CHAPTER IV

4. BASELINE ENVIRONMENT

4.1 Physical environment

4.1.1 Atmosphere

Climate

The Cambodian climate is tropical, dominated by two monsoons namely the Northeast and Southwest monsoons. The (wet) Southwest monsoon brings rainfall which amounts to about 90% of the total annual rainfall. The wet begins in May and lasts until November, with rains occurring almost daily during this season. The (dry) Northeast monsoon starts in November and continues until April. From November to February the weather is generally mild and dry, whereas the weather is hot from February until the onset of the Southwest Monsoon. The hottest temperatures occurs in March and April (40 °C), and the coolest from December to February (12 °C). In the Stung Treng meteorological station the hottest temperature recorded in 2007 was 39 °C and the coolest 16 °C.

The rainfall pattern varies in different parts of Cambodia, the highest precipitation (rainfall) occurred in the Southwest at coastal area (2000mm-3400mm) and Northeast plateau area (1800mm-2200mm). Figure 2 shows the annual rainfall distribution within the whole of Cambodia.

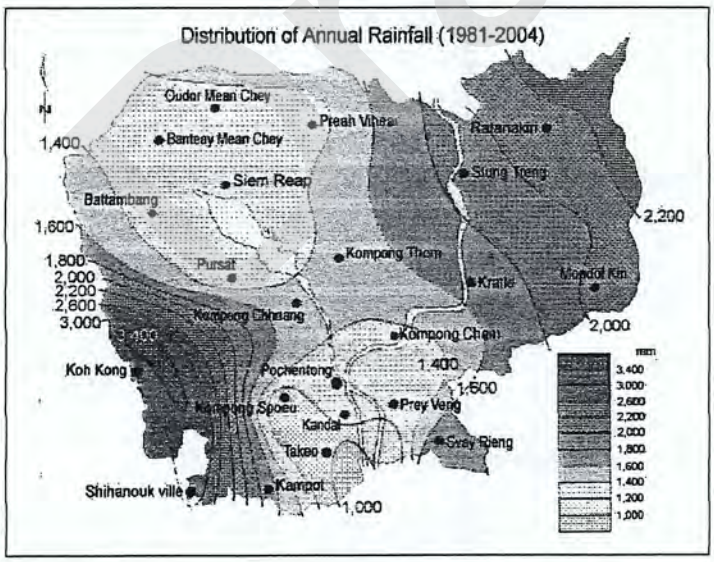


Figure 2: Distribution of Annual Rainfall in Cambodia.

However the rainfall in the whole country has decreased in the past few years. For instance the average annual total rainfall in last four years in the Sesan District (Kamphun station, Longitude: 106°06', Latitude:13°33') was 1483mm according to data obtained from Department of Meteorology/MoWRAM, 2008. Figure 3 shows the average monthly and annual rainfall from year 2004 to 2007 in Sesan district.

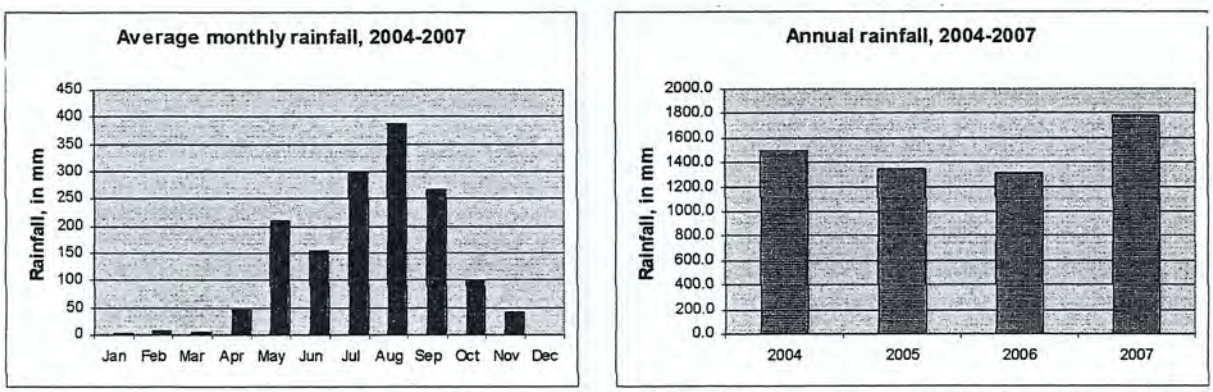


Figure 3: Average monthly and annual rainfall in Sesan district, Stung Treng

Air Quality

The project area is a rural area with the presence of forest (95%), agriculture (4%), and residential land (1%) of the total area. Mostly the area is calm and has no air pollution from industry, except from transportation activities on the National Road (NR) #78 and village roads. The NR #78 and village roads in the project area are built of laterite which can be very dusty in the dry season.

