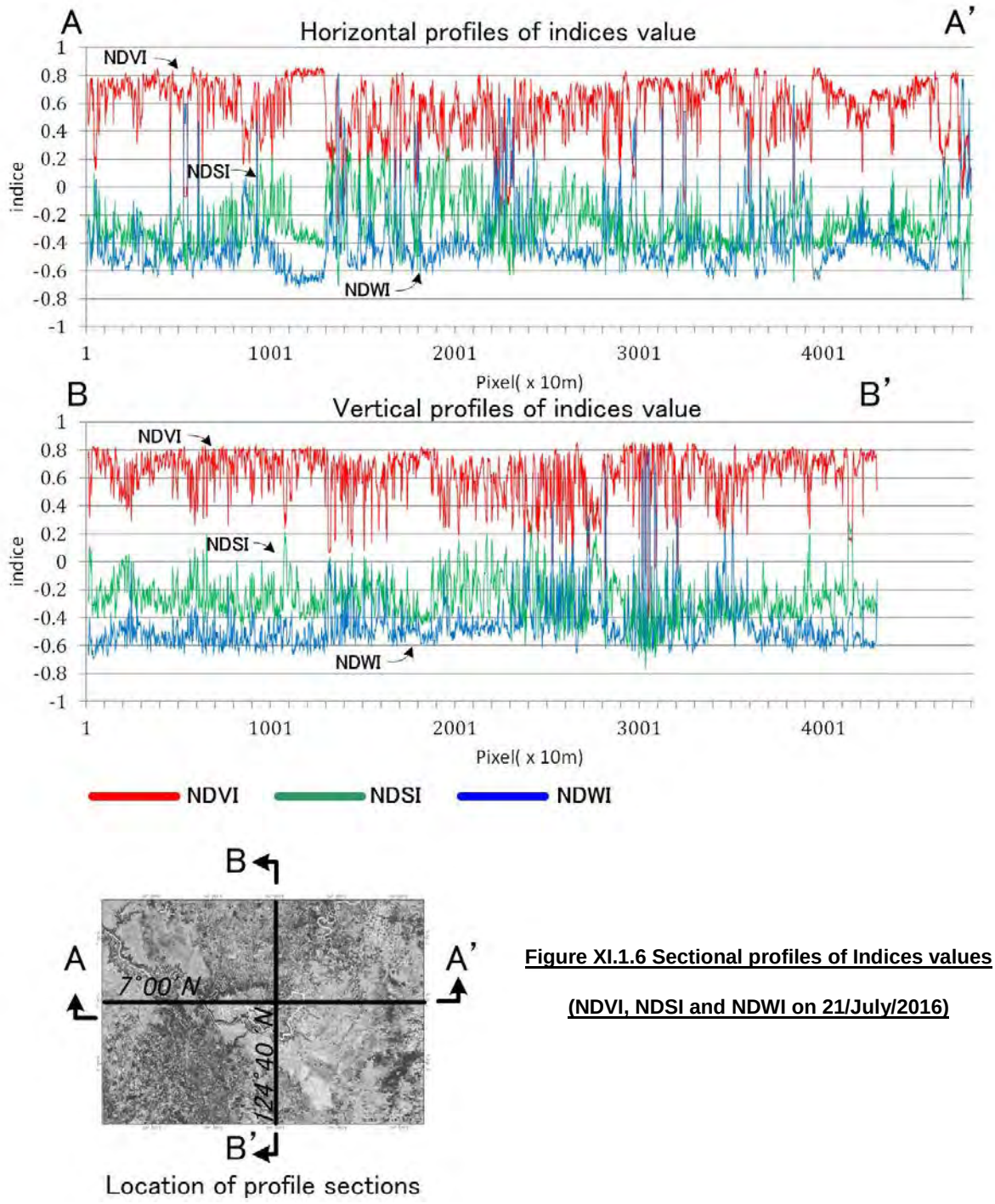


Figure XI.1.6 Sectional profiles of Indices values

(NDVI, NDSI and NDWI on 21/July/2016)

XI.2.7 Relationship of indices

The relationship between indices is found, but it is seems to be different due to water coverage. In dry land indicating as lower value than 0.5 of NDWI, positive correlation is seen between NDVI and NDSI, and on the contrary, negative correlation exists between NDVI and NDWI.

In wet land or marsh area, NDWI vs. NDSI has a positive relation while NDWI vs. NDVI is in negative relation. Although, clear correlation between NDVI and NDSI are not traced. 3D diagrams for relationships of three (3) indices are shown in Figure XI.1.7.

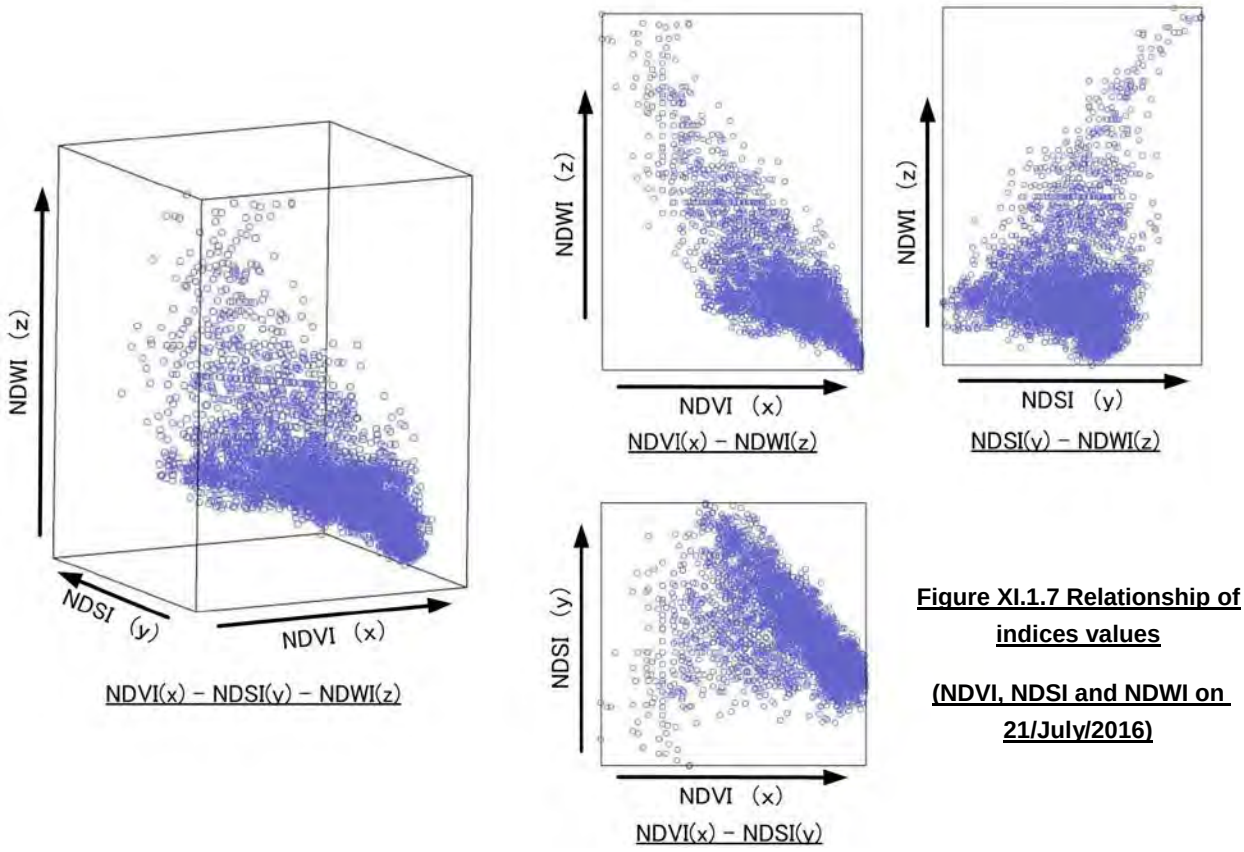


Figure XI.1.7 Relationship of indices values

(NDVI, NDSI and NDWI on 21/July/2016)

XI.2.8 Composite image of marsh

The normalized difference water index (NDWI) identifies areas of standing water. The normalized difference vegetation Index (NDVI) clarifies areas of vegetation and determines the vegetation class. The normalized difference soil Index (NDSI) has the sensitivity to areas where soil is dominant on background or foreground material.

Actually in the Project area and neighboring wet land, there is complicated mosaic zone mixed with vegetation, soil, and water. Thus, a common approach using NDVI reflection of only plants' biophysical parameters is not applicable for wet land classification. In addition to vegetative condition, other components i.e. soil and water should be taken into a consideration to identify land type.

In the Survey, the mixed pixel composed of NDVI (vegetation), NDSI (soil) and NDWI (water) was created for delineating the composite image with RGB. R (red), G (green), and B (blue) were assigned to NDVI, NDSI, and NDWI respectively.

In the composite image as shown in Figure XI.1.8, orange to reddish orange color is correlative with high NDVI value, which identifies the cultivated land in particular growing stage and woody lands covering shrubs and orchards. On the other hand, for reddish purple to red color indicates high values of both of NDVI and NDWI, which means a high water content like marshy area covered by aquatic plants and wetland herbaceous plants. Blue to purple color shows high value of NDWI taken from open water which spans isolated ponds and streams in the marsh. If bluish color is found in land areas separated form marsh, it may represent flooded paddy field with high NDWI. As for yellow to green color showing high value of NDSI, it is affected by reflection from soil and earthy material. In and around the Project area, mosaic patches of yellow and orange color can be traced widely and is located in agriculture land.

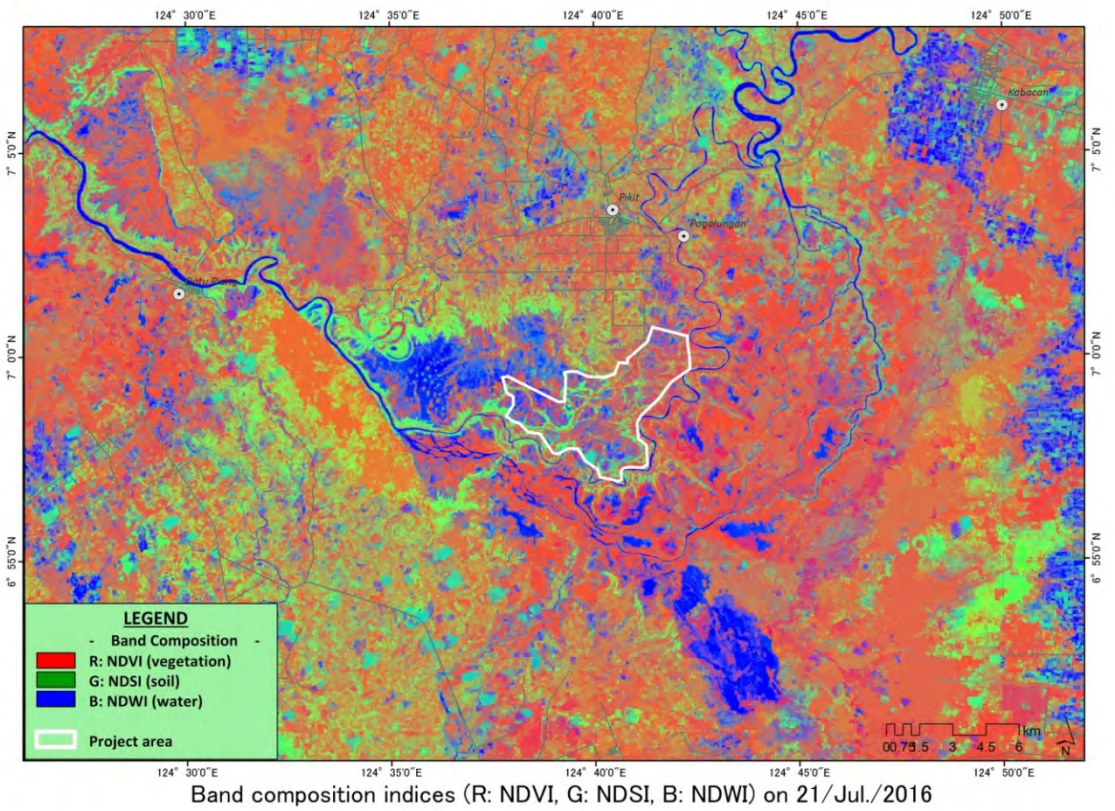


Figure XI.1.8 Composite Image of Liguasan marsh (21/July/2016)

XI.2.9 Land type classification

As described above, leaf pigments, internal scattering, and leaf water content affects the reflectance and transmittance property of leaves. In dominant factors controlling leaf reflectance, green plant has evolved to absorb wave length of light on visible region of the spectrum (0.35 to 0.70 μm). On the contrary, in typical green leaf, the near infrared reflectance increases drastically in the region from 700 to 1,200 μm as shown in Figure XI.1.9. Applying the spectral characteristics in leaf reflectance, the vegetation index was developed (Rouse et al. 1974).

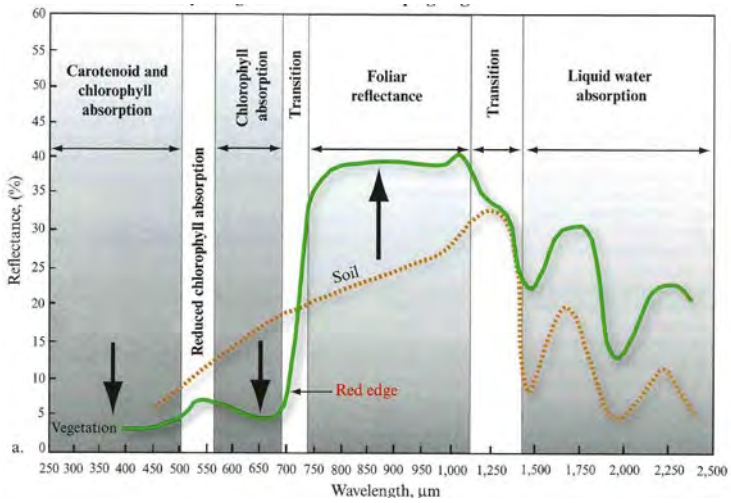


Figure XI.1.9 Physiological basis for developing vegetation indices
Source: Introductory digital image processing (J R. Jensen)

For soil ground, its reflectance gradually increases from visible range to the near infrared zone (foliar reflectance) and then decrease in the liquid water absorption zone. In case of the reflectance of water, it shows almost inverse changes compared to those of vegetation and soil.

The pixel has the square shape with 10 m x 10 m. In this range, mixed phase with vegetation, soil, and water, which are represented by NDVI, NDSI and NDWI receptively.

The difference between indices values in the ratio will dictate where the respective classifications lie

in the image. With the Jenks optimization method[2], each index value is designated to determine the best arrangement of values into five (5) different classes.

NDVI, NDSI, and NDWI are naturally classified into five (5) classes as shown in Figure XI.1.10. In a pixel, a set of classified indices composed of NDVI(v), NDSI(s) and NDWI(w) is allocated as a unique combination. Although possible number of combination is given as 125 classes (5 of NDVI x 5 of NDSI x 5 of NDWI = 125 land types), actually in the Survey area, 66 types of them are segmented in AOI as specific members of land types. Composition of indices (NDVI, NDSI, and NDVI) for 66 land cover types is shown in Table XI.1.4.

Those were then overlaid onto a single projected image, and annotations were identified to each type of particular classes (i.e. water, soil, and vegetation) to generate the draft map. Each of the unique combinations (66 types) was correlated with actual condition observed in field as well as satellite images such as natural color images on Google earth.

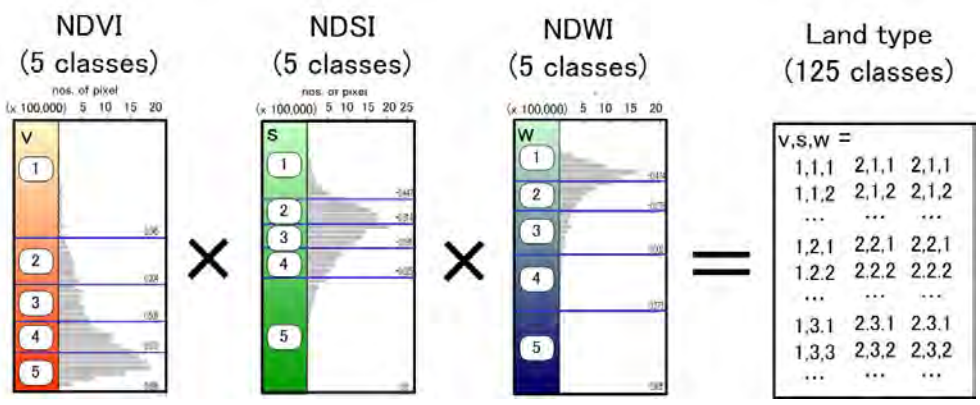


Figure XI.1.10 Index classes and land cover types

XI.3 Correlation and verification

With the draft map for land cover classification, the field verification was carried out during the Survey. However, due to deterioration of security, only two days i.e. 19 and 20 of June/2017 were able to be allocated for the field activity. 15 points was then applied for its verification as shown in Figure XI.1.11, XI.1.12, and XI.1.13. In the field, the draft map had been firstly checked by real condition, if it not concordance with the actual condition, the definition of applied land cover type was modified to adjust the actual condition.

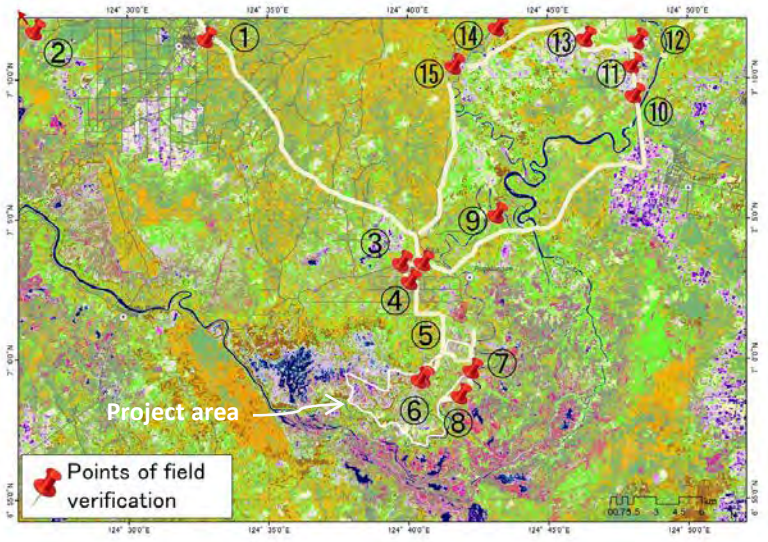


Figure XI.1.11 Location map of verification points

With correlation between land type definition and actual condition, the description of land cover type was added on

[2] Jenks method is done by seeking to minimize each class's average deviation from the class mean, while maximizing each class's deviation from the means of the other groups

the original. In case the same condition was found in different land cover types, those were merged into the same land cover type.

