

CHAPTER 5. AQUATIC BIOLOGY

5.1 Fish

























 <i>Xenentodon canciloides</i> Freshwater garfish	 <i>Dermogenys siamensis</i>	 <i>Clupeichthys</i> sp. Sprat
 <i>Acanthopsoides</i> sp.	 <i>Pangio anguillaris</i> Loach	 <i>Pangio fusca</i> Loach
 <i>Pangio</i> sp. Loach	 <i>Barbonymus schwanefeldii</i> Tinfoil barb	 <i>Cirrhinus ornatipinnis</i> Mud carp
 <i>Cyclocheilichthys apogon</i> Beardless barb	 <i>Cyclocheilichthys armatus</i>	 <i>Cyclocheilichthys repasson</i> White eye barb
 <i>Esomus longimana</i> Mekong flying barb	 <i>Esomus metallicus</i> Flying Barb	 <i>Henicortyncus ornatipinnis</i> Mud carp
 <i>Henicortyncus siamensis</i> Siamese mud carp	 <i>Hypsibarbus wetmorei</i> Ray-finned fish	 <i>Hypsibarbus</i> sp. Ray-finned fish
 <i>Labeo chrysophekadion</i> Black shark	 <i>Labiobarbus leptocheila</i>	 <i>Labiobarbus</i> sp.
 <i>Osteochilus lini</i>	 <i>Parachela williaminae</i> Glass fish	 <i>Parachela</i> sp. Glass fish

Photo 5.1.1 Observed Fish Species (1/3)






















 <i>Puntius aurotaeniatus</i> Barb	 <i>Puntius brevis</i> Swamp barb	 <i>Puntius jacobusboehlkei</i> Barb
 <i>Puntius</i> sp.	 <i>Puntioplites falcifer</i> Sickle fin barb	 <i>Rasbora aurotaenia</i> Pale rasbora
 <i>Rasbora rubrodorsalis</i> Red-fin rasbora	 <i>Gambusia affinis</i> Mosquitofish	 <i>Poecilia reticulata</i> Guppy
 <i>Parambassis siamensis</i> Siamese glassperch	 <i>Anabus testudineus</i> Climbing perch	 <i>Anabus</i> sp.
 <i>Channa aff. marulius</i> Great snakehead	 <i>Chana striata</i> Striped snakehead	 <i>Oreochromis niloticus</i> Nile tilapia
 <i>Oxyeleotris marmorata</i> Marble goby	 <i>Pristolepis fasciata</i> Malayan leaffish	 <i>Trichogaster pectoralis</i> Snakeskin gourami
 <i>Trichogaster trichopterus</i> Three spot gourami	 <i>Trichogaster</i> sp.	 <i>Trichopsis vittata</i> Croaking gourami

Photo 5.1.2 Observed Fish Species (2/3)














 <i>Trichopsis</i> sp.	 <i>Akysis varius</i> Bearded catfishes	 <i>Hemibargus nemurus</i> Asian redbtail catfish
 <i>Mystus albolineatus</i> Striped catfish	 <i>Mystus atrifasciatus</i> Catfish	 <i>Mystus multiradiatus</i> Striped catfish
 <i>Mystus mysticetus</i> Catfish	 <i>Mystus</i> sp. Catfish	 <i>Claris</i> sp. Walking catfish
 <i>Ompok bimaculatus</i> Butter catfish	 <i>Macragnathus semiocellatus</i>	 <i>Macragnathus siamensis</i> Peacock eel
 <i>Macragnathus</i> sp.		

Photo 5.1.3 Observed Fish Species (3/3)

Table 5.1.2 List of Observed Fish (February, 2009)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Belontiiformes	Belontiidae	<i>Xenentodon canciloides</i>	ປາສີເບຣຽງ	Freshwater garfish										+
2	Clupeiformes	Clupeidae	<i>Clupeichthys aesarmensis</i>	ປາເຄາະ	Thai river sprat		+								+
3	Cypriniformes	Amplycipitidae	<i>Amblypharyngodon chulabhornae</i>	ປາຮາກກ້ອຍ	Princess carplet						+	+			
4		Cobitidae	<i>Acanthopsooides delphax</i>	ປາຮາກກ້ອຍ	Loach										+
5			<i>Acanthopsooides gracilentus</i>	ປາຮາກກ້ອຍ	Loach										+
6			<i>Acanthopsooides sp.</i>	ປາຮາກກ້ອຍ	Loach										+
7		Cyprinidae	<i>Cylocheilichthys sp.</i>	ປາຊີເບຣຽງ	Loach										+
8			<i>Esomus longimana</i>	ປາປັກ	Mekong flying barb						+	+			+
9			<i>Osteochilus salsburyi</i>	ປາຂາວຂົງສັດຕໍ່											
10			<i>Puntius aurotaeniatatus</i>	ປາຊີເບຣຽງ							+				
11			<i>Rasbora dussonensis</i>	ປາຊີເບຣຽງ	Rose fin rasbora										+
12			<i>Rasbora rubrodorsalis</i>	ປາຊີເບຣຽງ	Red fin rasbora										+
13	Cyprinodontiformes	Poeciliidae	<i>Poecilia reticulata</i>	ປາຫຼັງນ້ຳຮຽງ	Guppy		+	+				+			
14			<i>Gambusia affinis</i>	ປາບຸນ	Mosquitofish						+				
15	Perciformes	Cichlidae	<i>Oreochromis niloticus</i>	ປາບຸນ	Nile tilapia							+			
16		Gobiidae	<i>Gobiopterus chuno</i>	ປາບຸນ	Glass goby							+			
17		Osphronemidae	<i>Trichopsis vittata</i>	ປາບຸນ	Croaking gourami		+				+				
18			<i>Trichogaster trichopterus</i>	ປາກະເດີນສີຂຽວ	Three spot gourami		+								+
19	Siluriformes	Bagridae	<i>Mystus atrifasciatus</i>	ປາຂະເຍງ											
20		Siluridae	<i>Ompok bimaculatus</i>	ປາເຊັອມ	Butter catfish										+
Number of species						4	1	3	0	6	5	5	5	5	3

+ shows observed species.

Table 5.1.3 List of Observed Fish (March, 2009)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9	
1	Belontiiformes	Belontiidae	<i>Xenentodon cancilloides</i>	ບາລີຄອນໂປຍ	Freshwater garfish		+						+		+	
2	Cypriniformes	Balitoridae	<i>Homaloptera orihogoniata</i>	ບາລີຄອນໂປຍ	Loach											
3		Cobitidae	<i>Acanthopsoidea delphax</i>	ບາລີຄອນໂປຍ	Loach		+						+			
4			<i>Acanthopsoidea gracilentus</i>	ບາລີຄອນໂປຍ	Loach										+	
5		Cyprinidae	<i>Cylocheilichthys</i> sp.	ບາລີຄອນໂປຍ	Mekong flying barb			+			+					
6			<i>Esomus longimana</i>	ບາລີຄອນໂປຍ												
7			<i>Osteochilus salsburyi</i>	ບາລີຄອນໂປຍ												
8			<i>Parachela maculicauda</i>	ບາລີຄອນໂປຍ												
9			<i>Puntius brevis</i>	ບາລີຄອນໂປຍ	Swamp barb											
10			<i>Rasbora dasonensis</i>	ບາລີຄອນໂປຍ	Rosefin rasbora											
11			<i>Rasbora rubrodorsalis</i>	ບາລີຄອນໂປຍ	Red fin rasbora											
12	Cyprinodontiformes	Poeciliidae	<i>Poecilia reticulata</i>	ບາລີຄອນໂປຍ	Guppy		+	+								
13			<i>Gambusia affinis</i>	ບາລີຄອນໂປຍ	Mosquitofish											
14	Perciformes	Chandidae	<i>Parambassis wolffi</i>	ບາລີຄອນໂປຍ	Duskyfin glassy perchlet											
15		Cichlidae	<i>Oreochromis niloticus</i>	ບາລີຄອນໂປຍ	Nile tilapia											
16		Gerreidae	<i>Glossogobius intermedius</i>	ບາລີຄອນໂປຍ	Goby											
17		Osphronemidae	<i>Trichopsis pumila</i>	ບາລີຄອນໂປຍ	Pygmy gourami											
18			<i>Trichopsis vittata</i>	ບາລີຄອນໂປຍ	Croaking gourami											
19			<i>Trichogaster trichopterus</i>	ບາລີຄອນໂປຍ	Three spot gourami											
20	Siluriformes	Bagridae	<i>Mystus atrifasciatus</i>	ບາລີຄອນໂປຍ												
21	Synbranchiformes	Mastacembelidae	<i>Macrognathus</i> sp.	ບາລີຄອນໂປຍ												
Number of species							4	2	3	3	4	8	7	4	7	

+ shows observed species.

Table 5.1.4 List of Observed Fish (July, 2009)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B10	B11	B12	B13	B14				
1	Cypriniformes	Balitoridae	<i>Homaloptera yunnanensis</i>	ປາເລືອຍ	Loach								+										
2		Cobitidae	<i>Acanthopsooides delphax</i>	ປາອາກກອຍ	Loach		++						+										
3		Cyprinidae		<i>Cylocheilichthys apogon</i>	ປາອາກກອຍ	Beardless barb								+									
4				<i>Cylocheilichthys repasson</i>	ປາອາກກອຍ	Whiteeye barb								++									
5				<i>Esomus longimana</i>	ປາອາກກອຍ	Mekong flying barb								++									
6				<i>Esomus metallicus</i>	ປາອາກກອຍ	Flying barb								+++									
7				<i>Hemibarbus labeo</i>	ປາອາກກອຍ	Barbel steed								++									
8		<i>Henicorynchus siamensis</i>	ປາຂາອາກກອຍ	Siamese mud carp								+											
9		<i>Puntius aurotaeniatus</i>	ປາຂາອາກກອຍ	Swamp barb								+											
10		<i>Puntius brevis</i>	ປາຂາອາກກອຍ	Swamp barb								++											
11		<i>Puntius jacobusboehlei</i>	ປາຂາອາກກອຍ	Swamp barb								+											
12		<i>Puntius orphoides</i>	ປາຂາອາກກອຍ	Javaen barb																			
13		<i>Rasbora dusonensis</i>	ປາຂາອາກກອຍ	Rose fin rasbora																			
14		<i>Rasbora rubrodorsalis</i>	ປາຂາອາກກອຍ	Red fin rasbora																			
15	Cyprinodontiformes	Poeciliidae	<i>Gambusia affinis</i>	ປາສູນຂອງ	Mosquitofish			++					+										
16	Perciformes	Ambasidae	<i>Parabassus siamensis</i>	ປາສູນຂອງ	Siamese glassy perchlet									++									
17		Anabantidae	<i>Anabas testudineus</i>	ປາສູນຂອງ	Climbing perch									++									
18		Channidae	<i>Channa aff. marulius</i>	ປາສູນຂອງ	Great snakehead																		
19		Eleotridae	<i>Oxyeleotris marmorata</i>	ປາສູນຂອງ	Marble goby																		
20			<i>Nandus oxyrhynchus</i>	ປາສູນຂອງ	Leaf fish																		
21			<i>Pristolepis fasciata</i>	ປາສູນຂອງ	Catopa																		
22			<i>Trichogaster pectoralis</i>	ປາສູນຂອງ	Snakeskin gourami																		
23			<i>Trichogaster trichopterus</i>	ປາສູນຂອງ	Three spot gourami																		
24			<i>Trichopsis vittata</i>	ປາສູນຂອງ	Croaking gourami																		
25		Siluriformes		<i>Mystus mysticetus</i>	ປາສູນຂອງ	Blackskin catfish																	
26			<i>Claris meladerna</i>	ປາສູນຂອງ	Butter catfish																		
27			<i>Ompok bimaculatus</i>	ປາສູນຂອງ	Peacock eel																		
28	Synbranchiformes	Mastacembelidae	<i>Macrognathus siamensis</i>	ປາສູນຂອງ	Peacock eel																		
29				<i>Macrognathus sp.</i>	ປາສູນຂອງ	Peacock eel																	

Marks show observed individual numbers; +: 1-5, ++: 5-10, +++: >20, (+*): Dominant species)

Table 5.1.5 List of Observed Fish (December, 2009)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Clupeiformes	Clupeidae	<i>Clupeichthys</i> sp.	ບາງລາວ	Sprat									+	
2	Cypriniformes	Cobitidae	<i>Acanthopsoles</i> sp.	ບາງລາວ	Loach								++		+
3		Cobitidae	<i>Pangio fusca</i>	ບາງລາວ	Loach		+								
4		Cyprinidae	<i>Cyclocheilichthys armatus</i>	ບາງລາວ			+							+	
5			<i>Cyclocheilichthys repasson</i>	ບາງລາວ			+				+++				++
6			<i>Esomus metallicus</i>	ບາງລາວ	Flying barb		++				++				+
7			<i>Labio barbatus leptocheila</i>	ບາງລາວ										+	
8			<i>Osteochilus lini</i>	ບາງລາວ							+				+
9			<i>Puntius brevis</i>	ບາງລາວ	Swamp barb										
10			<i>Puntius</i> sp.	ບາງລາວ							+				
11			<i>Rasbora rubrodorsalis</i>	ບາງລາວ	Red fin rasbora						++				
12	Cyprinodontiformes	Poeciliidae	<i>Poecilia reticulata</i>	ບາງລາວ	Guppy				+++	+++					
13			<i>Gambusia affinis</i>	ບາງລາວ	Mosquitofish			+							
14	Perciformes	Ambasidae	<i>Parambassis siamensis</i>	ບາງລາວ	Siamese glassy perchlet								++		
15		Belontiidae	<i>Trichopsis vittata</i>	ບາງລາວ	Croaking gourami						+				
16		Eleotridae	<i>Oxyeleotris marmorata</i>	ບາງລາວ	Marble goby									+	
17		Nandidae	<i>Pristolepis fasciata</i>	ບາງລາວ	Malayan leaffish									+++	
18		Osphronemidae	<i>Trichogaster trichopterus</i>	ບາງລາວ	Three spot gourami						+			++	
19			<i>Trichogaster</i> sp.	ບາງລາວ							+			++	
20	Siluriformes	Bagridae	<i>Hemibagrus nemurus</i>	ບາງລາວ	Asian redtail catfish										+
21			<i>Mystus mysticetus</i>	ບາງລາວ											+
22	Synbranchiformes	Mastacembelidae	<i>Macrognathus</i> sp.	ບາງລາວ											++
			Number of species			3	0	2	1	8	0	4	10	6	

Marks show observed individual numbers; + : 1-5, ++: 5-10, +++: >20

Table 5.1.6 List of Observed Fish (January, 2010)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Belontiiformes	Belontiidae	<i>Xenentodon cancilloides</i>	ປາສະຕິຢີ	Freshwater garfish		+								
2	Cypriniformes	Cobitidae	<i>Acanthopsooides sp.</i>	ປາສາກກອຍ	Loach						+				++
3			<i>Pangio sp.</i>	ປາສວງ	Loach		+								+++
4			<i>Cylocheilichthys repasson</i>	ປາຊື່ອນອອດ	White eye barb										
5			<i>Esomus longimana</i>	ປາຊື່ອນອອດ	Mekong flying barb		+								+
6			<i>Hypsibarbus sp.</i>	ປາປຸງ	Ray-finned fish									+	+
7			<i>Labeo chrysophekadion</i>	ປາເພຍ	Black shark										+
8			<i>Labioibarbus sp.</i>	ປາເມງ										+	+
9			<i>Osteochilus lini</i>	ປາແຕ່ນ									+		+
10			<i>Parachela williaminae</i>	ປາສະທາງ										+++	+
11			<i>Puntiplites falcifer</i>	ປາອອກທູງທູງ	Sickle fin barb										+
12			<i>Puntius brevis</i>	ປາອອກທູງທູງ	Swamp barb		+++						++		
13			<i>Puntius aurotaeniatus</i>	ປາຊື່ອນອອດ							+				
14			<i>Rasbora rubrodorsalis</i>	ປາຊື່ອນອອດ	Red fin rasbora									++	+
15			<i>Rasbora sp.</i>	ປາຊື່ອນອອດ									+		+
16	Cyprinodontiformes	Poeciliidae	<i>Poecilia reticulata</i>	ປາທູງທູງ	Guppy			+++	+++	+++					
17	Perciformes	Ambassisidae	<i>Parambassis siamensis</i>	ປາຂຸບຂອງ	Siamese glassy perchlet						+++	++			++
18			<i>Trichopsis vittata</i>	ປາບູດ	Croaking gourami				+			++			
19		Osphronemidae	<i>Oreochromis niloticus</i>	ປາບູນ	Nile tilapia						+				
20		Nandidae	<i>Pristolepis fasciata</i>	ປາກາງ	Malayan leaffish									++	
21		Osphronemidae	<i>Trichogaster trichopterus</i>	ກະຕິຕາງ	Three spot gourami										+
22	Sluriformes	Bagridae	<i>Mystus sp.</i>	ປາເພຍ											+
23	Synbranchiformes	Mastacembelidae	<i>Macrognathus semiocellatus</i>	ປາຫຼັງ											+
			Number of species			4	1	2	1	4	3	2	5	14	

Marks show observed individual numbers; + : 1-5, ++: 5-10, +++: >20

Table 5.1.7 List of Observed Fish (February, 2010)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14					
1	Belontiiformes	Hemirhamphidae	<i>Dermogenys siamensis</i>	ບາງແກ່ງ																					
2	Cypriniformes	Cobitidae	<i>Acanthopsoxoides</i> sp.	ບາງແກ່ງ	Loach										++										
3			<i>Pangio anguillaris</i>	ບາງແກ່ງ																					
4		Cyprinidae	<i>Cyclocheilichthys apogon</i>	ບາງແກ່ງ	Beardless barb																				
5			<i>Cyclocheilichthys repasson</i>	ບາງແກ່ງ	White eye barb																				
6			<i>Esomus metallicus</i>	ບາງແກ່ງ	Flying barb																				
7			<i>Hemicorymbus siamensis</i>	ບາງແກ່ງ	Siamese mud carp																				
8			<i>Hypsibarbus wetmorei</i>	ບາງແກ່ງ																					
9			<i>Osteochilus lini</i>	ບາງແກ່ງ																					
10			<i>Puntius brevis</i>	ບາງແກ່ງ	Swamp barb																				
11	Cyprinodontiformes	Poeciliidae	<i>Poecilia reticulata</i>	ບາງແກ່ງ	Guppy			+++																	
12	Perciformes	Ambassidae	<i>Parambassis siamensis</i>	ບາງແກ່ງ	Siamese glassy perchlet																				
13		Anabantidae	<i>Anabas testudineus</i>	ບາງແກ່ງ	Climbing perch																				
14		Belontiidae	<i>Trichopsis vittata</i>	ບາງແກ່ງ	Croaking gourami																				
15		Channidae	<i>Channa striata</i>	ບາງແກ່ງ	Striped snakehead																				
16		Cichlidae	<i>Oreochromis niloticus</i>	ບາງແກ່ງ	Nile tilapia																				
17		Nandidae	<i>Pristolepis fasciata</i>	ບາງແກ່ງ	Malayan leaffish																				
18		Osphronemidae	<i>Trichogaster trichopterus</i>	ບາງແກ່ງ	Three spot gourami																				
19	Siluriformes	Siluridae	<i>Ompok bimaculatus</i>	ບາງແກ່ງ	Butter catfish																				
							0	1	1	1	1	5	0	5	3	7	3	5	6	2	1				
							Number of species																		

Marks show observed individual numbers; + : 1-5, ++ : 5-10, +++ : >20

Table 5.1.8 List of Observed Fish (August, 2010)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9		
1	Cypriniformes	Cobitidae Cyprinidae	<i>Acanthopsooides</i> sp.	ບາດຟິນໄຟ້ຍູ້	Dwarf hourseface												
2			<i>Barbonymus schwanenfeldtii</i>	ບາດຟິນໄຟ້ຍູ້	Timfoil barb											+	
3			<i>Cyclocheilichthys apogon</i>	ບາດຟິນໄຟ້ຍູ້	Beardless barb							+					
4			<i>Cyclocheilichthys repasson</i>	ບາດຟິນໄຟ້ຍູ້	White eye barb												+
5			<i>Esomus metallicus</i>	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Flying barb			+								
6			<i>Henicorhynchus siamensis</i>	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Siamese mud carp											
7			<i>Hypsibarbus</i> sp.	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Mekong barb											+
8			<i>Puntioptiles tateiifer</i>	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Sickle fin barb											+
9			<i>Puntius brevis</i>	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Swamp barb						+++					+
10			<i>Rasbora rubrodorsalis</i>	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Red-fin rasbora											+
11	Cyprinodontiformes	Poeciliidae	<i>Gambusia affinis</i>	ບາດຟິນໄຟ້ຍູ້	Mosquitofish		+++	+++		+++							
12			<i>Poecilia reticulata</i>	ບາດຟິນໄຟ້ຍູ້	Guppy		+++	+++			+++						
13	Perciformes	Ambassidae Anabantidae	<i>Parambassis siamensis</i>	ບາດຟິນໄຟ້ຍູ້	Siamese Glassperch										+		
14			<i>Anabus testudineus</i>	ບາດຟິນໄຟ້ຍູ້	Climbing perch											+++	
15			<i>Anabus</i> sp.	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້												+
16			<i>Channa striata</i>	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Striped snakehead											
17			<i>Oreochromis niloticus</i>	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Nile tilapia						+					
18	Nandidae	Osphronemidae	<i>Pristolepis fasciata</i>	ບາດຟິນໄຟ້ຍູ້	Malayan leaffish										+		
19			<i>Trichogaster trichopterus</i>	ບາດຟິນໄຟ້ຍູ້	Tree spot gourami							+++				+	
20			<i>Trichogaster pectoralis</i>	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Snakeskin gourami							+++				
21	Siluriformes	Bagridae	<i>Trichopsis</i> sp.	ບາດຟິນໄຟ້ຍູ້											+		
22			<i>Mystus multiradiatus</i>	ບາດຟິນໄຟ້ຍູ້	Striped catfish											+	
23			<i>Macrogonathus siamensis</i>	ບາດຟິນໄຟ້ຍູ້	ບາດຟິນໄຟ້ຍູ້	Peacock eel											
24	Synbranchiformes	Mastacembelidae	<i>Macrognathus</i> sp.	ບາດຟິນໄຟ້ຍູ້	Spiny eel										+		
Number of species						0	3	2	4	10	5	8	12	7			