For a baseline study of air quality in the project area, the EIA study team selected two stations for measuring air quality: one behind the dam site (upper Phluk village) and another in the proposed resettlement area Srepok 1 (behind Chop village), to represent the existing air quality in and around the project site and proposed resettlement areas, see figure 5 (location map of air and water quality examination stations). The air quality measurement was conducted in April 2008 by an air pollution expert of the Department of Pollution Control in MoE, and the results of the measurements are shown in Table 1 below.

Table 1: Noise level in 24 hours (Date of survey 8-9 April 2008)

Station name	MoE Standard, Maximum permitted noise level in public and residential area (6:00AM-6:00PM)	L_{Aeq}, dB	L_{Amax}, dB	L_{Amin}, dB
Behind of dam site (upper Phluk village)	60 (*)	50.1	65.5	38.9
Resettlement area Srepok 1 (behind Chop village)	70 (**)	43.8	60.4	29.0

Note: (*) Residential area; (**) Commercial and service areas and mix

Table 2: Pollution level in 12 hours, 6:00AM-6:00PM (Date of survey 8-9 April 2008)

Parameters	Unit	Ambient Air Quality Standards of MoE, 24h	Station name	
			Behind of dam site (upper Phluk village)	Resettlement area Srepok 1 (behind Chop village)
Total Suspended Particles (TSP)	mg/m^3	0.33	0.903	1.25
Nitrogen Dioxide (NO_2)	mg/m^3	0.1	<0.004	<0.004
Sulfur Dioxide (SO_2)	mg/m^3	0.3	<0.004	<0.004
Carbon Monoxide (CO)	mg/m^3	20(i)	not detected	not detected

Note: (i) 8h average

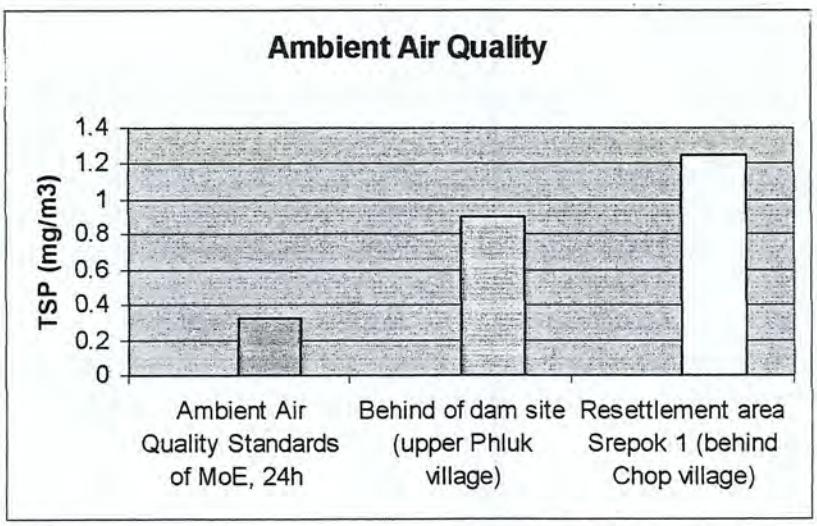


Figure 4: Ambient air quality, TSP value in project area before project construction

The result of ambient air quality measurement in the project area showed that the chemical pollution parameters (NO2, SO2) had a much lower value than the Cambodian Standards (Ambient Air Quality Standards of MoE). Figure 4 demonstrates that TSP in both stations had a higher concentration value than the 24h ambient air quality standards for Cambodia, but CO is zero value. The details of air quality measurement results are attached in annex 1.