Depending on water condition, i.e. dry (land) or wet (marsh) area, the description of land cover type differs. Even if being same land cover type (same composition of indices), actual vegetation is different due to water condition.

In the case of aquatic plants on marsh covering water surface by leafs, the area shows a high level of NDVI with low level of NDWI, which is same composition of indices as those of palm trees on dry land. As the opposite case, paddy field in transplant condition is indicated as a high level of NDWI and NDSI, which is similar composition to those of marsh area. Thus, the classification (legend) attached on map was prepared two types respectively for dry and wet area.

After the field survey, the correlation work has been continued by Google Earth for whole Survey area, and land cover was at last classified in to 34 types as shown in Table XI.1.3.

Table XI.1.3 Type of Land cover identified by field verification

< Marsh Area >	<Populated area and Farmland>
Water with no plant	Populated area（residence, road, open space and etc.)
Water with soil and aquatic plant(sparse distribution)	Bare ground (earthy open space, constructing yard, cultivated land and etc.)
Water with aquatic plant(sparse distribution)	Bare ground and farmland with cultivation (moderate-high density)
Water with aquatic plant(moderate occurrence)	Bare ground and farmland with cultivation (high density)
Water with aquatic plant/paddy in trans planting / cloud cover	<Tree and Orchard Land >
Water with aquatic plant(high density)	Tree(sparse distribution)
Shallow water with aquatic plant(part)	Tree(sparse-moderate distribution)
Shallow water with aquatic plant(high density)	Trees(palm trees)/cultivated land(high-mid density)
Shallow water with aquatic plant(mod.-high density)	Tree(palm tree, located on wet soil)
Marsh mixed with soil and plant(sparse distribution)	Tree(palm tree, located on dry soil)
Marsh mixed with soil and plant(mod. occurrence) / cloud cover	<Cultivated land>
Marsh mixed with soil and plant(mod.- high occurrence) / cloud cover	Mixed area with cultivated land, scrub, glass land, soil / cloud
Marsh(Soil) with aquatic plant(sparse distribution)	Mixed area with cultivated land, scrub and soil
Marsh(Soil) with plant(moderate occurrence)	Mixed area with cultivated land, scrub, soil and populated area.
Wetland with aquatic plant(high density)	Cultivated land with tree (palm tree) and crop(dense distribution)
Wetland with wetland-scrub(high density)	Cultivated land with soil and crop(dense distribution)
Wetland with wetland-scrub and aquatic plant (high density)	Cultivated land with soil and crop(moderate distribution)
Wetland with wetland-scrubland aquatic plant (mod.-high density)	Cultivated land with tree, soil and crop(high distribution: fallow field)

Table XI.1.4 Land cover types classified by mixed indices' value (NDVI, NDSI and NDWI)

ID	Color	RGB	Correlated Landcover condition	Classes by natural break		
				NDVI	NDSI	NDWI
125		115.178.115	vege/soil_palm tree/natural trees/farmland(high-mid glowing)/aqua plant/wet-scrub	5	2	1
225		255.128.124	vege/soil_palm tree/cultivation/trees_dense vege	5	2	2
133		255.176.127	vege/soil_mid. vegetation/farmland	3	3	1
134		255.176.127	vege/soil_mid. vegetation/farmland	4	3	1
511		0.0.102	water_water with no plant	1	1	5
512		153.0.255	water/vege_water minor plant/paddy in trans planting/clouds	2	1	5
214		102.255.51	soil/vege_bush/soil_mixed area of bush/farmland/populated area.	4	1	2
224		102.255.51	soil/vege_bush/soil_mixed area of bush/farmland/populated area.	4	2	2
233		102.255.51	soil/vege_bush/soil_mixed area of bush/farmland/populated area.	3	3	2
234		102.255.51	soil/vege_bush/soil_mixed area of bush/farmland(initial growing) /populated area.	4	3	2
243		102.255.51	soil/vege_bush/soil_mixed area of bush/farmland/populated area.	3	4	2
244		102.255.51	soil/vege_bush/soil_mixed area of bush/farmland/populated area.	4	4	2
142		204.204.0	tree/soil_plantation	2	4	1
143		204.204.0	tree/soil_plantation	3	4	1
144		204.204.0	tree/soil_plantation	4	4	1
541		0.102.102	water/soil_marsh with scarce aquatic plant	1	4	5
551		0.102.102	water/soil_marsh with scarce aquatic plant	1	5	5
151		153.102.51	soil/water/vege_bare ground	1	5	1
152		153.102.51	soil/water/vege_bare ground	2	5	1
153		153.102.51	soil/water/vege_bare ground	3	5	1
251		153.102.51	soil/water/vege_bare ground	1	5	2
252		153.102.51	soil/water/vege_bare ground	2	5	2
253		153.102.51	soil/water/vege_bare ground	3	5	2
351		221.221.221	soil/water/vege_populated area（residence, road, open space and etc.)	1	5	3
352		221.221.221	soil/water/vege_populated area（residence, road, open space and etc.)	2	5	3
353		221.221.221	soil/water/vege_populated area（residence, road, open space and etc.)	3	5	3
154		255.153.0	soil/water/vege_bare ground	4	5	1
155		165.0.33	soil/vege_cultivation	5	5	1
451		151.204.193	soil/water_marsh aquatic plant	1	5	4
513		102.0.102	water/vege_dense aquatic plant	3	1	5
514		102.0.102	water/vege_dense aquatic plant	4	1	5
522		0.204.153	water/vege/soil_mid aquatic plant	2	2	5
531		0.153.153	water/soil_shallow water with scarce aquatic plant	1	3	5
521		51.204.204	water/soil_water with scarce aquatic plant	1	2	5
315		255.0.255	water/vege_shallow water with aquatic plant	5	1	3
414		255.0.255	water/vege_shallow water with aquatic plant	4	1	4
415		255.0.255	water/vege_shallow water with aquatic plant	5	1	4
423		204.100.255	water/soil/vege_marsh mixed vege/soil/clouds	3	2	4
433		204.100.255	water/soil/vege_marsh mixed vege/soil	3	3	4
412		255.153.255	water/vege_shallow water with mid. aquatic plant	3	1	4
413		255.153.255	water/vege_shallow water with mid. aquatic plant	3	1	4
422		204.180.255	water/soil/vege_marsh mixed vege/soil/clouds/clouds	2	2	4
432		204.180.255	water/soil/vege_marsh mixed soil/vege	2	3	4
442		204.180.255	water/soil/vege_marsh mixed soil/vege	2	4	4
421		204.236.255	water/soil/vege_marsh mixed soil	1	2	4
431		204.236.255	water/soil/vege_marsh mixed soil	1	3	4
441		204.236.255	water/soil/vege_marsh mixed soil	1	4	4
145		230.76.0	vege/soil_cultivation	5	4	1
235		230.76.0	vege/soil_cultivation	5	3	2
115		230.0.169	vege_palm tree/wetland scrub(dense)	5	1	1
215		205.102.102	vege_aquia plant/palm tree	5	1	2
314		146.208.80	vege/soil/water_mixed wet area_forest/soil/marsh	4	1	3
324		146.208.80	vege/soil/water_mixed wet area with scrub/soil/marsh	4	2	3
325		146.208.80	vege/soil/water_mixed wet area with scrub/soil/marsh	5	2	3
334		146.208.80	vege/soil/water_mixed wet area_forest/soil/marsh	4	3	3
313		204.255.153	vege/soil/water_mixed wet area_forest/soil	3	1	3
323		204.255.153	vege/soil/water_mixed wet area_forest/soil	3	2	3
333		204.255.153	vege/soil/water_mixed wet area_forest/soil/marsh	3	3	3
343		204.255.153	vege/soil/water_mixed wet area_forest/soil	3	4	3
331		255.255.153	vege/soil/water_mixed wet area_bush/glass/soil/cloud	1	3	3
332		255.255.153	vege/soil/water_mixed wet area_bush/glass/soil/cloud	2	3	3
341		255.255.153	vege/soil/water_mixed wet area_bush/glass/soil/cloud	1	4	3
342		255.255.153	vege/soil/water_mixed wet area_bush/glass/soil/cloud	2	4	3
135		255.170.0	vege/soil_bareground with forest/trees, fallow field.	5	3	1
241		158.214.0	soil/	1	4	2
242		158.214.0	soil/	2	4	2

①Paddy filed in transplant (water/soil mixed)
(W:S:V=4:4:2, Midsayap@19/06/2107)

⑤Marsh with aquatic plants, soil and trees
(W:S:V=4:2:2, Paja Muda@19/06/2017)

②Fallow field and forest/trees
(W:S:V=1:3:5, Libungan–
Midsayap@19/06/2017)

⑤Mixed area with grassland and scrubs
(W:S:V=2:3:3,Paja Muda@19/06/2017)

③ Palm trees with dense vegetation
(W:S:V=2:2:5, Piket@19/06/2017)

⑥ Water with scarce aquatic plant
(W:S:V=5:2:1,Bolol@19/06/2017)

④ Palm tress, wet scrubs and aquatic plants
(W:S:V=1:2:5, Piket@19/06/2017)

⑦ Cultivation (paddy/corn) and palm trees
(W:S:V=2:2:5, Talitay@19/06/2017)

Figure XI.1.12 Field conditions of verification points (1/2)

⑧Pulungi river surrounded by palm trees
(W:S:V=5:2:1, 2:2:5, Dungguan@19/06/2017)

⑫Paddy field (soil/water/vegetation mixed)
(W:S:V=4:2:2, General Luna 18/06/2017)

Pulungi river (water/soil/vegetation mixed)
(W:S:V=1:3:4・5:1:1,Kalbugan@18/06/2017)

⑬Fallow field(farmland/soil/scrub mixed)
(W:S:V=2:4:3, General Luna@18/06/2017)

⑩Paddy filed (soil/water/vegetation mixed)
(W:S:V=4:3:2, Ugalingan@18/06/2017)

⑭Pagalungan diversion dam(water and trees)
(W:S:V=5:1:1・1:2:5,Linandangan@18/06/2017)

⑪Paddy field(soil/vegetation mixed)
(W:S:V=4:2:2, General Luna@18/06/2017)

⑮Pagalungan river(water and trees)
(W:S:V=5:1:1・1:2:5,General luna@18/06/2017)

Figure XI.1.13 Field conditions of verification points (2/2)

XI.4 Wetland classification of Liguasan marsh

The wetland area clarified from satellite image analysis is composed of open water (blue color), aquatic plants (purple color), mixed area with soil/water/plant (light purple color) and wetland scrub (pale green color). It can be traced in the center of Liguasan marsh where borders the south of the Project area. In the dry land located both sides of wetland, scrub/tree/orchards (green color), mixed dry-upland (orange color), mixed wet-upland (light green color) and paddy field (purple to light purple color) are recognized.

Topographically, the dry land is divided into two landforms of hilly area and low alluvial plain. Hilly area is mainly occupied by scrub/tree/orchards and mixed dry-upland, while low alluvial plain is covered by mixed wet-upland and paddy field as shown in Figure XI.1.14.

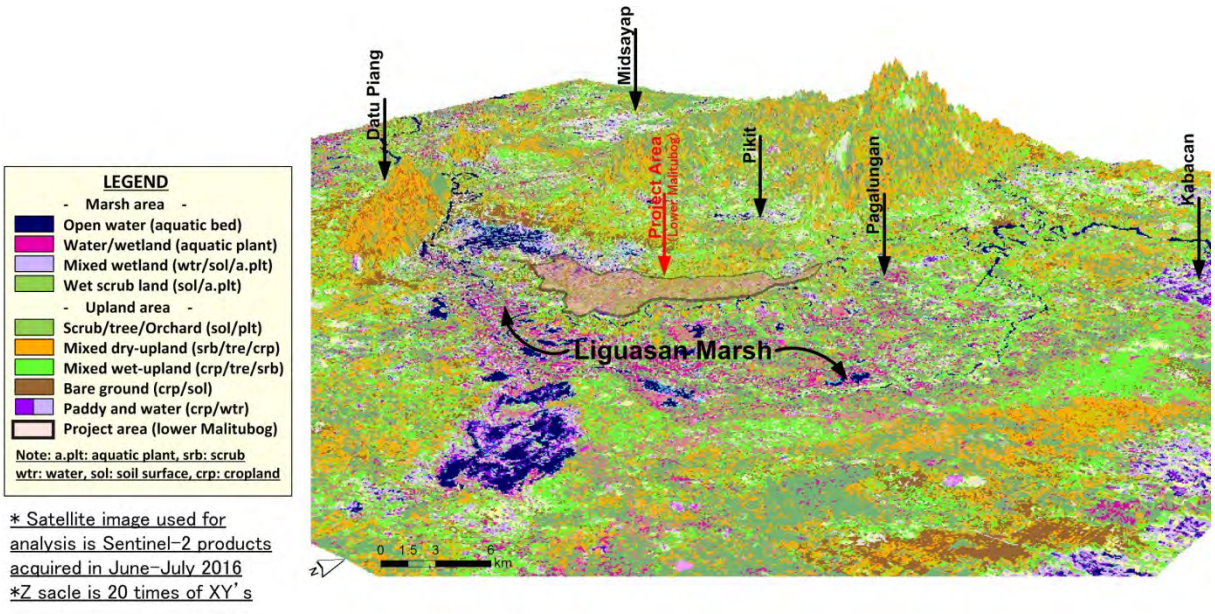


Figure XI.1.14 3D view of Liguasan marsh with land cover classification

XI.4.1 Land cover type classification of Liguasan marsh

In the land cover classification of Liguasan marsh as shown in Figure XI.1.15, the water cover is observed in the same range of Liguasan marsh, which extends both side of Pulangi river. The eastern side of water cover spreads wider and deeper than that of the western side where bounds on the south of Project area.

In topographical point of view, the Lower Malitubug Service Area (LMSA) is in back marsh depression. It stands slightly lower than adjacent alluvial plain extending from the Pulangi river sides, and is below natural levees that rise towards the main channel. In flood event, this back marsh has been occasionally connected to Pulangi river at Bakat to Paidu Pulangi and has left water in the depression after flooding. In the dry season, the remained water is evaporated and its water level has become low. In the SRTM data obtained in Feb. 2000, the deference of water level between Pulangi river and LMSA has reached to 4 meters.

The Liguasan marsh located nearby LMSA has the channel network and its main course runs in the center of the marsh with three (3) kilometer width. In between canals, it is widely covered by aquatic plants and wet-shrubs, and plural ponds are left sporadically. The deeper part of marsh including ponds and open waters is allayed in southwestern area and further to connected to Lake Puruan.

Both sides of the marsh, namely ARRM area at the south and LMSA at the north, are dominated by

new developing land mixed with farmland, orchard garden with bare ground. Further in dry season, these areas progresses toward the marsh in accordance with being lower water level. Actually in the margin area of marsh, farmland has been developing by the edge of water area.

XI.4.2 Application of land cover type classification for environment survey

As preliminary information for environmental survey, land type classification map is useful to understand a current condition in particular survey timing in the rainy season. Survey points and line were then determined in accordance with susceptibility on environmental impact and road access. As the result of the selection, survey points and line were decided on river bank and river bed of Pulangi river, channel network in marsh, flourish land of aquatic plant and wetland shrub, farmland and bare ground beside marsh. Besides, the selection was made with a consideration which can provide available information to feedback for revising the map later on.

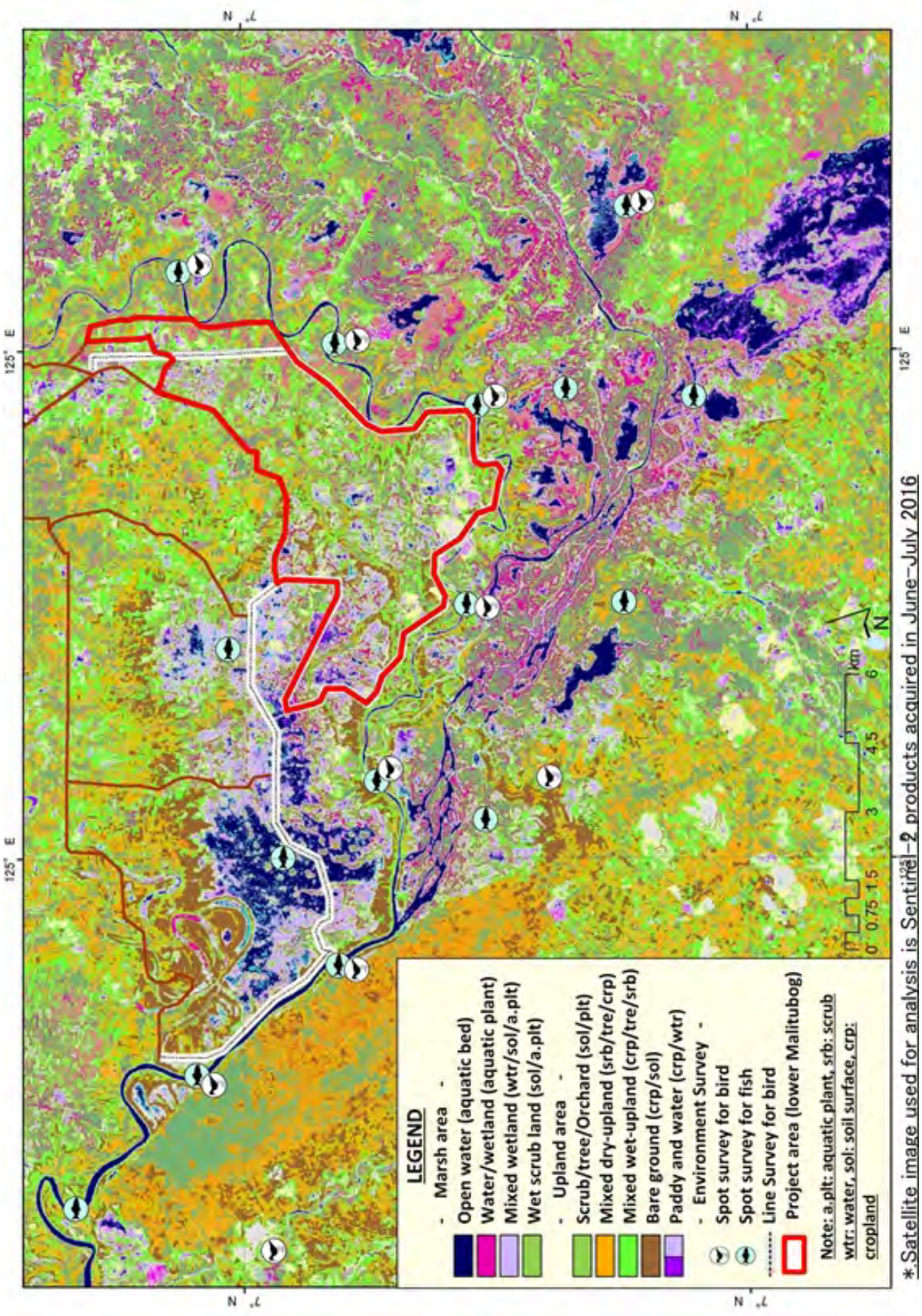


Figure XI.1.15 Land cover type classification map

XI.5 Hydrological condition of Liguasan marsh

XI.5.1 Location and size of the marsh

Basin area covering the Project area (or Liguasan marsh) is as large as about 13,700 sq.km as shown in Figure XI.1.16.