Marks show observed individual numbers; + : 1-5, ++: 5-10, +++: >20

Table 5.1.9 List of Observed Fish (November, 2010)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9					
1	Belontiiformes	Belontiidae	<i>Xenentodon cancoides</i>	ນ້ຳສັບນ້ຳສັບ	Freshwater garfish		+									+				
2			<i>Xenentodon</i> sp.	ນ້ຳສັບນ້ຳສັບ																
3	Clupeiformes	Clupeidae	<i>Clupeichthys</i> sp.	ນ້ຳສັບນ້ຳສັບ	Sprat		+													
4			Cypriniformes	Cobitidae	<i>Acanthopsooides</i> sp.	ນ້ຳສັບນ້ຳສັບ	Dwarf hourse/face loach		+							+	+++			
5			<i>Pangio anguillar</i>	ນ້ຳສັບນ້ຳສັບ	Loach		+						+							
6			<i>Pangio fusca</i>	ນ້ຳສັບນ້ຳສັບ	Loach		+													
7			<i>Pangio</i> sp.	ນ້ຳສັບນ້ຳສັບ	Loach		+													
8		Cyprinidae	<i>Cirrhinus ornati</i>	ນ້ຳສັບນ້ຳສັບ	Mud carp					+							+			
9			<i>Cylocheilichthys repasson</i>	ນ້ຳສັບນ້ຳສັບ	White eye barb		+													
10			<i>Cylocheilichthys</i> sp.	ນ້ຳສັບນ້ຳສັບ	Barb		+													
11			<i>Esomus</i> sp.	ນ້ຳສັບນ້ຳສັບ			+													
12			<i>Henicorhynchus ornati</i>	ນ້ຳສັບນ້ຳສັບ	Mud carp		+											+		
13			<i>Labiobarbus leptocheila</i>	ນ້ຳສັບນ້ຳສັບ	Long fine carp													+		
14			<i>Osteochilus lini</i>	ນ້ຳສັບນ້ຳສັບ	Dusky face carp													+		
15			<i>Parachela</i> sp.	ນ້ຳສັບນ້ຳສັບ	Glass fish													+		
16			<i>Puntius brevis</i>	ນ້ຳສັບນ້ຳສັບ	Swamp barb								+++					+		
17			<i>Rasbora aurotaenia</i>	ນ້ຳສັບນ້ຳສັບ	Pale rasbora								+++					+		
18			Cyprinodontiformes	Poeciliidae	<i>Gambusia affinis</i>	ນ້ຳສັບນ້ຳສັບ	Mosquitofish				+									
19					<i>Poecilia reticulata</i>	ນ້ຳສັບນ້ຳສັບ	Guppy			++	++									
20			Perciformes	Ambasidae	<i>Parambassis siamensis</i>	ນ້ຳສັບນ້ຳສັບ	Siamese Glassperch												+	
21	Anabantidae	<i>Anabas testudineus</i>			ນ້ຳສັບນ້ຳສັບ	Climbing perch					+		+++							
22			<i>Anabus</i> sp.	ນ້ຳສັບນ້ຳສັບ																
23			Characidae	<i>Chana striata</i>	ນ້ຳສັບນ້ຳສັບ	Striped snakehead						+						+		
24			Cichlidae	<i>Oreochromis niloticus</i>	ນ້ຳສັບນ້ຳສັບ	Nile tilapia				+									+	
25			Nandidae	<i>Pristolepis fasciata</i>	ນ້ຳສັບນ້ຳສັບ	Malayan leaf fish								+					+	
26			Osphronemidae		<i>Trichogaster trichopterus</i>	ນ້ຳສັບນ້ຳສັບ	Tree spot gourami						+++	+++						
27					<i>Trichogaster pectoralis</i>	ນ້ຳສັບນ້ຳສັບ	Shakeskin gourami					+		+++	+++					
28					<i>Trichopsis</i> sp.	ນ້ຳສັບນ້ຳສັບ														
29					<i>Trichopsis vittata</i>	ນ້ຳສັບນ້ຳສັບ	Croaking gourami					+			+					
30					Siluriformes	Akysidae	<i>Akysis varitus</i>	ນ້ຳສັບນ້ຳສັບ	Bearded catfishes							+				+
31					<i>Myxus albolineatus</i>	ນ້ຳສັບນ້ຳສັບ	Striped catfish						+						+	
32	Clariidae	<i>Claris</i> sp.			ນ້ຳສັບນ້ຳສັບ	Walking catfish							+					+		
33	Siluridae	<i>Kryptopterus</i> sp.			ນ້ຳສັບນ້ຳສັບ	Sheatfishes												+		
34			<i>Ompok bimaculatus</i>	ນ້ຳສັບນ້ຳສັບ	Butter catfish												+			
35			<i>Ompok</i> sp.	ນ້ຳສັບນ້ຳສັບ			+											+		
36			Sybranciformes	Mastacembeleidae	<i>Macrogathus siamensis</i>	ນ້ຳສັບນ້ຳສັບ	Peacock eel											+		
37			<i>Macrogathus</i> sp.	ນ້ຳສັບນ້ຳສັບ													+			
						Number of species	12	1	4	3	8	7	3	12	9					

Marks show observed individual numbers; + : 1-5, ++: 5-10, +++: >20

5.2 Benthic Invertebrates







 <p><i>Lymnaea (Radix) auricularia</i></p>	 <p><i>Physella gyrina</i></p>	 <p><i>Indoplanorbis exustus</i></p>
 <p><i>Bithynia siamensis</i></p>	 <p><i>Pachydrobia sp.</i></p>	 <p><i>Pila pesmi</i></p>
 <p><i>Goniobasis livescens</i></p>	 <p><i>Ademietta bousei</i></p>	 <p><i>Ademietta sp.</i></p>
 <p><i>Melanoides sp.</i></p>	 <p><i>Thiara sp.</i></p>	 <p><i>Filopaludina sp.</i></p>
 <p><i>Idiopoma sp.</i></p>	 <p><i>Sinotaia ingallsiana</i></p>	 <p><i>Sinotaia sp.</i></p>

Photo 5.2.1 Collected / Observed Benthic Invertebrates (1/3)




 <p><i>Trochotaia trochoides</i></p>	 <p><i>Esisdens ingallsianus</i></p>	 <p><i>Corbicula</i> sp.</p>
 <p><i>Sphaerium simile</i></p>	 <p><i>Hirudo</i> sp.</p>	 <p>Aquatic earthworm</p>
 <p>Polychaeta</p>	 <p><i>Palaemonetes paludosus</i></p>	 <p>Parathelphusidae</p>
 <p><i>Hydrobiomorpha</i> sp.</p>	 <p><i>Stemolophus</i> sp.</p>	 <p><i>Chironomus tentans</i></p>
 <p><i>Procladius</i> sp.</p>	 <p>Culicidae</p>	 <p><i>Potamanthus</i> sp.</p>

Photo 5.2.2

Collected / Observed Benthic Invertebrates (2/3)







 <i>Belostoma</i> sp.	 <i>Diplonychus rusticus</i>	 <i>Hydometra</i> sp.
 <i>Cercotmetus</i> sp.	 <i>Ranatra</i> sp.	 <i>Anax junius</i>
 <i>Anax</i> sp.	 <i>Cercion</i> sp.	 <i>Cordulia</i> sp.
 <i>Epicordulia</i> sp.	 <i>Megalogomphus</i> sp.	 <i>Trigomphus</i> sp.
 <i>Lestes vigilax</i>	 Libellulidae	 <i>Protoneura</i> sp.
 <i>Protosma</i> sp.	 <i>Cheumatopsych pettiti</i>	 <i>Macrostemum</i> sp.

Photo 5.2.3 Collected / Observed Benthic Invertebrates (3/3)

Table 5.2.1 List of Benthic Invertebrates Collected through the Survey (Quantitative Sampling)

No.	Class	Order	Family	Scientific name	Common name	Location Survey point Group	Regular points					Additional points								
							Upstream			Urban area		Downstream		B10	B11	B12	B13	B14		
							B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14
1	Castropoda	Archaeogastropoda	Hydroscandae	<i>Crezarsia</i> sp.	Snail		0.4													
2		Bassomatophora	Lymnaeidae	<i>Lymnaea</i> sp.	Snail		2.9													
3			Physidae	<i>Physella gyrina</i>	Snail		12.8	6.6	1.0	0.3	0.1	0.1	8.0	1.6						15.5
4			Planorbidae	<i>Gyrionis deflexus</i>	Snail		0.6													0.5
5				<i>Indoplanorbis exustus</i>	Red ramshorn		12.0													
6		Mesogastropoda	Bithyniidae	<i>Bithynia stamensis</i>	Snail		3.4					16.9	3.1	0.6		7.5	23.0	23.0		1.5
7			Hydrobiidae	<i>Pachydrobia</i> sp.	Snail		0.4													
8				<i>Paracrostoma</i> sp.	Snail															79.5
9			Pilidae	<i>Pila pesm</i>	Snail		0.3					5.5	0.9	1.0	0.3	10.0	1.5	4.0	12.0	
10			Pleuroceridae	<i>Goniobasis livescens</i>	Snail		9.1	33.3	0.5	1.3	0.5	1.3	0.5	0.6		2.5	2.5	2.0		
11			Thiaridae	<i>Admetia bausei</i>	Snail		0.5							0.9						2.0
12				<i>Admetia</i> sp.	Snail		4.5						2.9	2.0						
13				<i>Melanoides</i> sp.	Snail		12.3						5.6							
14				<i>Thiara</i> sp.	Snail		0.4													23.5
15			Viviparidae	<i>Filopaludina</i> sp.	Snail		4.3					11.4	0.4			1.5				3.5
16				<i>Idiopoma</i> sp.	Snail		7.3					6.0	0.5			2.5	6.5	6.0		2.0
17				<i>Mekongia pongensis</i>	Snail			38.8	0.8	1.6		5.6								
18				<i>Sinoaita ingalstana</i>	Snail															
19				<i>Sinoaita</i> sp.	Snail															
20				<i>Trochotata trachoides</i>	Snail							0.3	0.8	1.5	18.6	1.0	3.5	1.0		12.0
21		Stylomatophora	Eradomiridae	<i>Philolanka</i> sp.	Snail															
22			Sublimidae	<i>Opeas</i> sp.	Snail															
23	Bivalvia	Unionoida	Amblymidae	<i>Erismdens ingalstana</i>	Mussel	B-II	2.0	0.1												3.5
24			Unionidae	<i>Anodonta cygnea</i>	Mussel	B-III														
25		Veneroida	Corbiculidae	<i>Corbicula</i> sp.	Clam	B-II	0.4	0.3					0.4	1.4	2.4					4.5
26			Sphaeriidae	<i>Sphaerium simile</i>	Clam			0.1												
27	Polychaeta	(unknown)	(unknown)	(unknown)	Worm		0.1													
28	Oligochaeta	(unknown)	(unknown)	<i>Aquatic earthworm</i>	Aquatic earthworm		5.5	4.3				394.3	10.0	1.8						1176.5
29	Crustacea	Decapoda	Palaeomonidae	<i>Palaeomonetes patidus</i>	Giant shrimp		0.1	3.4												
30			Paratropididae	(unknown)	Crab															
31	Insecta	Coleoptera	Hydrophilidae	<i>Hydrobiomorpha</i> sp.	Water scavenger beetle	B-I	5.1	3.8	1617.5	516.9		66.3	4.9	1.4	2.0	60.5				17.5
32		Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm	B-I		107.8	109.0	50.6							8.5			
33			Culicidae	<i>Culiseta</i> sp.	Mosquito	B-I		2.1	0.6	1.5										
34			Psychodidae	<i>Pericoma</i> sp.	Moth fly	B-I		1.5												
35			Simuliidae	<i>Simulium venustum</i>	Black fly	B-I		1.1	0.5	232.5										
36			Stratiomyidae	<i>Euparyphus</i> sp.	Soldier fly			0.1												1.7
37			Syrphidae	<i>Eristalis tenax</i>	Hoverfly															
38				<i>Uria</i> sp.	Cray fly															
39				<i>Uria</i> sp.	Cray fly															
40				<i>Uria</i> sp.	Cray fly															
41	Ephemeroptera		Belontiidae	<i>Belantsea</i> sp.	Mayfly															
42			Potamanthidae	<i>Potamanthus</i> sp.	Mayfly								0.1							
43				<i>Pteroparides albimaculatus</i>	Mayfly	B-II	1.0													0.4
44	Hemiptera		Naucoridae	<i>Petocoris</i> sp.	Creeping water bugs	B-II						0.1	0.6	0.4						1.5
45				<i>Petocoris</i> sp.	Water scorpions	B-II														
46				<i>Kanatra</i> sp.	Water stick insect															
47			Notonectidae	<i>Notonecta unifasciata</i>	Backswimmers			0.1												
48			Aeshnidae	<i>Anax junius</i>	Green darner (Dragonfly)	B-II	0.4													1.5
49				<i>Anax</i> sp.	Dragonfly															
50			Calopterygidae	<i>Matrona</i> sp.	Broad-winged damselfly	B-II			0.5											
51				<i>Epicoeridia</i> sp.	Dragonfly	B-II														0.4
52			Corduliidae	<i>Ictinogomphus</i> sp.	Clubtail dragonfly		0.1													
53			Gomphidae	<i>Megalogomphus</i> sp.	Clubtail dragonfly		0.4													
54				<i>Lestes vigilax</i>	Swamp spreadwing (Damselfly)								0.1							
55			Libellulidae	(unknown)	Dragonfly		1.6													
56			Macronemidae	<i>Macromia macrifica</i>	Western river cruiser (Dragonfly)		0.1													
57	Trichoptera		Hydropsychidae	<i>Cheimatopsych petiti</i>	Caddis fly	B-III														125.3
58				<i>Macrostemum</i> sp.	Caddis fly	B-III														40.0
							23	15	11	22	14	14	15	18	13	8	5	13	8	4

Notes) 1. Values in the table show the average density through the survey (number of individuals/0.25m²).
2. Group (B-I, III and III) is for indicating water quality.

Table 5.2.2 List of Benthic Invertebrates Observed through the Survey (Qualitative Observation)

No.	Class	Order	Family	Scientific name	Common name	Location Survey point Group	Regular points										Additional points				
							Upperstream			Urban area				Downstream			B10	B11	B12	B13	B14
							B1	B2	B3	B4	B6	B7	B8	B9							
1	Gastropoda	Basommatophora	Lymnaeidae	<i>Lymnaea (Radix) auricularia</i>	Snail																
2			Physidae	<i>Physella gyrina</i>	Snail		2	2	2												
3			Planorbidae	<i>Gyrorus deflectus</i>	Snail																
4				<i>Indoplanorbis exustus</i>	Red ramshorn		2														
5	Mesogastropoda		Brithyniidae	<i>Brithynia siamensis</i>	Snail		4	5			1	1	1								
6			Pilidae	<i>Pila pesmi</i>	Snail		5	5	2	4	6	6	4	2	1	2	2	2	2		
7			Pleuroceridae	<i>Goniobasis fivescens</i>	Snail		3	5			2	1	1								
8			Thiaridae	<i>Ademietta bousei</i>	Snail		4				1	1	1								
9				<i>Melanoides</i> sp.	Snail		2					2	2								
10				<i>Thiara</i> sp.	Snail		1														
11			Viviparidae	<i>Filopaludina</i> sp.	Snail		4	6	1		2	6	4	1	2						
12				<i>Idiopoma</i> sp.	Snail		5				2	2	2	2	1	2	2	1			
13				<i>Trochoaia trochoides</i>	Snail																
14				<i>Ensisia ingalstianus</i>	Mussel	B-II															
15	Bivalvia	Unionoidea	Amblemidae	<i>Physunio eximus</i>	Mussel																
16				<i>Corbicula</i> sp.	Clam	B-II	1	3	1			1	2								
17		Veneroidea	Corbiculidae	<i>Hirudo</i> sp.	Leech																
18	Hirudinea	Arhynchobdellia	Hirudimidae	(unknown)	Aquatic earthworm																
19	Oligochaeta	(unknown)	(unknown)	<i>Palaemonetes paltidosus</i>	Ghost shrimp		4	6	1	1	3	4	5	5	1						
20	Crustacea	Decapoda	Parahelphusidae	(unknown)	Crab		2	3	1												
21	Insecta	Coleoptera	Hydrophilidae	<i>Stenolophus</i> sp.	Water scavenger beetle		1														
22			Chironomidae	<i>Chironomus tentans</i>	Blood worm																
23				<i>Procladius</i> sp.	Blood worm	B-I	3	3	3		1	2									
24				Culicidae	Mosquito	B-I	2	2	1												
25				Culicidae	Mosquito	B-I															
26		Hemiptera	Belostomatidae	<i>Belostoma</i> sp.	Water bug		1														
27				<i>Diplomachus rusticus</i>	Water bug		1														
28			Hydrometridae	<i>Hydometra</i> sp.	Marsh treader		1														
29			Naucoridae	<i>Pelocoris</i> sp.	Creeping waterbug		1														
30			Nepidae	<i>Cercomatus</i> sp.	Water scorpion	B-II	2														
31			Aeshnidae	<i>Anax</i> sp.	Dragonfly		2														
32			Coenagrionidae	<i>Cercion</i> sp.	Damselfly		1														
33			Corduliidae	<i>Cordulia</i> sp.	Dragon fly		1														
34				<i>Epicordulia</i> sp.	Dragonfly	B-II															
35			Gomphidae	<i>Trigomphus</i> sp.	Clubtail dragonfly																
36			Lestidae	<i>Lestes vigilax</i>	Swamp spreading (Damselfly)		1														
37			Libellulidae	(unknown)	Dragonfly		1														
38			Protoneuridae	<i>Protoneura</i> sp.	Damselfly		1														
39				<i>Protosma</i> sp.	Damselfly		1														
40		Tricoptera	Hydropsychidae	<i>Macrostemum</i> sp.	Caddisfly	B-III															
				Number of species				23	13	8	12	14	9	12	18	12	9	7	8	8	9

Notes) 1. Values in the table show frequency of which the species was observed.
2. Group (B-I, II and III) is for indicating water quality.

Table 5.2.3 Results of Quantitative Sampling of Benthic Invertebrates (February, 2009)

No.	Class	Order	Family	Scientific name	Common name	B1		B2		B3		B4		B5		B6		B7		B8		B9	
						ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.
1	Gastropoda	Archaeogastropoda	Hydroceiidae	<i>Georissa</i> sp.	Snail									3	0.39								
2		Basommatophora	Physidae	<i>Physella gyrina</i>	Snail	33	2.32	7	0.28	4	0.30					1	0.23	7	0.49				
3			Planorbidae	<i>Gyraulus deflectus</i>	Snail					1	0.64												
4		Mesogastropoda	Pleuroceridae	<i>Gontobasis lvescens</i>	Snail	4	0.10	136	69.40	2	0.19	1	0.44										
5			Viviparidae	<i>Sinotata ingallsiana</i>	Snail			150	39.17	3	1.01	7	0.63			15	9.08					1	2.29
6			Endodontidae	<i>Mekongia pongensis</i>	Snail																		
7			Stylommatophora	<i>Philolanka</i> sp.	Snail													1	0.11				
8			Subulinidae	<i>Oppeas</i> sp.	Snail																2	1.24	
9	Bivalvia	Unionoidea	Unionidae	<i>Anodonta cygnea</i>	Mussel																	2	38.77
10			Amblemidae	<i>Ensidens ingallsianus</i>	Mussel									6	55.20							1	7.51
11		Veneroidea	Sphaeriidae	<i>Sphaerium simile</i>	Clam			1	1.08														
12	Oligochaeta	(unknown)	(unknown)	Aquatic earthworm				1	0.01	215	0.13	106	0.25	9	0.05	36	0.63	6	0.05				
13	Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm	8	0.02	1740	9.46	2763	14.00	783	6.70			14	0.04	10	0.03	6	0.01	6	0.03
14				<i>Procladius</i> sp.	Blood worm			67	0.33	93	0.05	38	0.23										
15			Psychodidae	<i>Pericoma</i> sp.	Moth fly			4	0.01														
16				<i>Psychoda alternata</i>	Moth fly			5	0.02	2	0.01												
17			Culicidae	Culicidae	Mosquito			4	0.01			2	0.01										
18			Syrphidae	<i>Eristalis tenax</i>	Hoverfly							4	0.32										
19			Tipulidae	<i>Tipula</i> sp.	Crane fly							3	0.04										
20			Simuliidae	<i>Simulium venustum</i>	Black fly																	4	0.03
21		Ephemeroptera	Tricorythidae	<i>Tricorythodes albilineatus</i>	Mayfly	4	0.01															2	0.02
22		Trichoptera	Hydropsychidae	<i>Cheumatopsyche petiti</i>	Caddis fly																	437	12.55
Number of species						4		10		8		8		3		4		4		2		7	
Total						49	2.45	2115	119.77	3083	16.33	944	8.62	18	55.64	66	9.98	24	0.68	8	1.25	453	61.20

ind.: number of individuals (0.25m²)
w.w. wet weight (g/0.25m²)
sampling date: 13-15/Feb./2009

Sampling methodology: Collection using quadrat (50cm × 50cm) and sieve (mesh size 0.5mm) .

Table 5.2.4 Results of Quantitative Sampling of Benthic Invertebrates (March, 2009)

ind.: number of individuals (0.25m²)
w.w. wet weight (g/0.25m²)
sampling date: 21-22/Mar./2009

No.	Class	Order	Family	Scientific name	Common name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
						ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.
1	Gastropoda	Basommatophora	Physidae	<i>Physella gyrina</i>	Snail	40	2.35	4	0.14	4	0.30		57	0.44	
2		Mesogastropoda	Pleuroceridae	<i>Goniobasis livescens</i>	Snail	2	0.05	130	69.01	2	0.19	3	1.03		
3			Viviparidae	<i>Mekongia pongensis</i>	Snail					6	0.62				
4				<i>Sinotata ingallsiana</i>	Snail			160	39.19	3	1.01	15	9.05		
5	Bivalvia	Stylommatophora	Subulinidae	<i>Opeas</i> sp.	Snail									3	1.20
6			Unionidae	<i>Anodonta cygnea</i>	Mussel										
7			Amblemidae	<i>Ensisides ingallsianus</i>	Mussel						3	25.10			1
8	Oligochaeta	(unknown)	(unknown)	(unknown)	Aquatic earthworm					200	0.11	38	0.64		
9	Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm	8	0.02	1620	9.20	2750	13.05	710	6.50	10	0.03
10				<i>Procladius</i> sp.	Blood worm			65	0.31	85	0.03	40	0.23		
11				<i>Pericoma</i> sp.	Moth fly			8	0.02						
12				<i>Psychoda alternata</i>	Moth fly			3	0.01	2	0.01				
13				(unknown)	Mosquito			4	0.01			10	0.10		
14				<i>Tipula</i> sp.	Crane fly							3	0.04		
15				<i>Simulium venustum</i>	Black fly										
16	Ephemeroptera		Tricorythidae	<i>Tricorythodes albilineatus</i>	Mayfly	4	0.01								8
17	Trichoptera		Hydropsychidae	<i>Cheumatopsyche peititi</i>	Caddis fly										1
18	Odonata		Gomphidae	<i>Ictinogomphus</i> sp.	Clubtail dragonfly					1	0.02				440
19		Odonata (Zygoptera)	Calopterygidae	<i>Matrona</i> sp.	Broad-winged damselfly					4	0.04				
				Number of species		4		8		9		7		2	
				Total		54	2.43	1994	117.89	3051	14.76	882	8.78	8	25.13
				Collection using quadrat (50cm × 50cm) and seine (mesh size 0.5mm).								63	9.72	8	1.22
												80	0.55	8	458
														2	31.38

Table 5.2.5 Results of Quantitative Sampling of Benthic Invertebrates (July, 2009)

ind.: number of individuals (0.25m²)
w.w. wet weight (g/0.25m²)
sampling date: 15-17/July/2009

No	Class	Order	Family	Scientific name	Common name	St	B1	B2	B3	B4	B5	B6	B7	B8	B10	B11	B12	B13	B14													
							ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.												
1	Gastropoda		Physidae	<i>Physella gyrina</i>	Snail		28	0.03	42	3.70																						
2			Planorbidae	<i>Gyrovus deflexus</i>	Snail							2	0.73																			
3				<i>Indoplanorbis exustus</i>	Red ramshorn																											
4		Mesogastropoda		<i>Bithynia stamensis</i>	Snail		11	0.70																								
5			Pilidae	<i>Pila pexmi</i>	Snail		96	12.53	27	2.52	55	7.85	7	0.91	5	0.46	15	2.56	46	5.02	3	0.52										
6			Pleuroceridae	<i>Gonobasis foveolens</i>	Snail		4	10.41				8	29.21	2	0.58	20	24.25	3	11.64	8	60.37	20	88.12									
7			Thiaridae	<i>Adamieta bousei</i>	Snail		38	4.27			73	10.90	10	1.33	4	0.52	5	1.06	5	0.39	4	0.50										
8			Viviparidae	<i>Filopaludina sp.</i>	Snail		4	2.32			13	6.32	7	1.96																		
9				<i>Filopaludina sp.</i>	Snail		28	16.72			4	0.45	33	36.58			4	5.60	5	6.32	13	20.98	12	33.16	4	0.88						
10				<i>Trochanta trochoides</i>	Snail					3	1.64	12	21.09	7	12.42	3	7.16															
11				<i>Sinotia ingalsiana</i>	Snail		2	6.45																								
12	Bivalvia	Venerida	Corbiculidae	<i>Corbicula sp.</i>	Clam							9	6.46																			
13		Unionida	Amblemidae	<i>Ensidens ingalsianus</i>	Mussel							1	5.41																			
14	Oligochaeta	(unknown)	(unknown)	(unknown)	Aquatic earthworm		44	0.07	40	0.10	28.53	1.71	2370	8.32	20	0.03	6	0.01														
15	Crustacea	Decapoda	Paralichnidae	<i>Palaeomonetes paltalosis</i>	Ghost shrimp							4	0.03	13	1.12	1	0.17	13	5.92	5	1.20											
16				(unknown)	Crab																											
17	Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm		10	0.03	1516	2.73	243	0.61			18	0.45	12	0.02														
18				<i>Procladius sp.</i>	Blood worm																											
19				<i>Psychoda alternata</i>	Moth fly							30	2.05																			
20				<i>Euaerophus sp.</i>	Soldier fly							1	0.01																			
21				<i>Culex sp.</i>	Mosquito							9	0.03	5	0.01																	
22		Odonata	Macromiidae	<i>Macromia magnifica</i>	Western river cruiser (Dragonfly)																											
24			Aeshidae	<i>Anax junius</i>	Green darner (Dragonfly)																											
25			Lestidae	<i>Lestes vigilax</i>	Swamp spreadwing (Damselfly)																											
26			Corduliidae	<i>Epicordulia sp.</i>	Dragonfly																											
27		Ephemeroptera	Baetidae	<i>Baetis sp.</i>	Mayfly																											
28		Hemiptera	Naucoridae	<i>Pelocoris sp.</i>	Creeper water bugs																											
29			Notonectidae	<i>Notonecta unifasciata</i>	Backswimmers																											
30			Neptidae	<i>Cercomantis sp.</i>	Water scorpions																											
					Number of species		12		7		3	15	8	11	6	5	11	6	7	1												
					Total		171	38.13	1610	6.59	3101	2.33	4398	53.59	173	47.98	154	98.43	29	15.09	51	30.05	47	37.08	74	42.50	123	183.24	41	97.11	2353	20.53

Sampling methodology: Collection using quadrat (50cm × 50cm) or grab sampler and sieve (mesh size 0.5mm).

