REGIONAL DATABASE SYSTEM AND GIS FOR INFORMATION GATHERING OF INLAND CAPTURE FISHERIES

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1.0   Introduction

In present, fishery management tends to be more attractive and widely open in fishery research. Mostly fishery researches provide the information in biological, environmental and socio-economical studies. In Southeast Asian Region, there are many researches on inland capture fisheries, however these information are still not in record gradually and rarely available. Therefore, the gathering information in inland capture fishery becomes more importance and necessary. Developing of regional database system of collected information in inland capture fisheries is one of the most important mechanisms in order to provide the skeleton for more systematic collection of such information. In addition, to know the status and trend of inland capture fisheries information, of which is a key to sound policy-making and management.

Application of Geographical Information System (GIS) for inland capture fisheries is a tool to help in analysis and present the results from complicated information as visualized mapping information of which can reflect exactly the perception of users.

2.0   System Analysis

Generally, in inland capture fishery, researchers have attention in four main information namely: fisheries information, biological information, environmental conditions and socio-economic information. For fisheries information, the main components are fishery species, inland water area, fishing gear and landing. All above are related by some relations, which is shown in Figure 1.
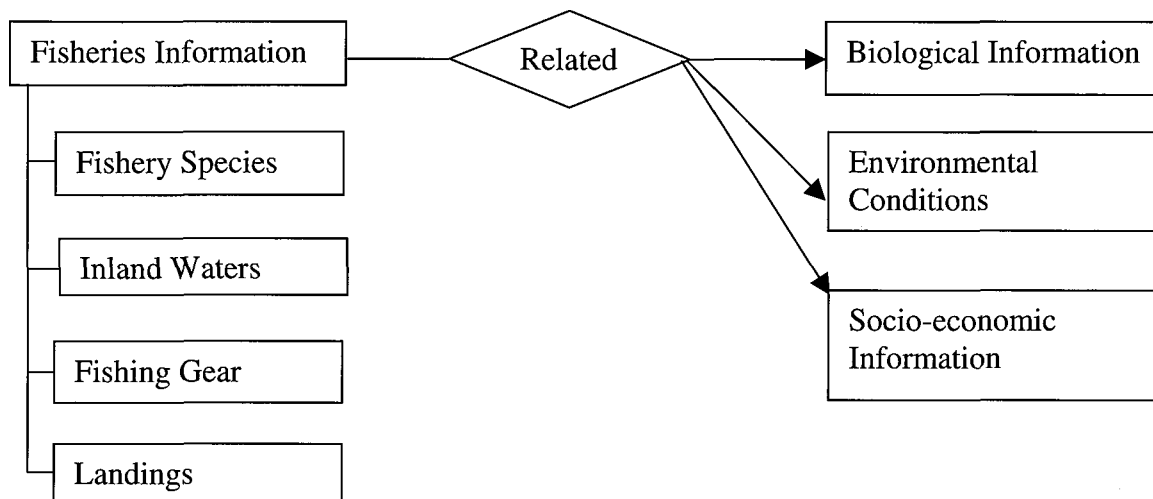
Figure 1: The skeleton of regional database system for Inland Capture Fisheries.

- **Fishery Species**: defines details and information of each fishery species.
- **Inland Waters**: defines details and information of each Inland water resources. (Lakes, Rivers, Reservoirs/dam, Swamps)
- **Fishing Gear**: defines details and information of each fishing gear.
- **Landing**: defines community, market, fish species, quantity and value of each landing place.

3.0   System Design

3.1   Fisheries Information

The data in inland capture fishery will be stored in database as tables. Each table is consisted of details and information for one type of Inland data called 'Entity' as:

- **Fishery_species**(*fish_code*, common_name, family_name, sub_family, order, class, weight, length, bmp_file)

- **Land/Area**(*land_id*, definition, country_reference)

- **Water_type**(*id*, definition)

- **Inland_water**(*inlandwater_id*, watertype_reference, definition, environmental_condition[1])

- **Market**(*market id*, definition, country_reference)

- **Gear**(*gearcode*, definition, bmp_file, remark)

- **Community**(*community_id*, definition)