Figure XI.1.16 Watershed area for Liguasan marsh

Source: JICA Survey Team

XI.5.2 Meteo-hydrological condition

There is heavy rainfall of over 3,200 mm/year, which is the mean catchment area-rainfall during the past 35 years from 1979 to 2013. The total rainwater in the basin is thus estimated as 44 BCM per annum. In case 0.3 of discharge coefficient obtained from the analysis of Tinutulan gauging station is applied to the rainwater amount, the surface discharge comes to huge amount i.e. $10^{9\text{-}10}$ cum/year. In addition, Liguasan marsh which behaves as receiving area covers only 1% of the basin area (156 sq.km / 13,700 sq.km). Due to the recent deforestation and the development of agricultural land, the condition of the basin has been changed. Floods tend to occur frequently and its damage becomes serious. Because of the recent tendency of heavy rainfalls, soil erosion occurs and heavy siltation has been taking place along the rivers within the basin. This siltation can also be seen in the main channel of Pulangi river, where natural levees have been developed along the southern boundary of the Project area, the Lower Malitubog Service Area. Besides, there are thousands of cubic tons of water hyacinths and grasses and they will plug the water course at the time of flood in particular at the outlet of Liguasan marsh

XI.5.3 Global surface water

The water occurrence in Liguasan marsh is referred to 'Global surface water analysis' which has been studied as Joint Research Centre's mission. Based on over three million satellite scenes (1,823 terabytes of data) collected between 1984 and 2015, surface water extent was detected and published in 'Global Surface Water Explore' (https://global-surface-water.appspot.com/). The individual images were transformed into a set of global maps with a 30-metre resolution, which enable to measure the changes in the location and persistence of surface water by region, or for a specific area.

In the Survey, the area for Liguasan marsh and the Project area was downloaded from Global Surface Water Explore and applied for the hydrological evaluation.

XI.5.4 Water extent of Liguasan marsh

Spatial and temporal distribution of water extent in Liguasan marsh is described as 1)water occurrence, 2)occurrence change intensity, 3)seasonality, 4)recurrence, 5)transitions, 6) maximum water extent and 7)water history (monthly and annual history) in accordance with published contents of 'Global Surface Water'.

1) Water Occurrence

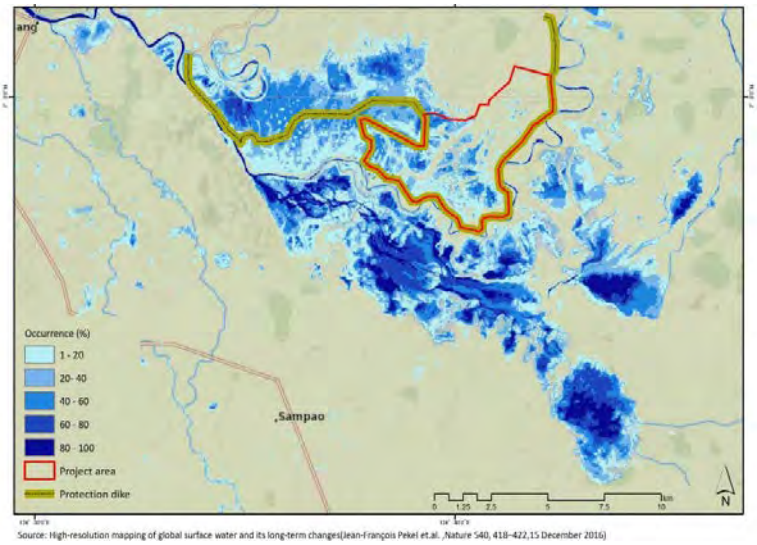


Figure XI.1.17 Long term water occurrence change (1984-2014)

Data of the surfaces water in Liguasan marsh was obtained from 'Global Surface Water Explore' and the analytical result of 'Mapping long-term global surface water occurrence [3] ' which was utilized by millions of LANDSAT images for a period of 32 years from 1984 to 2015. It was recorded when water was presented, where the occurrence has changed, and how its form changed in terms of the seasonality and the continuity.

As for the adjacent area to the Project area, specifically the Lower Malitubog Service Area, water occurrence could be traced in both sides of Pulangi river. The coverage of the water surface has been changing by season. In rainy season, the flood water spilled over natural levees and flowed into hinterland in the right side of Pulangi river as temporal waters. In dry season, on the other hand, permanent water remains only along the main channels in the left side of Pulangi river as shown in Figure XI.1.17.

Description of water occurrence (from the paper)

The frequency with which water was present on the surface from March 1984 to October 2015 was captured in a single product called surface water occurrence (SWO). To compute SWO, the water detections (WD) and valid observations (VO) from the same months are summed, that is, water detections and valid observations from March 1984 are added to water detections and valid observations from March 1985 and so on, such that SWOmonth = ΣWD month / ΣVO month. Averaging the results of all monthly SWO month calculations gives the long-term overall surface water occurrence. The month-by-month time step normalizes occurrence against seasonal variation in the number of valid observations across the year. Typically, more cloud-free observations (and thus valid observations) are available during dry seasons than wet. Without monthly weighting, the overall water occurrence (that is, computed over the full period) would be biased by temporal distribution of the valid observations (that is, giving more weight to the dry season than to the wet season).

[3] High-resolution mapping of global surface water and its long-term changes (Jean-François Pekel, Andrew Cottam, Noel Gorelick& Alan S. Belward, Nature 540, 418–422 ,15 December 2016)

2) Occurrence change intensity

The occurrence change intensity provides information on where surface water occurrence increased, decreased or remained the same between 1984-1999 and 2000-2015. Both the direction of change and its intensity are traced as shown in Figure XI.1.18.

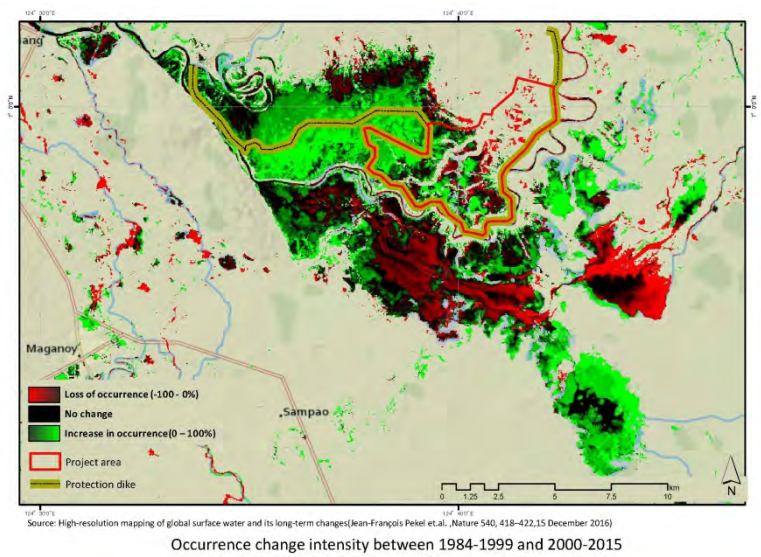


Figure XI.1.18 Occurrence change intensity between 1984-1999 and 2000-2015

In Figure XI.1.18, increases in water occurrence are shown in green and decreases are shown in red. Black areas are those areas where there is no significant change in the water occurrence during the 1984 -2015 period. The intensity of the color represents the degree of change (as a percentage). For example, bright red areas show greater loss of water than light red areas. Some areas appear grey in the maps, these are locations where there is insufficient data to compute meaningful change statistics.

Description of occurrence change intensity (from the paper)

Change in water occurrence intensity between two epochs (16 March 1984 to 31 December 1999, and 1 January 2000 to 10 October 2015) was also produced. This is derived from homologous pairs of months (that is, the same months contain valid observations in both epochs). The occurrence difference between epochs was computed for each pair and differences between all homologous pairs of months were then averaged to create the surface water occurrence change intensity map. Areas where there are no pairs of homologue months could not be mapped. The averaging of the monthly processing mitigates variations in data distribution over time (that is, both seasonal variation in the distribution of valid observations, temporal depth and frequency of observations through the archive) and provides a consistent estimation of the water occurrence change.

3) Seasonality

The Seasonality map provides information concerning the intra-annual behavior of water surfaces for a single year (2014-2015) and shows permanent and seasonal water and the number of months water was present.

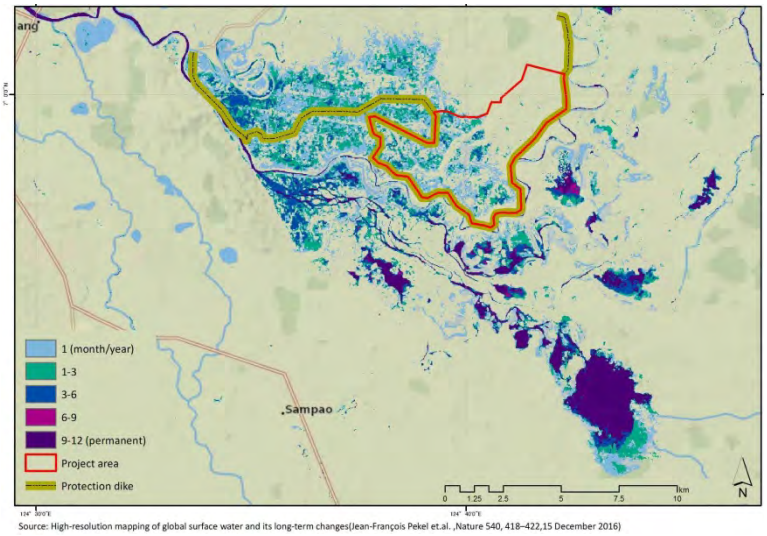


Figure XI.1.19 Seasonality of water surface (2014-2015)

The seasonality map is shown in Figure XI.1.19. The permanent water is represented in dark blue and areas of seasonal water are shown in lighter blue. In the climax of rainy season, the most of areas are once covered by water at least for one month. However, in dry season, several ponds and channels separately remains at the deeply depressed areas along the main tributaries. The area of permanent water is estimated at only 1,570 ha, which covers only

10% of the maximum water extent in the rainy season.

Description of seasonality (from the paper)

A permanent water surface is underwater throughout the year, while a seasonal water surface is underwater for less than 12 months of the year. In some places we do not have observations for all 12 months of the year and in these cases water is considered to be seasonal if the number of months where water is present is less than the number of months where valid observations were acquired. If water is present throughout the observation period, the lake is considered to be a permanent water surface. If the area of the lake contracts, then the pixels along the borders of the lake no longer represent water, and those pixels will be considered to represent seasonal water surface. Seasonality is computed for every year. A single data set for the contemporary period (October 2014 to October 2015) is made available.

4) Recurrence

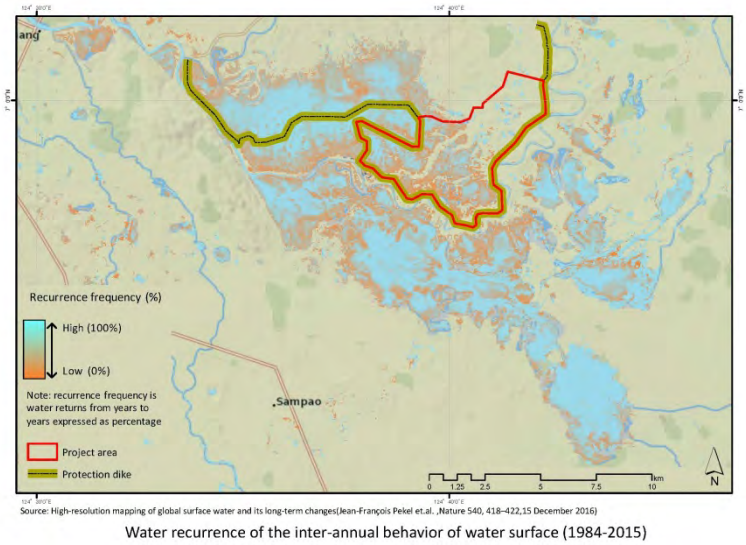


Figure XI.1.20 Recurrence of water surface (1984-2015)

The recurrence provides information concerning the inter-annual behavior of water surfaces and captures the frequency with which water returns from year to year. In Figure XI.1.20, areas are inundated regularly, whether seasonal or permanent, shown in light blue and areas that are flooded on an episodic basis shown in orange. It indicates almost half of the Project area is occupied by high recurrence area of water surface.

Description of recurrence (from the paper)

Water recurrence is a measurement of the degree of inter-annual variability in the presence of water. This describes how frequently water returned from one year to another (expressed as a percentage). Recurrence refers specifically to the temporal behavior of water surfaces; unlike occurrence, recurrence is not systematically computed over the full span of the archive, because water may not have been present from the beginning to the end of the archive. Thus, we first have to define a 'water period'—that is, that part of the archive where water was present at least from time to time; the recurrence in fact quantifies this 'time to time'. The water period is established individually for each pixel. The water period runs from the first month in the first year in which water is observed to the last month of the last year in which water is observed of the entire 32-year period. In addition to defining the water period we also need to define a 'water season' (not equivalent to a 'wet season'). The water season is identified from the monthly water recurrence and is defined as those months of the year that from time to time have water. A 'water year' is a year with at least one water observation, while an 'observation year' is a year with at least one valid observation within the water season. Water recurrence is then calculated as the ratio of the number of water years to observation years. The count of the number of years starts with the year in which water was first observed and ends with the most recent year in which water was observed. Years that contain only observations outside the water season are not counted; we have no way of knowing whether water might have occurred in the water season because we have no observations.

5) Transitions

The Transitions provides information on the change in seasonality between the first and last years and captures changes between the three classes of not water, seasonal water and permanent water.

In Liguasan area, the water transition behaver is classified into 10 types of permanent water to almost dry area (Ephemeral water) as shown in Figure XI.1.21.

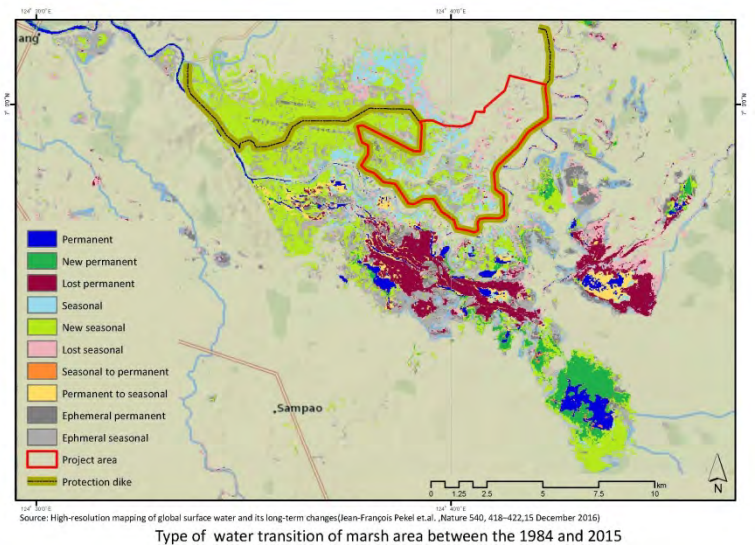


Figure XI.1.21 Type of water transition (1984-2015)

Among 10 types, the widest type of area is 'New seasonal water'. It had been turned from dry to seasonal inundation area, and it covers the most of the Project area and LMSA.

On the other hand, for the center of Liguasan marsh, the type of 'Lost permanent' is large extent which indicates permanent water has shifted to dry condition in last 3 decades.

In other words, main parts of Liguasan marsh has become to be dry condition and floods has instead taken place in the lower reach of the marsh more frequently than ever, which is derived from the changes of land use and water diversion project.

Description (from the paper)

The thematic maps and temporal profiles were used to identify a set of water classes that characterize transitions between the first year in which representative observations were acquired and the last year of observation. Representative years are identified by comparing each year in turn with the annual pattern of monthly recurrence from the temporal profiles. These profiles identify months in which water was observed, and indicate the percentage of valid observations classified as water in any given month. A year is flagged as representative if it contains sufficient valid observations from any combination of months to bring confidence to the determination of the presence or absence of water. The overall level of confidence is determined by the annual sum of the monthly long-term recurrences of observed months (per year). The rationale is that the likelihood of a real absence of water for a year is higher if the water is absent for months showing a high long-term water recurrence than from one showing small rates of recurrence. In the latter case the absence of water may be explained by a seasonal shift, and does not confer enough confidence to conclude that water was not present later.

Therefore, we considered that if the sum of the recurrence of the observed months is greater than 100, the absence of water observation brings enough confidence to consider that water was actually not present. Conversely, a single water presence is enough to demonstrate water presence. The water class in that representative year is then fixed as the 'first' year. The last year's water class is always the class assigned to the last year of observation (October 2014 to October 2015) because we have enough observations available within a year during this period.

The following transitions were mapped: unchanging permanent water surfaces; new permanent water surfaces (conversion of land into permanent water); lost permanent water surfaces (conversion of permanent water into land); unchanging seasonal water surfaces; new seasonal water surfaces (conversion of land into seasonal water); lost seasonal water surfaces (conversion of a seasonal water into land); conversion of permanent water into seasonal water; and the conversion of seasonal water into permanent water.

These conversions refer to changes in state from the beginning and end of the time series; they do not describe what happened in the intervening years, so an unchanging water surface means that the seasonality at that particular point was the same in the first and last year it was observed, and not necessarily that it was stable throughout. Stability must be checked at the pixel scale by using the long term water history described by the temporal profiles plus the recurrence and occurrence maps. There are instances where water is not present at the beginning or the end of the observation record but is present in some of the intervening years. By tracking the inter-annual patterns of such 'ephemeral' events and their intra-annual characteristics, each such pixel can be classified as either ephemeral permanent water (land replaced by permanent water that subsequently disappears) or ephemeral seasonal water (land replaced by seasonal water that subsequently disappears), depending on the majority of the observed seasonality during the period of water presence.