Table 5.2.6 List of Qualitatively Observed Invertebrates (July, 2009)

Survey date: 15-17/July/2009

No.	Class	Order	Family	Scientific name	Common name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14						
1	Gastropoda	Basommatophora	Physidae	<i>Physella gyrina</i>	Snail		+	++	+					+							+					
2			Planorbidae	<i>Gyrorus deflectus</i>	Snail											+										
3					<i>Indoplanorbis exustus</i>	Red ramshorn					+															
4	Mesogastropoda		Bithyniidae	<i>Bithynia siamensis</i>	Snail		+	+	++	++	+++	+++	+++	++	+	++	++	++	++	++	++	+				
5			Pilidae	<i>Pila pesmi</i>	Snail		+	+	+	+	+	+++	+++	+++	++	+	+	+	+	+	+	+	++			
6			Thiaridae	<i>Ademietta housei</i>	Snail		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
7			Viviparidae		<i>Idiopoma</i> sp.	Snail		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
8					<i>Filopaludina</i> sp.	Snail							++	+	+	+	+	+	+	+	+	+	+	+	+	
9					<i>Trochotata trochooides</i>	Snail													+	+	+	+	+	+	+	+
10					Neotaenioglossa	Pleuroceridae	<i>Goniobasis livescens</i>	Snail		+			+	++	++	++	++	+								
11	Bivalvia	Unionoidea	Amblemidae	<i>Ensidens ingallsianus</i>	Mussel									+												
12	Crustacea	Decapoda	Palaeomonidae	<i>Palaeomonetes paltodosus</i>	Ghost shrimp		++	+	+	+	++	+	++	+	+	+	+	+	+	+	+	+				
13			Parathelphusidae	<i>Parathelphusidae</i>	Crab									+	+											
14			Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm																			
15	Hemiptera	Odonata	Corduliidae	<i>Epicordulia</i> sp.	Dragonfly																					
16			Naucoridae	<i>Pelocoris</i> sp.	Creeping water bugs																					
17			Nepidae	<i>Cercozetes</i> sp.	Water scorpions																					
							8	4	3	8	4	6	7	11	2	5	5	8	5	8	5	3				
						Number of species																				

Approximate number of individuals observed during the survey.
+: 1-5, ++: 5-10, +++: >20

Table 5.2.7 Results of Quantitative Sampling of Benthic Invertebrates (December, 2009)

ind.: number of individuals (0.25m²)
w.w. wet weight (g/0.25m²)
sampling date: 21-22/Dec./2009

No.	Class	Order	Family	Scientific name	Common name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9									
							ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.								
1	Gastropoda	Basommatophora	Physidae	<i>Physella gyrina</i>	Snail		1	0.28																
2		Mesogastropoda	Bithyniidae	<i>Bithynia siamensis</i>	Snail		24	40.25				48	14.66											
3			Hydrobiidae	<i>Pachydrobia</i> sp.	Snail					3	1.70													
4			Pilidae	<i>Pila pesoni</i>	Snail							4	5.90	2	20.85									
5			Pleuroceridae	<i>Gontobasis lveccens</i>	Snail		29	6.51																
6			Thiaridae	<i>Ademittia bousei</i>	Snail					2	0.12													
7				<i>Melanoides</i> sp.	Snail						32	3.44												
8			Viviparidae	<i>Filopaludina</i> sp.	Snail							39	72.21											
9				<i>Idiapoma</i> sp.	Snail							9	28.78											
10				<i>Sinoaita</i> sp.	Snail										87	128.38								
11				<i>Trochataia trochoides</i>	Snail							6	1.80											
12	Bivalvia	Veneroidea	Corbiculidae	<i>Corbicula</i> sp.	Clam		1	1.01			4	3.02												
13			Sphaeriidae	<i>Sphaerium simile</i>	Clam								568	2.38										
14	Oligochaeta	(unknown)	(unknown)	(unknown)	Aquatic earthworm																			
15	Crustacea	Decapoda	Palaeomonidae	<i>Palaeomonetes paltadosus</i>	Ghost shrimp		1	0.46																
16			Parathelphusidae	(unknown)	Crab		1	0.23																
17	Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Bloodworm			3256	36.64	562	21.05	268	2.30	5	0.02									
18				<i>Procladius</i> sp.	Bloodworm			253	16.45	127	12.08	15	0.13											
19	Ephemeroptera		Potamanthidae	<i>Potamanthus</i> sp.	Mayfly										1	0.01								
20	Odonata		Aeshidae	<i>Anax junius</i>	Green darner (Dragonfly)																			
21			Lestidae	<i>Lestes vigilax</i>	Swamp spreadwing (Damselfly)		3	0.45																
22	Tricoptera		Hydropsychidae	<i>Macrostemum</i> sp.	Caddis fly											15	2.26							
				Number of species			8	2	2	2	3	5	2	4	4	1								
				Total			61	49.71	3509	53.09	689	33.13	853	4.93	39	8.16	106	123.35	6	0.03	98	216.03	15	2.26

Sampling methodology: Collection using quadrat (50cm × 50cm) and sieve (mesh size 0.5mm) .

Table 5.2.8 List of Qualitatively Observed Invertebrates (December, 2009)

Survey date: 21-22/Dec./2009

No.	Class	Order	Family	Scientific name	Common name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Gastropoda	Basommatophora	Physidae	<i>Physella gyrina</i>	Snail		++								
2		Mesogastropoda	Bithyniidae	<i>Bithynia siamensis</i>	Snail		++				+++				
3			Pilidae	<i>Pila pesmi</i>	Snail						+	++	++		
4			Pleuroceridae	<i>Goniobasis livescens</i>	Snail						++				
5			Thiaridae	<i>Ademietta bousei</i>	Snail		++								
6				<i>Melanoides</i> sp.	Snail								++		
7				<i>Filopaludina</i> sp.	Snail		+++				+++		+++		
8			Viviparidae	<i>Idiopoma</i> sp.	Snail										++
9				<i>Trochotata trochoides</i>	Snail										+++
10	Bivalvia	Unionoidea	Amblemidae	<i>Ensidens ingallsianus</i>	Mussel									+++	
11		Veneroidea	Corbiculidae	<i>Corbicula</i> sp.	Clam		+						+		
12	Crustacea	Decapoda	Palaeomonidae	<i>Palaeomonetes paltudosus</i>	Ghost shrimp		+++				++				
13			Parathephusidae	<i>Parathephusidae</i>	Crab		+				+		+	+++	
14	Insecta	Hemiptera	Nepidae	<i>Cercozetus</i> sp.	Water scorpion		+								
15		Tricoptera	Hydropsychidae	<i>Macrostemum</i> sp.	Caddis fly										+++
					Number of species		8	0	0	0	6	1	5	3	3

Approximate number of individuals observed during the survey.

+: 1-5, ++: 5-10, +++: >20

Table 5.2.9 Results of Quantitative Sampling of Benthic Invertebrates (January, 2010)

ind.: number of individuals (0.25m²)
w.w. wet weight (g/0.25m²)
sampling date: 26-27/Jan./2010

No.	Class	Order	Family	Scientific name	Common name	St.		B1		B2		B3		B4		B5		B6		B7		B8		B9			
						ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.
1	Gastropoda	Basommatophora	Planorbidae	<i>Indoplanorbis exustus</i>	Red ramshorn	6	15.07																				
2	Mesogastropoda		Bithyniidae	<i>Bithynia stamensis</i>	Snail																						
3			Pilidae	<i>Pila plesni</i>	Snail																						
4			Thaeridae	<i>Ademieta</i> sp.	Snail																						
5						<i>Melanoides</i> sp.	Snail	48	25.46	2	0.09																
6						<i>Thiara</i> sp.	Snail																				
7						<i>Filopaludina</i> sp.	Snail	34	54.37																		
8						<i>Sinotata</i> sp.	Snail																				
9			Bivalvia	Unionoida	Amblemidae	<i>Ensisidens ingallsianus</i>	Mussel			1	0.02																
10	Oligochaeta		Veneroida	<i>Corbicula</i> sp.	Clam			2	0.12																		
11			(unknown)	(unknown)	Aquatic earthworm				5	0.01	58	2.24															
12			Decapoda	<i>Palaemonetes paludosus</i>	Ghost shrimp																						
13	Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm			32	0.28	312	5.06	429	6.04														
14			Chironomidae	<i>Procladius</i> sp.	Blood worm				3	0.01	254	4.03	163	2.54													
15	Hemiptera	Trioptera	Nepidae	<i>Ranatra</i> sp.	Water stick insect																						
16			Hydropsychidae	<i>Macrostremum</i> sp.	Caddis fly																						
Number of species						3	6	6	6	3	3	3	3	3	3	5	5	2	3	3	3	3	3	3			
Total						88	94.90	45	0.53	624	11.33	594	8.70	45	10.12	53	147.41	16	4.56	24	38.18	14	6.88				

Sampling methodology: Collection using quadrat (50cm × 50cm) and seive (mesh size 0.5mm).

Table 5.2.10 List of Qualitatively Observed Invertebrates (January, 2010)

Survey date: 26-27/Jan./2010

No.	Class	Order	Family	Scientific name	Common name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Gastropoda	Basommatophora	Pianorbidae	<i>Indoplanorbis exustus</i>	Red ramshorn						+				
2			Bithyniidae	<i>Bithynia siamensis</i>	Snail	++					+++				
3			Pilidae	<i>Pila pesmi</i>	Snail	+			+++	++	++	++	+++	+	
4			Pleuroceridae	<i>Goniobasis livescens</i>	Snail	++					++				
5			Thiaridae	<i>Adamieta bousei</i>	Snail	++									
6				<i>Melanooides</i> sp.	Snail								++		
7			Viviparidae	<i>Filopaludina</i> sp.	Snail	+++			++		+++		+++	+++	
8				<i>Idiopoma</i> sp.	Snail	++									++
9				<i>Trochotaita trochooides</i>	Snail										+++
10	Bivalvia	Unionoidea	Amblemidae	<i>Ensidens ingallsianus</i>	Mussel									+++	
11		Veneroidea	Corbiculidae	<i>Corbicula</i> sp.	Clam			+			+			+++	
12	Crustacea	Decapoda	Palaemonidae	<i>Palaemonetes paludosus</i>	Ghost shrimp	+++			++		+++			++	+++
13			Parathelphusidae	Parathelphusidae	Crab	+			+		+		+	+++	+
14	Insecta	Diptera	Culicidae	Culicidae	Mosquito				++						
15		Hemiptera	Belostomatidae	<i>Belostoma</i> sp.	Water bug	+									
16		Odonata	Cordulidae	<i>Cordulia</i> sp.	Dragon fly	+									
17			Protoneuridae	<i>Protoneura</i> sp.	Damselfly	+									
18		Tricoptera	Hydropsychidae	<i>Macrostemum</i> sp.	Caddis fly										+++
				Number of species		11	1	1	5	1	8	1	4	6	5

Approximate number of individuals observed during the survey.

+: 1-5, ++: 5-10, +++: >20

Table 5.2.11 Results of Quantitative Sampling of Benthic Invertebrates (February, 2010)

ind.: number of individuals (0.25m²)
w.w.: wet weight (g/0.25m²)
sampling date: 26-28/Feb/2010

No	Class	Order	Family	Scientific name	Common name	St.	B1		B2		B3		B4		B5		B6		B7		B8		B9		B10		B11		B12		B13		B14					
							ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.		
1	Gastropoda	Basommatophora	Lymnaeidae	<i>Lymnaea</i> sp.	Snail																																	
2			Planorbidae	<i>Indoplanorbis exustus</i>	Red ramshorn																																	
3				Bithyniidae	<i>Bithynia siamensis</i>	Snail		1	1.04																													
4					Hydrobiidae	<i>Paracerasoma</i> sp.	Snail																															
5					Phidae	<i>Pila plesi</i>	Snail																															
6						<i>Ademietta</i> sp.	Snail																															
7						<i>Melanoidea</i> sp.	Snail																															
8						<i>Thiara</i> sp.	Snail																															
9					Viviparidae	<i>Filopaludina</i> sp.	Snail																															
10						<i>Littorina</i> sp.	Snail																															
11				<i>Trochata trochoides</i>	Snail																																	
12				<i>Ensiscaena ingalitanus</i>	Mussel																																	
13	Bivalvia	Unionoida	Amblemidae																																			
14				Corbiculidae	<i>Corbicula</i> sp.	Clam																																
15				Sphaeriidae	<i>Sphaerium simile</i>	Clam																																
16	Crustacea	Decapoda	Palaeomonidae	<i>Palaeomonetes patulus</i>	Ghost shrimp																																	
17				Chironomidae	<i>Chironomus tentans</i>	Blood worm				451	41.64	2735	18.05	1521	11.23																							
18	Insecta	Diptera		<i>Procladius</i> sp.	Blood worm																																	
19				Aeshidae	<i>Anax junius</i>	Green darner (Dragonfly)																																
20					<i>Lestes vigilax</i>	Swamp spreadwing (Dragonfly)																																
21	Trichoptera	Hydropsychidae		<i>Macrostomum</i> sp.	Caddisfly (Damsel fly)																																	
22				Coleoptera	<i>Hydrobiomorpha</i> sp.	Water scavenger beetle																																
						Number of species	9		2		2	2	2	6	3	4	3	4	3	4	3	2	2	2	0	0	2	3	3									
						Total	173	110.57	4802	61.16	3028	31.51	1555	17.36	37	21.74	83	120.74	75	61.36	43	129.73	259	21.89	138	8.34	0	0.00	206	38.31	60	46.44	41	73.27				

Sampling methodology: Collection using quadrat (50cm × 50cm) and sieve (mesh size 0.5mm).

Table 5.2.12 List of Qualitatively Observed Invertebrates (February, 2010)

Survey date: 26-28/feb./2010

No.	Class	Order	Family	Scientific name	Common name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14			
1	Gastropoda	Basommatophora	Planorbidae	<i>Indoplanorbis exustus</i>	Red ramshorn							+											
2	Mesogastropoda		Bithyniidae	<i>Bithynia siamensis</i>	Snail		+				+++	+++						+++					
3			Pilidae	<i>Pila pesmi</i>	Snail			+				+++	+++	+++					+++	+++			
4			Pleuroceridae	<i>Goniobasis livescens</i>	Snail			+++						++									
5			Thiaridae	<i>Ademietta bousei</i>	Snail			+															
6						<i>Thiara sp.</i>	Snail						+										
7					Viviparidae	<i>Filopadina sp.</i>	Snail						+++	+	+++			+++					+++
8				<i>Idiopoma sp.</i>	Snail		+					+											
9				<i>Trochotaia trochooides</i>	Snail																		
10	Bivalvia	Unionoidea	Amblemidae	<i>Ensidens ingallsianus</i>	Mussel									+									
11	Oligochaeta	(unknown)	(unknown)	(unknown)	Aquatic earthworm																		
12	Crustacea	Decapoda	Palaeomonidae	<i>Palaeomonetes paltodosus</i>	Ghost shrimp						++		++	+		+++					+		
13			Parathephusidae	(unknown)	Crab									+									
14	Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm					+													
15			Chironomidae	<i>Procladius sp.</i>	Blood worm			+															
16		Odonata	Cordulidae	<i>Epicordulia sp.</i>	Dragonfly									+									
17			Lestidae	<i>Lestes vigilax</i>	Swamp spreading (Damselfly)																		
18		Tricoptera	Hydropsychidae	<i>Macrostemum sp.</i>	Caddisfly																		
19		Hemiptera	Belostomatidae	<i>Belostoma sp.</i>	Water bug																		
20			Nepidae	<i>Cercotmetus sp.</i>	Water scorpion																		
	Approximate number of individuals observed during the survey.						6	1	2	2	4	4	4	7	3	5	4	4	4	4	4	7	
	Number of species																						

+: 1-5, ++: 5-10, +++: >20

Table 5.2.13 Results of Quantitative Sampling of Benthic Invertebrates (August, 2010)

ind.: number of individuals (0.25m²)
w.w.: wet weight (g/0.25m²)
sampling date: 16-17/Aug./2010

No.	Class	Order	Family	Scientific name	Common name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9									
							ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.								
1	Gastropoda	Basommatophora	Planorbidae	<i>Indoplanorbis exustus</i>	Red ramshorn								1	0.30										
2	Mesogastropoda		Bithyniidae	<i>Bithynia siamensis</i>	Snail								5	1.05										
3			Pilidae	<i>Pila pesmi</i>	Snail									3	1.05	2	22.05							
4			Thiaridae	<i>Ademietta</i> sp.	Snail											8	10.90							
5				<i>Melanoides</i> sp.	Snail				3	1.05														
6				<i>Filopaludina</i> sp.	Snail																			
7				<i>Sinoatia</i> sp.	Snail																			
8			Bivalvia	Unionoidea	Amblyemidae	<i>Ensisidens ingallsianus</i>	Mussel						2	1.89				7	6.30					
9		Veneroidea	Corbiculidae	<i>Corbicula</i> sp.	Clam						1	0.02												
10	Polychaeta	(unknown)	(unknown)	(unknown)	Worm																			
11	Crustacea	Decapoda	Palaemonidae	<i>Palaemonetes paltadosus</i>	Ghost shrimp								2	0.67			5	1.42						
12	Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm		152	2.98	202	3.02	12	0.50	35	1.15	5	0.02								
13				<i>Procladius</i> sp.	Blood worm		8	0.09	10	0.08	50	1.25												
14	Odonata	Libellulidae	(unknown)	(unknown)	Dragonfly																			
15	Trichoptera		Hydropsychidae	<i>Macrostremum</i> sp.	Caddis fly												15	2.15	2	0.02				
Number of species							3		2		3	1	5	4	2									
Total							6	2.12	160	3.07	212	3.10	359	5.53	15	2.41	35	1.15	16	3.09	32	41.40	7	1.44

Sampling methodology: Collection using quadrat (50cm × 50cm) or grab sampler and seive (mesh size 0.5mm).

Table 5.2.14 List of Qualitatively Observed Invertebrates (August, 2010)

Survey date: 16-17/Aug./2010

No.	Class	Order	Family	Scientific name	Common name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9	
1	Gastropoda	Basommatophora	Lymnaeidae	<i>Lymnaea (Radix) auricularia</i>	Snail			+++	+++	+++						
2			Planorbidae	<i>Indoplanorbis exustus</i>	Red ramshorn						++			+		
3		Mesogastropoda	Bithyniidae	<i>Bithynia siamensis</i>	Snail						+++					
4			Pilidae	<i>Pila pesmi</i>	Snail		+++	+++	+++	+++	++		+++	+++	+	
5			Thiaridae	<i>Ademieta</i> sp.	Snail		+									
6				<i>Melanoides</i> sp.	Snail						+++			+++		
7			Viviparidae	<i>Filopaludina</i> sp.	Snail		+++				+++		+++	+++		
8				<i>Idiopoma</i> sp.	Snail		+									
9		Neotaenioglossa	Pleuroceridae	<i>Goniobasis livescens</i>	Snail						++					
10	Bivalvia	Veneroida	Corbiculidae	<i>Corbicula</i> sp.	Clam						+					
11	Hirudinea	Arhynchobdellida	Hirudinidae	<i>Hirudo</i> sp.	Leech						+				+	
12	Crustacea	Decapoda	Palaeomonidae	<i>Palaeomonetes paltidosus</i>	Ghost shrimp		+++				+++	+	+++	++	+++	
13			Parathephusidae	(unknown)	Crab						+			+		
14	Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm			+++	+++	+++			+++			
15		Hemiptera	Belostomatidae	<i>Diplonychus rusticus</i>	Waterbug		+									
16			Hydrometridae	<i>Hydometra</i> sp.	Marsh treater		+				+			+++		
17		Odonata	Aeshnidae	<i>Anax</i> sp.	Dragonfly		+									
18			Coenagrionidae	<i>Cercion</i> sp.	Damselfly		+									
19			Gomphidae	<i>Trigomphus</i> sp.	Clubtail dragonfly										+	
20			Libellulidae	(unknown)	Dragonfly		+	+	+	+	+					
21			Protoneuridae	<i>Protosma</i> sp.	Damselfly		+			+++		+	+			
22		Tricoptera	Hydropsychidae	<i>Macrostemum</i> sp.	Caddis fly									+++		
						Number of species	11	4	4	4	5	12	3	5	9	3

Approximate number of individuals observed during the survey.

+: 1-5, ++: 5-10, +++: >20

Table 5.2.15 Results of Quantitative Sampling of Benthic Invertebrates (November, 2010)

ind.: number of individuals (/0.25m²)
w.w.: wet weight (g/0.25m²)
sampling date: 26 and 29/Nov./2010

No.	Class	Order	Family	Scientific name	Common name	St.		B1		B2		B3		B4		B5		B6		B7		B8		B9			
						ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.	ind.	w.w.
1	Gastropoda	Mesogastropoda	Bithyniidae	<i>Bithynia siamensis</i>	Snail	12	30.10																				
2			Pilidae	<i>Pila pesmi</i>	Snail	1	0.45														6	1.09					
3			Thiaridae	<i>Ademietta</i> sp.	Snail																						
4					<i>Melanoides</i> sp.	Snail																					
5					<i>Filopaludina</i> sp.	Snail																					
6					<i>Sinotata</i> sp.	Snail																					
7	Bivalvia	Unionoidea	Amblemidae	<i>Ensisides ingallsianus</i>	Mussel																						
8		Veneroidea	Corbiculidae	<i>Corbicula</i> sp.	Clam																						
9	Crustacea	Decapoda	Palaemonidae	<i>Palaemonetes paludosus</i>	Ghost shrimp																						
10	Insecta	Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm	15	0.05	273	4.91	1012	17.32	115	1.42														
11					<i>Procladius</i> sp.	Blood worm			15	0.15	10	0.05	35	1.02													
12				Odonata	Aeshnidae	<i>Anax</i> sp.	Dragonfly																				
13					Gomphidae	<i>Ictinogomphus</i> sp.	Clubtail dragonfly	3	0.51																		
14						<i>Megalogomphus</i> sp.	Clubtail dragonfly																				
15		Trichoptera	Hydropsychidae	<i>Macrostemum</i> sp.	Caddis fly																						
Number of species						4		2		2		2		2		4		2		3		3		6			
Total						31	31.11	288	5.06	1022	17.37	150	2.44	18	3.18	439	5.37	12	1.76	16	18.15	22	5.07				

Sampling methodology: Collection using quadrat (50cm × 50cm) or grab sampler and seive (mesh size 0.5mm) .

Table 5.2.16 List of Qualitatively Observed Invertebrates (November, 2010)

Survey date: 26 and 29/Nov./2010

No.	Class	Order	Family	Scientific name	Common name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Gastropoda	Basommatophora	Lymnaeidae	<i>Lymnaea (Radix) auricularia</i>	Snail			+++	+++	+++					
2		Mesogastropoda	Bithyniidae	<i>Bithynia siamensis</i>	Snail						++				
3			Pilidae	<i>Pila pesmi</i>	Snail		+		++	++	+	+++	++	+	+
4			Pleuroceridae	<i>Goniobasis livescens</i>	Snail						+				
5			Thiaridae	<i>Ademietta</i> sp.	Snail		+								
6				<i>Melanooides</i> sp.	Snail						+			++	
7			Viviparidae	<i>Filopaludina</i> sp.	Snail		+++				++		+++	++	+
8				<i>Idiopoma</i> sp.	Snail		+								
9	Bivalvia	Unionoidea	Amblemidae	<i>Ensidens ingallsianus</i>	Mussel										+
10				<i>Physunio eximius</i>	Mussel										+
11		Veneroidea	Corbiculidae	<i>Corbicula</i> sp.	Clam						+			+++	
12	Crustacea	Decapoda	Palaeomonidae	<i>Palaeomonetes paltidosus</i>	Ghost shrimp						++	+	+	+++	+++
13			Parathelphusidae	(unknown)	Crab										+
14	Insecta	Coleoptera	Hydrophilidae	<i>Stenolophus</i> sp.	Water scavenger beetle		+		+						
15		Diptera	Chironomidae	<i>Chironomus tentans</i>	Blood worm			+++	+++	+++		+++	+		
16				<i>Procladius</i> sp.	Blood worm			++	+++	+++					
17		Odonata	Aeshmidae	<i>Anax</i> sp.	Dragonfly		+								+
					Number of species		6	3	5	4	7	3	4	5	7

Approximate number of individuals observed during the survey.