And these tables represent the relations between/among Entities as;

a. **Fish_habitat(**_inlandwater_id_, _fish_code_, **biology_information**[2]**)**

This table is represented a relation between Fishery species and Inland water areas. For example, one fishery species belongs to one Inland water area or many, and in despite, one Inland water area is consisted of one fishery species or many also. Therefore, there is a relation between these two entities, Fishery species and Inland water; which specifies which types of fishery species belong in Inland water area in which types and where. The relation is shown as in Figure 2.
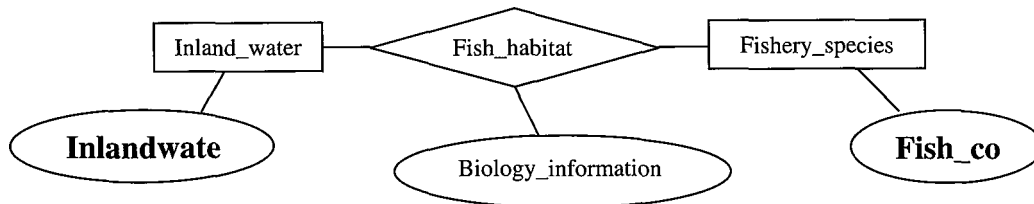
Figure 2:   Relation between Inland_water and Fisheries_species entities

b. **Water_land** (_inlandwater_id_, _land_id_, **waterland_id**)

This table is represented a relation between Inland water areas and Land/Area. In one Land/Area may be consisted of one Inland water area or many, in despite, also. Land/Area could be province, district or any kinds of land areas and Inland water area could be lake, river, reservoir/dam or swamp. The relation is shown as Figure 3.
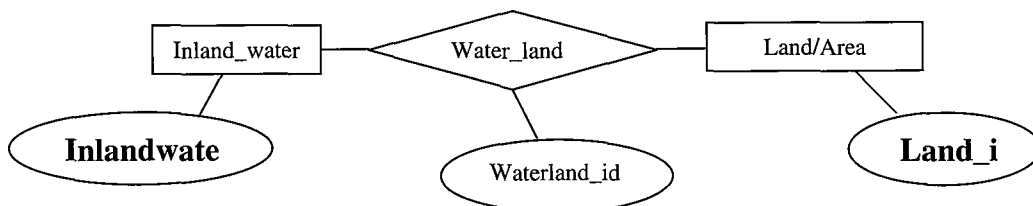
Figure 3:   Relation between Inland_water and Land/Area entities.

c. **Inland_community** (_community_id_, _waterland_id_, **socio-economic_information**[3]**)**

This table is represented a relation between Community and waterland area. For example, one community exists one or many waterland area, one or many types of Inland water area and one or many Land/Area; and one waterland area may belong to one community or many. Therefore, this relation could specify which community exists which types and which waterland area, including how socio-economic management is. The relation is shown as Figure 4.
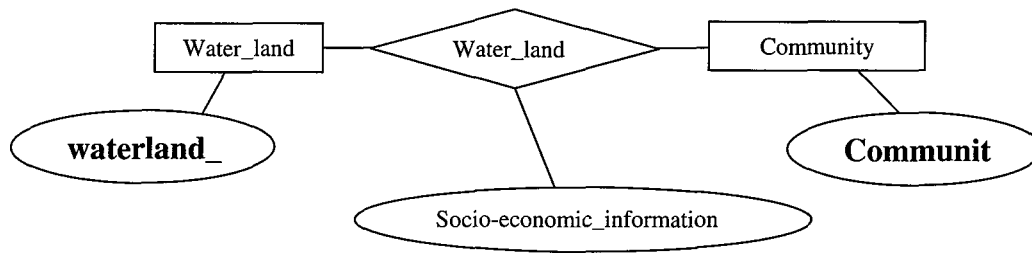
Figure 4: Relation between Water_land and Community entities

d. Landing (*community_id, fish_code, market_id*, quantity, value)