6) Maximum water extent

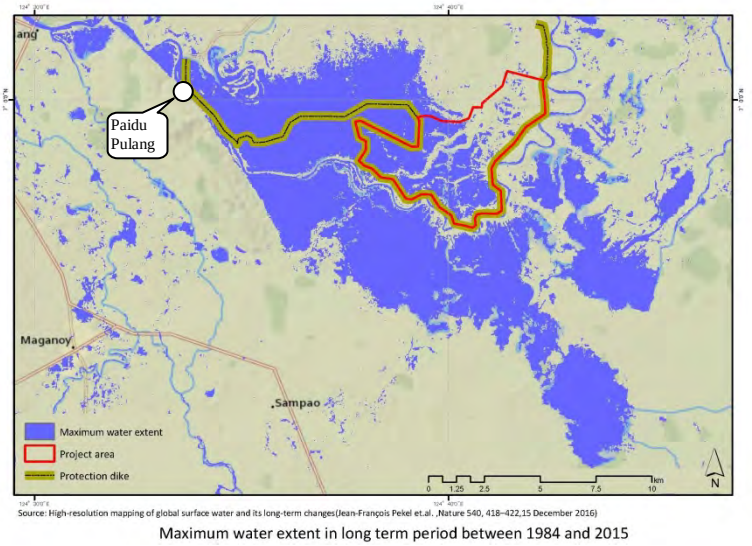


Figure XI.1.22 Max water extent (1984-2015)

The maximum water extent image consisted of a composite image which provides information of detected water on all locations ever over the 32 years from 1984 by 2015. The blue part in Figure XI.1.22 shows an area of the maximum surface water extent and could be correlative with the maximum food extent within the last three (3) decades. Its distribution broadly covers almost the half of LMSA by the damming-up, which spreads from the narrow outlet channel at Paidu Pulangi. Note that the water inundating the southern parts of the Lower Malitubog Service Area (LMSA) comes back mostly from the Paidu Pulangi area, not directly from the Pulangi river running along the southern side of the area due to elevation difference.

7) Water history (monthly and annual history)

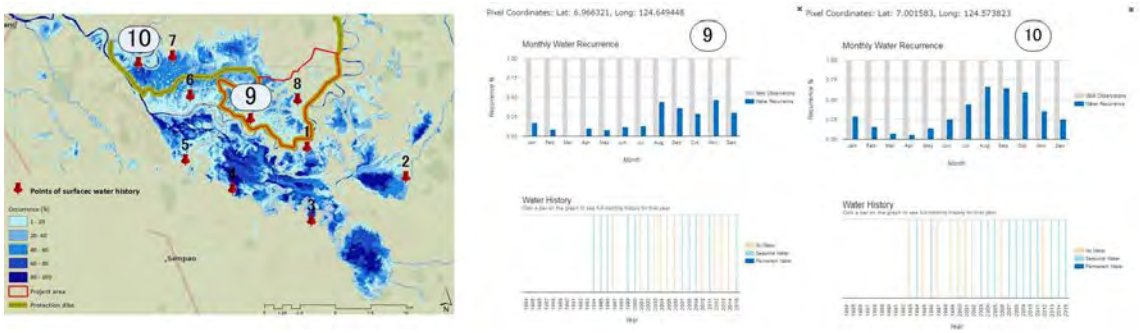


Figure XI.1.23 History of water surface between 1984 and 2015

The temporal distribution of water; the monthly recurrence, yearly water history, and the monthly water history is also available in the Global surface water to help understand how water is distributed temporally throughout the 1984-2015.

The history at specific point is taken from Global surface water explorer and an example of the history dataset is given in Figure XI.1.23 with two types of charts which are monthly and yearly recurrence in LMSA. In LMSA, seasonal change is clearly traced in monthly charts showing that inundation period starts from early summer and continued by the end of year. As year to year change, flood occurs frequently in latest 20 years.

In the history of water transition, the seasonal change in right bank of Pulangi river can be regarded as ‘New seasonal areas’, which has turned to a wet-land from the dry land during the last 3 decades. On the other hand, the left bank area is characterized as ‘Lost permanent area’ which has interrupted or dried-up water in dry season.

XI.6 Flood occurrences and its magnitude

Flood occurs once two years. It means inundation of LMSA is common status as normal hydrological year. If it compares with the maximum water extent in last 32 years, it covers 60 % to 90 % of the

maximum water extent as shown in Figure XI.1.24.

XI.6.1 Flood extent in the Project area

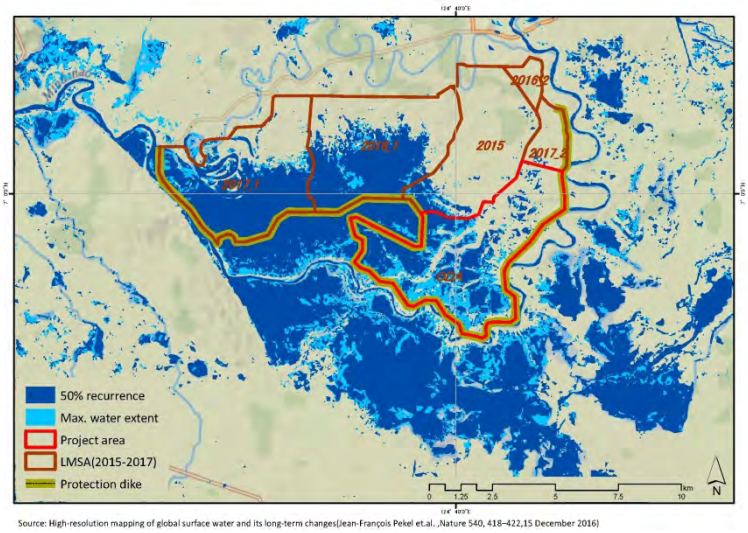
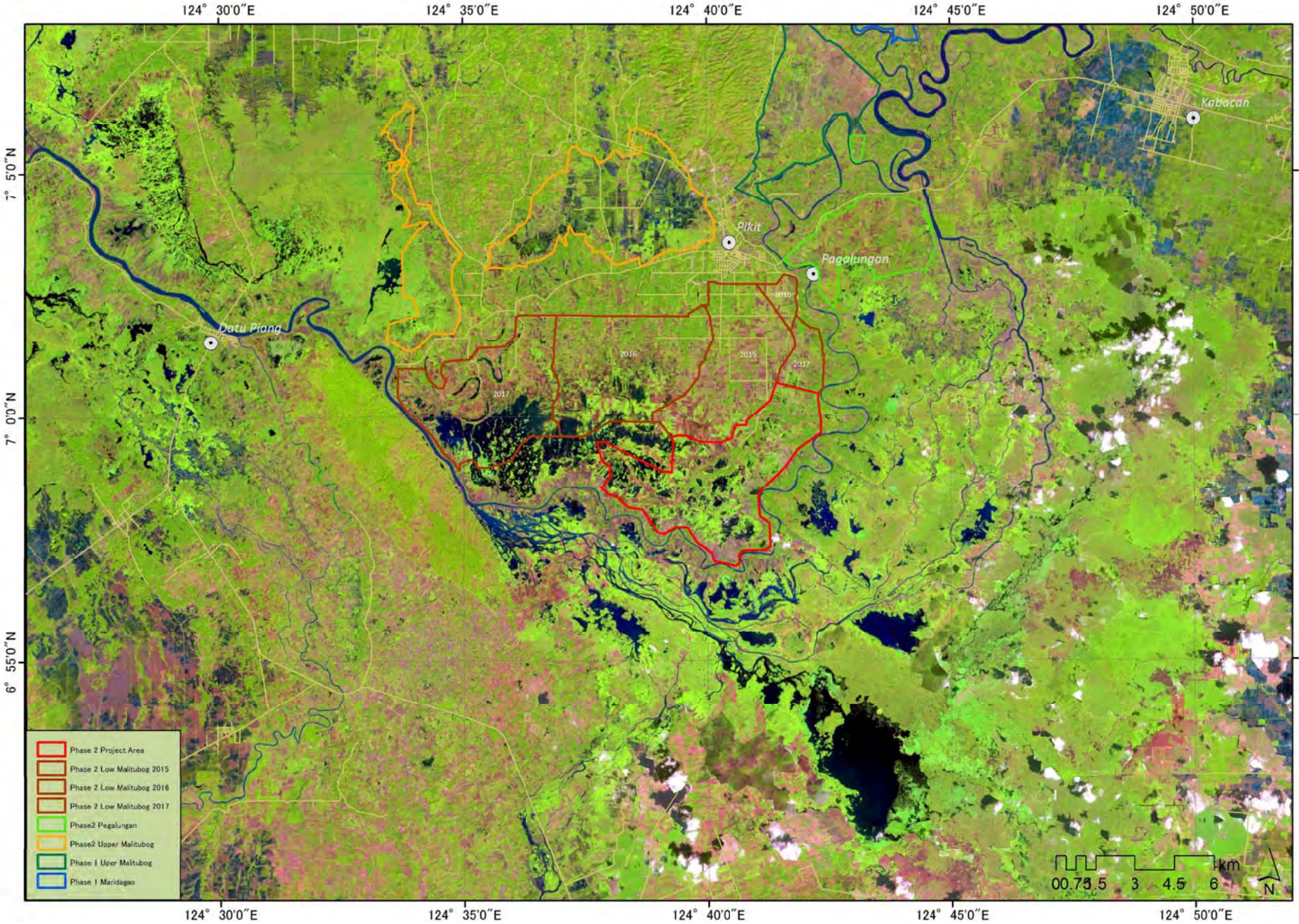


Figure XI.1.24 Flood area of LMSA

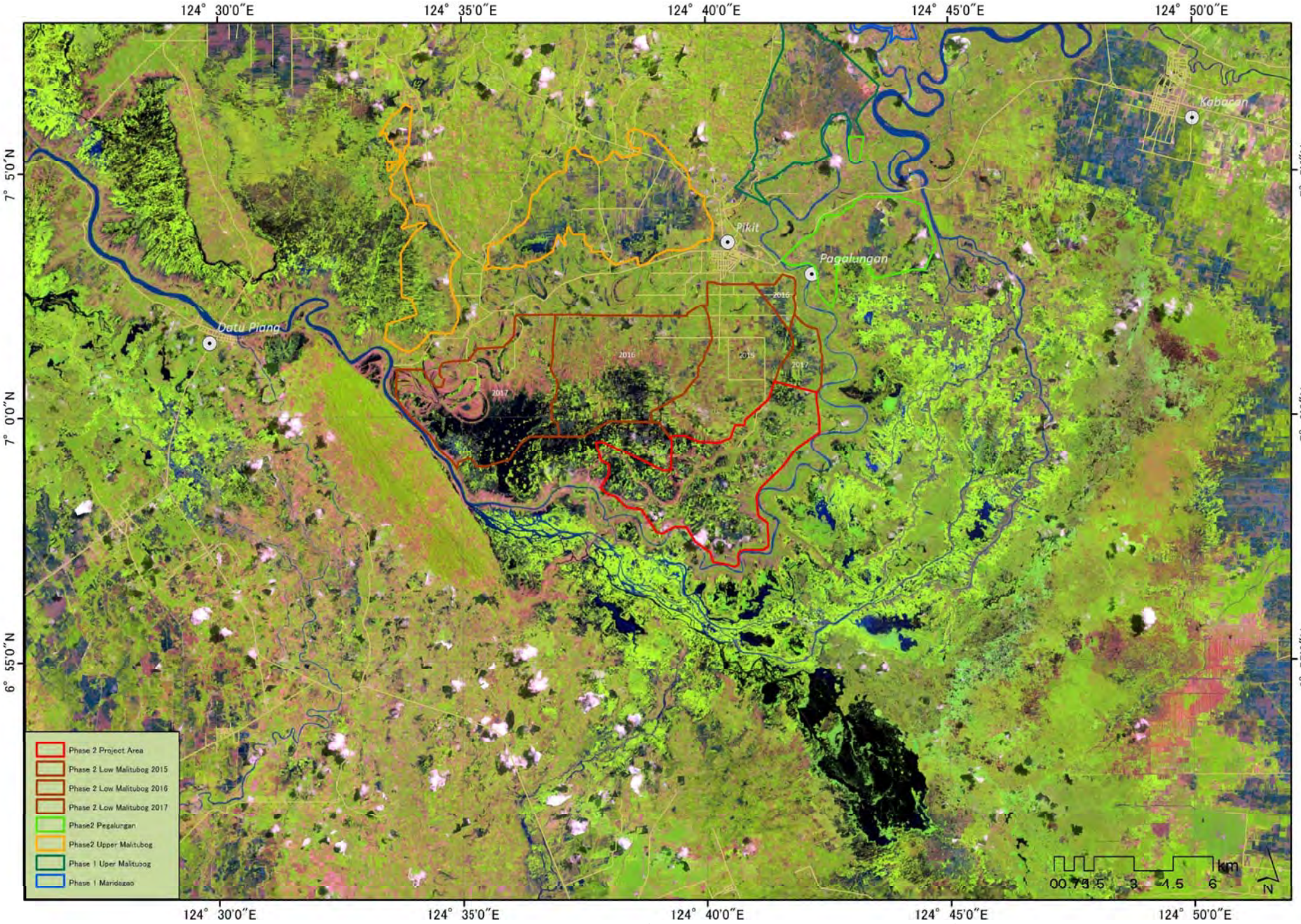
On the other hand, the ratio between the water occurrence in normal year and the total LMSA area comes to 0 to 55 % with the overall average of 34%. It means that during the normal hydrological year, 34% of LMSA had been inundated, leaving only 66% as surface land. Likewise, the ratio between the maximum occurrence water extent and the total area comes to 0 to 63 % with the overall average of 44%. It means that during the maximum water extent year, 44% of the LMSA had been inundated, leaving only 54% as surface land. Concerning the ODA target area located at most eastern part of LMSA, the inundated areas reached 32% and 53% respectively for the 50% occurrence and maximum water extent occurrence.