+: 1-5, ++: 5-10, +++: >20

5.3 Plants











 <p><i>Limnocharis flava</i> Yellow velvetleaf</p>	 <p><i>Colocasia antiquorum</i> Imperial taro</p>	 <p><i>Pistia stratiotes</i> Water cabbage</p>
 <p><i>Lemna perpusilla</i> Minute duckweed</p>	 <p><i>Cleome rutidosperma</i> Yellow cleome</p>	 <p><i>Glinus</i> sp. Sweetjuice</p>
 <p><i>Achyranthes aspera</i> Devil's horsewhip</p>	 <p><i>Alternanthera sessilis</i> Sessile joyweed</p>	 <p><i>Amaranthus viridis</i> Green amaranth</p>
 <p><i>Gomphrena celosioides</i> Gomphrena weed</p>	 <p><i>Commelina benghalensis</i> Benghal dayflower</p>	 <p><i>Commelina diffusa</i> Climbing dayflower</p>

Photo 5.3.1 Observed Plant Species (1/5)













		
<p><i>Cyperus difformis</i> Variable flatsedge</p>	<p><i>Cyperus pulcherrimus</i> Elegant sedge</p>	<p><i>Cyperus rotundus</i> Coco-grass</p>
		
<p><i>Kyllinga brevifolia</i> Shortleaf spikesedge</p>	<p><i>Scirpus grossus</i> Coarse bullrush</p>	<p><i>Phyllanthus niruri</i> Stonebreaker</p>
		
<p><i>Aeschynomene</i> sp. Jointvetches</p>	<p><i>Crotalaria mucronata</i> Smooth rattlepod</p>	<p><i>Crotalaria</i> sp. Rattlepods</p>
		
<p><i>Desmodium triflorum</i> Tick clover</p>	<p><i>Mimosia pigra</i> Giant sensitive tree</p>	<p><i>Eichornia crassipes</i> Water hyacinth</p>

Photo 5.3.2 Observed Plant Species (2/5)

		
<p><i>Monochoria hastate</i> Hastate-leaved pondweed</p>	<p><i>Abutilio hirtum</i> Florida keys indian mallow</p>	<p><i>Combertum</i> sp. Bushwillows</p>
		
<p><i>Ammania baccifera</i></p>	<p><i>Jusisaea suffruticosa</i> Primrose willow</p>	<p><i>Ludwigia adscenden</i> Sunrose willow</p>
		
<p><i>Brachiaria mutica</i> Para grass</p>	<p><i>Cenchus</i> sp.</p>	<p><i>Chrysopogon aciculatus</i> Golden false beardgrass</p>
		
<p><i>Dactyloctenium aegyptium</i> Egyptian grass</p>	<p><i>Eleusine indica</i> Gaertn. Wire grass</p>	<p><i>Leersia</i> sp.</p>

Photo 5.3.3 Observed Plant Species (3/5)












		
<p><i>Leptochloa chinensis</i> Chinese sprangletop</p>	<p><i>Polygonum tomentosum</i> Prince's feather</p>	<p><i>Heliotropium indicum</i> Indian heliotrope</p>
		
<p><i>Ipomoea aquatica</i> Swamp morning glory</p>	<p><i>Ipomoea obscura</i> Small white morningglory</p>	<p><i>Physalis minima</i> Pygmy groundcherry</p>
		
<p><i>Nelumbo nucifera</i> Indian lotus</p>	<p><i>Nymphaea</i> sp. Water lily</p>	<p><i>Acmella oleraceae</i> Toothache plant</p>
		
<p><i>Ageratum conyzoides</i> Billygoat-weed</p>	<p><i>Chromolaena odorata</i> Siam weed (Christmas bush)</p>	<p><i>Crassocephalum crepidioides</i> Fireweed</p>

Photo 5.3.4 Observed Plant Species (4/5)

 <p><i>Eclipta prostrate</i> False daisy</p>	 <p><i>Sphaeranthus africanus</i></p>	 <p><i>Sphaeranthus</i> sp.</p>
 <p><i>Spilanthes acmella</i> Toothache plant</p>	 <p><i>Synedrella nodiflora</i> Cinderella weed</p>	 <p><i>Vernonia cinerea</i> Little ironweed</p>
 <p><i>Xanthium strumarium</i> Rough cocklebur</p>		

Photo 5.3.5 Observed Plant Species (5/5)

Table 5.3.1 List of Plant Species Observed through the Survey

Order	Family	Scientific name	English name	Location Survey Point Category	Regular Points									Additional points					
					Upstream		Urban area			Downstream				B10	B11	B12	B13	B14	
					B1	B5	B2	B3	B4	B6	B7	B8	B9						
1	Alismatales	Butomaceae	<i>Limnocharis flava</i> (L.) Buchenau	Yellow velvetleaf	II	1		5	2	3	1		2						
2	Arales	Araceae	<i>Colocasia antiquorum</i> Schott	Imperial taro	IV			4	1									1	
3			<i>Pistia stratiotes</i> L.	Water cabbage (Water lettuce)	I	6			1		3							1	
4		Lemnaceae	<i>Lemna perpusilla</i> Torr.	Minute duckweed	I	5		3	2	2	3							1	1
5	Capparales	Capariaceae	<i>Cleome rutidosperma</i> DC.	Yellow cleome	V			2	1	1								1	1
6	Caryophyllales	Aizoaceae	<i>Glinus</i> sp.	Sweetjuice	V								3						
7		Amaranthaceae	<i>Achyranthes aspera</i> L.	Devil's horsewhip	V	4	3					1	2						2
8			<i>Alternanthera sessilis</i> (L.) DC.	Sessile joyweed (Dwarf copperleaf)	V	7	3	7	5	7	7	6	4	1	2	2			2
9			<i>Amaranthus viridis</i> L.	Green amaranth	V			5											
10			<i>Gomphrena celosioides</i> Mart.	Gomphrena weed	V						1								
11	Commelinales	Commelinaceae	<i>Commelina benghalensis</i> L.	Benghal dayflower	IV	1		2	2	1								1	
12			<i>Commelina diffusa</i> Burm.f.	Climbing dayflower	IV			5	2	2	1								
13	Cyperales	Cyperaceae	<i>Cyperus difformis</i> L.	Variable flatsedge	IV							2							
14			<i>Cyperus pulcherrimus</i> Willd. Ex Kunth	Elegant sedge	IV	2	1	4	2	7	1	6							2
15			<i>Cyperus rotundus</i> L.	Coco-grass	IV										2				
16			<i>Kyllinga brevifolia</i> Rottb.	Shortleaf spikesedge	IV									2					
17			<i>Scirpus grossus</i> L.f.	Coarse bullrush	I	4	5		2		3	1					1	1	1
18	Euphorbiales	Euphobiaceae	<i>Phyllanthus niruri</i> L.	Stonebreaker	V														1
19	Fabales	Fabaceae	<i>Aeschynomene</i> sp.	Jointvetches	V						1								2
20			<i>Crotalaria mucronata</i> Desv.	Smooth rattlepod	V		2											1	
21			<i>Crotalaria</i> sp.	Rattlepods	V									2					
22			<i>Desmodium triflorum</i> (L.) DC.	Tick clover	V													1	
23			<i>Indigofera</i> sp.		V	1								4					
24			<i>Mimosa pigra</i> L.	Giant sensitive tree	V						3	2					1	2	
25	Liliales	Pontederiaceae	<i>Eichornia crassipes</i> (Mart.) Solms	Water hyacinth	I	6					7	4			1			2	1
26			<i>Monochoria hastata</i> (L.) Solms	Hastate-leaved pondweed	I	7			3	2	5	2			2			1	2
27	Malvales	Malvaceae	<i>Abutilo hirtum</i> Sweet	Florida keys indian	V							2	2					1	
28	Myrtales	Combretaceae	<i>Combretum</i> sp.	Bushwillows	V						1	5							2
29		Lythraceae	<i>Ammania baccifera</i> L.		V	2													
30		Onagraceae	<i>Jusisaea suffruticosa</i> L.	Primrose willow	IV	5	3	5	5	3	4	3		3					2
31			<i>Ludwigia adscenden</i> (L.) Hara	Sunrose willow	IV	5		6	7	7	3				2				
32	Poales	Poaceae	<i>Brachiaria mutica</i> (Forssk.) Stapf	Para grass	IV	8	7	3	4	7	5	3	3	1			1	2	
33			<i>Cenchrus</i> sp.		IV					2									
34			<i>Chrysopogon aciculatus</i> (Retz.) Trin.	Golden false beardgrass	IV		2					2	4						
35			<i>Dactyloctenium aegyptium</i> (L.) P.Beauv.	Egyptian grass	IV	1				1			3					1	
36			<i>Eleusine indica</i> (L.) Gaertn.	Wire grass	IV					2									
37			<i>Leersia</i> sp.	Gutgrass	IV							1			2	2			
38			<i>Leptochloa chinensis</i> (L.) Nees	Chinese sprangletop	IV	3	7	4	4	1	4	6					2	2	2
39	Polygonales	Polygonaceae	<i>Polygonum tomentosum</i> Willd	Prince's feather	V	2	2			6	3	4		6	2		2	2	2
40		Boraginaceae	<i>Heliotropium indicum</i> L.	Indian heliotrope	V						3	4	5	4	1	1		1	2
41		Convolvulaceae	<i>Ipomoea aquatica</i> Forssk.	Swamp morning glory (Water spinach)	IV	8		8	6	8	8	2			1	2		1	2
42			<i>Ipomoea obscura</i> (L.) Ker-Gawl	Small white morningglory	V	6							3	2					
43		Solanaceae	<i>Physalis minima</i> L.	Pygmy groundcherry	V									3					1
44	Ranales	Nymphaeaceae	<i>Nelumbo nucifera</i> Gaertn.	Indian lotus	II										2	2			
45			<i>Nymphaea</i> sp.	Water lily	II										1	2			
46	Rubiales	Compositae	<i>Acmella oleraceae</i> (L.) R.K. Jansen	Toothache plant	V	4	1	1	1	3	1	5	1	1					2
47			<i>Ageratum conyoides</i> L.	Billygoat-weed	V													2	
48			<i>Chromolaena odorata</i> (L.) R.M.King &H. Robins	Siam weed (Christmas bush)	V		1											2	
49			<i>Crassocephalum crepidioides</i> (Benth.) S.Moore	Fireweed	V									1					
50			<i>Eclipta prostrata</i> L.	False daisy	V	2	2			2	2	2	2						
51			<i>Sphaeranthus africanus</i> L.		V		2			2	1	2	2	2					
52			<i>Sphaeranthus</i> sp.		V							2	4	1					1
53			<i>Spilanthes acmella</i> Wallex DC.	Toothache plant	V						1			1					
54			<i>Synedrella nodiflora</i> (L.) Gaertn.	Cinderella weed	V	4			3	1	3		3	2					2
55			<i>Vernonia cinerea</i> (L.) Less.	Little ironweed	V		3	2					3						
56			<i>Xanthium strumarium</i> L.	Rough cocklebur	V									3					
Number of species						22	16	16	18	21	25	19	15	21	9	12	6	19	15

Notes)1. Numbers in the table show frequency of which the species was observed.

2. Category I: Floating species II: Emerged species III: Submerged species IV: Marginal species V: Terrestrial species

Table 5.3.2 List of Observed Plants (February, 2009)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Alismatales	Butomaceae	<i>Limncharis flava</i> (L.) Buchenau	ອາກຳພັກ (ອາກຳພັກ)	Yellow velvetleaf										
2	Arales	Araceae	<i>Pistia stratiotes</i> L.	ອາກຳພັກ	Water cabbage (Water lettuce)		+								
3		Lemnaceae	<i>Lemna perpusilla</i> Torr.	ອາກຳພັກ	Minute duckweed		+	+	+						
4	Caryophyllales	Aizoaceae	<i>Glinus</i> sp.	ອາກຳພັກ	Sweetjuice										+
5		Amaranthaceae	<i>Alternanthera sessilis</i> (L.) DC.	ອາກຳພັກ	Sessile joyweed (Dwarf copperleaf)		+	+	+						+
6	Commelinales	Commelinaceae	<i>Commelina diffusa</i> Burm.f.	ອາກຳພັກ	Climbing dayflower		+	+	+						
7	Cyperales	Cyperaceae	<i>Cyperus difformis</i> L.	ອາກຳພັກ	Variable flatsedge										+
8			<i>Cyperus pulcherrimus</i> Willd. Ex Kunth	ອາກຳພັກ	Elegant sedge										+
9			<i>Cyperus rotundus</i> L.	ອາກຳພັກ	Coco-grass										+
10			<i>Kyllinga brevifolia</i> Rottb.	ອາກຳພັກ	Shortleaf spikesedge										+
11			<i>Scirpus grossus</i> L.f.	ອາກຳພັກ	Coarse bullrush										+
12	Fabales	Fabaceae	<i>Crotalaria</i> sp.	ອາກຳພັກ	Rattlepods										+
13	Liliales	Pontederiaceae	<i>Monochoria hastata</i> (L.) Solms	ອາກຳພັກ	Hastate-leaved pondweed		+	+	+						
14	Myrtales	Combretaceae	<i>Combretum</i> sp.	ອາກຳພັກ	Bushwillows										+
15		Lythraceae	<i>Ammannia baccifera</i> L.	ອາກຳພັກ			+								
16		Onagraceae	<i>Jussiaea suffruticosa</i> L.	ອາກຳພັກ	Primrose willow		+	+	+						+
17			<i>Ludwigia adscenden</i> (L.) Hara	ອາກຳພັກ	Sunrose willow		+	+	+						
18	Poales	Poaceae	<i>Bracharia mutica</i> (Forsk.) Stapf	ອາກຳພັກ	Para grass		+	+	+						+
19			<i>Cenchrus</i> sp.	ອາກຳພັກ			+								
20			<i>Chrysopogon aciculatus</i> (Retz.) Trin.	ອາກຳພັກ	Golden false beardgrass										+
21			<i>Eleusine indica</i> (L.) Gaertn.	ອາກຳພັກ	Wire grass										+
22			<i>Leptochloa chinensis</i> (L.) Nees	ອາກຳພັກ	Chinese sprangletop										+
23	Polygonales	Polygonaceae	<i>Polygonum tomentosum</i> Willd.	ອາກຳພັກ	Prince's feather		+								+
24		Boraginaceae	<i>Heliotropium indicum</i> L.	ອາກຳພັກ	Indian heliotrope										+
25		Convolvulaceae	<i>Ipomoea aquatica</i> Forssk.	ອາກຳພັກ	Swamp morning glory (Water spinach)		+	+	+						+
26	Rubiales	Compositae	<i>Acmella oleracea</i> (L.) R.K. Jansen	ອາກຳພັກ	Toothache plant										+
27			<i>Eclipta prostrata</i> L.	ອາກຳພັກ	False daisy		+								+
28			<i>Sphaeranthus africanus</i> L.	ອາກຳພັກ											+
29			<i>Sphaeranthus</i> sp.	ອາກຳພັກ											+
30			<i>Synedrella nodiflora</i> (L.) Gaertn.	ອາກຳພັກ	Cinderella weed		+								+
31			<i>Xanthium strumarium</i> L.	ອາກຳພັກ	Rough cocklebur										+
Number of species						13	8	10	15	7	12	11	6	11	

+: Observed species

Table 5.3.3 List of Observed Plants (March, 2009)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Alismatales	Butomaceae	<i>Limnorchis flava</i> (L.) Buchenau	ອຳນາດນ້ຳ	Yellow velvetleaf			+							
2	Arales	Araceae	<i>Pistia stratiotes</i> L.	ອຳນາດນ້ຳ	Water cabbage (Water lettuce)		+								
3		Lemnaceae	<i>Lemna perpusilla</i> Torr.	ອຳນາດນ້ຳ	Minute duckweed		+	+	+						
4	Caryophyllales	Aizoaceae	<i>Glinus</i> sp.	ອຳນາດນ້ຳ	Sweetjuice										+
5		Amaranthaceae	<i>Alternanthera sessilis</i> (L.) DC.	ອຳນາດນ້ຳ	Sessile joyweed (Dwarf copperleaf)		+	+	+						+
6		Amaranthaceae	<i>Gomphrena celosoides</i> Mart.	ອຳນາດນ້ຳ	Gomphrena weed										+
7	Commelinales	Commelinaceae	<i>Commelina diffusa</i> Burm.f.	ອຳນາດນ້ຳ	Climbing dayflower										+
8	Cyperales	Cyperaceae	<i>Cyperus difformis</i> L.	ອຳນາດນ້ຳ	Variable flatsedge										+
9			<i>Cyperus pulcherrimus</i> Willd. Ex Kunth	ອຳນາດນ້ຳ	Elegant sedge										+
10			<i>Cyperus rotundus</i> L.	ອຳນາດນ້ຳ	Coco-grass										+
11			<i>Kyrtlinga brevifolia</i> Rothb.	ອຳນາດນ້ຳ	Shortleaf spikesedge										+
12			<i>Scirpus grossus</i> L.f.	ອຳນາດນ້ຳ	Coarse bullrush										+
13	Fabales	Fabaceae	<i>Crotalaria</i> sp.	ອຳນາດນ້ຳ	Rattlepods										+
14	Liliales	Pontederiaceae	<i>Eichornia crassipes</i> (Mart.) Solms	ອຳນາດນ້ຳ	Water hyacinth										+
15			<i>Monochoria hastata</i> (L.) Solms	ອຳນາດນ້ຳ	Hastate-leaved pondweed										+
16	Myrtales	Combretaceae	<i>Combretum</i> sp.	ອຳນາດນ້ຳ	Bushwillows										+
17		Lythraceae	<i>Ammania baccifera</i> L.	ອຳນາດນ້ຳ											+
18		Onagraceae	<i>Jussiaea suffruticosa</i> L.	ອຳນາດນ້ຳ	Primrose willow										+
19			<i>Ludwigia adscenden</i> (L.) Hara	ອຳນາດນ້ຳ	Sunrose willow										+
20	Poales	Poaceae	<i>Bracharia mutica</i> (Forssk.) Stapf	ອຳນາດນ້ຳ	Para grass										+
21			<i>Cenchrus</i> sp.	ອຳນາດນ້ຳ											+
22			<i>Chrysopogon aciculatus</i> (Retz.) Trin.	ອຳນາດນ້ຳ	Golden false beardgrass										+
23			<i>Eleusine indica</i> (L.) Gaertn.	ອຳນາດນ້ຳ	Wire grass										+
24			<i>Leptochloa chinensis</i> (L.) Nees	ອຳນາດນ້ຳ	Chinese sprangletop										+
25	Polygonales	Polygonaceae	<i>Polygonum tomentosum</i> Willd	ອຳນາດນ້ຳ	Prince's feather										+
26		Boraginaceae	<i>Heliotropium indicum</i> L.	ອຳນາດນ້ຳ	Indian heliotrope										+
27		Convolvulaceae	<i>Ipomoea aquatica</i> Forssk.	ອຳນາດນ້ຳ	Swamp morning glory (Water spinach)										+
28		Solanaceae	<i>Physalis minima</i> L.	ອຳນາດນ້ຳ	Pygmy groundcherry										+
29	Rubiales	Compositae	<i>Acmella oleraceae</i> (L.) R.K. Jansen	ອຳນາດນ້ຳ	Toothache plant										+
30			<i>Crassocephalum crepidioides</i> (Benth.) S.Moore	ອຳນາດນ້ຳ	Fireweed										+
31			<i>Eclipta prostrata</i> L.	ອຳນາດນ້ຳ	False daisy										+
32			<i>Sphaeranthus africanus</i> L.	ອຳນາດນ້ຳ											+
33			<i>Sphaeranthus</i> sp.	ອຳນາດນ້ຳ											+
34			<i>Spilanthes acmella</i> Wall ex DC.	ອຳນາດນ້ຳ	Toothache plant										+
35			<i>Synedrella nodiflora</i> (L.) Gaertn.	ອຳນາດນ້ຳ	Cinderella weed										+
36			<i>Xanthium strumarium</i> L.	ອຳນາດນ້ຳ	Rough cocklebur										+
Number of species						13	8	10	15	7	9	11	6	14	

+: Observed species

Table 5.3.4 List of Observed Plants (July, 2009)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B10	B11	B12	B13	B14	
1	Alismatales	Butomaceae	<i>Limncharis flava</i> (L.) Buchenau	ສະຕະນາມາດ	Yellow velvetleaf															
2	Arabs	Araceae	<i>Colocasia antiquorum</i> Schott	ສະຕະນາມາດ	Imperial taro															
3		Lemnaceae	<i>Lemna perpusilla</i> Torr.	ສະຕະນາມາດ	Minute duckweed															
4	Capparales	Capparidaceae	<i>Cleome rutidosperma</i> DC.	ສະຕະນາມາດ	Yellow cloome															
5	Caryophyllales	Amaranthaceae	<i>Achyranthes aspera</i> L.	ສະຕະນາມາດ	Devil's horsewhip															
6			<i>Alternanthera sessilis</i> (L.) DC.	ສະຕະນາມາດ	Sessile joyweed (Dwarf copperleaf)															
7			<i>Amaranthus viridis</i> L.	ສະຕະນາມາດ	Green amaranth															
8	Commelinales	Commelinaceae	<i>Commelina benghalensis</i> L.	ສະຕະນາມາດ	Benghal dayflower															
9			<i>Commelina diffusa</i> Burmf.	ສະຕະນາມາດ	Climbing dayflower															
10	Cyperales	Cyperaceae	<i>Cyperus pulcherrimus</i> Willd. Ex Kunth	ສະຕະນາມາດ	Elegant sedge															
11			<i>Scirpus grossus</i> L.f.	ສະຕະນາມາດ	Coarse bullrush															
12	Euphorbiales	Euphorbiaceae	<i>Phyllanthus niruri</i> L.	ສະຕະນາມາດ	Stonebreaker															
13	Fabales	Fabaceae	<i>Aeschynomene</i> sp.	ສະຕະນາມາດ	Jointveiches															
14			<i>Crotalaria mucronata</i> Desv.	ສະຕະນາມາດ	Smooth rattlepod															
15			<i>Desmodium triflorum</i> (L.) DC.	ສະຕະນາມາດ	Tick clover															
16			<i>Indigofera</i> sp.	ສະຕະນາມາດ																
17			<i>Mimosa pigra</i> L.	ສະຕະນາມາດ	Giant sensitive tree															
18	Liliales	Pontederiaceae	<i>Eichornia crassipes</i> (Mart.) Solms	ສະຕະນາມາດ	Water hyacinth															
19			<i>Monochoria hastata</i> (L.) Solms	ສະຕະນາມາດ	Hastate-leaved pondweed															
20	Malvales	Malvaceae	<i>Abutilon hirtum</i> Sweet	ສະຕະນາມາດ	Florida keys indian mallow															
21	Myrtales	Combretaceae	<i>Combretum</i> sp.	ສະຕະນາມາດ	Bushwillows															
22			<i>Jussiaea suffruticosa</i> L.	ສະຕະນາມາດ	Prinrose willow															
23			<i>Ludwigia adscenden</i> (L.) Hara	ສະຕະນາມາດ	Sunrose willow															
24	Poales	Poaceae	<i>Brachiaria nutica</i> (Forssk.) Stapf	ສະຕະນາມາດ	Para grass															
25			<i>Chrysopogon aciculatus</i> (Retz.) Trin.	ສະຕະນາມາດ	Golden false beardgrass															
26			<i>Dactyloctenium aegyptium</i> (L.) P.Beauv.	ສະຕະນາມາດ	Egyptian grass															
27			<i>Leersia</i> sp.	ສະຕະນາມາດ	Gulgrass															
28			<i>Leptochloa chinensis</i> (L.) Nees	ສະຕະນາມາດ	Chinese sprangletop															
29	Polygonales	Polygonaceae	<i>Polygonum tomentosum</i> Willd	ສະຕະນາມາດ	Prince's feather															
30			<i>Heliotropium indicum</i> L.	ສະຕະນາມາດ	Indian heliotrope															
31			<i>Ipomoea aquatica</i> Forssk.	ສະຕະນາມາດ	Swamp morning glory (Water spinach)															
32			<i>Ipomoea obscura</i> (L.) Ker-Gawl	ສະຕະນາມາດ	Small white morningglory															
33			<i>Physalis minima</i> L.	ສະຕະນາມາດ	Pygmy groundcherry															
34	Ranales	Nymphaeaceae	<i>Nelumbo nucifera Gaertn.</i>	ສະຕະນາມາດ	Indian lotus															
35			<i>Nymphaea</i> sp.	ສະຕະນາມາດ	Water lily															
36			<i>Aemella oleraceae</i> (L.) R. K. Jansen	ສະຕະນາມາດ	Toothache plant															
37			<i>Ageratum conyzoides</i> L.	ສະຕະນາມາດ	Billy goat-weed															
38			<i>Chromolaena odorata</i> (L.) R.M.King & H. Robins	ສະຕະນາມາດ	Siam weed (Christmas bush)															
39			<i>Synedrella nodiflora</i> (L.) Gaertn.	ສະຕະນາມາດ	Cinderella weed															
40			<i>Vernonia cinerea</i> (L.) Less.	ສະຕະນາມາດ	Little ironweed															
						8	8	4	7	7	5	5	6	6	5	10	4	12	12	
						Number of species														