This table is represented a relation among Community, Fishery species and Market place. For example, one community exists one or many market place(s) and one market place sells one fishery species or many species, and as the same way, one fishery species may be sold in one community or many communities. Hence, these three entities could specify which market in which community sells fishery specie in which in how many quantities and how much in value as a relation. The relation is shown as Figure 5.
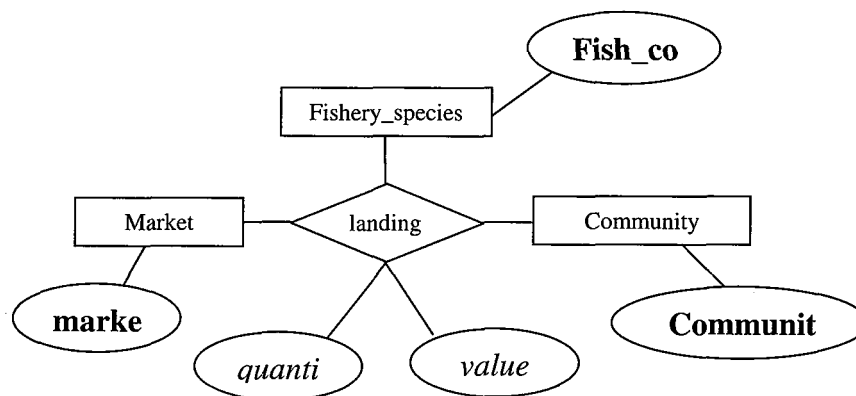
Figure 5: Relation among Market, Fisheries_species and Community entities.

e. Capture (*waterland_id, fish_code, gearcode*)

This table is represented a relation among Water_land, Fishery species and Fishing Gear. For example, in one water_land, which is a relation between Inland water areas and Land/Area; exists one fishery specie or many and the fishery specie(s) is caught by one or many types of gears. Therefore, this relation could specify which fishery species are caught by which types of gears in where and which types of water_land area. The relation is shown as in Figure 6.

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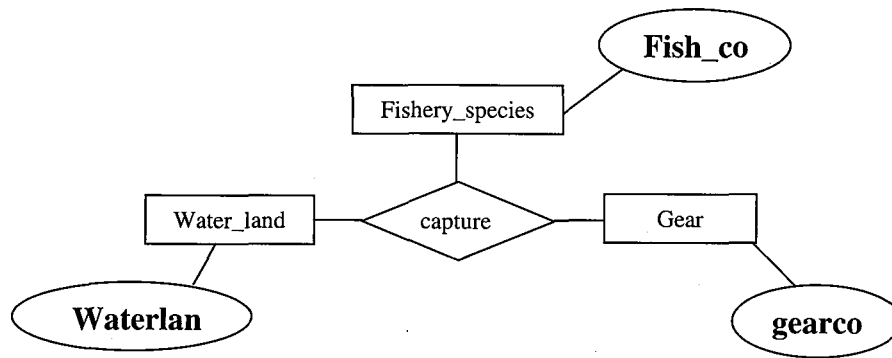
Figure 6: Relation among Water_land, Fisheries_species and Gear entities.

3.2   Environmental Conditions

The parameters are:

Physical: water_depth,   water_current-   (speed,   direction),   conductivity, turbidity, alkalinity, hardness, water temperature, air temperature, sediment, temperature, rainfall, etc.

Chemical: Phosphate, Nitrate, Nitrite, Ammonia, Ferric, Dissolved Oxygen, Silicate, etc.

Biological: Chlorophyll,   plankton,   larvae,   benthos,   sediments,   organic matter, etc.

3.3   Biological Information

Biological information is data such as development, stomach contents, habitat, distribution, sex ratio, etc.

3.4   Socio-economic Information

Examples of data are amount of household in community, race, age group, culture, etc.

4.0   Data Requirements for GIS

Basic data requirements for GIS of Inland Capture Fisheries in the ASEAN region are tabulated in Tables 1 (Brunei Darussalam), Table 2 (Cambodia), Table 3 (Indonesia), Table 4 (Lao PDR), Table 5 (Malaysia), Table 6 (Myanmar), Table 7 (Phillippines), Table 8 (Thailand) and Table 9 (Viet Nam).

Table 1:   Check List of Important Rivers and Reservoir/ Dam/Lake in Brunei Darussalam.