XI.7 Maps

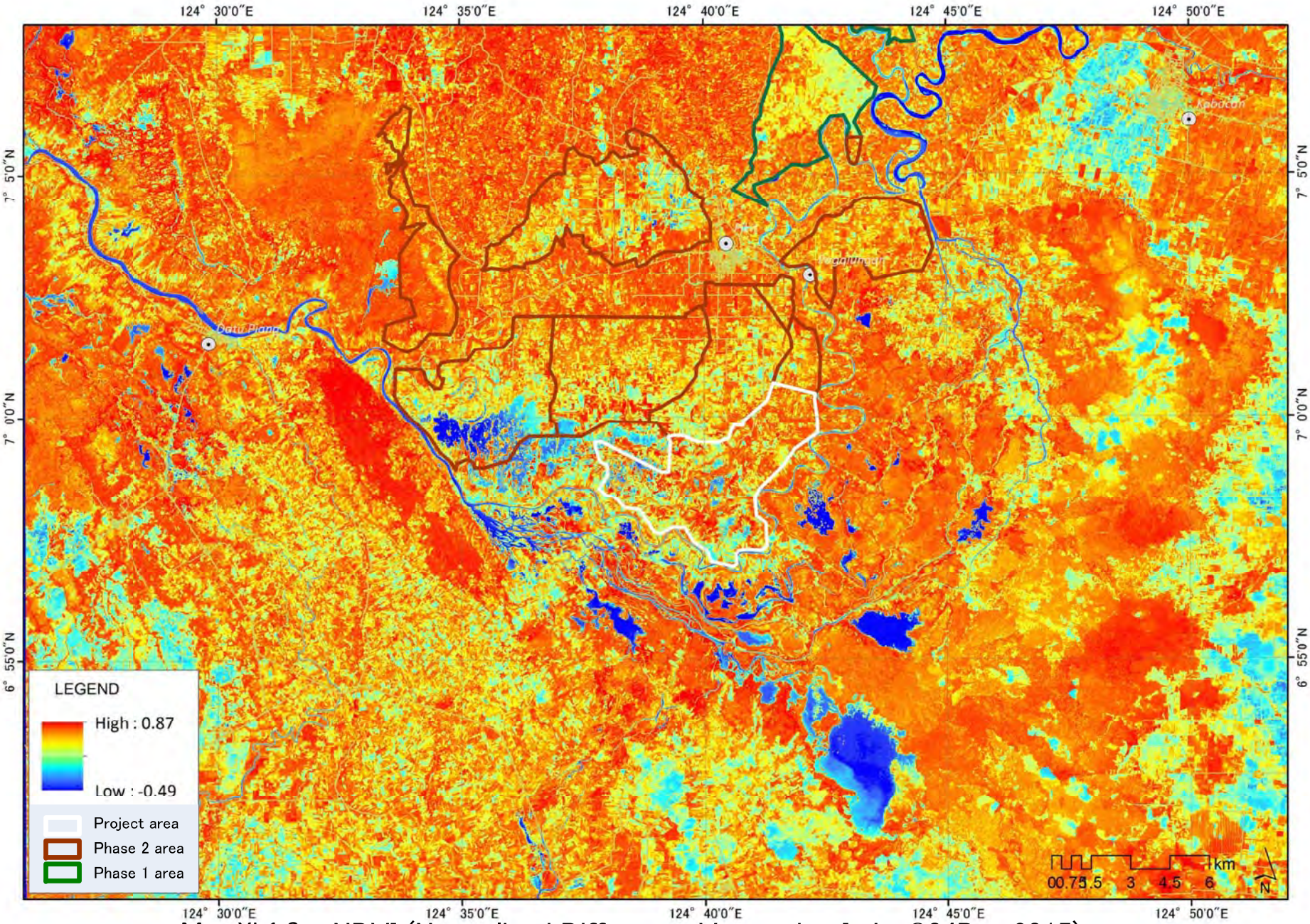
Table XI.1.5 List of Maps



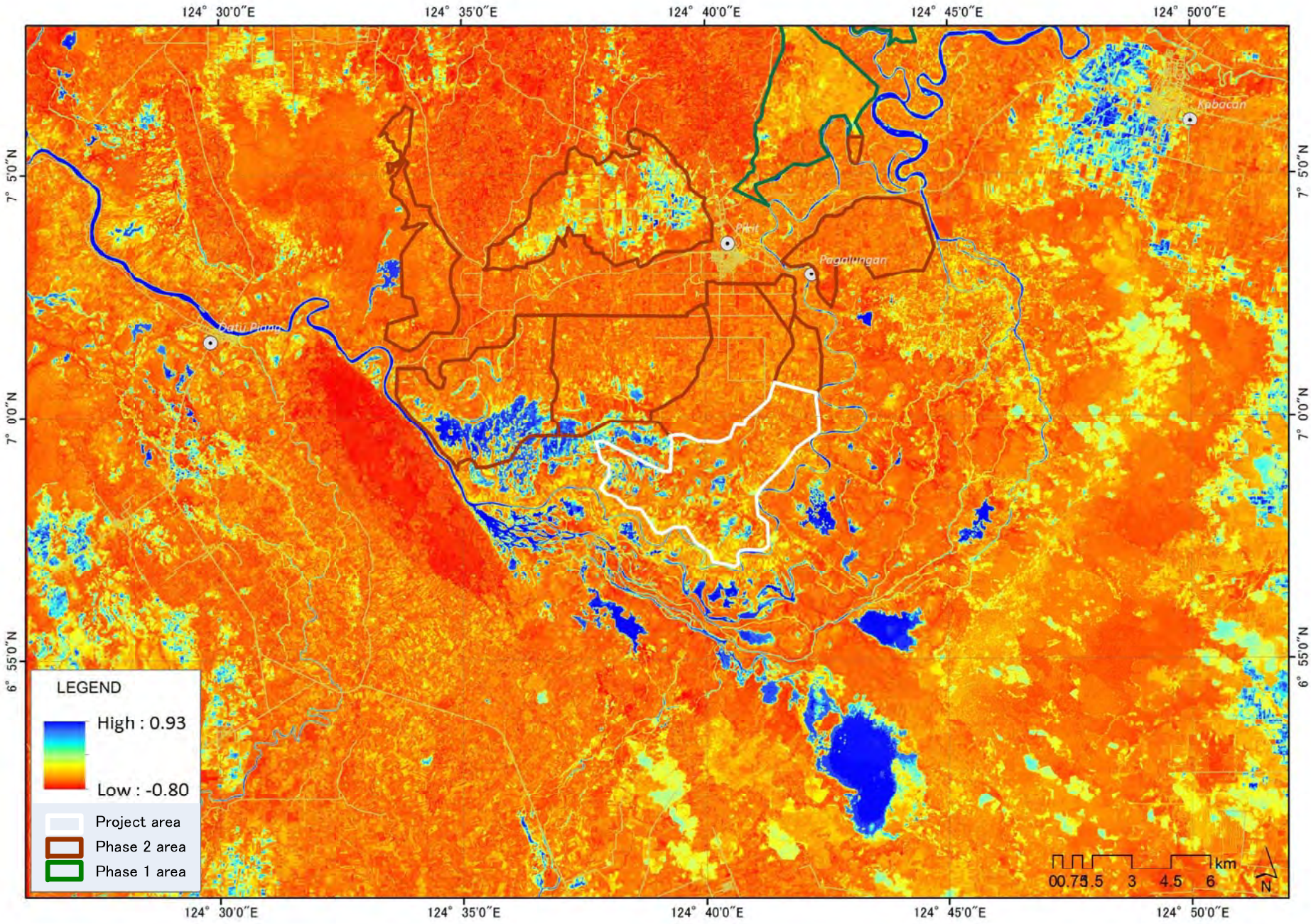
Map XI.1.1 False color image (sentinel-2a 04/Dec/2015)



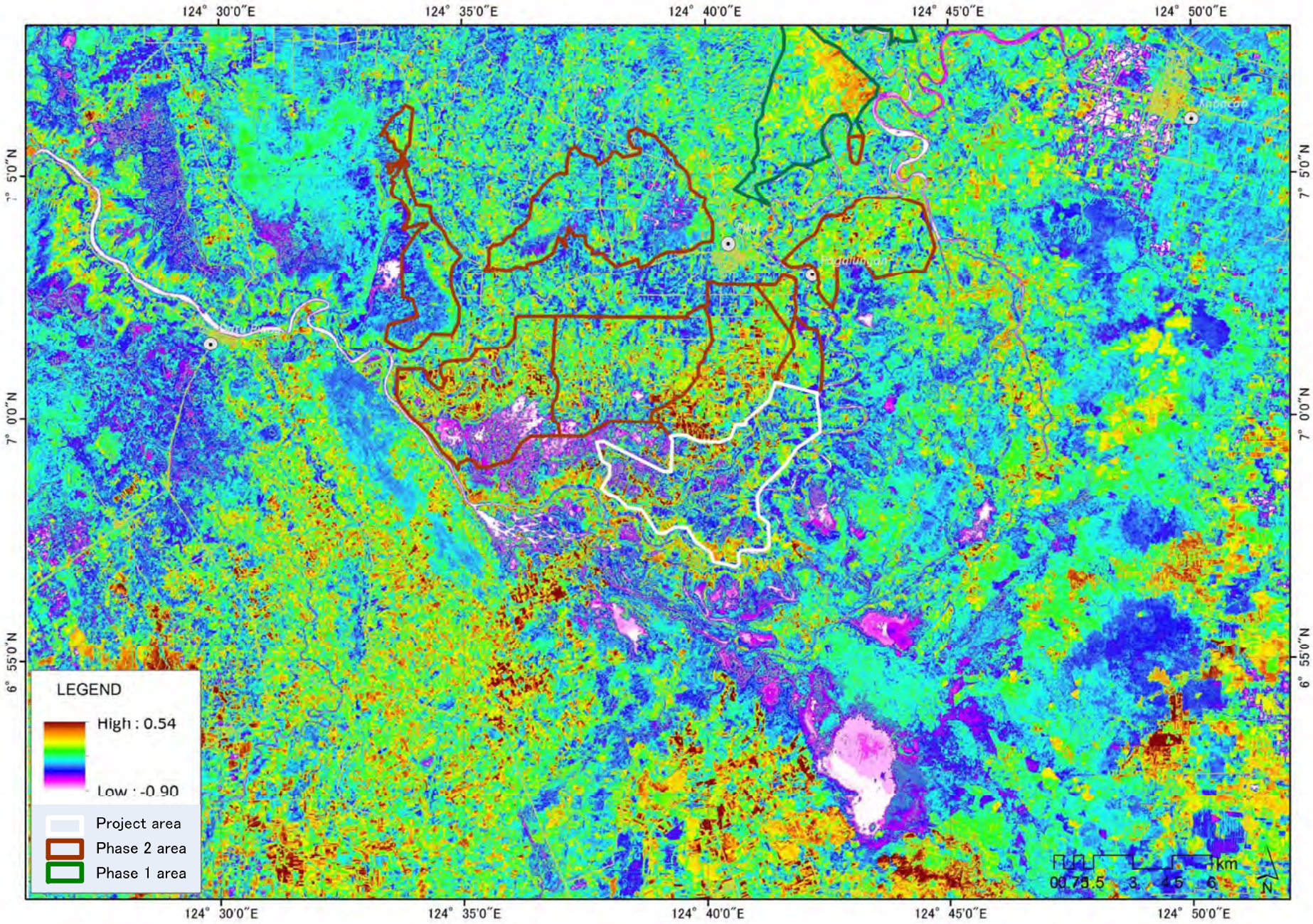
Map XI.1.2 False color image (sentinel-2a 21/Jul/2016)



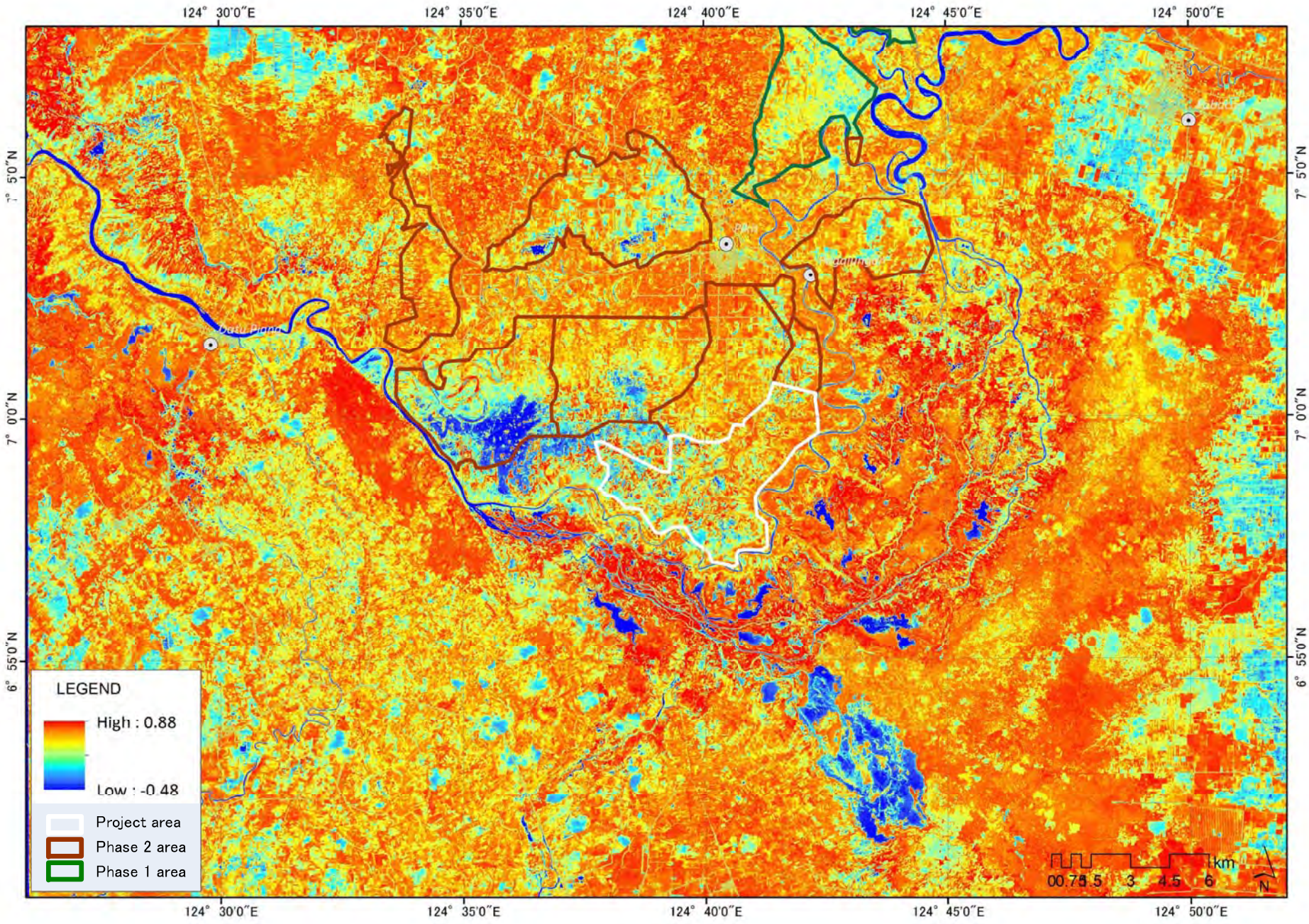
Map XI.1.3 NDVI (Normalized Difference Vegetation Index@04Dec.2015)



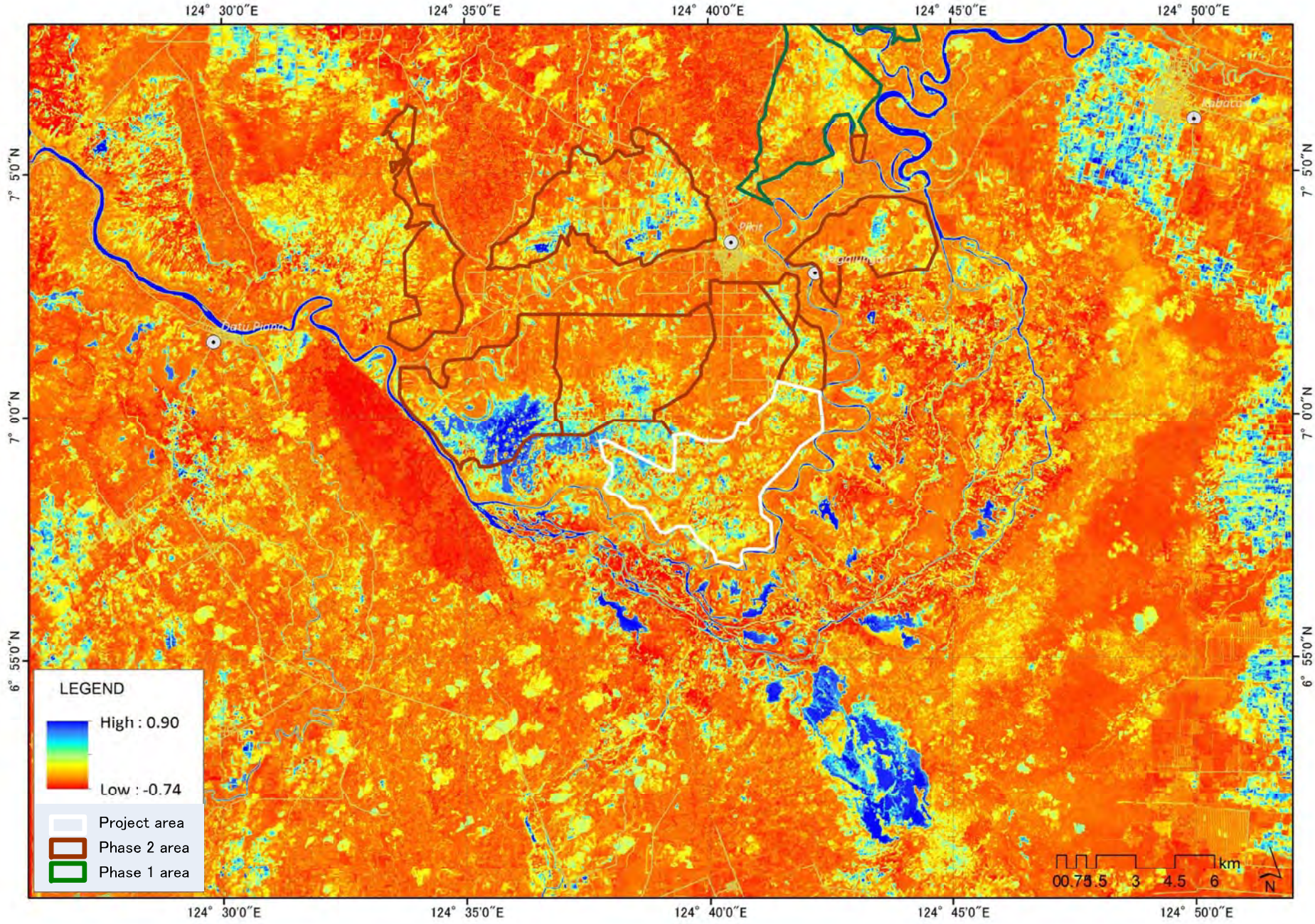
Map XI.1.4 NDWI (Normalized Difference Water Index@04Dec.2015)



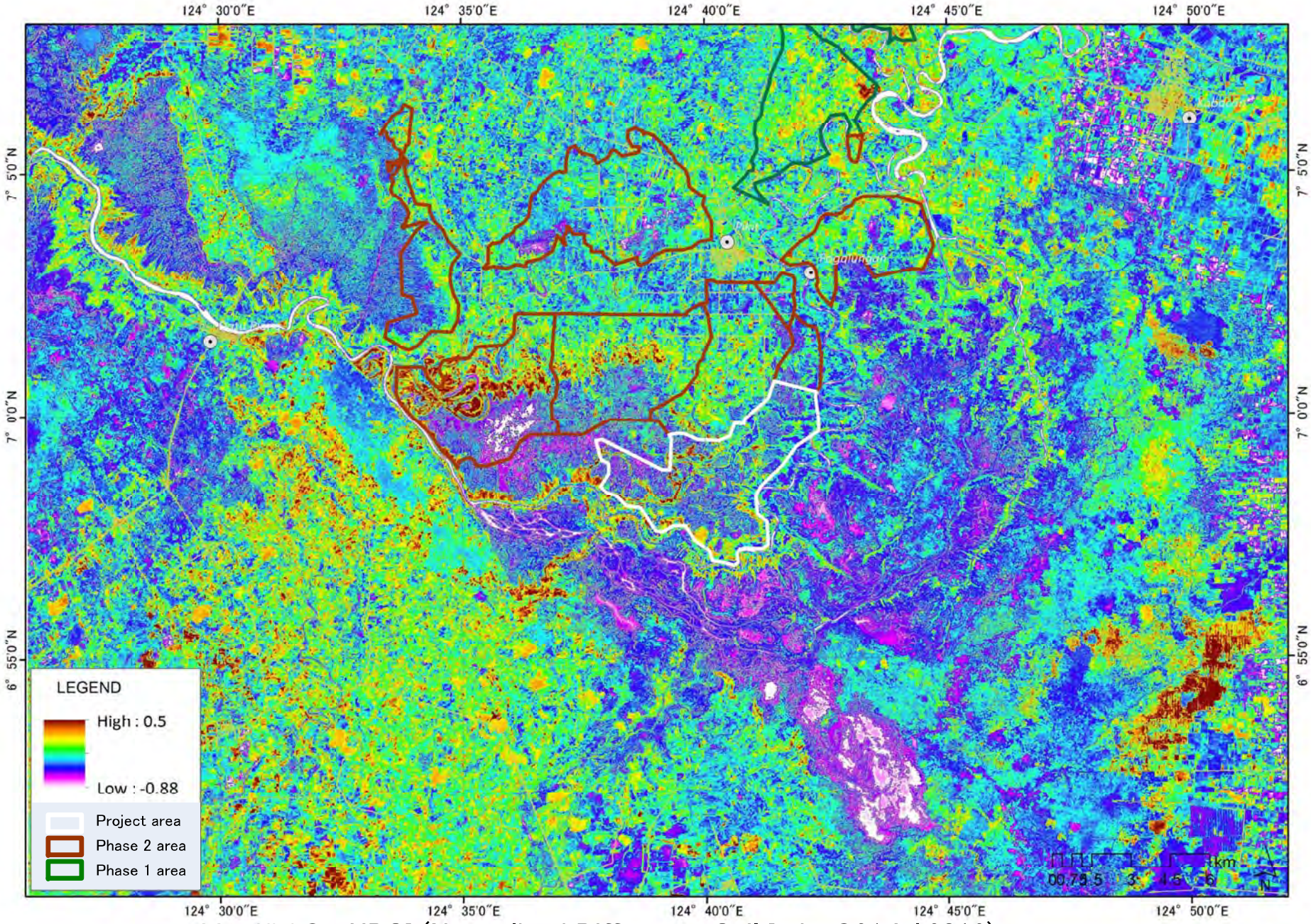
Map XI.1.5 NDSI (Normalized Difference Soil Index@04Dec.2015)