+: Observed species

Table 5.3.5 List of Observed Plants (December, 2009)

No. Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Araceae	<i>Pistia stratiotes</i> L.	ອຳປຸງ	Water cabbage (Water lettuce)		+								
2	Lemnaceae	<i>Lemna perpusilla</i> Torr.	ອຳປຸງນ້ຳ	Minute duckweed		+								
3	Caryophyllales	<i>Achyranthes aspera</i> L.	ອຳປຸງນ້ຳຍາວ	Devil's horsewhip		+				+		+		
4		<i>Alternanthera sessilis</i> (L.) DC.	ອຳປຸງນ້ຳສັດ	Sessile joyweed (Dwarf copperleaf)		+	+	+			+	+		
5		<i>Amaranthus viridis</i> L.	ອຳປຸງນ້ຳສັດ	Green amaranth			+							
6	Cyperaceae	<i>Cyperus pulcherrimus</i> Willd. Ex Kunth	ອຳປຸງນ້ຳ	Elegant sedge		+	+				+	+		
7		<i>Scirpus grossus</i> L. f.	ອຳປຸງນ້ຳຍາວ	Coarse bullrush						+				
8	Fabaceae	<i>Indigofera</i> sp.	ອຳປຸງນ້ຳ											+
9		<i>Mimosia pigra</i> L.	ອຳປຸງນ້ຳ	Giant sensitive tree							+			
10	Liliales	<i>Eichhornia crassipes</i> (Mart.) Solms	ອຳປຸງນ້ຳ	Water hyacinth		+					+			
11	Malvales	<i>Abutilon hirtum</i> Sweet	ອຳປຸງນ້ຳ	Florida keys indian mallow										+
12	Myrtales	<i>Jussiaea suffruticosa</i> L.	ອຳປຸງນ້ຳ	Primrose willow		+	+							
13		<i>Ludwigia adscenden</i> (L.) Hara	ອຳປຸງນ້ຳ	Sunrose willow		+	+							
14	Poales	<i>Brachiaria mutica</i> (Forssk.) Stapf	ອຳປຸງນ້ຳ	Para grass		+				+	+			
15		<i>Leptochloa chinensis</i> (L.) Nees	ອຳປຸງນ້ຳ	Chinese sprangletop		+	+			+	+			
16	Polygonales	<i>Polygonum tomentosum</i> Willd	ອຳປຸງນ້ຳ	Prince's feather						+				+
17	Boraginaceae	<i>Heliotropium indicum</i> L.	ອຳປຸງນ້ຳ	Indian heliotrope										
18	Polymomales	<i>Ipomoea aquatica</i> Forssk.	ອຳປຸງນ້ຳ	Swamp morning glory (Water spinach)		+	+				+			
19		<i>Ipomoea obscura</i> (L.) Ker-Gawl	ອຳປຸງນ້ຳ	Small white morningglory		+								
20	Rubiales	<i>Acmella oleraceae</i> (L.) R.K. Jansen	ອຳປຸງນ້ຳ	Toothache plant		+								+
21		<i>Synedrella nodiflora</i> (L.) Gaertn.	ອຳປຸງນ້ຳ	Cinderella weed		+					+			+
Number of species					12	7	3	8	4	8	5	4	4	4

+: Observed species

Table 5.3.6 List of Observed Plants (January, 2010)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Alismatales	Butomaceae	<i>Limnorchis flava</i> (L.) Buchenau	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Yellow velvetleaf		+								
2	Arales	Araceae	<i>Pistia stratiotes</i> L.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Water cabbage (Water lettuce)										
3		Lemnaceae	<i>Lemna perpusilla</i> Torr.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Minute duckweed		+								
4	Capparales	Capardaceae	<i>Cleome rutidosperma</i> DC.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Yellow cleome			+							
5	Caryophyllales	Amaranthaceae	<i>Achyranthes aspera</i> L.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Devil's horsewhip		+							+	
6			<i>Alternanthera sessilis</i> (L.) DC.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Sessile joyweed (Dwarf copperleaf)		+	+	+	+				+	
7			<i>Amaranthus viridis</i> L.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Green amaranth			+							
8	Commelinales	Commelinaceae	<i>Commelina benghalensis</i> L.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Benghal dayflower			+	+						
9	Cyperales	Cyperaceae	<i>Cyperus pulcherrimus</i> Willd. Ex Kunth	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Elegant sedge				+						+
10			<i>Scirpus grossus</i> L.f.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Coarse bullrush					+					
11	Fabales	Fabaceae	<i>Indigofera</i> sp.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ											+
12	Liliales	Pontederiaceae	<i>Eichornia crassipes</i> (Mart.) Solms	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Water hyacinth		+							+	
13			<i>Monochoria hastata</i> (L.) Solms	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Hastate-leaved pondweed		+								
14	Myrtales	Combretaceae	<i>Combretum</i> sp.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Bushwillow										+
15		Onagraceae	<i>Jussiaea suffruticosa</i> L.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Primrose willow		+								+
16			<i>Ludwigia adscenden</i> (L.) Hara	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Sunrose willow		+	+	+						
17	Poales	Poaceae	<i>Brachiaria mutica</i> (Forssk.) Stapf	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Para grass		+								+
18			<i>Leptochloa chinensis</i> (L.) Nees	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Chinese sprangletop		+							+	
19	Polygonales	Polygonaceae	<i>Polygonum tomentosum</i> Willd	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Prince's feather					+					+
20		Boraginaceae	<i>Heliotropium indicum</i> L.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Indian heliotrope									+	+
21		Convolvulaceae	<i>Ipomoea aquatica</i> Forssk.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Swamp morning glory (Water spinach)		+	+	+	+					
22			<i>Ipomoea obscura</i> (L.) Ker-Gawl	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Small white morningglory		+								+
23		Solanaceae	<i>Physalis minima</i> L.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Pygmy groundcherry										+
24	Rubiales	Compositae	<i>Acmella oleraceae</i> (L.) R.K. Jansen	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Toothache plant		+								+
25			<i>Chromolaena odorata</i> (L.) R.M.King & H. Robins	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Siam weed (Christmas bush)										+
26			<i>Sphaeranthus</i> sp.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ											+
27			<i>Synedrella nodiflora</i> (L.) Gaertn.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Cinderella weed		+								+
28			<i>Vernonia cinerea</i> (L.) Less.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Little ironweed										+
29			<i>Xanthium strumarium</i> L.	ສາຍນ້ຳໄຫຼນ້ຳສີເຫຼືອງ	Rough cocklebur										+
							13	6	6	6	4	5	7	6	9
							Number of species								

+: Observed species, *: Dominant species

Table 5.3.7 List of Observed Plants (February, 2010)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14					
1	Alismatales	Butomaceae	<i>Limnorchis flava</i> (L.) Buchenau	ນ້ຳຢາງ	Yellow velvetleaf			+																	
2	Arales	Araceae	<i>Colocasia antiquorum</i> Schott	ນ້ຳຢາງ	Imperial taro		+																		
3			<i>Pistia stratiotes</i> L.	ນ້ຳຢາງ	Water cabbage (Water lettuce)		+																		
4		Lemnaceae	<i>Lemna perpusilla</i> Torr.	ນ້ຳຢາງ	Minute duckweed																				
5	Caryophyllales	Aizoaceae	<i>Gibbus</i> sp.	ນ້ຳຢາງ	Sweetjuice																				
6		Amaranthaceae	<i>Achyranthes aspera</i> L.	ນ້ຳຢາງ	Devil's horsehair																				
7			<i>Alternanthera sessilis</i> (L.) DC.	ນ້ຳຢາງ	Sessile joyweed (Dwarf copperleaf)		+																		
8			<i>Amaranthus viridis</i> L.	ນ້ຳຢາງ	Green amaranth		+																		
9	Commelinales	Commelinaceae	<i>Commelina diffusa</i> Burm.f.	ນ້ຳຢາງ	Climbing dayflower		+																		
10	Cyperales	Cyperaceae	<i>Cyperus pulcherrimus</i> Willd. Ex Kunth	ນ້ຳຢາງ	Elegant sedge																				
11			<i>Scirpus grossus</i> L.f.	ນ້ຳຢາງ	Coarse bullrush		+																		
12	Fabales	Fabaceae	<i>Aeschynomene</i> sp.	ນ້ຳຢາງ	Jointvetches																				
13			<i>Crotalaria mucronata</i> Desv.	ນ້ຳຢາງ	Smooth rattlepod																				
14			<i>Indigofera</i> sp.	ນ້ຳຢາງ																					
15			<i>Mimosa pigra</i> L.	ນ້ຳຢາງ	Giant sensitive tree																				
16	Liliales	Pontederiaceae	<i>Eichornia crassipes</i> (Mart.) Solms	ນ້ຳຢາງ	Water hyacinth		+																		
17			<i>Monochoria hastata</i> (L.) Solms	ນ້ຳຢາງ	Hastate-leaved pondweed		+																		
18	Malvales	Malvaceae	<i>Abutilon hirtum</i> Sweet	ນ້ຳຢາງ	Florida keys indian mallow																				
19	Myrtales	Combretaceae	<i>Combretum</i> sp.	ນ້ຳຢາງ	Bushwillows																				
20			<i>Jussiaea suffruticosa</i> L.	ນ້ຳຢາງ	Primrose willow																				
21			<i>Ludwigia adscenden</i> (L.) Hara	ນ້ຳຢາງ	Sumrose willow																				
22	Poales	Poaceae	<i>Brachiaria mutica</i> (Forssk.) Stapf	ນ້ຳຢາງ	Para grass																				
23			<i>Dactyloctenium aegyptium</i> (L.) P. Beauv.	ນ້ຳຢາງ	Egyptian grass																				
24			<i>Leersia</i> sp.	ນ້ຳຢາງ																					
25			<i>Leptochloa chinensis</i> (L.) Nees	ນ້ຳຢາງ	Chinese sprangletop																				
26	Polygonales	Polygonaceae	<i>Polygonum tomentosum</i> Willd	ນ້ຳຢາງ	Prince's feather																				
27		Boraginaceae	<i>Heliotropium indicum</i> L.	ນ້ຳຢາງ	Indian heliotrope																				
28		Convolvulaceae	<i>Ipomoea aquatica</i> Forssk.	ນ້ຳຢາງ	Swamp morning glory (Water spinach)																				
29			<i>Ipomoea obscura</i> (L.) Ker-Gawl	ນ້ຳຢາງ	Small white morningglory																				
30		Solanaceae	<i>Physalis minima</i> L.	ນ້ຳຢາງ	Pygmy groundcherry																				
31	Ranales	Nymphaeaceae	<i>Nelumbo nucifera</i> Gaertn.	ນ້ຳຢາງ	Indian lotus																				
32			<i>Nymphaea</i> sp.	ນ້ຳຢາງ	Water lily																				
33		Compositae	<i>Acmella oleraceae</i> (L.) R.K. Jansen	ນ້ຳຢາງ	Toothache plant																				
34			<i>Ageratum conyzoides</i> L.	ນ້ຳຢາງ	Billygoat-weed																				
35			<i>Chromolaena odorata</i> (L.) R.M. King & H. Robins	ນ້ຳຢາງ	Siam weed (Christmas bush)																				
36			<i>Sphaeranthus</i> sp.	ນ້ຳຢາງ																					
37			<i>Synedrella nodiflora</i> (L.) Gaertn.	ນ້ຳຢາງ	Cinderella weed																				
38			<i>Vernonia cinerea</i> (L.) Less.	ນ້ຳຢາງ	Little ironweed																				
							12	8	7	7	8	13	7	8	10	8	10	5	14	13					
							Number of species																		

+: Observed species, *: Dominant species

Table 5.3.8 List of Observed Plants (August, 2010)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Alismatales	Butomaceae	<i>Limnorchis flava</i> (L.) Buchenau	ໝັງໝັງ (ໝັງໝັງ)	Yellow velvetleaf			+			+				
2	Arales	Araceae	<i>Colocasia antiquorum</i> Schott	ໝັງໝັງ	Imperial taro			+							
3			<i>Pistia stratiotes</i> L.	ໝັງໝັງ	Water cabbage (Water lettuce)		+					+			
4		Lemnaceae	<i>Lemna perpusilla</i> Torr.	ໝັງໝັງ	Minute duckweed							+			
5	Caryophyllales	Amaranthaceae	<i>Achyranthes aspera</i> L.	ໝັງໝັງ	Devil's horsewhip		+								
6			<i>Aalternanthera sessilis</i> (L.) DC.	ໝັງໝັງ	Sessile joyweed (Dwarf copperleaf)		+	+		+				+	
7			<i>Amaranthus viridis</i> L.	ໝັງໝັງ	Green amaranth			+							
8	Commelinales	Commelinaceae	<i>Commelina diffusa</i> Burm.f.	ໝັງໝັງ	Climbing dayflower			+							
9	Fabales	Fabaceae	<i>Mimosa pigra</i> L.	ໝັງໝັງ	Giant sensitive tree										
10	Liliales	Pontederaceae	<i>Eichhornia crassipes</i> (Mart.) Solms	ໝັງໝັງ	Water hyacinth		+					+	+		
11			<i>Monochoria hastata</i> (L.) Solms	ໝັງໝັງ	Hastate-leaved pondweed		+					+	+		
12	Myrtales	Combretaceae	<i>Combretum</i> sp.	ໝັງໝັງ	Bushwillows										+
13		Onagraceae	<i>Jussiaea suffruticosa</i> L.	ໝັງໝັງ	Primrose willow			+							
14			<i>Ludwigia adscenden</i> (L.) Hara	ໝັງໝັງ	Sunrose willow			+							
15	Poales	Poaceae	<i>Brachiaria mutica</i> (Forsk.) Stapf	ໝັງໝັງ	Para grass										
16			<i>Leptochloa chinensis</i> (L.) Nees	ໝັງໝັງ	Chinese sprangletop			+							+
17	Polygonales	Polygonaceae	<i>Polygonum tomentosum</i> Willd.	ໝັງໝັງ	Prince's feather										
18		Boraginaceae	<i>Heliotropium indicum</i> L.	ໝັງໝັງ	Indian heliotrope										
19		Convolvulaceae	<i>Ipomoea aquatica</i> Forsk.	ໝັງໝັງ	Swamp morning glory (Water spinach)										+
20			<i>Ipomoea obscura</i> (L.) Ker-Gawl	ໝັງໝັງ	Small white morningglory										+
21	Rubiales	Compositae	<i>Acmella oleracea</i> (L.) R.K. Jansen	ໝັງໝັງ	Toothache plant										+
22			<i>Vernonia cinerea</i> (L.) Less.	ໝັງໝັງ	Little ironweed										+
Number of species						9	10	2	3	2	2	9	5	5	0

+: Observed species; *: Dominant species

Table 5.3.9 List of Observed Plants (November, 2010)

No.	Order	Family	Scientific name	Local name	English name	St.	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Artales	Araceae	<i>Colocasia antiquorum</i> Schott	ນ້ອມ	Imperial taro			+							
2			<i>Pistia stratiotes</i> L.	ພັນນາ	Water cabbage (water lettuce)			+							
3		Lemnaceae	<i>Lemna perpusilla</i> Torr.	ນ້ອມນ້ອມ	Mnute duckweed		+								
4	Capparales	Capparidaceae	<i>Cleome ruidosperma</i> DC.	ນ້ອມນ້ອມ	Yellow cleome		+								
5	Caryophyllales	Amaranthaceae	<i>Achyranthes aspera</i> L.	ນ້ອມນ້ອມ	Devil's horsewhip		+								
6			<i>Alternanthera sessilis</i> (L.) DC.	ນ້ອມນ້ອມ	Sessile pennyweed (dwarf copperleaf)		+			+					
7			<i>Amaranthus viridis</i> L.	ນ້ອມນ້ອມ	Green amaranth										
8	Comme liniales	Comme linaceae	<i>Commelina benghalensis</i> L.	ນ້ອມນ້ອມ	Benghal dayflower		+			+					
9			<i>Commelina diffusa</i> Burm.f.	ນ້ອມນ້ອມ	Climbing dayflower							+			
10	Cyperales	Cyperaceae	<i>Cyperus pulcherrimus</i> Willd. Ex Kunth	ນ້ອມນ້ອມ	Elegant sedge		+			+					
11			<i>Scirpus grossus</i> L.f.	ນ້ອມນ້ອມ	Coarse bullrush		+								
12	Fabales	Fabaceae	<i>Aeschynomene</i> sp.	ນ້ອມນ້ອມ	Jointvetches										
13			<i>Indigofera</i> sp.	ນ້ອມນ້ອມ											+
14			<i>Mimosa pigra</i> L.	ນ້ອມນ້ອມ	Giant sensitive tree										+
15	Liliales	Pontederiaceae	<i>Eichornia crassipes</i> (Mart.) Solms	ນ້ອມນ້ອມ	Water hyacinth		++					++			
16			<i>Monochoria hastata</i> (L.) Solms	ນ້ອມນ້ອມ	Haslate-leaved pondweed		++					++			
17	Myrtales	Onagraceae	<i>Jussiaea suffruticosa</i> L.	ນ້ອມນ້ອມ	Primrose willow										
18			<i>Ludwigia adscenden</i> (L.) Hara	ນ້ອມນ້ອມ	Sunrose willow										
19	Poales	Poaceae	<i>Brachiaria mutica</i> (Forssk.) Stapf	ນ້ອມນ້ອມ	Para grass		++					++			
20			<i>Chrysopogon aciculatus</i> (Retz.) Trin.	ນ້ອມນ້ອມ	Golden false beardgrass										+
21			<i>Dactyloctenium aegyptium</i> (L.) P. Beauv.	ນ້ອມນ້ອມ	Egyptian grass		+								+
22			<i>Leptochloa chinensis</i> (L.) Nees	ນ້ອມນ້ອມ	Chinese sprangletop										+
23	Polygonales	Polygonaceae	<i>Polygonum tomentosum</i> Willd	ນ້ອມນ້ອມ	Prince's feather										+
24		Boraginaceae	<i>Heliotropium indicum</i> L.	ນ້ອມນ້ອມ	Indian heliotrope										+
25		Convolvulaceae	<i>Ipomoea aquatica</i> Forssk.	ນ້ອມນ້ອມ	Swamp morning glory (water spinach)		+								+
26			<i>Ipomoea obscura</i> (L.) Ker-Gawl	ນ້ອມນ້ອມ	Small white morningglory		+								+
27	Rubiales	Compositae	<i>Amelia oleraceae</i> (L.) R.K. Jansen	ນ້ອມນ້ອມ	Toothache plant										+
28			<i>Synedrella nodiflora</i> (L.) Gaertn.	ນ້ອມນ້ອມ	Cinderella weed		+								+
29			<i>Pernonia cinerea</i> (L.) Less.	ນ້ອມນ້ອມ	Little ironweed		+								+
Number of species						13	11	11	9	6	13	6	4	3	

+: Observed species, *: Dominant species

5.4 Others

Table 5.4.1 Observation Results of the Site Conditions (February, 2009)

St.	B1	B2	B3	B4	B5
Date	13/02/2009	13/02/2009	13/02/2009	14/02/2009	14/02/2009
Time From	9:15	10:15	10:55	10:25	9:30
To	10:00	10:45	11:20	10:55	10:05
Water depth	25 cm	20 cm	15 cm	20 cm	45-50 cm
Water temperature	25 °C	25 °C	28.5 °C	24 °C	22 °C
Air temperature	30 °C	29 °C	34 °C	30 °C	26 °C
Sediment condition	mud / sand	mud / rubbish	mud / sand	mud	mud
Sediment color	pale brown	black	dark gray	black	pale brown
Smell	none	weak sewage odor	weak sewage odor	weak smell in sometime	none

St.	B6	B7	B8	B9
Date	13/02/2009	14/02/2009	15/02/2009	15/02/2009
Time From	12:10	11:15	11:40	9:50
To	12:40	12:00	12:25	10:25
Water depth	20 cm	55-60 cm	50-60 cm	5 cm
Water temperature	28 °C	27 °C	29 °C	24.5 °C
Air temperature	34 °C	38 °C	32 °C	27.5 °C
Sediment condition	mud	mud / gravel	mud / sand	gravel
Sediment color	pale gray	pale brown	pale gray	pale gray
Smell	none	none	none	none

Table 5.4.2 Observation Results of the Site Conditions (March, 2009)

St.	B1	B2	B3	B4	B5
Date	22/03/2009	22/03/2009	22/03/2009	22/03/2009	21/03/2009
Time From	11:30	11:00	10:25	9:30	13:48
To	12:00	11:20	10:45	9:55	14:07
Water depth	40 cm	20 cm	9 cm	20 cm	60 cm
Water temperature	30 °C	31 °C	30 °C	27 °C	31 °C
Air temperature	35 °C	35 °C	39 °C	30 °C	40 °C
Sediment condition	mud / sand	mud / sement	sand / sement	mud / sement	mud
Sediment color	pale gray	black	pale gray	black	pale gray
Smell	none	strong sewage odor	weak sewage odor	strong sewage odor	none

St.	B6	B7	B8	B9
Date	21/03/2009	21/03/2009	21/03/2009	21/03/2009
Time From	15:20	14:33	12:07	10:20
To	16:00	14:55	12:30	10:50
Water depth	70 cm	45-50 cm	70 cm	25 cm
Water temperature	25 °C	28 °C	27 °C	25 °C
Air temperature	33 °C	33 °C	38 °C	32 °C
Sediment condition	mud	mud / gravel	sand	gravel
Sediment color	dark gray	pale gray	pale gray	pale gray
Smell	strong sewage odor	none	none	none

Table 5.4.3 Observation Results of the Site Conditions (July, 2009)

St.	B1	B2	B3	B4	B5
Date	16/07/2009	16/07/2009	16/07/2009	16/07/2009	15/07/2009
Time From	10:15	10:55	12:30	13:05	9:05
To	10:25	11:25	13:05	13:25	10:30
Water depth	100 cm	?	50 cm	70 cm	70 cm
Water temperature	31 °C	27 °C	31 °C	30 °C	28 °C
Air temperature	34 °C	35 °C	32 °C	33 °C	34 °C
Sediment condition	mud / sand	mud	mud	mud / gravel	mud
Sediment color	dark gray	black	black / dark gray	black	dark gray / dark brown
Smell	none	strong sewage odor	strong sewage odor	strong sewage odor	none

St.	B6	B7	B8	B9	B10
Date	15/07/2009	17/07/2009	17/07/2009	17/07/2009	15/07/2009
Time From	15:00	14:50	13:45	10:25	13:50
To	15:25	15:15	14:20	11:00	14:25
Water depth	100 cm	50 cm	40 cm	110 cm	50 cm
Water temperature	31 °C	31 °C	25 °C	?	33 °C
Air temperature	32 °C	27 °C	26 °C	26 °C	36 °C
Sediment condition	mud	mud / gravel	gravel	sand / gravel	mud
Sediment color	dark brown	dark gray / dark brown	dark gray	dark brown	dark brown
Smell	none	none	none	none	weak sewage odor

St.	B11	B12	B13		B14
Date	15/07/2009	15/07/2009	15/07/2009		16/07/2009
Time From	13:15	12:40	10:50		9:10
To	13:40	13:00	11:45		9:45
Water depth	50 cm	60 cm	100 cm		70 cm
Water temperature	33 °C	33 °C	31 °C		30 °C
Air temperature	39 °C	38 °C	35 °C		34 °C
Sediment condition	mud	sand / gravel	mud ¹	gravel ²	mud
Sediment color	dark brown	dark brown / pale brown	black ¹	pale brown ²	dark brown
Smell	weak sewage odor	weak sewage odor	strong sewage odor ¹	weak sewage odor ²	none
Remarks			^{1,2} there are 2 sediment samples for benthic animal analysis		