No.	Name	Location/ Position	Area (unit)	Province/ State	Any Landings	Available map (y/n)
	Rivers					
1.	Sungai Temburong					
2.	Sungai Pandaruan					
3.	Sungai Tutong					
4.	Sungai Belait					
	Reservoir and Dam					
1.	Tasek Reservoir*					
2.	Benutan Dam*					
	Lake					
1.	Laboi Lake*					
2.	Pedu Lake*					
3.	Tasek Merimbun Lake*					

Table 2:   Check List of Important Rivers and Reservoir/ Dam/Lake in Cambodia.

No.	Name	Location/ Position	Area (unit)	Province/ State	Any Landings	Available map (y/n)
	Rivers					
1.	Sreng					
2.	Svaychek					
3.	Sanker					
4.	Pouthisat					
5.	Sen					
6.	Chinit					
7.	Thnot					
8.	Mekong					
9.	Kong					
10.	Sanker					
11.	Srepok					
12.	Chbar					
13.	Te					
14.	Tonle Sap					
	Reservoir and Dam					
1.	Prek Thnot Dam*					
2.	Kamchay*					
3.	Sambor Dam*					
4.	Ochum Dam*					
	Lake					
1.	Tonle Sap					
2.	West Barai Lake*					
3.	Lak Lake*					

Table 3: Check List of Important Rivers and Reservoir/ Dam/Lake in Indonesia.

No.	Name	Location/ Position	Area (unit)	Province/ State	Any Landings	Available map (y/n)
	Rivers					
1.	Woyla					
2.	Tripa					
3.	Alas					
4.	Asahan					
5.	Rokan					
6.	Mandau					
7.	Siak					
8.	Kampar					
9.	Inderagiri					
10.	Hari					
11.	Tembesi					
12.	Musi					
13.	Mesuji					
14.	Tulangbawang					
15.	Landak					
16.	Kapuas					
17.	Pawan					
18.	Jelai					
19.	Pembuang					
20.	Seruyan					
21.	Melawi					
22.	Sampit					
23.	Katingan					
24.	Kahayan					
25.	Kapuas					
26.	Barito					
27.	Teweh					
28.	Murung					
29..	Mahakam					
30.	Belayan					
31.	Kutai					
32.	Telen					
33.	Kelai					
34.	Kayan					
35.	Iwan					
36.	Bahau					
37.	Sembakung					
38.	Lariang					

39.	Palu				
40.	Karama				
41.	Bangka				
42.	Lalindu				
43.	Lasolo				
44.	Apu				
45.	Kais				
46.	Timbuni				
47.	Siriwo				
48.	Wapoga				
49.	Uta				
50.	Derewo				
51.	Mamberamo				
52.	Tariku				
53.	Van Daalen				
54.	Tor				
55.	Taritata				
56.	Sobger				
57.	Cemara				
58.	Northwest				
59.	Unir				
60.	Baliem				
61.	Palua				
62.	Mapi				
63.	Digul				
64.	Uwimmerah				
65.	Bian				
66.	Merauke				
67.	Jatiluhur*				
	Reservoir and Dam				
1.	Balambano Dam*				
2.	The Wonogiri Multipurpose Dam Reservoir*				
3.	PLTA Kotopanjang*				
4.	PLTA Poso-3 Hydro Dam*				
	Lake				
1.	Danau Lout Tawar				
2.	Danau Toba				
3.	Danau Singkarak				
4.	Danau Kerinci				
5.	Danau Ranau				
6.	Danau Jempang				
7.	Danau Poso				

8.	Danau Matano					
9.	Danau Towuti					
10.	Danau Yamar	104				
11.	Danau Paniai					
12.	Danau Romberbai					
13.	Anggi Gigi					
14.	Anggi Gita					
15.	Lake Saguling*					
16.	Danau Manindjau*					.
17.	Danau Sentani*					
18.	DanauSentarum*					
19.	Triton Lakes*					
20.	Irain Jaya Lake*					
21.	Danau Rawa*					
22.	Keli Muta Volcanic Lake*					
23.	Tiwu Ata Polo*					
24.	Tiwu Nua Muri Fah*					

Table 4:　Check List of Important Rivers and Reservoir/ Dam/Lake in Lao PDR.