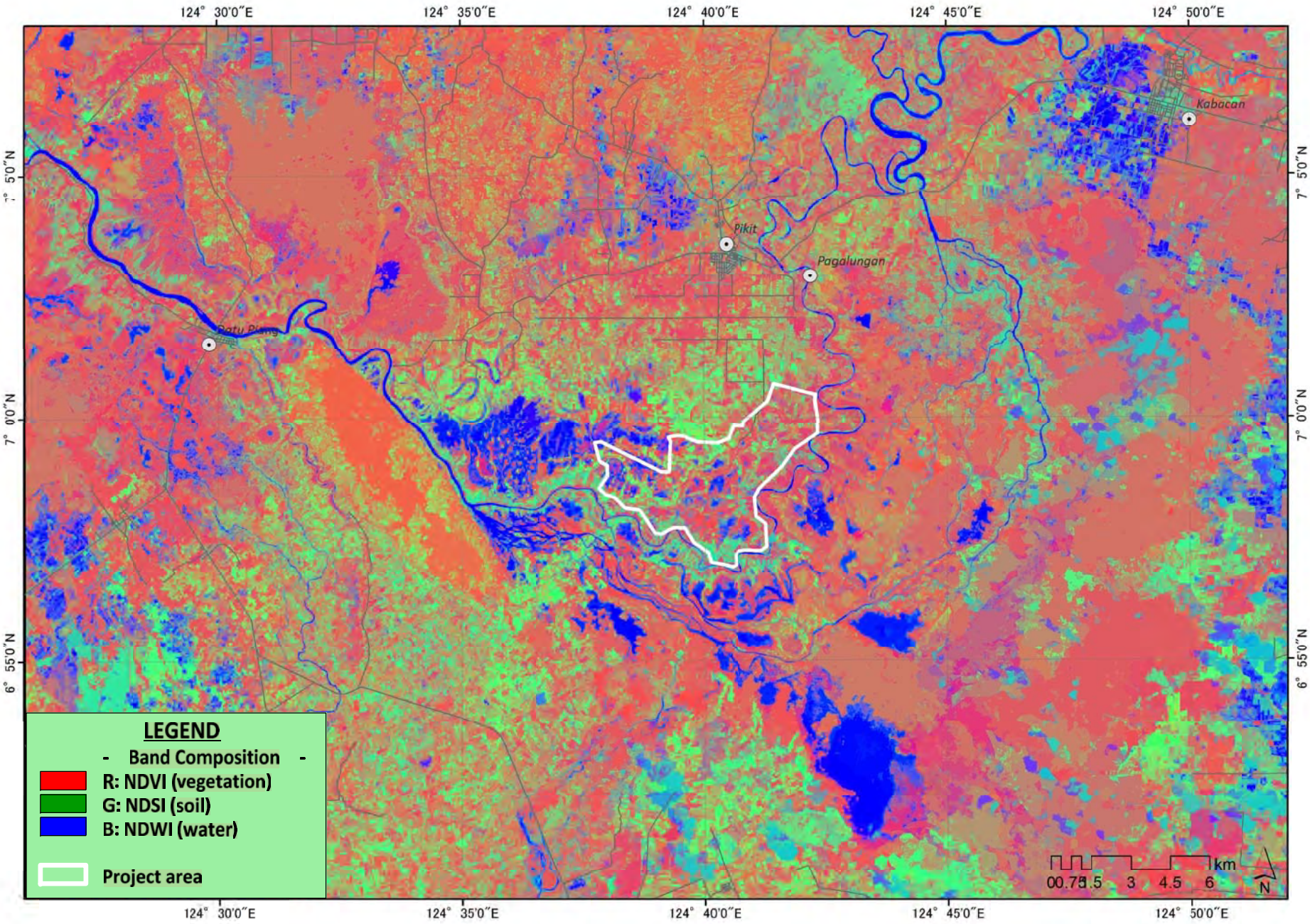
Map XI.1.6 NDVI (Normalized Difference Vegetation Index@21Jul.2016)



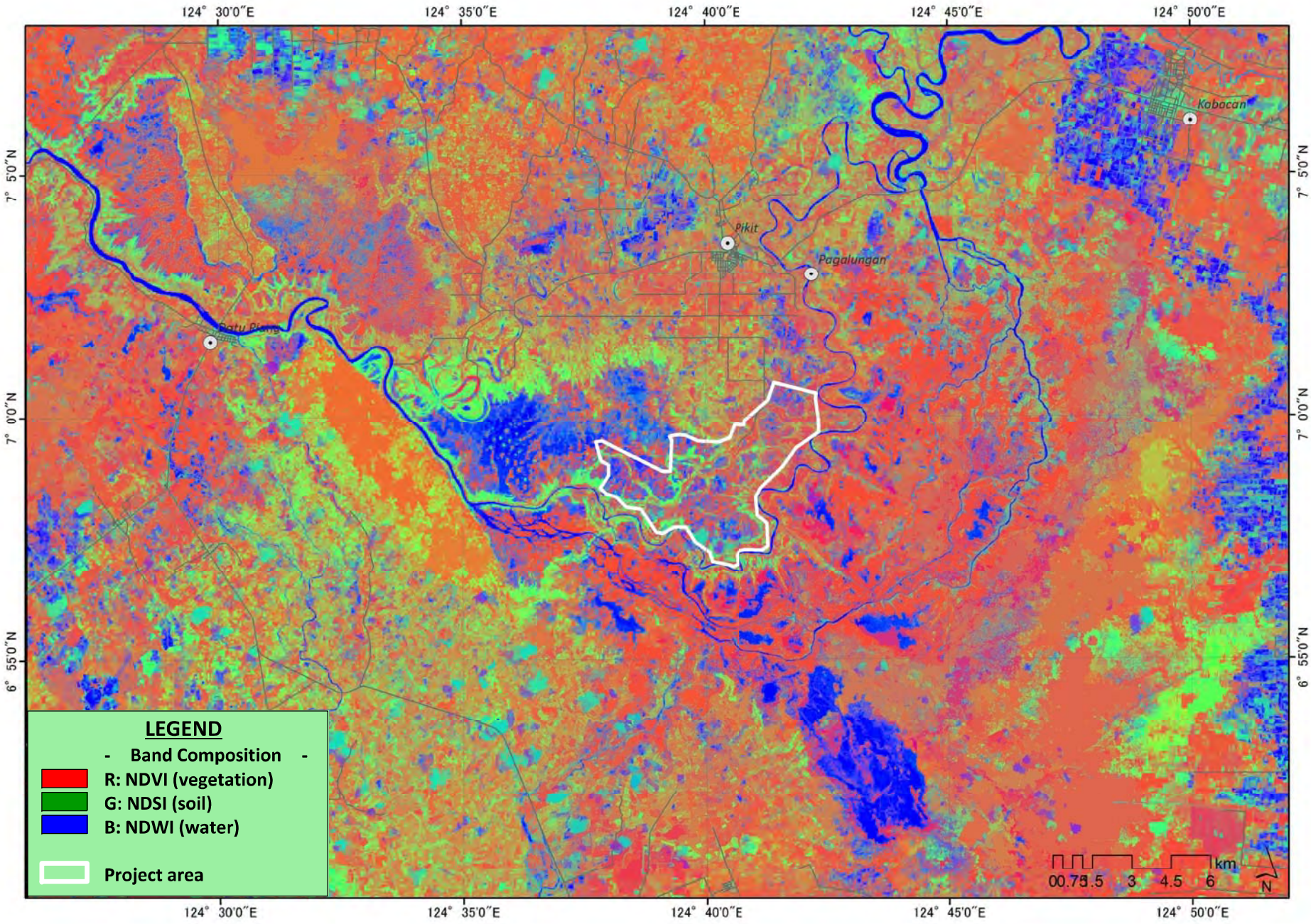
Map XI.1.7 NDWI (Normalized Difference Water Index@21Jul.2016)



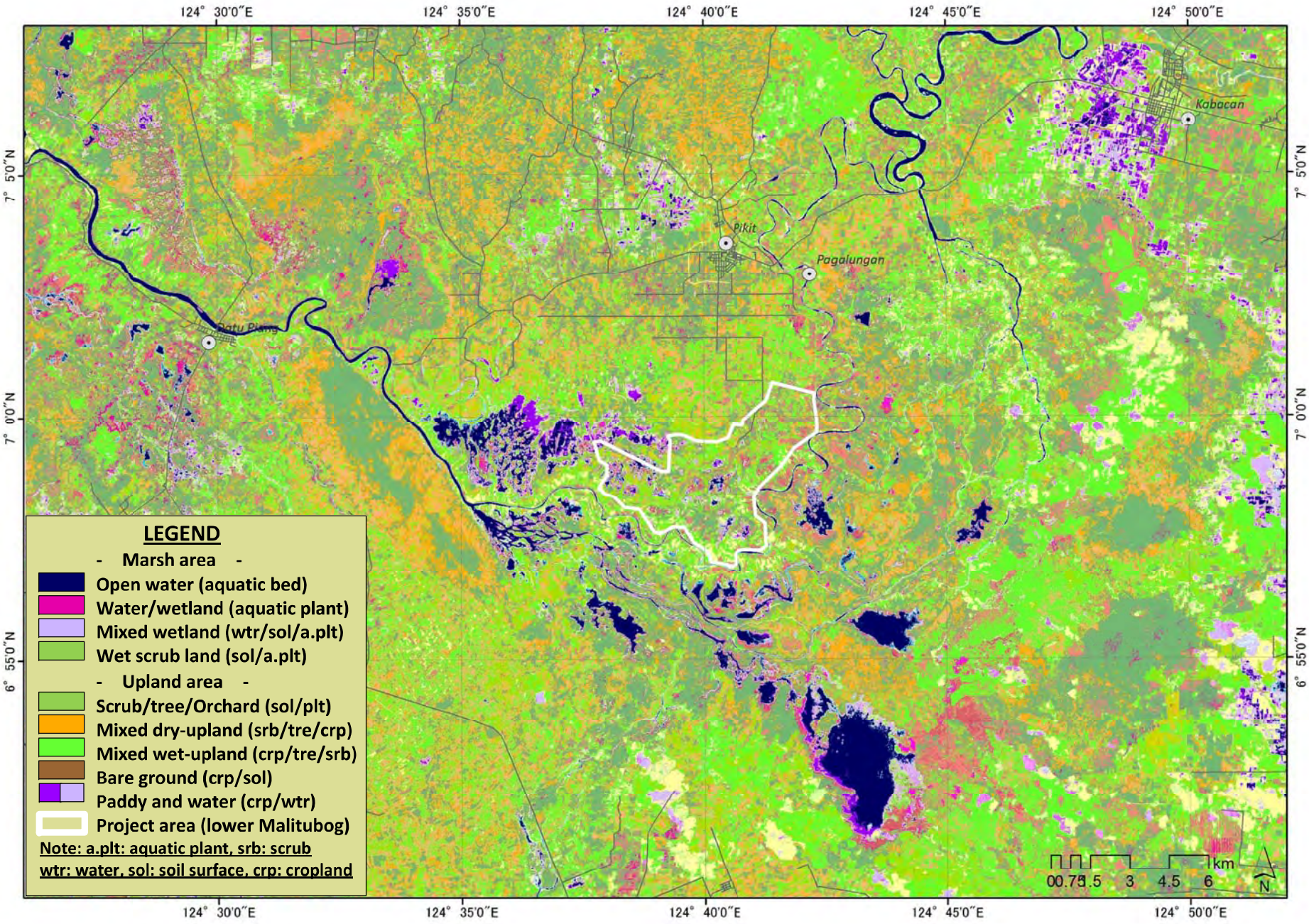
Map XI.1.8 NDSI (Normalized Difference Soil Index@21Jul.2016)



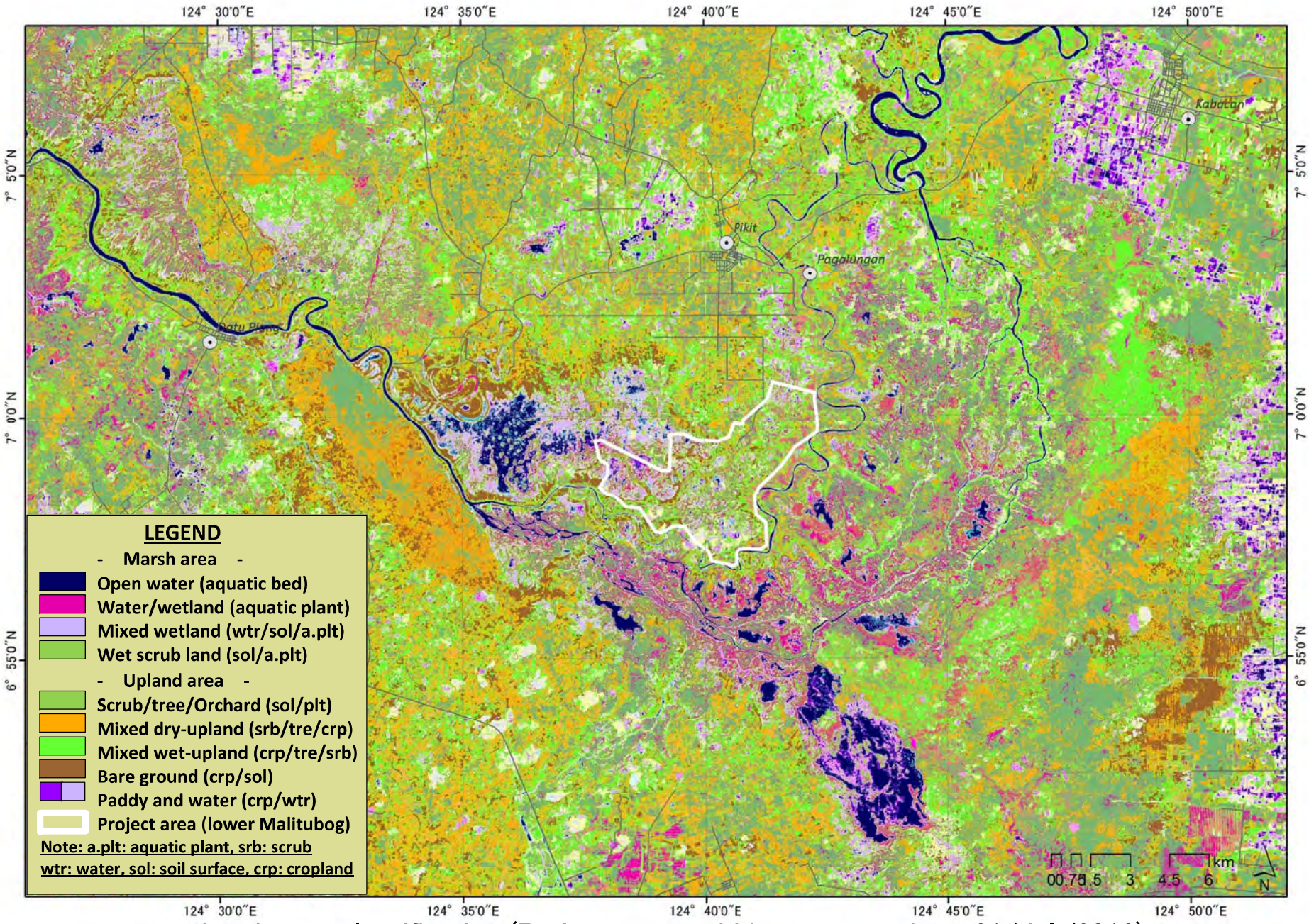
Map XI.1.9 Band composition indices (R: NDVI, G: NDSI, B: NDWI) on 04/Dec./2015



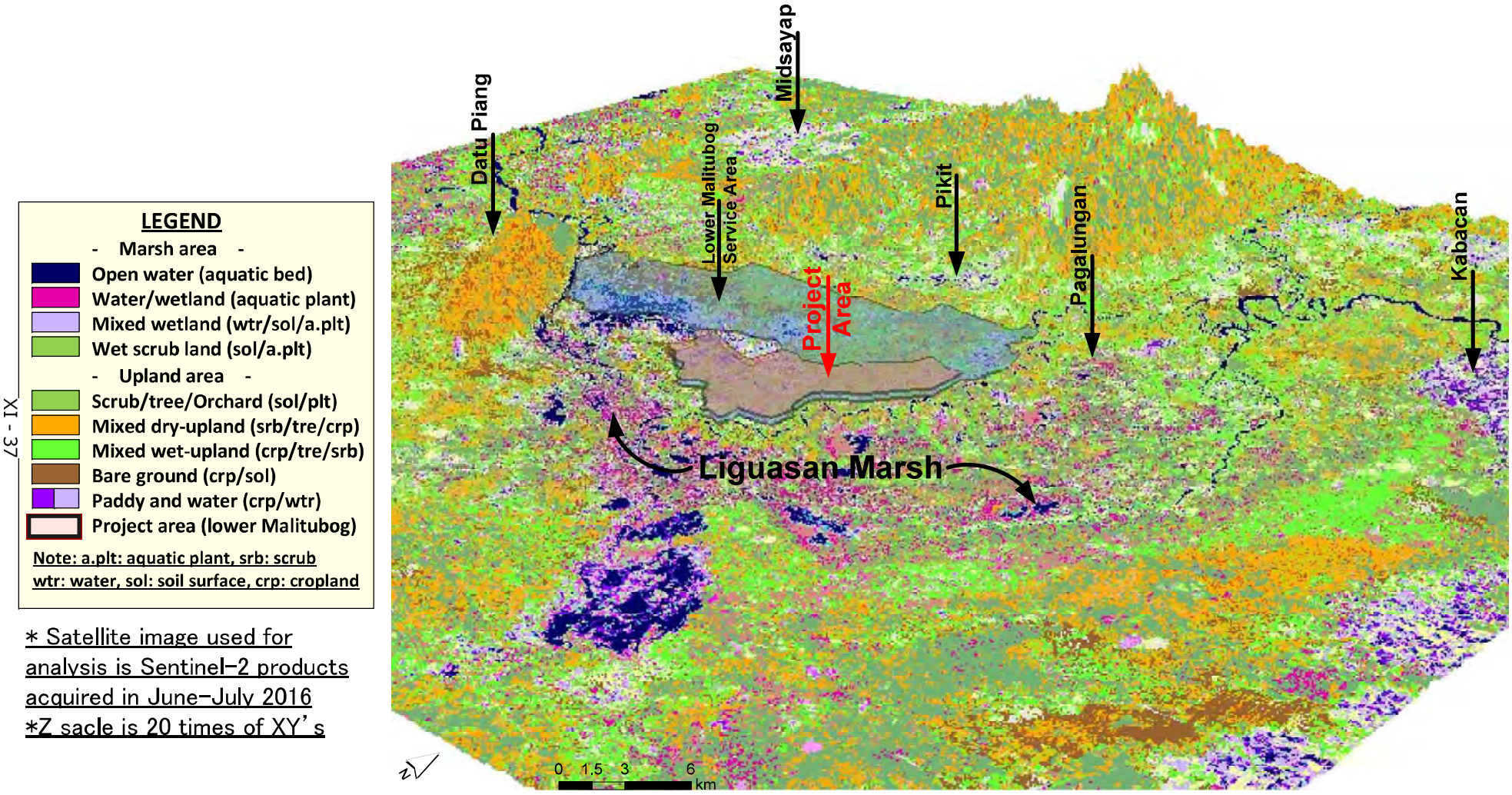
Map XI.1.10 Band composition indices (R: NDVI, G: NDSI, B: NDWI) on 21/Jul./2016