Table 5.4.4 Observation Results of the Site Conditions (December, 2009)

St.	B1	B2	B3	B4	B5
Date	2009/12/22	2009/12/22	2009/12/22	2009/12/22	2009/12/22
Time From	9:22	10:15	10:40	11:16	11:40
To	9:42	10:24	11:00	11:30	12:00
Water depth	50 cm	15 cm	13 cm	20 cm	60 cm
Water temperature	21 °C	25 °C	27 °C	27 °C	23 °C
Air temperature	23 °C	28 °C	25 °C	25 °C	25 °C
Sediment condition	mud	mud	mud	mud	mud
Sediment color	pale brown	dark gray	black	black	dark gray
Smell	weak sewage odor	weak sewage odor	weak sewage odor	weak sewage odor	weak sewage odor

St.	B6	B7	B8	B9
Date	2009/12/21	2009/12/21	2009/12/21	2009/12/21
Time From	14:15	13:37	11:32	9:59
To	14:40	14:00	12:00	10:24
Water depth	50 cm	25 cm	20 cm	25 cm
Water temperature	27 °C	25 °C	23 °C	23 °C
Air temperature	29 °C	29 °C	26 °C	26 °C
Sediment condition	mud	gravel	sand	gravel
Sediment color	pale brown	dark brown	pale gray	dark brown
Smell	strong sewage odor	weak sewage odor	none	none

Table 5.4.5 Observation Results of the Site Conditions (January, 2010)

St.	B1	B2	B3	B4	B5
Date	2009/12/22	2009/12/22	2009/12/22	2009/12/22	2009/12/22
Time From	9:25	10:07	10:40	11:07	11:30
To	9:50	10:20	10:55	11:25	11:50
Water depth	40 cm	18 cm	8 cm	20 cm	45 cm
Water temperature	26 °C	26 °C	26 °C	28 °C	29 °C
Air temperature	24 °C	29.5 °C	27.5 °C	30 °C	30.5 °C
Sediment condition	mud	mud	mud	mud	mud
Sediment color	pale gray	black	dark gray	black	pale brown
Smell	weak sewage odor	strong ewage odor	weak sewage odor	strong sewage odor	weak sewage odor

St.	B6	B7	B8	B9
Date	2010/1/27	2010/1/27	2010/1/27	2010/1/27
Time From	14:40	14:10	11:43	10:00
To	14:50	14:30	12:05	10:30
Water depth	73 cm	53 cm	77 cm	40 cm
Water temperature	28 °C	27 °C	26 °C	22 °C
Air temperature	32 °C	30 °C	32 °C	28 °C
Sediment condition	mud	gravel	sand	gravel
Sediment color	black	pale brown	pale brown	pale brown
Smell	strong sewage odor	weak sewage odor	none	none

Table 5.4.6 Observation Results of the Site Conditions (February, 2010)

St.	B1	B2	B3	B4	B5
Date	2010/2/26	2010/2/26	2010/2/26	2010/2/26	2010/2/26
Time From	10:05	10:35	11:00	11:30	12:45
To	10:20	10:50	11:15	11:45	13:05
Water depth	50 cm	18 cm	5 cm	20 cm	30 cm
Water temperature	26 °C	28 °C	28 °C	28 °C	29 °C
Air temperature	30 °C	31 °C	30 °C	30 °C	31 °C
Sediment condition	mud	mud	mud	mud	mud
Sediment color	dark brown	black	black	black	pale brown
Smell	none	strong ewage odor	weak sewage odor	strong sewage odor	weak sewage odor

St.	B6	B7	B8	B9	B10
Date	2010/2/27	2010/2/27	2010/2/27	2010/2/27	2010/2/26
Time From	12:10	11:50	10:55	9:30	14:00
To	12:25	12:05	11:20	10:00	14:20
Water depth	60 cm	20 cm	18 cm	30 cm	30 cm
Water temperature	29 °C	28 °C	25 °C	22 °C	30 °C
Air temperature	31 °C	29 °C	27.5 °C	24 °C	32 °C
Sediment condition	mud	mud/sand	mud/sand	sand/gravel	mud
Sediment color	pale brown	black	pale brown	drak brown	drak brown
Smell	strong sewage odor	none	none	none	none

St.	B11	B12	B13	B14
Date	2010/2/26	2010/2/26	2010/2/26	2010/2/26
Time From	13:15	14:40	15:05	9:30
To	13:40	14:50	15:20	9:55
Water depth	80 cm	20 cm	40 cm	45 cm
Water temperature	29 °C	33 °C	30 °C	26 °C
Air temperature	32 °C	30 °C	28 °C	29 °C
Sediment condition	sand/gravel	sand/gravel	mud	mud
Sediment color	drak gray	drak gray	black	black
Smell	none	none	strong ewage odor	none

Table 5.4.7 Observation Results of the Site Conditions (August, 2010)

St.	B1	B2	B3	B4	B5
Date	2010/8/17	2010/8/17	2010/8/17	2010/8/17	2010/8/18
Time From	10:00	10:50	11:25	12:40	13:25
To	10:30	11:10	11:45	13:00	13:50
Water depth	165 cm	60 cm	85 cm	150 cm	130 cm
Water temperature	20.0 °C	19.0 °C	19.0 °C	19.0 °C	21.0 °C
Air temperature	27.0 °C	27.0 °C	28.0 °C	30.0 °C	30.0 °C
Sediment condition	mud	mud	sand	mud	mud
Sediment color	drak gray	black	black	black	pale brown
Smell	none	strong ewage odor	weak sewage odor	strong sewage odor	none

St.	B6	B7	B8	B9
Date	2010/8/16	2010/8/16	2010/8/16	2010/8/16
Time From	15:05	14:35	13:20	10:30
To	15:30	14:55	14:00	11:15
Water depth	90 cm	120 cm	80 cm	600 cm
Water temperature	21.5 °C	21.0 °C	21.0 °C	20.0 °C
Air temperature	29.0 °C	29.0 °C	27.0 °C	27.0 °C
Sediment condition	mud	gravel/sand	gravel/sand	mud
Sediment color	black	pale brown	drak brown	pale brown
Smell	strong sewage odor	none	none	none

Table 5.4.8 Observation Results of the Site Conditions (November, 2010)

St.	B1	B2	B3	B4	B5
Date	29/11/2010	29/11/2010	29/11/2010	29/11/2010	29/11/2010
Time From	9:45	10:30	11:00	11:30	12:00
To	10:15	10:50	11:20	11:55	12:15
Water depth	70 cm	20 cm	15 cm	10 cm	10 cm
Water temperature	17 °C	20 °C	20 °C	21 °C	20 °C
Air temperature	27 °C	29 °C	29 °C	30 °C	31 °C
Sediment condition	mud	mud	mud	mud	mud
Sediment color	pale brown	black	black	black	pale brown
Smell	none	strong sewage odor	weak sewage odor	strong sewage odor	weak sewage odor

St.	B6	B7	B8	B9	B10
Date	26/11/2010	26/11/2010	26/11/2010	26/11/2010	30/11/2010
Time From	16:00	15:20	13:55	11:10	11:20
To	16:15	15:55	14:30	11:35	11:40
Water depth	100 cm	50 cm	70 cm	65 cm	80 cm
Water temperature	19 °C	22 °C	19 °C	17 °C	18 °C
Air temperature	30 °C	32 °C	31 °C	28 °C	31 °C
Sediment condition	mud	gravel	mud / gravel	mud	mud
Sediment color	dark brown	pale brown	pale brown	dark brown	dark gray
Smell	strong sewage odor	none	none	none	none

St.	B11	B12	B13	B14
Date	30/11/2010	30/11/2010	30/11/2010	30/11/2010
Time From	10:55	10:30	10:00	9:00
To	11:10	10:45	10:15	9:30
Water depth	80 cm	120 cm	80 cm	25 cm
Water temperature	18 °C	19 °C	17 °C	15 °C
Air temperature	29 °C	28 °C	27 °C	27 °C
Sediment condition	sand / gravel	mud / gravel	sand / gravel	mud
Sediment color	dark brown	pale brown	black	pale brown
Smell	none	none	strong sewage odor	weak sewage odor

Table 5.4.9 Supplemental Observation Results of Water Quality (August, 2010)

Name of Monitoring Point	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14
Date	2010/8/17	2010/8/17	2010/8/17	2010/8/17	2010/8/17	2010/8/17	2010/8/16	2010/8/16	2010/8/16	2010/8/16	2010/8/18	2010/8/18	2010/8/18	2010/8/18
Time	10:00	10:50	11:25	12:40	13:25	15:05	14:35	13:20	10:45	12:10	11:28	11:03	10:31	9:28
Weather	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy
	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy	Rainy

Items	Unit	Field observation													
		none	strong	weak	strong	none	strong	none	strong	none	strong	none	strong	none	strong
Oder	-	none	strong	weak	strong	none	strong	none	strong	none	strong	none	strong	none	strong
Color	-	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow
Air Temperature	celsius	27.0	27.0	28.0	30.0	29.0	29.0	27.0	27.0	29.0	28.0	28.0	28.0	26.5	
pH	-	8.00	8.14	7.98	8.01	8.09	7.74	8.17	7.50	8.22	7.58	8.13	9.04	8.20	
Electric conductivity	mS/cm	0.084	0.388	0.321	0.31	0.178	0.161	0.127	0.085	0.219	0.149	0.088	0.234	0.095	
Turbidity	NTU	64.1	95.5	80.3	89.4	54.2	54.7	36	44.7	5.6	34.5	73.1	30.9	18.5	
DO	mg/l	3.78	2.36	2.49	2.47	1.91	5.76	5.08	4.61	2.22	1.75	8.74	1.66	2.6	
Water temperature	celsius	20.0	19.3	19.1	19.4	21.5	21.2	21.3	20.2	20.06	19.86	18.5	19.35	19.68	
TDS	g/l	0.054	0.252	0.208	0.202	0.115	0.104	0.083	0.055	0.142	0.097	0.057	0.152	0.062	
ORP	mV	135	28	70	84	-31	154	133	126	129	33	130	95	104	

Table 5.4.10 Supplemental Observation Results of Water Quality (November,2010)

Name of Monitoring Point	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14
Date	2010/11/29	2010/11/29	2010/11/29	2010/11/29	2010/11/29	2010/11/29	2010/11/26	2010/11/26	2010/11/26	2010/11/26	2010/11/30	2010/11/30	2010/11/30	2010/11/30
Time	9:50	10:35	11:05	11:40	12:10	16:05	15:30	13:55	11:10	11:35	11:00	10:35	10:10	9:15
Weather	Previous day	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
	On the day	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

Items	Unit	Observation Results																		
		none	light yellow	strong	strong	strong	weak	strong	strong	strong	strong	none	none	none	strong	weak				
Field observation	Oder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
	Color	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Surface water	Air Temperature	celsius	27	29	29	30	31	30	30	31	30	32	31	28	31	29	28	27	27	
	Total depth	cm	70	20	15	10	10	100	100	10	100	50	70	65	80	80	120	80	25	
	Measured depth	cm	15	20	15	10	10	5	10	10	10	10	10	15	10	10	15	10	5	5
	pH	-	8.38	8.85	8.26	8.83	8.51	8.79	8.51	8.42	8.79	8.42	8.25	8.12	8.17	7.60	8.35	8.11	8.01	8.01
	Electric conductivity	mS/cm	1.07	0.515	0.416	0.419	0.537	0.438	0.537	0.657	0.438	0.657	0.652	0.497	0.215	0.214	0.936	0.522	1.45	1.45
	Turbidity	NTU	396	70.8	43.1	28.6	106	146	106	125	146	125	365	87.6	22.4	51.7	96	62	265	265
	DO	mg/l	5.49	15.14	9.23	13.15	3.04	9.97	3.04	6.32	9.97	6.32	5.03	8.73	2.94	3.93	7.62	1.84	5.93	5.93
	Water temperature	celsius	16.8	19.7	20.0	20.7	19.3	20.2	19.3	21.8	20.2	19.3	19.5	16.9	17.7	18.5	18.5	11.1	14.67	14.67
	TDS	g/l	0.687	0.329	0.271	0.272	0.343	0.285	0.343	0.420	0.285	0.343	0.418	0.323	0.140	0.139	0.599	0.334	0.929	0.929
	ORP	mV	7	81	68	57	83	70	83	84	70	83	100	-6	54	100	47	-21	154	154
	Measured depth	cm	55	-	-	-	-	-	-	-	-	-	80	30	60	55	95	55	20	20
	pH	-	8.15	-	-	-	-	-	-	-	-	-	8.23	8.32	8.15	8.02	7.46	8.15	7.98	8.01
	Bottom water	Electric conductivity	mS/cm	1.06	-	-	-	-	-	-	-	-	0.537	0.657	0.660	0.498	0.210	0.933	0.525	1.47
		Turbidity	NTU	540	-	-	-	-	-	-	-	-	329	125	377	87.9	267	165	62.2	611
DO		mg/l	4.70	-	-	-	-	-	-	-	-	1.82	6.32	4.94	8.64	0.64	5.26	1.59	5.96	
Water temperature		celsius	16.5	-	-	-	-	-	-	-	-	19.2	21.8	19.2	16.8	16.1	17.8	17.1	14.15	
TDS		g/l	0.677	-	-	-	-	-	-	-	-	0.344	0.421	0.422	0.324	0.136	0.597	0.336	0.939	
ORP		mV	18	-	-	-	-	-	-	-	-	80	90	101	6	39	53	-93	166	

Table 5.4.11 Supplemental Analysis Results of Water Quality (August, 2010)

16-18/Aug/2010

Item	Regular Points									Additional Points				
	B1	B5	B2	B3	B4	B6	B7	B8	B9	B10	B11	B12	B13	B14
NH ₃ -N (mg/L)	0.07	0.22	4.6	3.3	3.6	0.84	0.36	0.16	0.02	0.04	0.26	0.09	0.52	0.04

Note) Collected from surface of the water.

Table 5.4.12 Supplemental Analysis Results of Water Quality (November, 2010)

22,23,30/Nov/2010

Item	Regular Points									Additional Points				
	B1	B5	B2	B3	B4	B6	B7	B8	B9	B10	B11	B12	B13	B14
NH ₃ -N (mg/L)	1.0	2.0	10.5	10.0	9.0	9.0	7.5	6.5	5.0	0.05	0.02	0.72	8.00	1.9

Note) 1. Collected from surface of the water.

2. Results of B1-B9 were measured by regular water quality survey.

CHAPTER 6. GIS

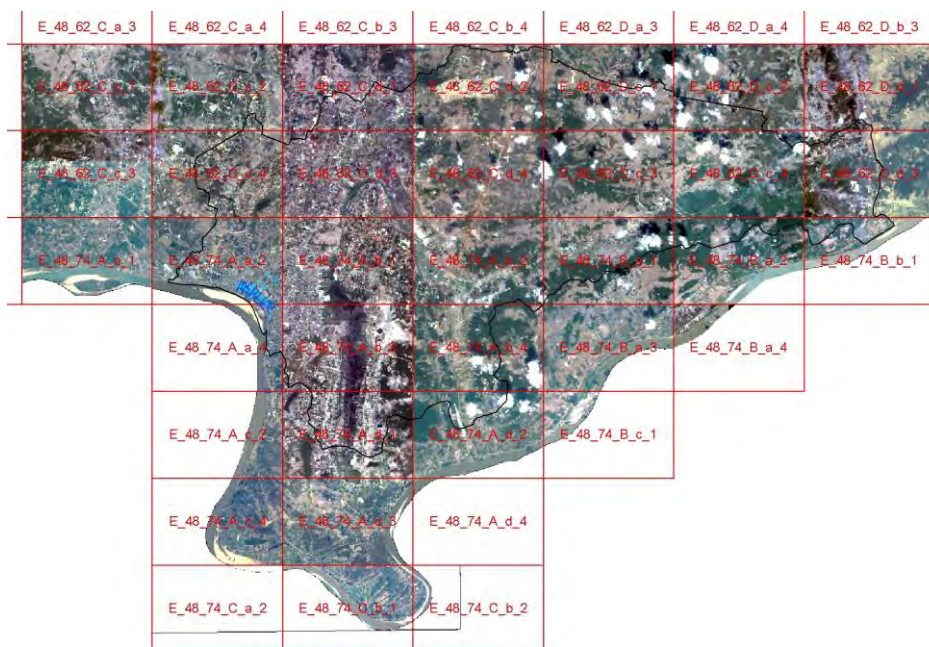
6.1 Outline

GIS study includes establishment of GIS database and GIS analysis. All of the data and their specifications are reviewed in this report, and the detailed study items are as follows.

- QUICKBIRD Satellite Images
- GIS Database
- GIS Database Viewer System
- GIS Analysis

6.2 Quickbird Satellite Image

Quickbird Satellite Image Data with 3 bands and 61 cm resolution were collected from the counterpart organization (PTI). These images were taken during December of 2007 and February of 2008, and formatted in ERDAS Imagine format. The data is also clipped by 1:10000 scale map index with WGS84 coordinate system. The data is very clear with less cloudy because it was taken in dry season. It can be used as a basic or background data in this study.



Source: PTI

Fig. 6.2.1 Index Map of Quick Bird Satellite Image Data

6.2.1 Quickbird Satellite Image Specification

Spatial Resolution: ~0.6m panchromatic (black & white) and ~2.4m multispectral (color).

Table 6.2.1 Specification of Quick Bird Satellite Image Data

	Description	Abbreviation	Resolution	Bandwidth
Black & White	Panchromatic	PAN	~0.6m	0.45 – 0.90 micrometers
Color	Band 1 (Blue)	VIS B	~2.4m	0.45 – 0.52 micrometers
	Band 2 (Green)	VIS G	~2.4m	0.52 – 0.60 micrometers
	Band 3 (Red)	VIS R	~2.4m	0.63 – 0.69 micrometers
	Band 4 (Near Infrared)	NIR	~2.4m	0.76 – 0.90 micrometers

Source: Digital Globe, Inc.

Accuracy: average 14-meters RMS error in horizontal accuracy, excluding effects of terrain displacement.

Level of Correction: Systematically corrected (map-oriented). The correction process removes image distortions introduced by the collection geometry and re-samples the imagery to a uniform ground sample distance and a specified map projection.

6.2.2 Quickbird Satellite Image List (DVD label)

Totally 10 pieces of DVD data covering whole Vientiane City were collected. The data list is shown as follows.

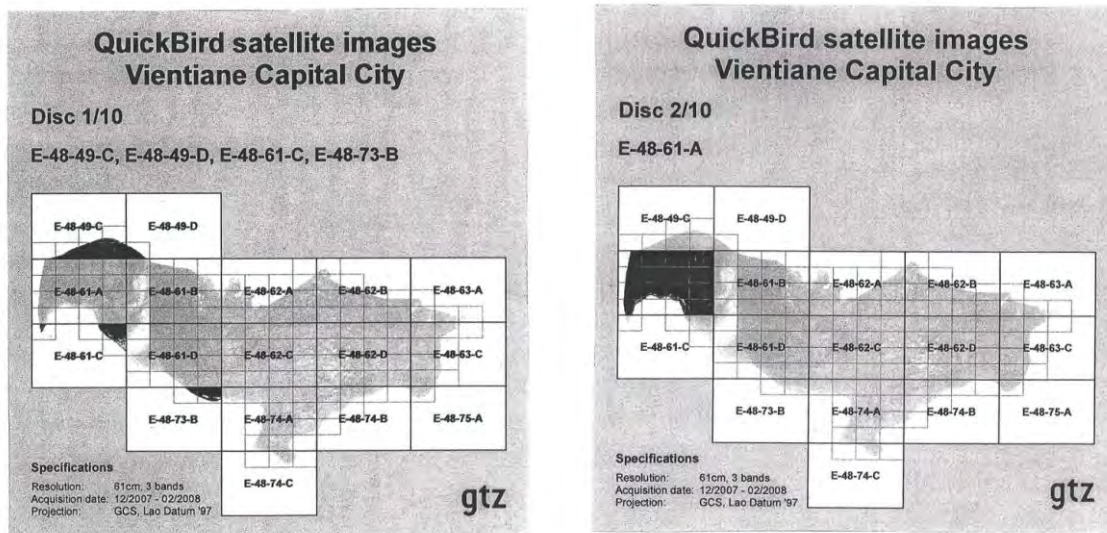


Fig. 6.2.2 Label Samples of Quick Bird Satellite Image DVD (1/3)

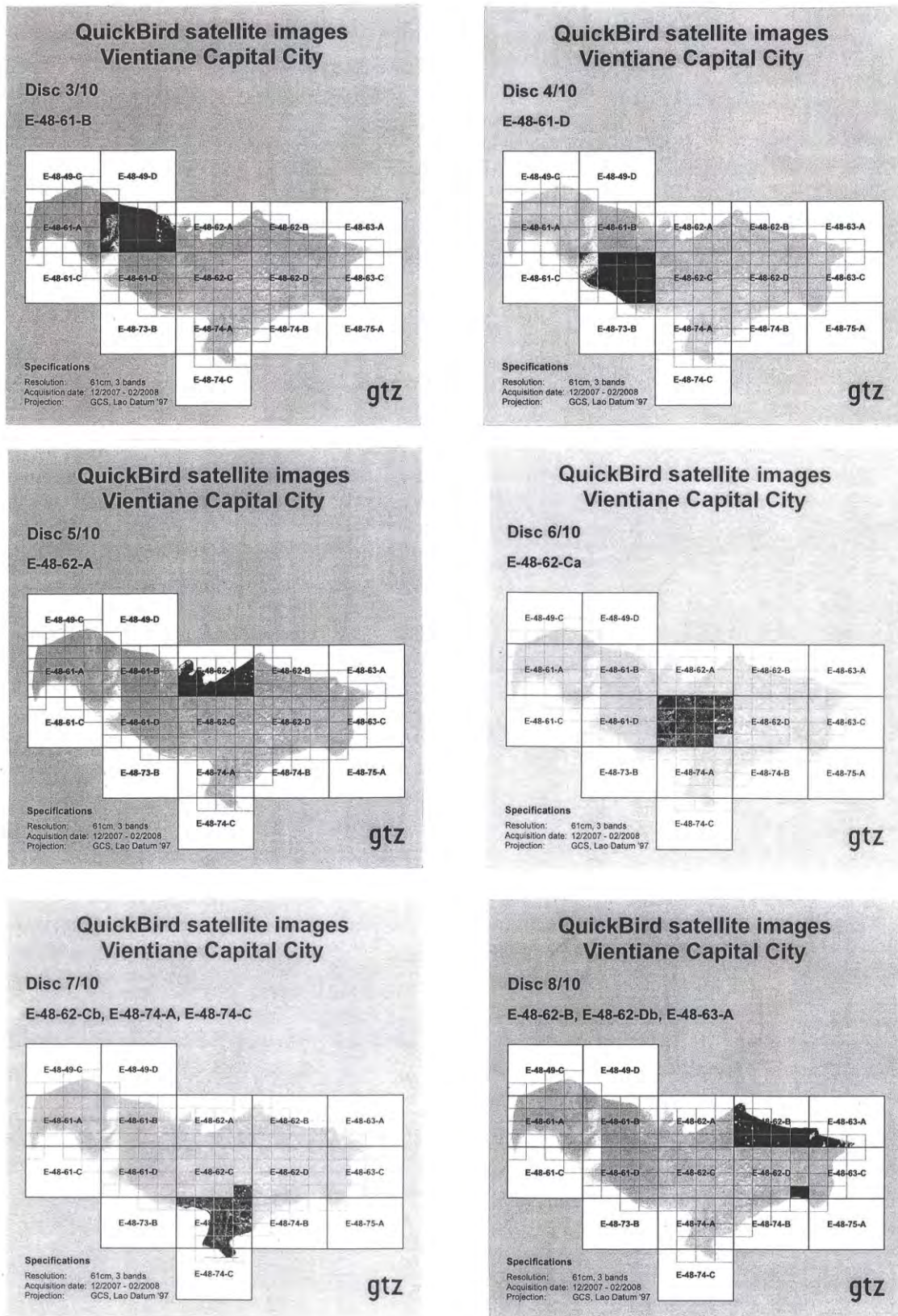


Fig. 6.2.3

Label Samples of Quick Bird Satellite Image DVD (2/3)