No.	Name	Location/ Position	Area (unit)	Province/ State	Any Landings	Available map (y/n)
	Rivers					
1.	Tha					
2.	Ou					
3.	Xeng					
4.	Khan					
5.	Ngum					
6.	Nuen					
7.	Ngiep					
8.	Theun					
9.	Kong					
10.	Bang Fai					
11.	Bang Hieng					
12.	Done					
13.	Tale*					
14.	Nam Ma*					
15.	Nam Mat*					
16.	Nam Xa*					
17.	Nam Luang*					
18.	Nam Mo*					
	Reservoir and Dam					
1.	Nam Ngum Dam					
2.	Nam Mouan Dam*					
3.	Nam Ou Dam*					
4.	Nam Hai Dam*					
5.	Nam Ngiep Dam*					
6.	Nam Theun Dam*					
7.	Nam Tha Dam*					
8.	Nam Theun Hinboun Dam*					
9.	Nam Suang Dam*					
10.	Nam Khan Dam*					
11.	Nam Cha Dam*					
12.	Nam Kong Dam*					
13.	Nam Lik Dam*					
14.	Nam Sane Dam*					
15.	Nam Ting Dam*					
16.	Nam Leuk Dam*					
17.	Nam Beng Dam*					
18.	Nam Mang Dam*					

19.	Nam Ko Dam*					
20.	Nam Noua Dam*					
21.	Houay Ho Dam*					
22.	Huay Lamphanh Dam*					
23.	Keng Wek Dam*					
24.	Sebangfai Dam*					
25.	Sebanghieng Dam*					
26.	Sebangnouane Dam*					
27.	Sedone Dam*					
28.	Sekaman Dam*					
29.	Sekong Dam*					
30.	Selabam Dam*					
31.	Senamnoy Dam*					
32.	Sepone Dam*					
33.	Sexou Dam*					
34.	Xeset Dam*					
	Lake					
1.	Nong Chanh Marsh Lake*					

Table 5:   Check List of Important Rivers and Reservoir/ Dam/Lake in Malaysia.

No.	Name	Location/ Position	Area (unit)	Province/ State	Any Landings	Available map (y/n)
	Rivers					
1.	Perak					
2.	Kelantan					
3.	Pahang					
4.	Rajang					
5.	Batang Baleh·					
6.	Batang Baram					
7.	Sungai Tinjar					
8.	Sungai Tutoh					
9.	Sungai Limbang					
10.	Batang Trusan					
11.	Sugat					
12.	Lupar Batang*					
13.	Nenggiri*					
14.	Sungai Batu Pahat*					
15.	Lemanak*					
16.	Skrang*					
17.	Terengganu*					
18.	Dungun*					
19.	Endau*					
20.	Sedili*					
	Reservoir and Dam					
1.	Kenyir Reservoir*					
2.	Bakun Dam*					
3.	Chenderah Reservoir*					
4.	Talang Dam*					
5.	Pahang Dam*					
	Lake					
1.	Tasek Kenyir lake*					
2.	Pedu Lake*					
3.	Ulu Lepar Lake*					
4.	Tasek Bera Lake*					
5.	Tasek Chini Lake*					
6.	Tasek Temenggor Lake*					
7.	Biru Kundang Lake*					
8.	Taiping Lake*					
9.	Ayer Keroh Lake*					

10.	Tasek Melati*					
11.	Tasek Timah-Tasoh*					
12.	Tasek Raban*					

Table 6:   Check List of Important Rivers and Reservoir/ Dam/Lake in Myanmar.

No.	Name	Location/ Position	Area (unit)	Province/ State	Any Landings	Available map (y/n)
	Rivers					
1.	Nmai					
2.	Mali					
3.	Uyu					
4.	Chindwin					
5.	Shweli					
6.	Manipur					
7.	Myittha					
8.	Mu					
9.	Tu					
10.	Pang					
11.	Nam Hka					
12.	Mon					
13.	Kaladan					
14.	Irrawaddy (Ayeyarwady)					
15.	Sittang (Sittoung)					
16.	Pilu					
17.	Teng					
18.	Salween (Thanlwin)					
19.	Great Tenasserim					
20.	MeKong					
	Reservoir and Dam					
1.	Nyauggyat (Kinda) Dam*					
2.	Yeywa Dam*					
3.	Bilin Dam*					
4.	Paunglaung Dam*					
5.	Ta Sang Dam*					
	Lake					
1.	Indawgyi lake					
2.	Inle lake					

Table 7:   Check List of Important Rivers and Reservoir/ Dam/Lake in Philippines.