Map XI.1.11 Landcover classification (Project area and Liguasan marsh on 04/Dec./2015)



Map XI.1.12 Landcover classification (Project area and Liguasan marsh on 21/Jul./2016)

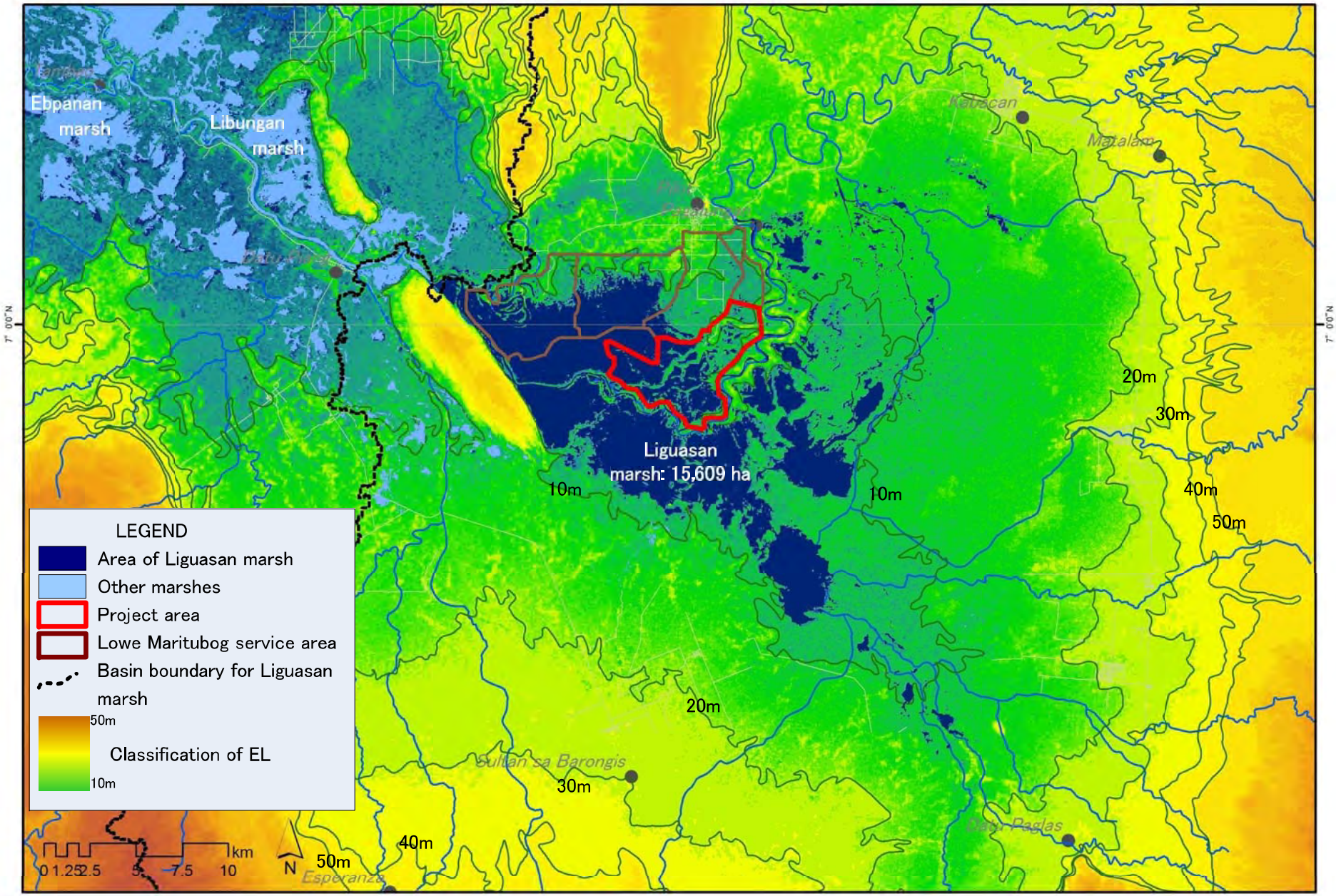


Map XI.1.13 3D view of Liguasan marsh (landcover classification)

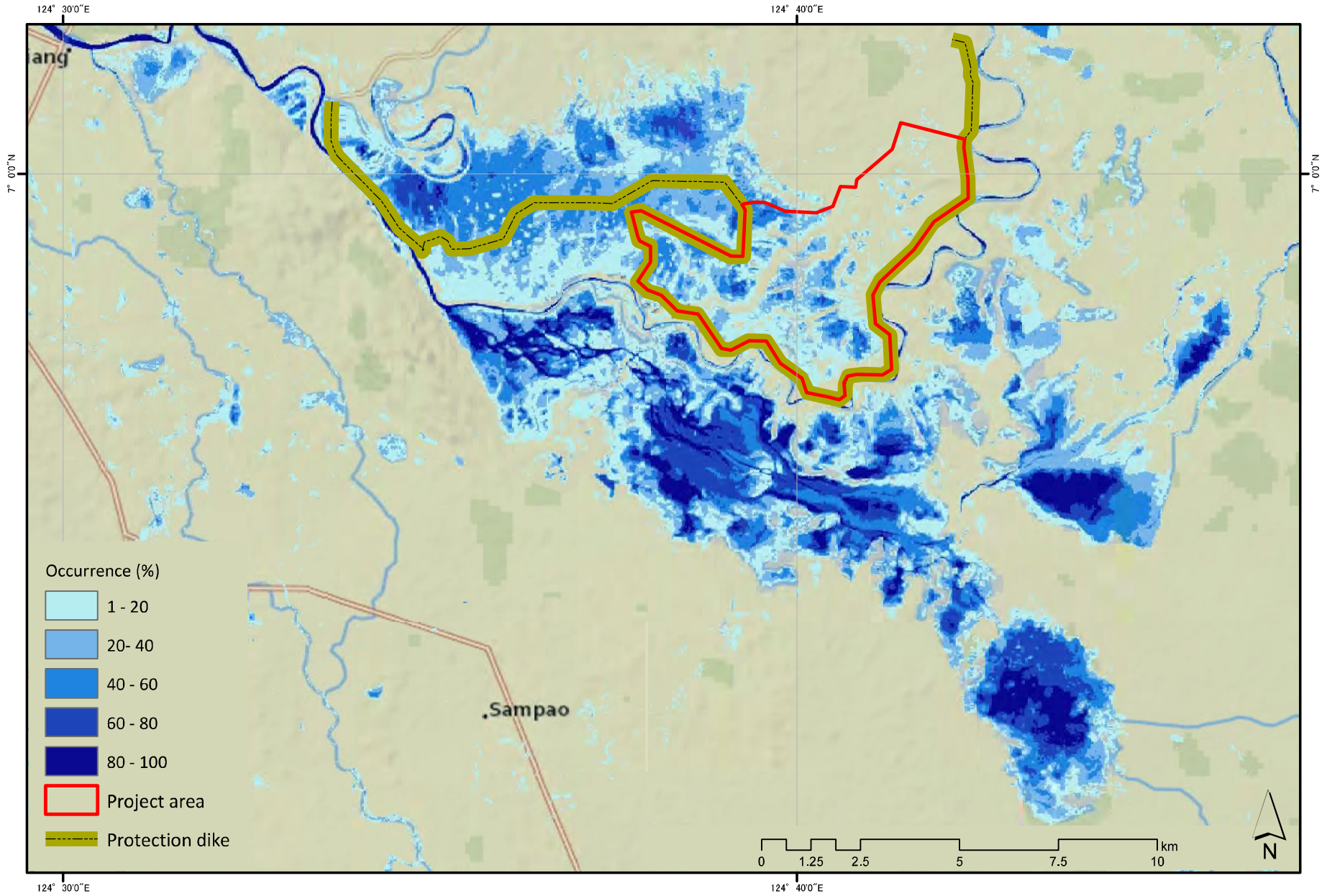
Map XI.1.14

Note: Iso-hyet line is delineated based on CFSR (Climate Forecast System Reanalysis) data sourced https://rda.ucar.edu/datasets/ds093.2/

Isohyet of mean annual rainfall (1979–2014) of Liguasan marsh

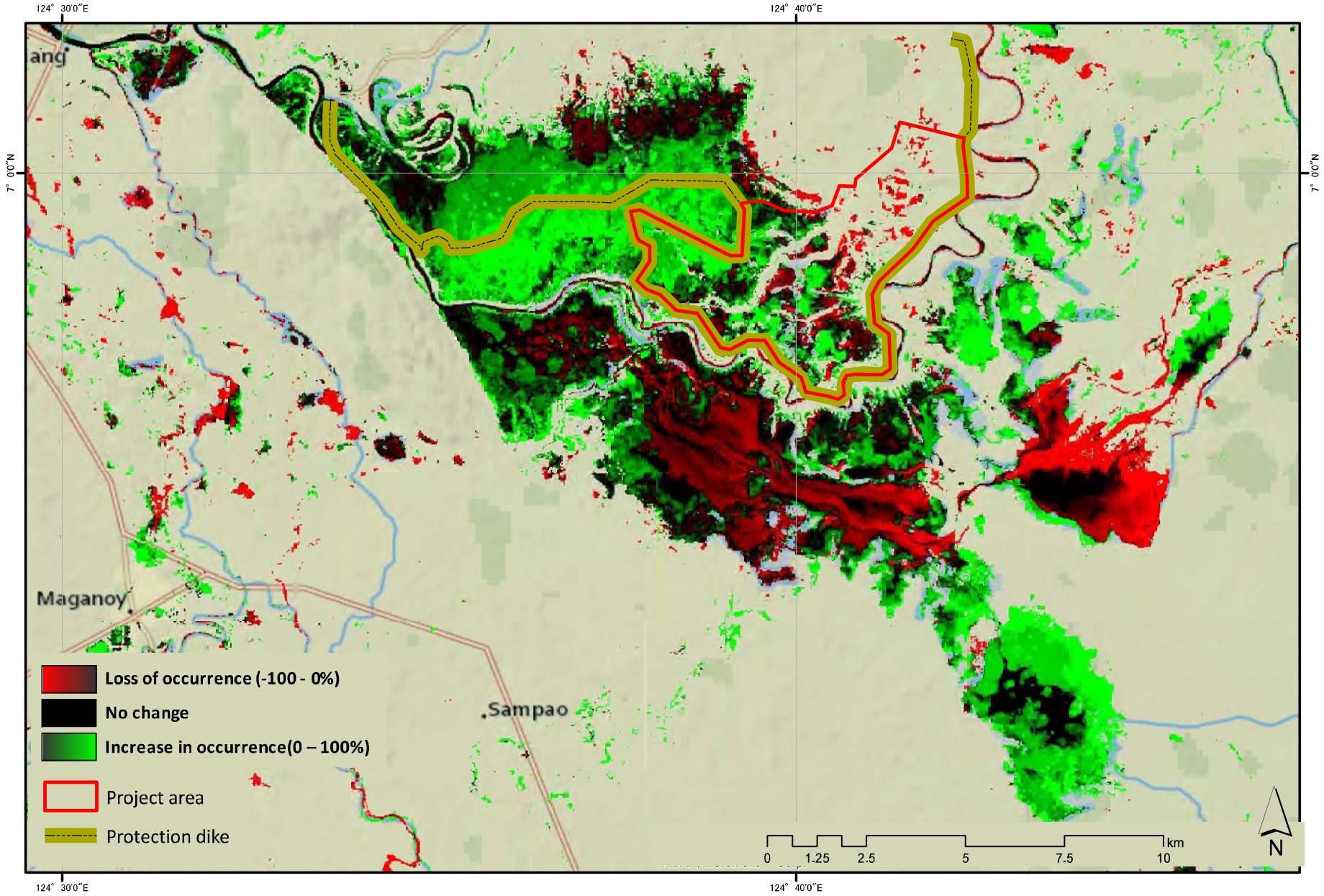


Map XI.1.15 Location and size of Liguasan marsh (as max. extent of water cover)



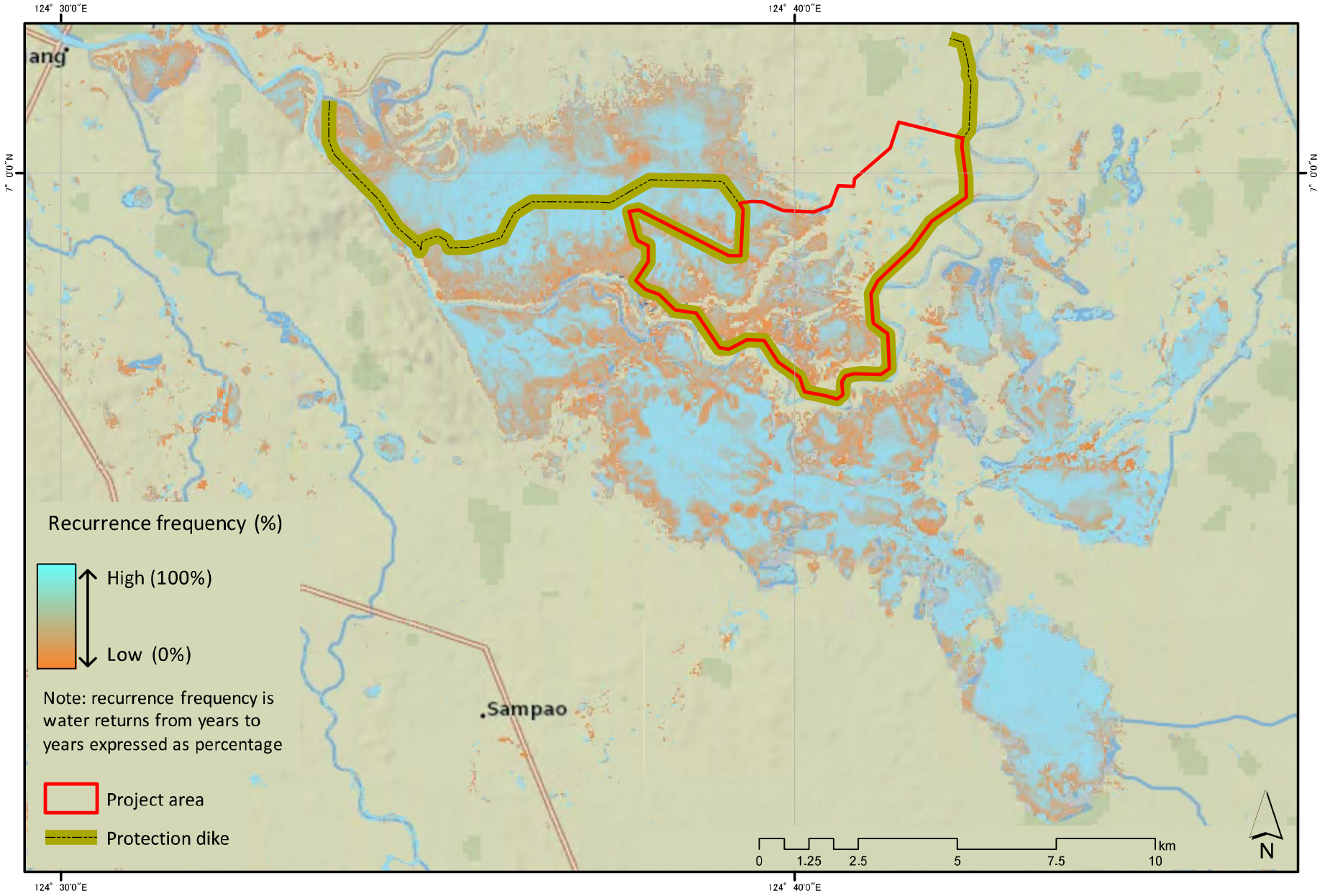
Source: High-resolution mapping of global surface water and its long-term changes(Jean-François Pekel et.al. ,Nature 540, 418–422,15 December 2016)