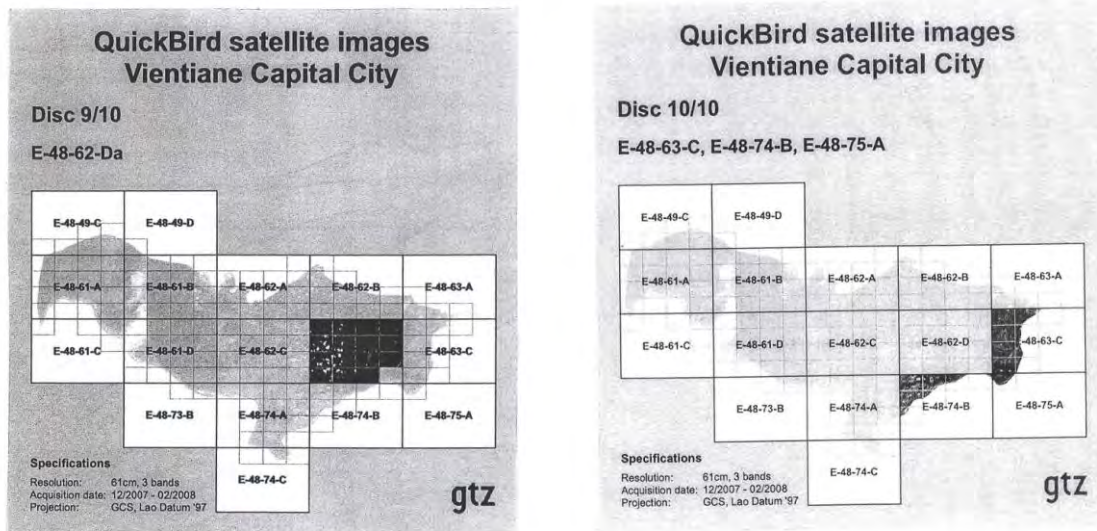


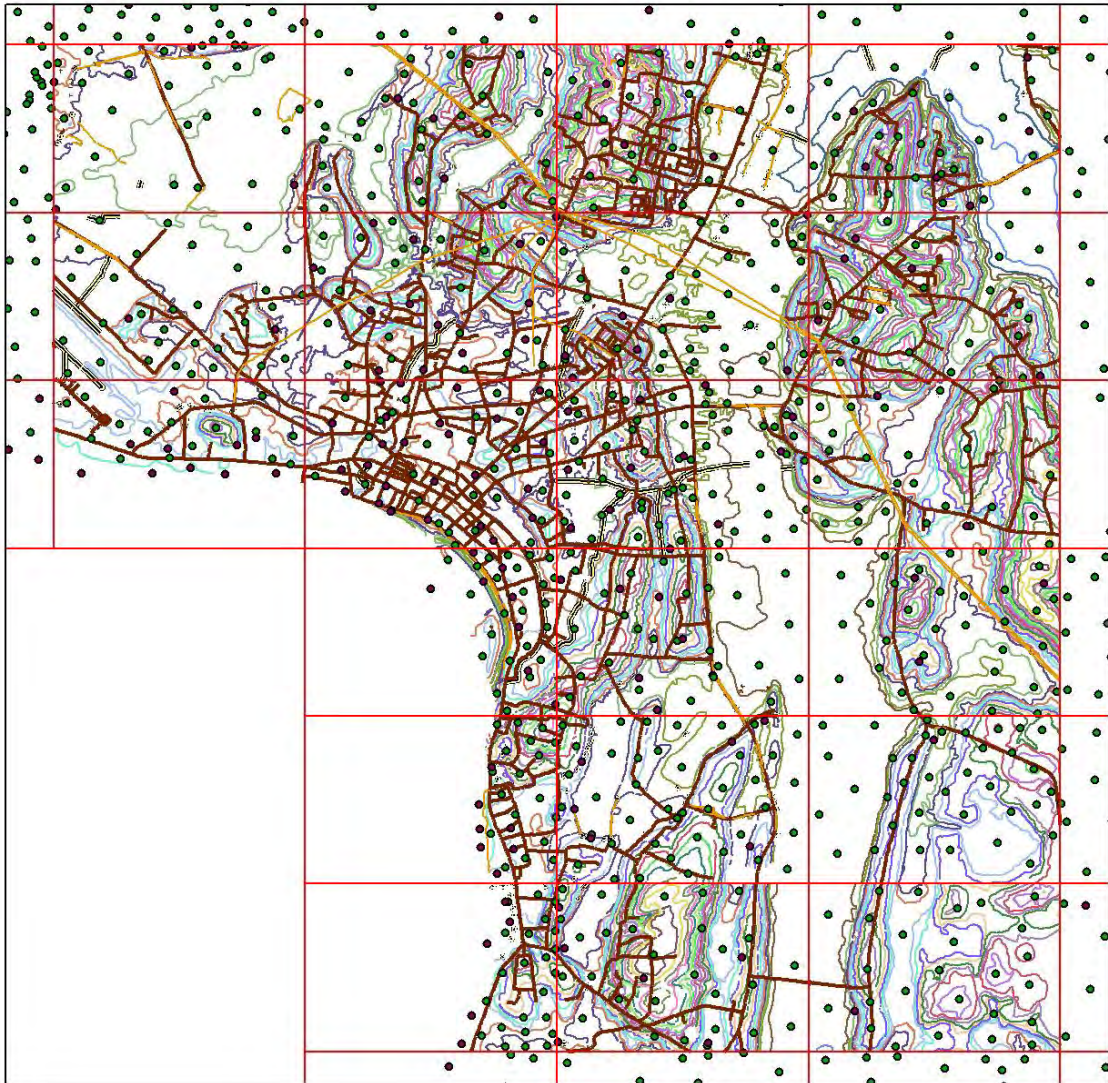
Fig. 6.2.4 Label Samples of Quick Bird Satellite Image DVD (3/3)

6.3 GIS Database

Through the study, many GIS source data and satellite image data were collected.

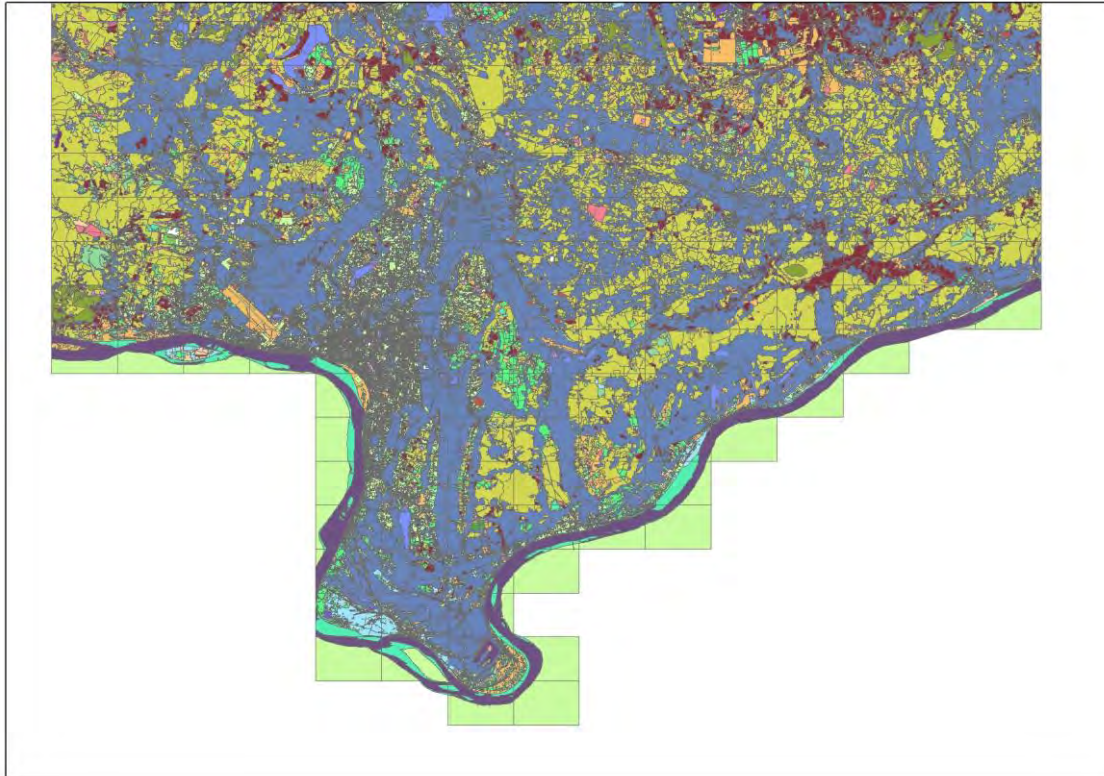
6.3.1 Topographic Map Data

The topographic data and land cover data in 1:5000 scale were collected from National Geographic Department of Lao PDR. The topographic data covers inner Vientiane City area, which includes 21 map sheets. The land cover data covers whole study area, which includes 116 map sheets. The data source is the aerial photos taken in February of 1999, and the data is formatted into LaoDatum 1997, UTM 48N Zone coordinate system.



Source: National Geographic Department

Fig. 6.3.1 **1 : 5000 Topographic Index Map**



Source: National Geographic Department

Fig. 6.3.2 **1 : 5000 Land Cover Index Map**

6.3.2 Hydrology Data

The hydrology data were created through the study. It includes Sub-basin boundary, sewage drainages, marshes, and catchment area data covering Mak Hiao River Basin. All these data are digitized from high quality satellite image, and formatted into 1:5000 scale.

6.3.3 Current River Status Data

Through the study, a huge volume data associated with current river status are collected. For good management of these data, they are all linked to GIS database and managed by a viewer system. The data includes river environment, river facilities, river ecology monitor, and river water quality monitor. The data are formatted in texts, photos and drawings, and linked to GIS viewer system.

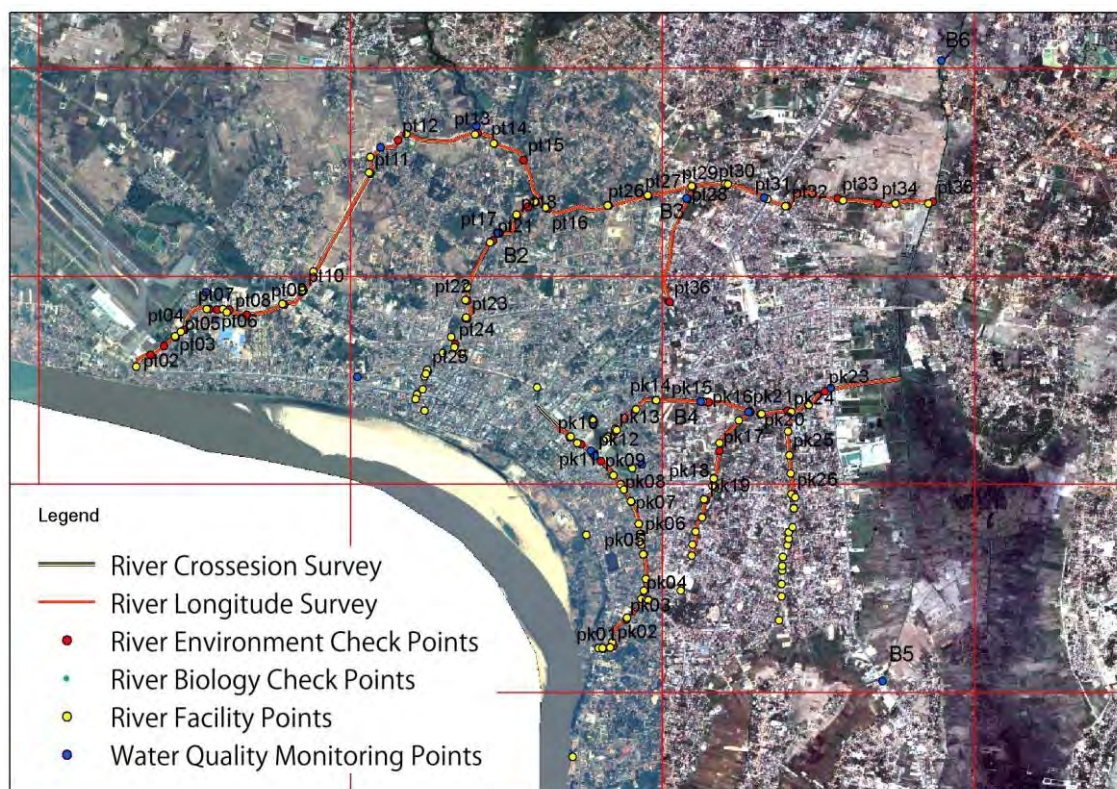


Fig. 6.3.3 Image map of current river status

6.3.4 Other Data

Besides above mentioned data, the social environment data, for example, population data linked to administration boundary are created through the study. Also, the natural environmental data, for example, forest reserve area data in the study area, are created into GIS database.

6.3.5 Unification of GIS Database Coordination System

The GIS data collected from different data source producers have different coordination system. So the data cannot be overlaid and matched to each other without converted to a unification coordination system. The original data coordination systems are listed as follows.

Table 6.3.1 Coordination System of GIS Data Sources

Data source	Coordination	Projection	Unit	Provider
Quick Bird Satellite Image	Geographic Coordination	WGS84	Decimal Degree	PTI
Topographic Map Data in 1:5K scale	UTM 48N	Datum of Lao 1997	Meter	National Geographic Department
Statistical Population Data	Geographic Coordination	North American 1927	Decimal Degree	National Statistic Department
Catchment Distribution	Geographic Coordination	WGS84	Decimal Degree	JICA Study Team
Field Survey Data	Geographic Coordination	WGS84	Decimal Degree	GPS
New Town	No Info	No Info	Meter	CAD data

The unification coordination system is decided to use UTM_48N_LAO97, because it is the standard coordination system in National Geographic Department. CAD data without any coordination information are also converted to those with the UTM_48N_LAO97 through Rubber Sheeting Tool. Parameters of the unification coordination system are as follows.

Table 6.3.2 Parameters of Standard Coordination System Name: UTM_48N_LAO97

Project Parameters	Projection	Transverse_Mercator
	False_Easting	500000.000000
	False_Northing	0.000000
	Central_Meridian	105.000000
	Scale_Factor	0.999600
	Latitude_Of_Origin	0.000000
Datum Parameters	Linear Unit	Meter
	Datum Name	The Lao National Datum 1997
	Angular Unit	Degree (0.017453292519943299)
	Prime Meridian	Greenwich (0.000000000000000000)
	Spheroid	Krasovsky 1940
	Semimajor Axis	6378245.000000000000000000
	Semiminor Axis	6356863.018773047300000000
Inverse Flattening	298.300000000000010000	

6.3.6 GIS Database Structure

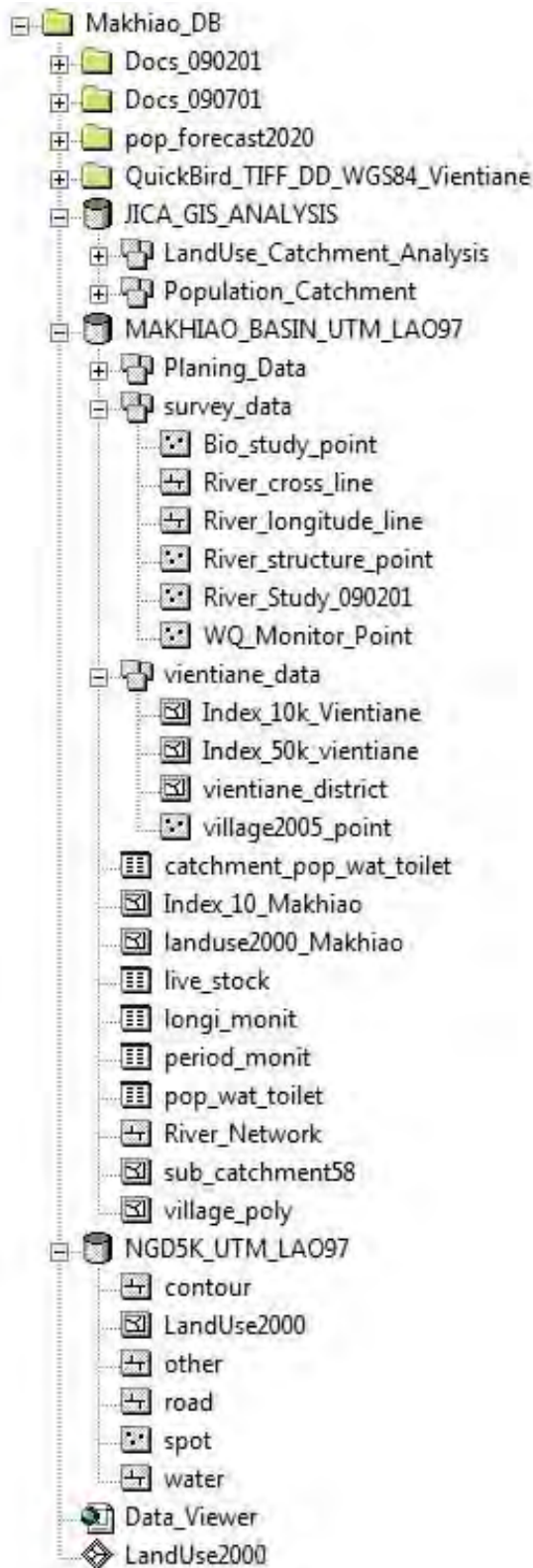


Fig. 6.3.4 Structure of GIS Database

All the files related to the database are installed in to Makhiao_DB folder. The documents data of photos and CAD drawings that collected through the study during February 2009 are saved in DOCS_090201 sub folder. The photos show the drainage conditions in dry season. The rainy season photos and docs are saved in DOCS_090701 sub folder. Pop_forecast2020, and JICA GIS ANALYSIS Folder are saved as the GIS analysis data. Quickbird_TIFF_DD_WGS84 folder stores the Quickbird satellite image data. MAK HIAO_BASIN_UTM_LAO97 personal database stores a group GPS field survey data, which is named DOC_VIEW, and also linked to the photos and docs which are stored in DOCS folder, so the docs and photos are easy to view in GIS software. Other data, sort of Industrial park, New Town, New Road which show development plans in the catchment area are also stored in this personal database. NGD5K_UTM_LAO97 personal database stored the 1:5k topographic map data which is collected from National Geographic Department.

Data_Viewer, which is an ARCGIS9.2 View File, can easy to view above data base.

6.4 GIS Database Viewer System

For simple browsing above GIS database, a GIS data viewer system was created. The functions of the viewer system are as follows.

6.4.1 River Environment GIS Viewer

According to the study, two main sewage drainages of Hong Xeng and Hong Ke are monitored through a field survey. Up to 62 main points of river environment along with the drainage canals, are surveyed and a photo database linked to those points is created. The photo database is linked to the GIS database, and can be easily displayed in the viewer system background with a high resolution satellite image.

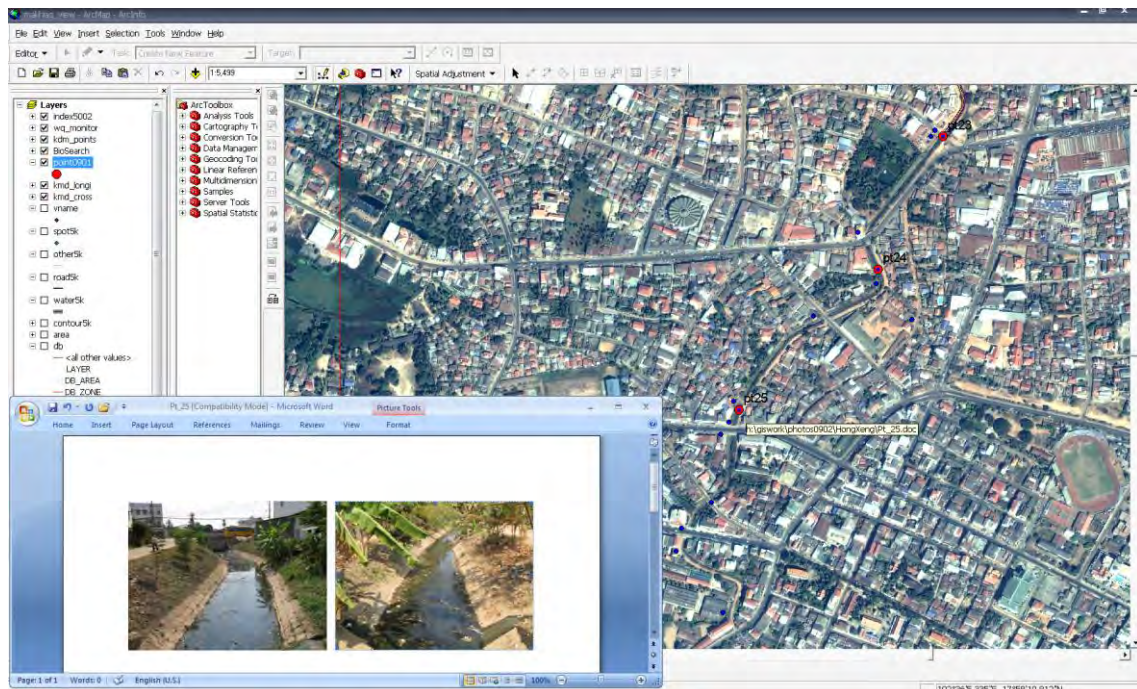


Fig. 6.4.1 River Environment Viewer

Explanation of the viewer system:

1. Opening the viewer from ARCMAP software, the map with satellite image background will be displayed. The river environment survey points are showed as red circle symbols.
2. Moving the mouse point over the river environment survey points, a file name that linked to photos will be displayed.
3. Clicking the file name, then a photo file will be opened.

6.4.2 Ecology and Water Quality Monitoring GIS Viewer

In this study, 6 ecology monitoring points and 14 water quality monitoring points are selected. The point position information and the photos showing the status of monitoring are linked together, and saved in GIS database. The operation of viewer system is same as the river environment viewer; Clicking the point, the photos will be opened.

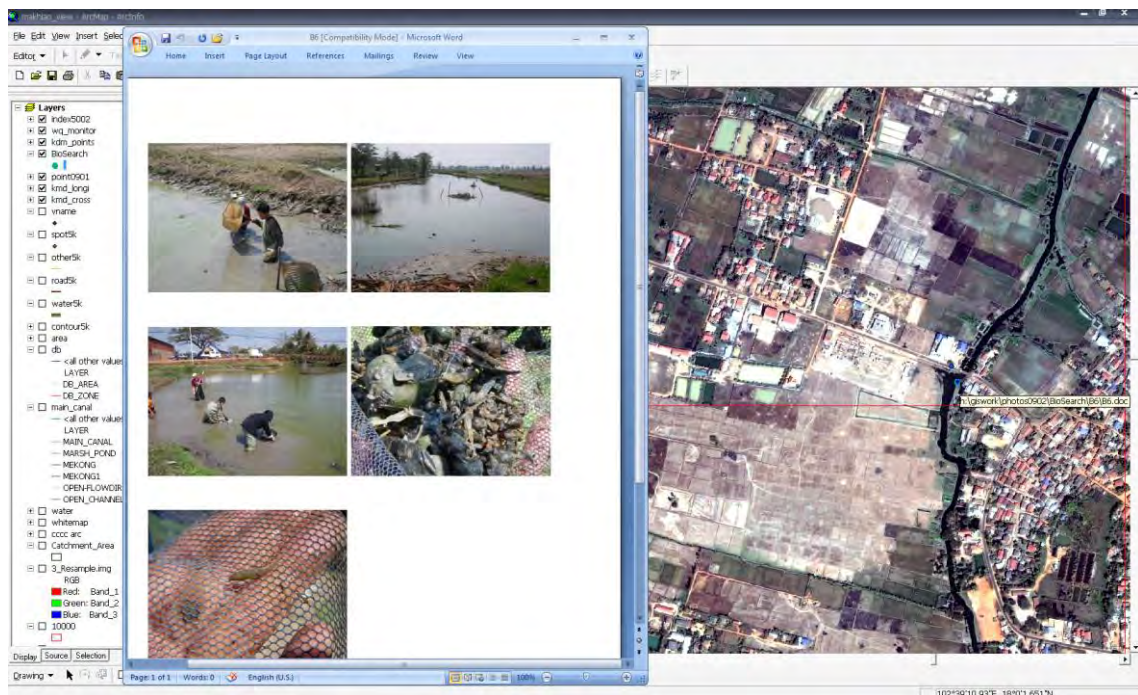


Fig. 6.4.2 Ecology and Water Quality Monitoring Viewer

6.4.3 River Facility GIS Viewer

Up to 117 river facility points, 89 river longitudinal survey lines, and 139 river cross-section survey lines information were collected in this study. The information includes facility photos and survey drawings. The point and line positions linked with photos and drawings are saved into the GIS database. The operation of viewer system is same as the river environment viewer, to click the point or line, the linked photos or drawings will be displayed.