No.	Name	Location/ Position	Area (unit)	Province/ State	Any Landings	Available map (y/n)
	Rivers					
1.	Cagayan					
2.	Agusan					
3.	Pampanga*					
4.	Agno*					
5.	Mindanao*					
	Reservoir and Dam					
1.	San Roque Dam*					
2.	Ambuklao Dam*					
3.	Masiway Dam*					
4.	Pantabangan Dam*					
5.	Binga Dam*					
6.	Sibuguey Dam*					
7.	Manangga Hydro Dam*					
8.	Matuno Dam*					
9.	Panay River Dam*					
10.	Angat Dam*					
11.	Palangui IV Dam*					
12.	Magat Dam*					
13.	La Mesa Dam*					
14.	Ipo Dam*					
15.	Agus Dam*					
	Lake					
1.	Laguna de Bay					
2.	Lake Taal					
3.	Naujan Lake					
4.	Bato Lake*					
5.	Lanao Lake*					
6.	Lake Sebu*					
7.	Caliraya Lake*					
8.	Lake Buhi*					
9.	Mainit*					
10.	Pinatubo*					

Table 8:   Check List of Important Rivers and Reservoir/ Dam/Lake in Thailand.

No.	Name	Location/ Position	Area (unit)	Province/ State	Any Landings	Available map (y/n)
	Rivers					
1.	Chao Phraya River					
2.	Sa Kae Krang River					
3.	Pasak River					
4.	Noi River					
5.	Lop Buri River					
6.	Mae Klong River					
7.	Khwae Yai River					
8.	Khwae Noi River					
9.	Tha Chin River					
10.	Phetburi River					
11.	Pran Buri River					
12.	Ping River					
13.	Wang River					
14.	Yom River					
15.	Nan River					
16.	Kok River					
17.	Sala Win River					
18.	Nam Mae Tun					
19.	Moei River					
20.	Kong River					
21.	Chi River					
22.	Mun River					
23.	Lam Ta Khong					
24.	Ta Pi River					
25.	Pat Tani River					
26.	Bang Nara River					
27.	Ko Lok River					
28.	Khlong Phum Duang					
29.	Bang Pa Kong River					
30.	Pra Chin Buri River					
31.	Nakhon Nayok River					
	Reservoir and Dam					
1.	Ban Phu Reservoir					
2.	Bung Don Wai Reservoir					
3.	Bung Katon Reservoir					
4.	Huai Chan Reservoir					
5.	Huai Chorakhe Mak Reservoir					

6.	Huai Khem Reservoir					
7.	Huai Kho Reservoir					
8.	Huai Kut Daeng Reservoir					
9.	Huai Mekha Reservoir					
10.	Huai Raeng Reservoir					
11.	Huai Nong Han Reservoir					
12.	Huai Sai Reservoir					
13.	Huai Saneng Reservoir					
14.	Huai Sap Reservoir					
15.	Huai Sawai Reservoir					
16.	Huai Seg Reservoir					
17.	Huai Som Hong Reservoir					
18.	Huai Talat Reservoir					
19.	Huai Som Poi Reservoir					
20.	Huai Yai Reservoir					
21.	Kaset Reservoir					
22.	Khok Sa Kat Reservoir					
23.	Khok Thom Reservoir					
24.	Krathiam Reservoir					
25.	Kut Sang Reservoir					
26.	Lam Pratiap Reservoir					
27.	Lam Dom Noi Reservoir					
28.	Lam Nang Rong Reservoir					
29.	Lam Phok Reservoir					
30.	Lam Chamuak Reservoir					
31.	Sinakharin Reservoir					
32.	Krasieo Reservoir					
33.	Huai Thian Reservoir					
34.	Kaeng Krachan Reservoir					
35.	Khlong Som Poi Reservoir					
36.	Huai Chan Reservoir					
37.	Tha Krabak Reservoir					
38.	Angkepnam Nong Nam Khieo					
39.	Angkepnam Bung Phra					
40.	Map Prachan Reservoir					
41.	Huai Dok Krai Reservoir					
42.	Khlong Bang Phai Reservoir					
43.	Ampun Reservoir					
44.	Angkepnam Bang Phuan					
45.	Angkepnam Huai Kan Luang					
46.	Angkepnam Bung Aram					
47.	Angkepnam Huai Aeng					
48.	Angkepnam Huai Kham Pla Khao					
49.	Angkepnam Huai Pho					