Map XI.1.16 Long term water occurrence between 1984 and 2015



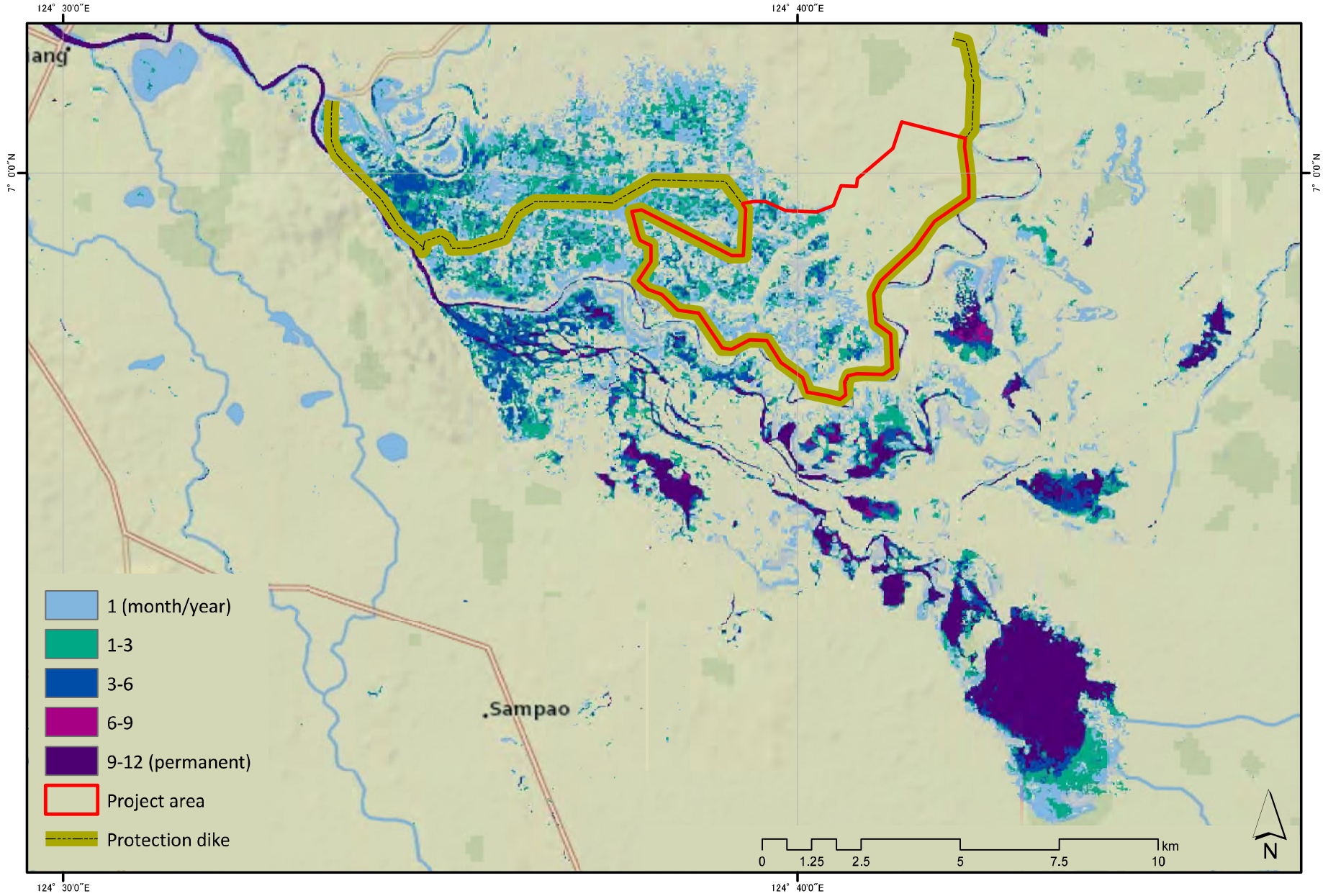
Source: High-resolution mapping of global surface water and its long-term changes(Jean-François Pekel et.al. ,Nature 540, 418–422,15 December 2016)

Map XI.1.17 Occurrence change intensity between 1984-1999 and 2000-2015



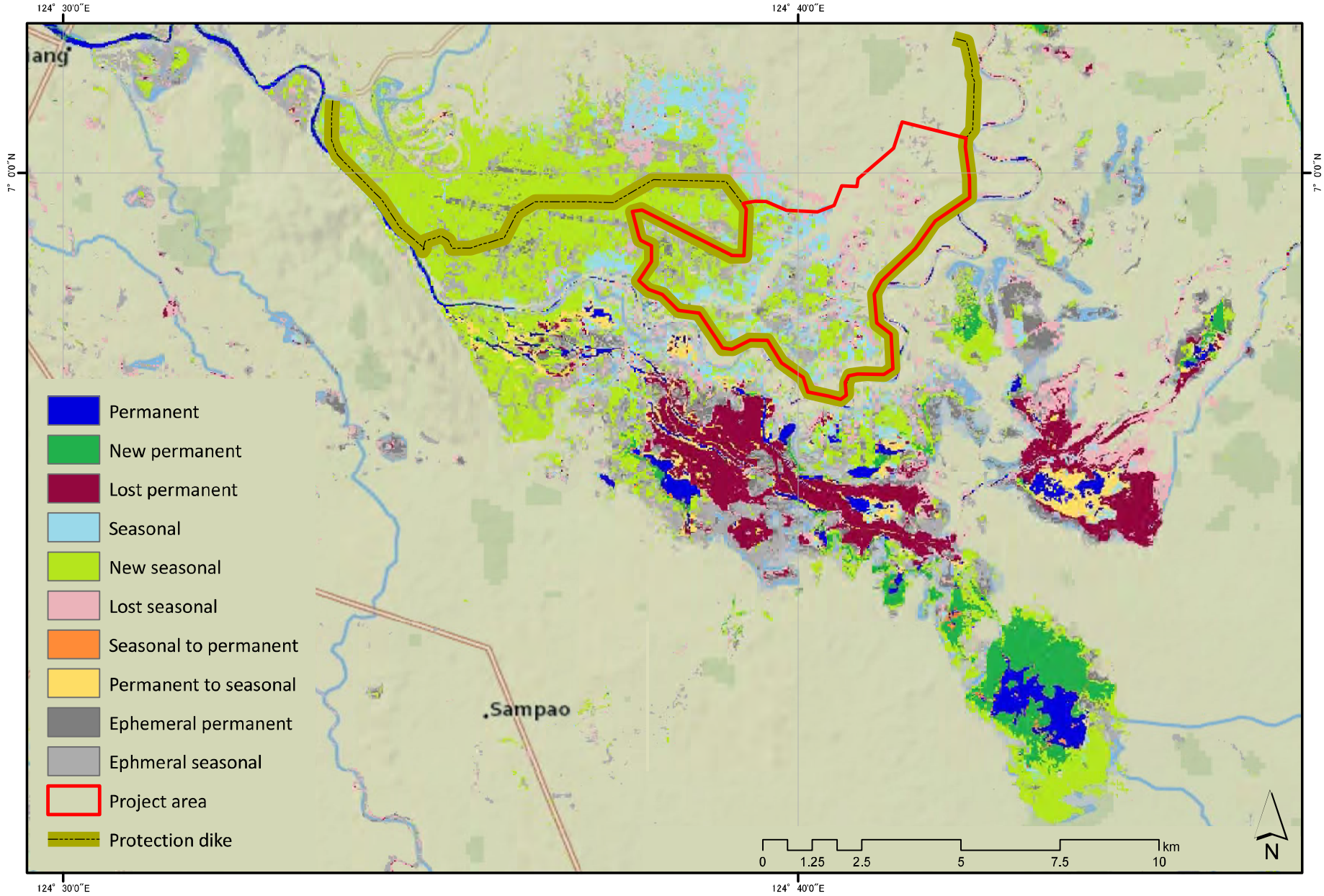
Source: High-resolution mapping of global surface water and its long-term changes(Jean-François Pekel et.al. ,Nature 540, 418–422,15 December 2016)

Map XI.1.18 Water recurrence of the inter-annual behavior of water surface (1984-2015)



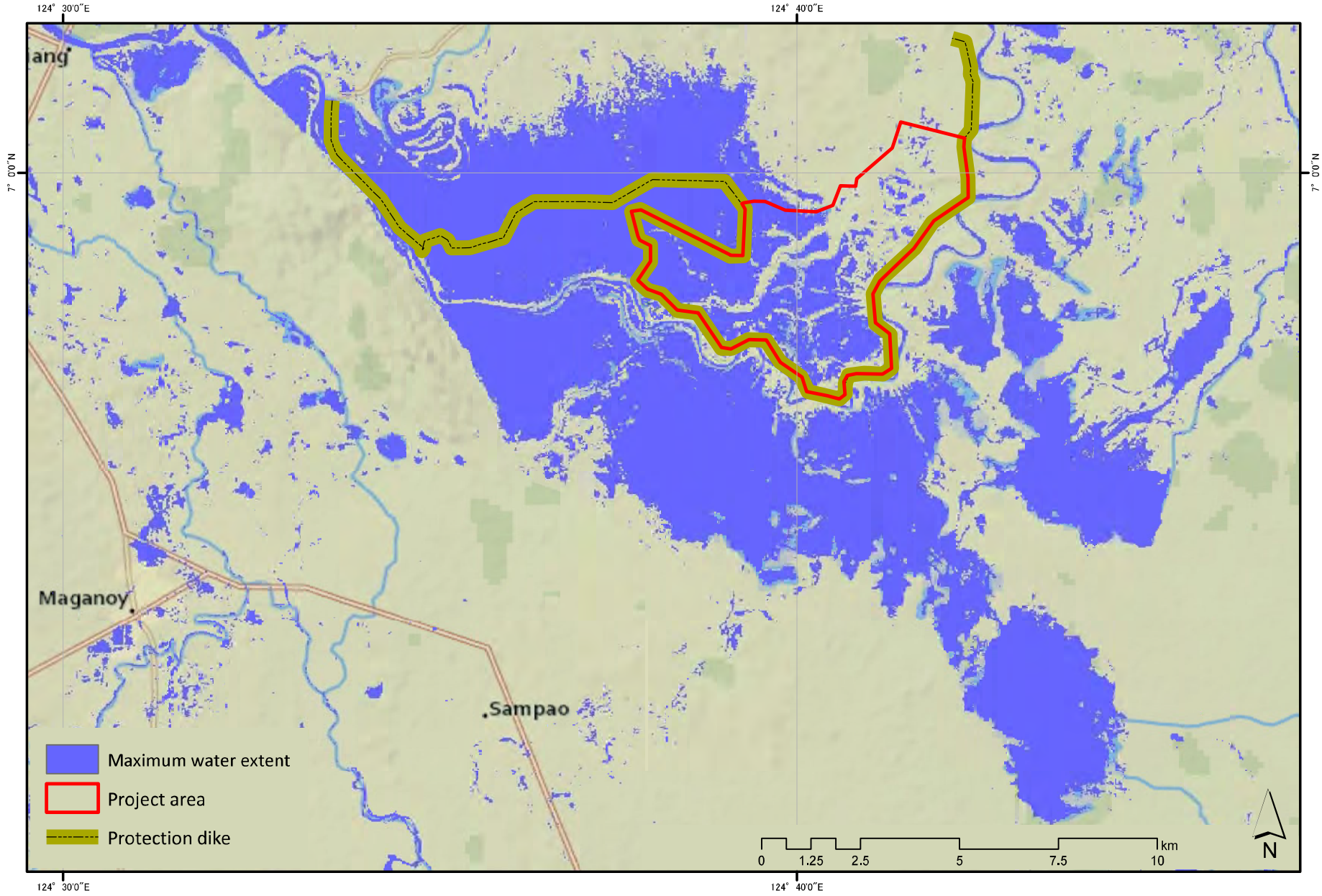
Source: High-resolution mapping of global surface water and its long-term changes(Jean-François Pekel et.al. ,Nature 540, 418–422,15 December 2016)

Map XI.1.19 Seasonality of the intra-annual behavior of water surface (2014-2015)



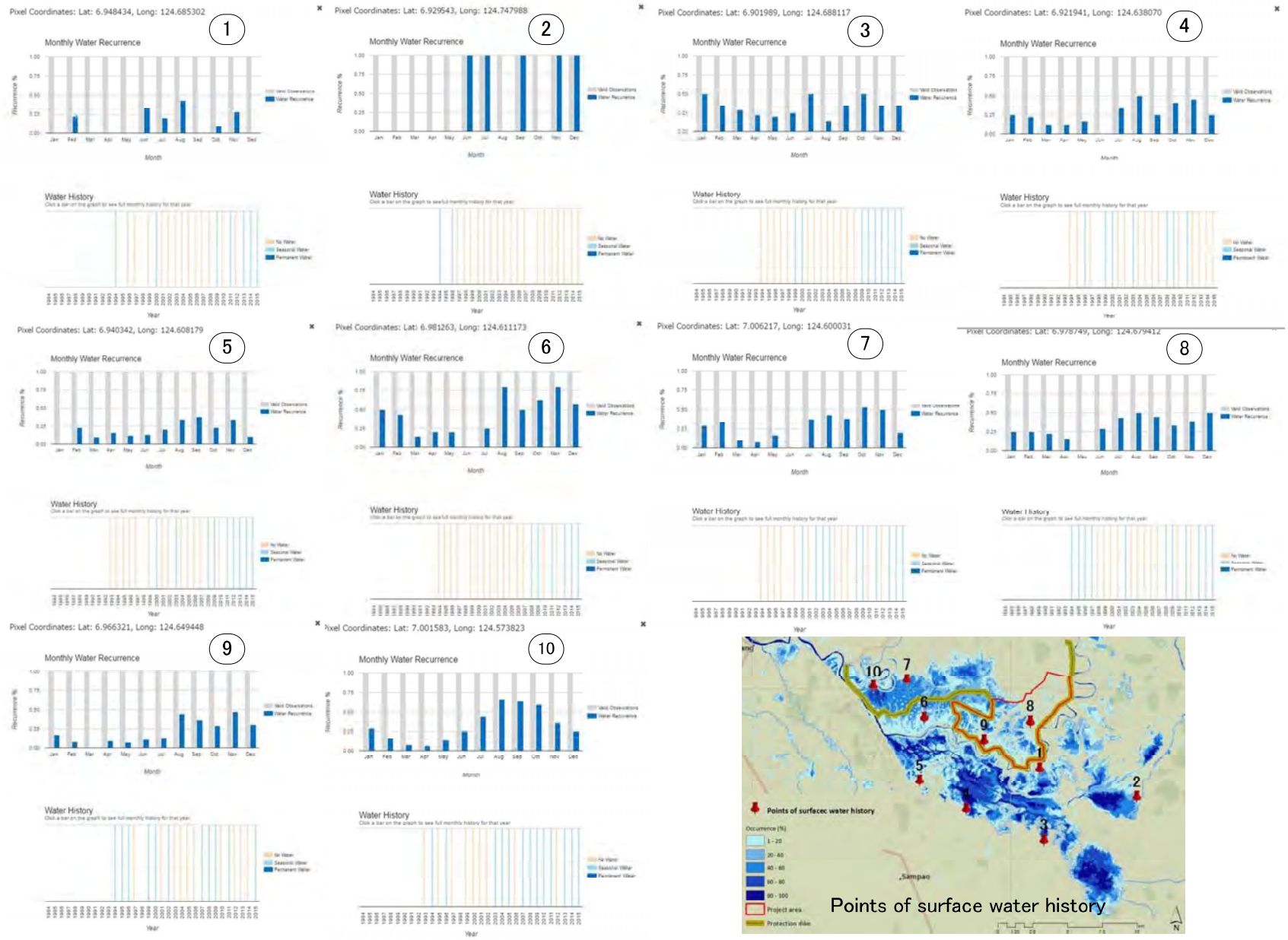
Source: High-resolution mapping of global surface water and its long-term changes(Jean-François Pekel et.al. ,Nature 540, 418–422,15 December 2016)

Map XI.1.20 Type of water transition of marsh area between the 1984 and 2015

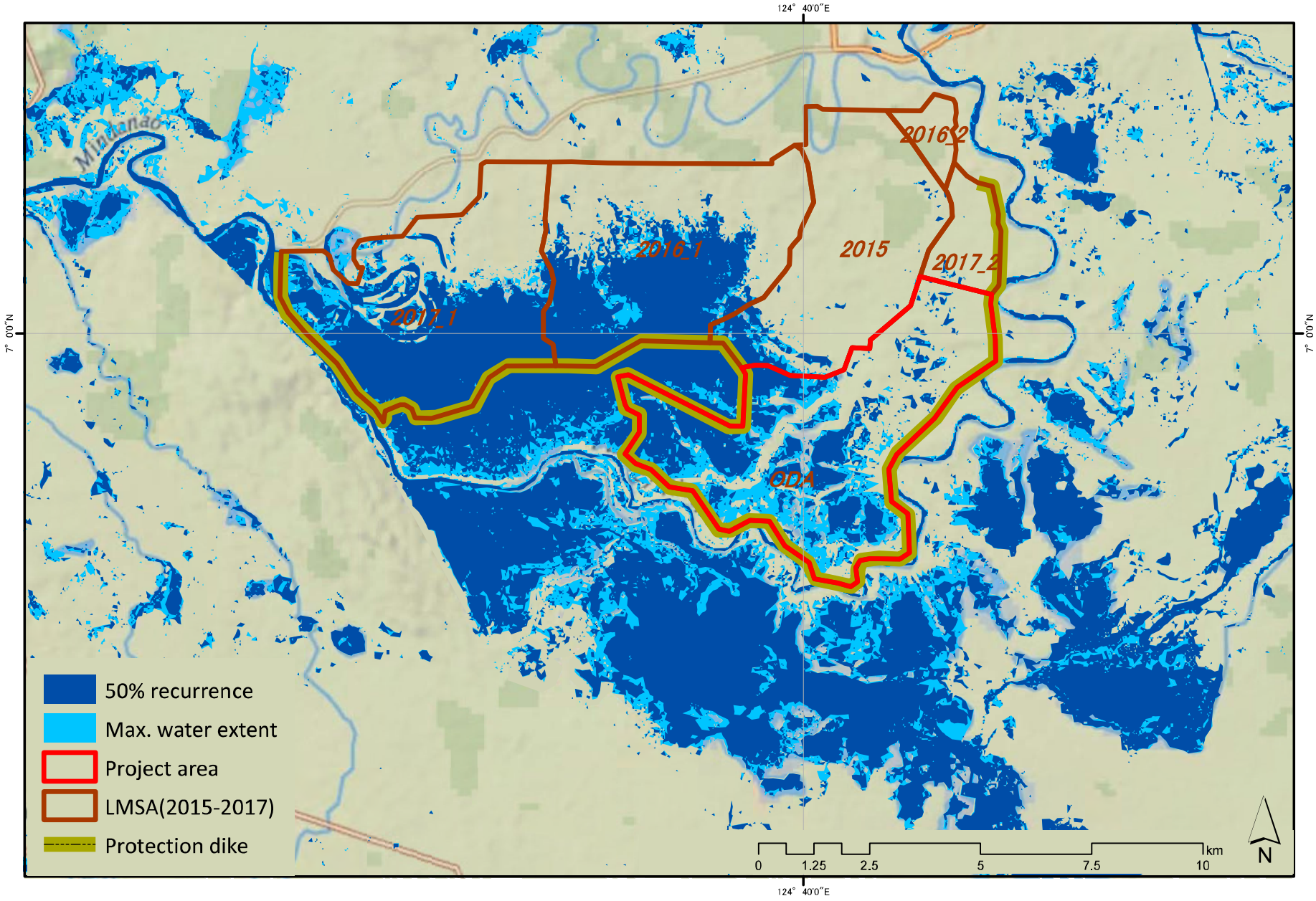


Source: High-resolution mapping of global surface water and its long-term changes(Jean-François Pekel et.al. ,Nature 540, 418–422,15 December 2016)

Map XI.1.21 Maximum water extent in long term period between 1984 and 2015



Map XI.1.22 History of water surface between 1984 and 2015



Source: High-resolution mapping of global surface water and its long-term changes(Jean-François Pekel et.al. ,Nature 540, 418–422,15 December 2016)

Map XI.1.23 Flood area and recurrence of annual behavior of water surface (1984-2014)