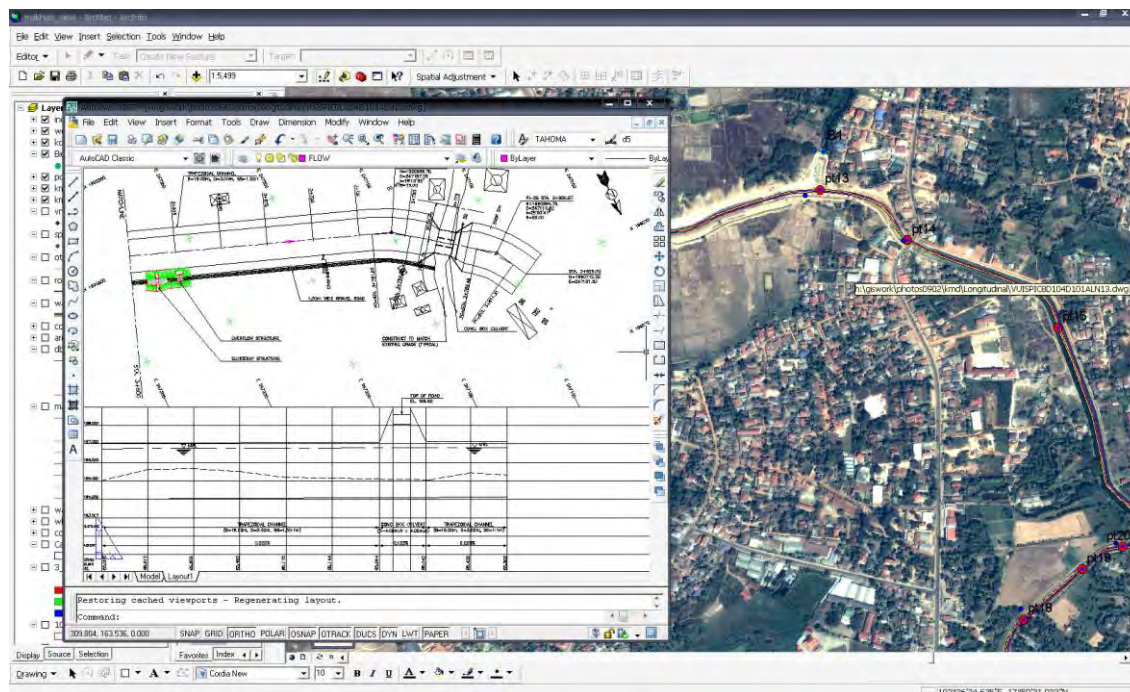


Fig. 6.4.3 River Facility Viewer

6.5 GIS Analysis

6.5.1 Basic Data

(1) Demographic Data at Village Level

In this analysis, the first data is the population data on 1995 and 2005 at village level; it is collected from National Statistic Department. The data includes village code and name, population in 1995 and 2005, water supply type in 1995 and 2005, toilet type in 1995 and 2005. The data items are as follows.

Table 6.5.1 Statistic Data List

Key Index Item	Village Code, Village Name
Population in 2005	House Holds, Male, Female, Total Populations
Supply Water Type in 2005	Pipe Water, Well Borehole Protected, Well Borehole Unprotected, River Stream Dam, Mountain Source, Rain Water, Other, Not Stated
Toilet Type in 2005	Type0, Type1, Type2, Type3, Type4
Population in 1995	House Holds, Male, Female, Total Populations
Supply Water Type in 1995	Pipe Water, Well Borehole Protected, Well Borehole Unprotected, River Stream Dam, Rain Water, Other
Toilet Type in 1995	Modern Toilet, Normal Toilet, Soak Pit, Other, None

(2) Village Administration Boundary GIS Data

The second data for this analysis is the village boundary GIS data; it is surveyed in a PTI project. The data covers all the study area and was made in 2009. So the demographic data can be linked to this village boundary data and easy to calculate the population density by using the boundary area value.

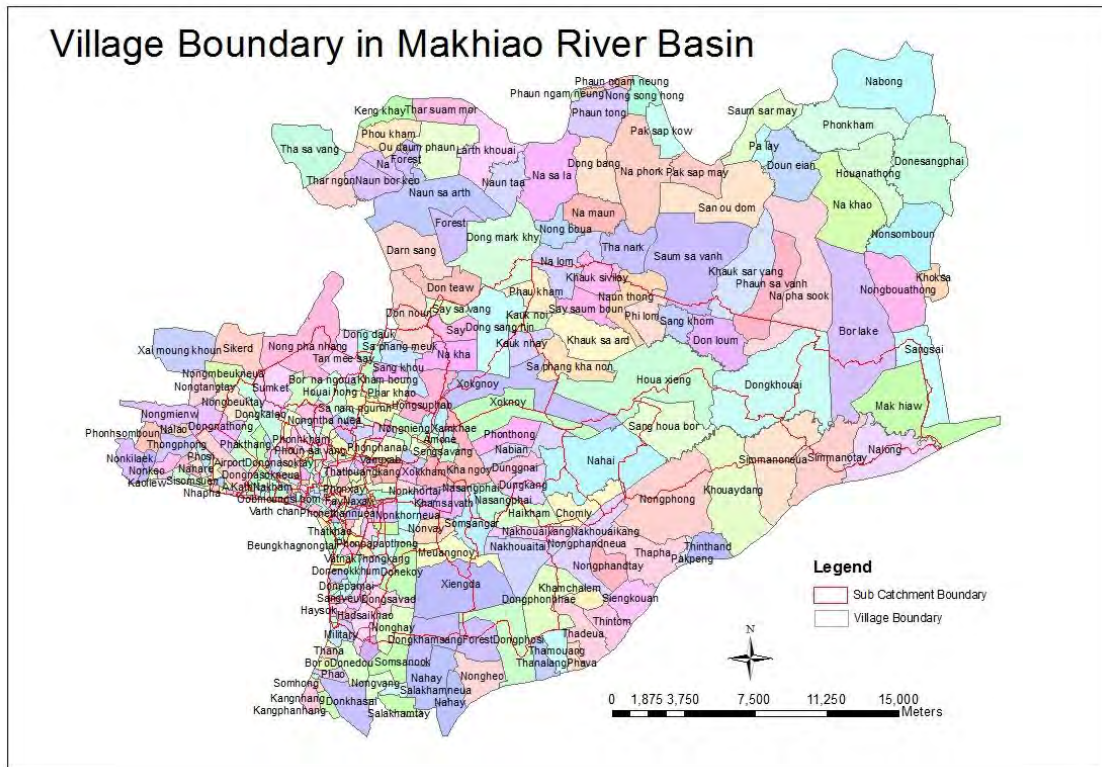
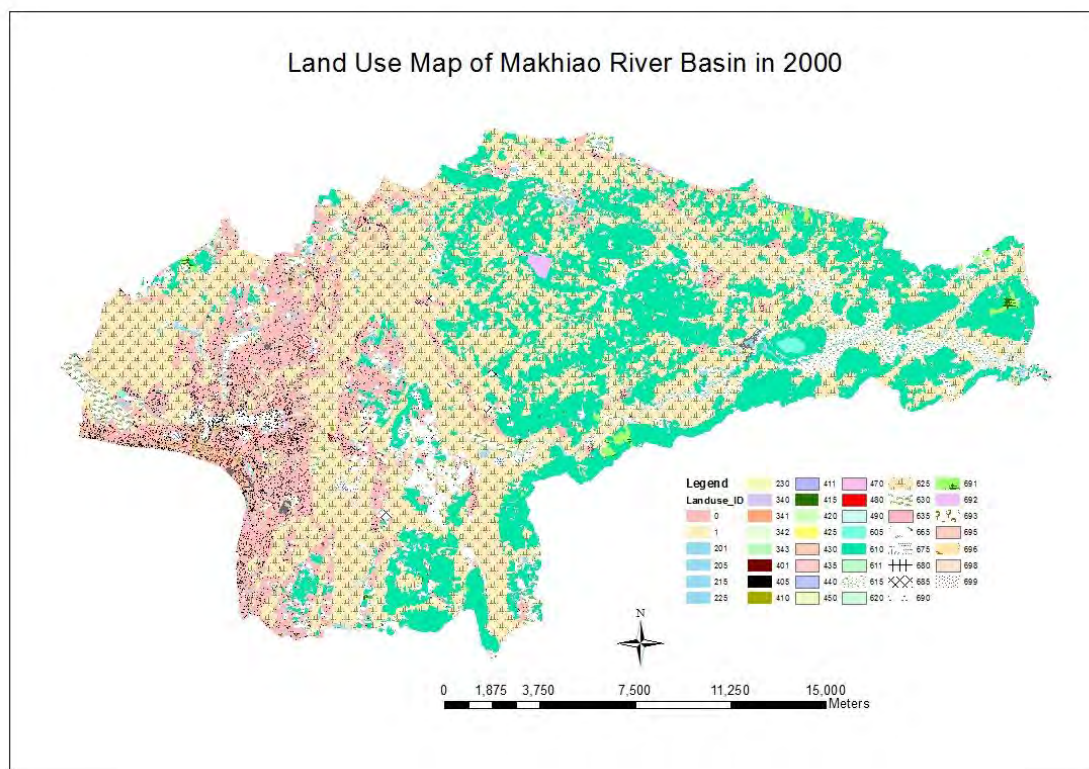


Fig. 6.5.1 Village Map in Mak Hiao River Basin

(3) Land Use Data in 2000

The land use data was already collected from the National Geographic Department, which is an old one in 2000, but it is a 1:5000 scale data. So the information can be easy to update with Quickbird satellite image. The data is clipped by catchment boundary.



Source: National Geographic Department

Fig. 6.5.2 Land Use Map of Mak Hiao River Basin in 2000

Table 6.5.2 Table of Land Use Description

Land Use ID	Land Use Description	Land Use ID	Land Use Description
0	Inner City	490	Christian Church
201	River, Stream	605	Dense Forest
205	Intermittent River or Stream	610	Sparse Forest
215	Water Canal (Width lt 10m)	615	Bush
225	Water, Pool, Pond	620	Bamboo
230	Basin, Swimming Pool	625	Rice Field
340	Road Edge (Paved)	630	Grass
401	Public/Office House	665	Orchard
405	Private House	675	Perennial Swamp
410	Commercial Building	680	Park
415	Industrial Building	685	Cemetery
420	School (University)	690	Other Plantation
425	Temple	691	Teak
435	Monument	692	Eucalyptus
440	Water Tower, Tank	693	Banana
450	Power Substation	696	Sugar
470	Gasoline	698	Papaya
480	Hospital	699	Sand

6.5.2 Population Projection of Vientiane City

(1) Projection Method

At first, the population of the Study Area in 2005 is calculated with that of Vientiane City in 2005, which is presented in "Population and Housing Census 2005". Then, the population is increased/decreased until 2020 with the same annual average rate between 1995 and 2005 for each village. As a result, the total population of Vientiane City implied in this calculation is larger than that projected by the Industrial Zone Survey because the annual average growth rate in 2005-2020 is assumed to be lower than that in 1995-2005 in the Industrial Zone Survey.

When the projection of the Industrial Zone Survey is considered, the population in the Study Area should be adjusted with the ratio of the two projections for Vientiane City in the same year in order to coincide with that of the Industrial Zone Survey.

The result of the population projection is summarized in the following table:

Table 6.5.3 Population Projection of the Study Area in 2020

Year	Vientiane City Industrial Zone	Vientiane City Water Environment	Adjustment Ratio	Study Area Before Adjustment	Study Area After Adjustment	Hong Ke Sub-basin After Adjustment	Hong Xeng Sub-basin After Adjustment
(1)	(2)	(3)	(4) = (2) / (3)	(5)	(6) = (5) × (4)	(7)	(8)
2005	692	692	1.000	328	328	51	112
2020	1,074*	1,284	0.837	551	462(499**)	44	164

Note: *) Since the Industrial Zone Survey presented only the data in 2015 and 2025, the data in 2020 was calculated by applying the annual average growth rate between the two years.

***) Value in parentheses includes population of new development area assumed by the Study Team

Source: Preparatory Survey on Industrial Zone Development in The Lao People's Democratic Republic, Interim Report, 2009, JICA

Projected population of each Village in year n can be calculated as follows:

$$P_n = P_{2005} \cdot (1 + R_{1995 \rightarrow 2005})^{(n-2005)} \cdot A_n$$

where,

P_n : Projected population of a village in year n

$R_{1995 \rightarrow 2005}$: Annual average growth rate of the Village between 1995 and 2005

A_n : Adjustment ratio in year n to coincide with the projection by the Industrial Zone Survey. For example, $A_{2020} = 0.837$.

Table 6.5.4 Adjustment Ratio

	2005	2006	2007	2008	2009	2010	2011	2012
Adjustment Ratio	1.000	0.997	0.996	0.991	0.986	0.979	0.971	0.961
Year	2013	2014	2015	2016	2017	2018	2019	2020
Adjustment Ratio	0.950	0.938	0.924	0.909	0.893	0.876	0.867	0.837

(2) Analysis of Population Projection Result

Change in population density between 2005 and 2020 in the center of Vientiane City is shown below. Mostly the increased populations are concentrated in Hong Xeng river basin, and the population distribution is extended form center to north east of the city.

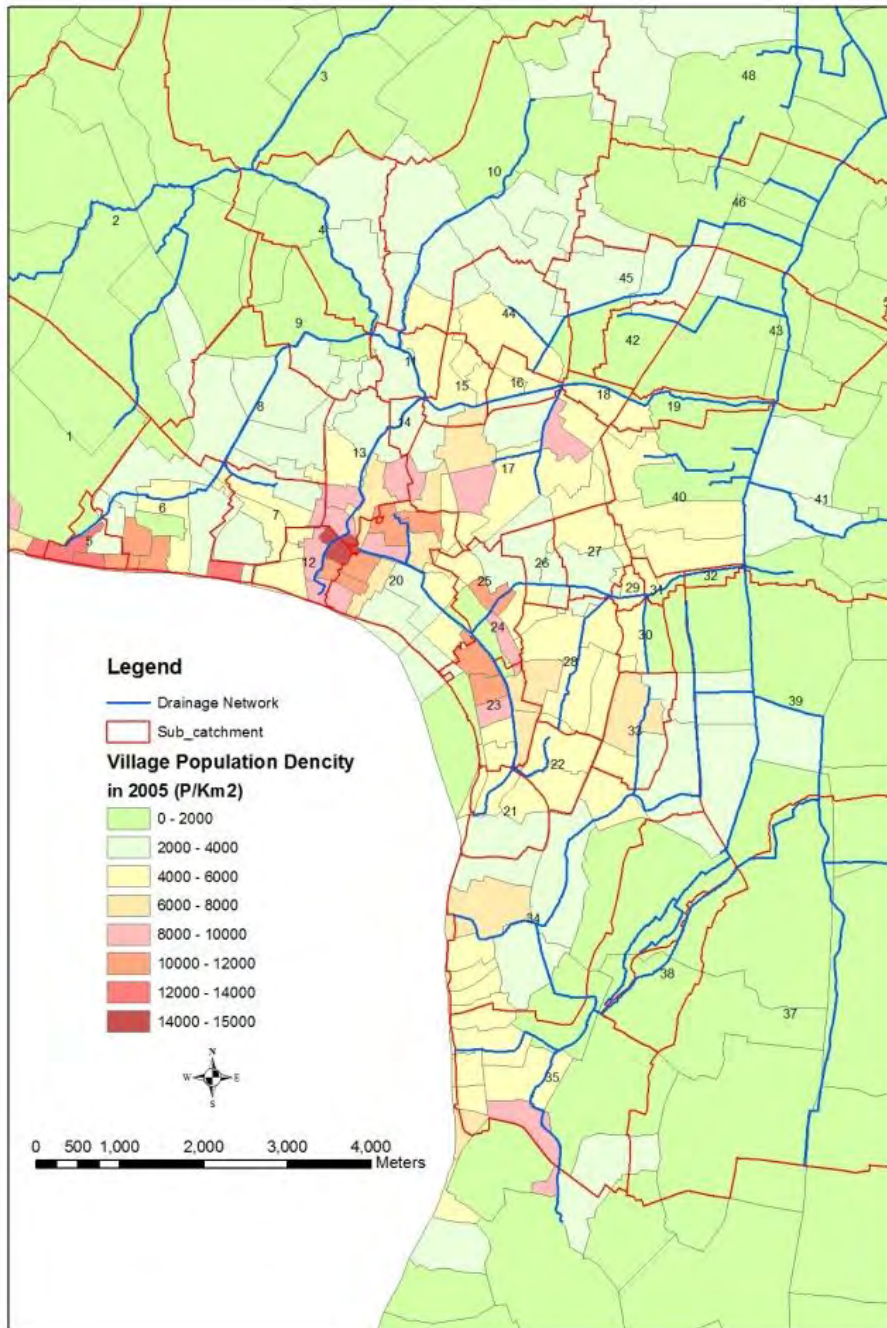


Fig. 6.5.3 Vientiane City Population Density in 2005

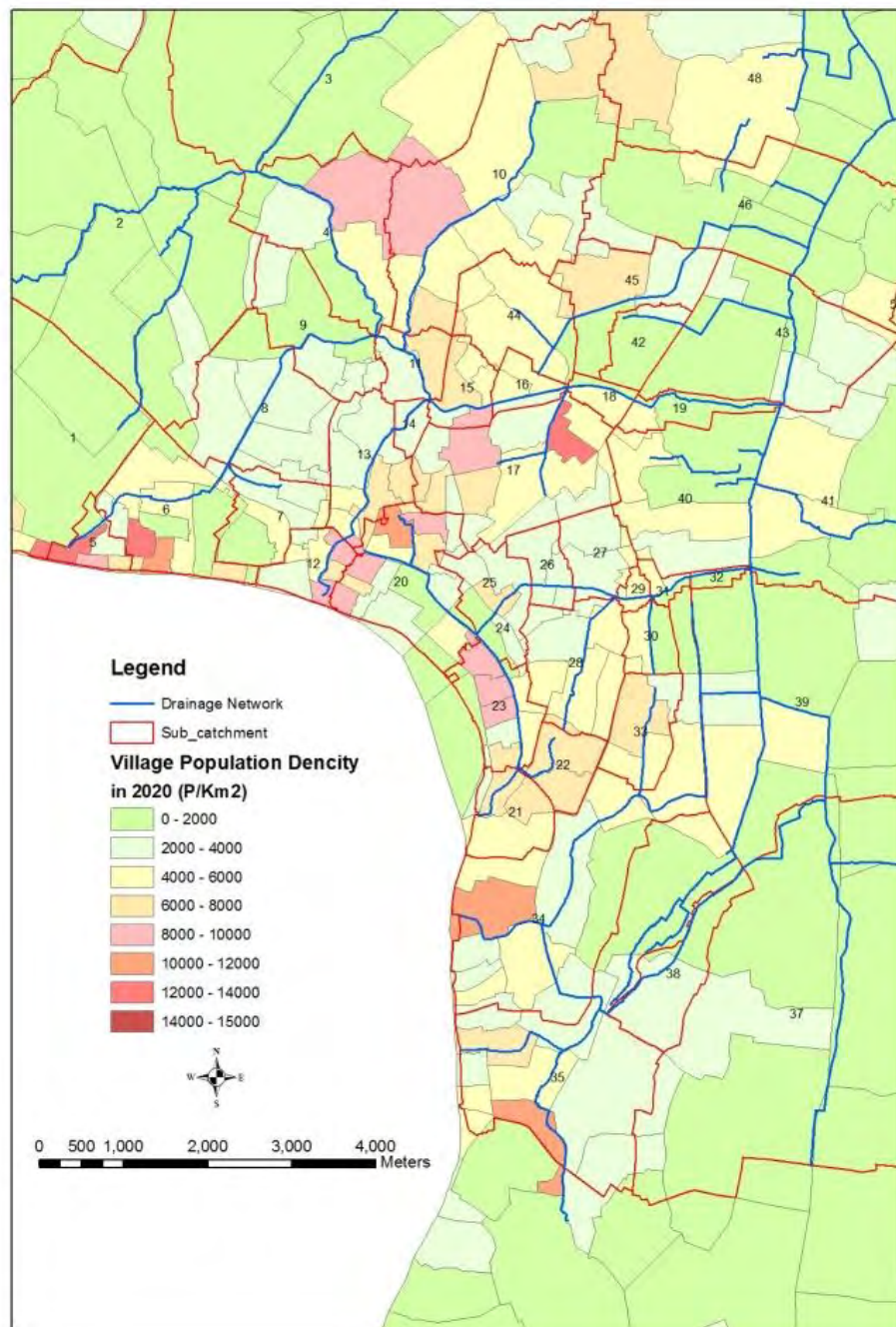


Fig. 6.5.4 Vientiane City Population Density in 2020

6.5.3 Sub-catchment Land Use Analysis

(1) Reclassification for better analysis

For easy analysis in this study, Land Use ID is reclassified to Class ID as follows.

Table 6.5.5 Land Use Reclassification

Land Use ID	Land Use Description	Class ID	Class Description		
0	Inner City				
340	Road Edge (Paved)				
401	Public/Office House				
405	Private House				
410	Commercial Building				
415	Industrial Building				
420	School(University)				
425	Temple				
435	Monument				
440	Water Tower, Tank				
450	Power Substation				
470	Gasoline				
480	Hospital				
490	Christian Church			1	Build Up Area
201	River, Stream			2	River
205	Intermittent River or Stream				
215	Water Canal (Width lt 10m)				
225	Water Pool, Pond	3	Marsh		
230	Basin, Swimming Pool				
675	Perennial Swamp	4	Forest		
605	Dense Forest				
610	Sparse Forest				
615	Bush				
620	Bamboo				
625	Rice Field	5	Rice Field		
630	Grass	6	Natural Field		
665	Orchard				
699	Sand				
680	Park	7	Park		
685	Cemetery				
690	Other Plantation	8	Farm Land		
691	Teak				
692	Eucalyptus				
693	Banana				
696	Sugar				
698	Papaya				

(2) Analysis of Sub Catchment Land Use by GIS Overlay

Finally, to overlay the Land Use and sub catchment area data, the GIS software can generate a new land use classification data. In this data, the Land Use is also divided into small polygon by sub catchment boundary.

To use Excel or statistic tools, the Land Use distribution area in every sub catchment area is calculated.

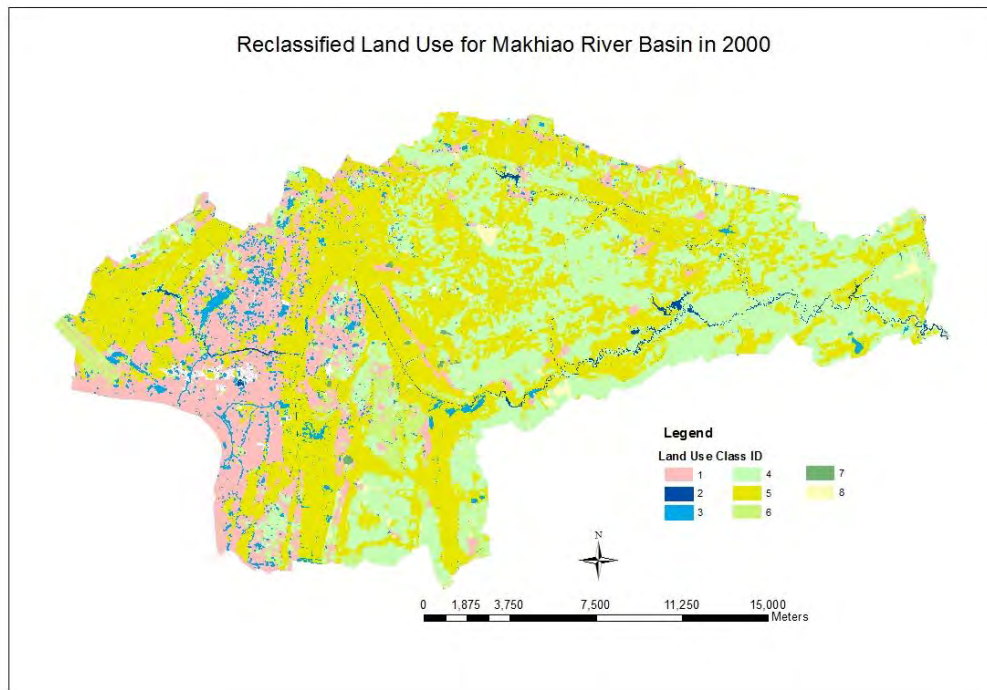


Fig. 6.5.5 Land Use Classification Map of Mak Hiao River Basin in 2000