50.	Angkepnam Kaeng Loeng Chan					
51.	Angkepnam Lam pao					
52.	Angkepnam Lam Sam Lai					
53.	Angkepnam Nam Phar					
54.	Angkepnam Nam Phung					
55.	Angkepnam Nong On					
56.	Angkepnam Phong					
57.	Angkepnam Phuttha Utthayan					
58.	Angkepnam Soa Nam Khao					
59.	Ban Ko Kaeo Reservoir					
60.	Ban Khok Yang Reservoir					
61.	Nam Phrom Reservoir					
62.	Nam Un Reservoir					
63.	Nong Fa Reservoir					
64.	Nong Hai Reservoir					
65.	Nong Han Kumphawapi					
66.	Nong Hi Reservoir					
67.	Nong Khaen Reservoir					
68.	Nong Kraman Reservoir					
69.	Nong Lao Hin Reservoir					
70.	Nong Luang Reservoir					
71.	Nong Phu Reservoir					
72.	Nong Sam Nga Reservoir					
73.	Nong Sang Yai Reservoir					
74.	Nong Si Reservoir					
75.	Nong Song Hong Reservoir					
76.	Nong Thalok Reservoir					
77.	Nong Yat Reservoir					
78.	Phu Phek Reservoir					
79.	Ta Kao Reservoir					
80.	Ta Mai Reservoir					
81.	Tha Chok Reservoir					
82.	Thung Kraten Reservoir					
83.	Wang Hin Reservoir					
84.	Kwan Phayao					
85.	Sirikit Reservoir					
86.	Bhuamibol Reservoir					
87.	Bung Boraphet					
88.	Angkebnam Bang Lang					
89.	Lam Phra Phloeng Dam					
90.	Lam Takhong Dam					
91.	Ratchaprapha Dam					
92.	Ubonrat Reservoir					
93.	Kaeng Sua Ten Dam*					

94.	Klong Ta Lew, Klong Ta Rong Dam*					
95.	Lam Dom Yai Dam*					
96.	Mae wong Dam*					
97.	Phong Khut Phet Dam*					
98.	Tasae Dam*					
99.	Pak Mun Dam*					
	Lake					
1.	Songkhla lake					

Table 9: Check List of Important Rivers and Reservoir/ Dam/Lake in Viet Nam.

No.	Name	Location/ Position	Area (unit)	Province/ State	Any Landings	Available map (y/n)
	Rivers					
1.	Gam					
2.	Lo					
3.	Hong					
4.	Da					
5.	Ma					
6.	Chu					
7.	Ca					
8.	Se San					
9.	Ba					
10.	Sai Gon					
11.	Dong Nai					
12.	Tien Giang					
13.	Hau Giang					
	Reservoir and Dam					
1.	Hoa Binh Dam*					
2.	Yali Falls Dam*					
3.	Son La Dam*					
4.	Can Don Dam*					
5.	Dai Ninh Dam*					
6.	Dai Thi Dam*					
7.	Dong Nai Hydropower Project*					
8.	Pleikrong Dam*					
9.	Rao Quan Dam*					
10.	Se San Dam*					
11.	Ta Trach Dam*					
12.	Thuong Kontum Dam*					
13.	Upper Easup Dam*					
14.	Cam Son Dam*					
15.	Thac Ba Dam*					
16.	Dau Tieng Dam*					
17.	Tri An Dam*					
	Lake					
1.	Babe Lake*					
2.	Ho-Tay (West) Lake*					
3.	Ho Tri An*					
4.	Ho Dau Tieng*					

5.	Ho Song Da*					
6.	Ho Thac Ba*					
7.	Ho Kiem*					