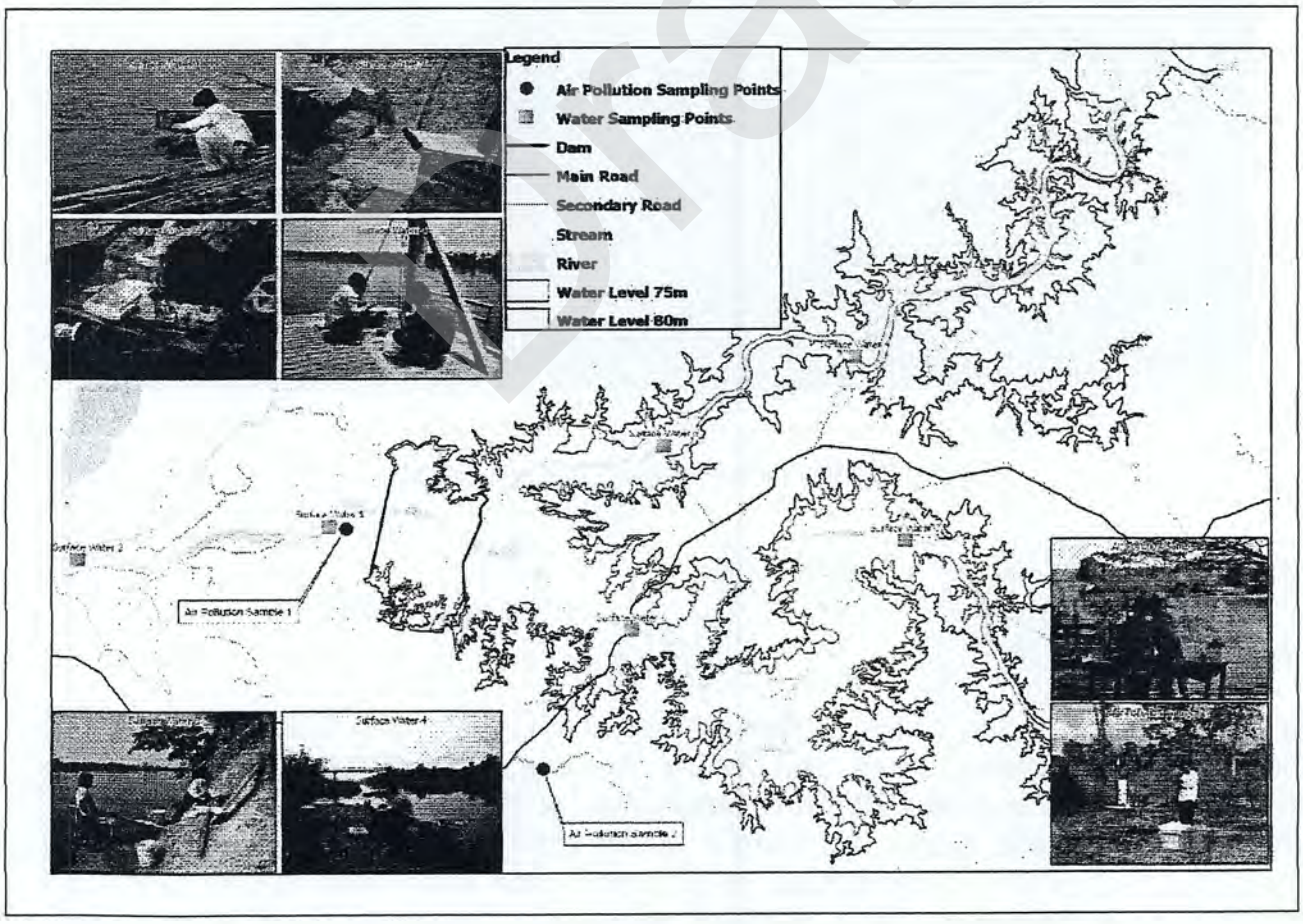


Figure 5: Location map of air and water quality examination station

4.1.2 Topography and soils

The topographical conditions of the project area are sloping ground gently rising towards the plateau of the Rattanakiri province. The elevation ranges from 50 to 100 meters above mean sea level. The river valleys of the Sesan and Srepok rivers also form the topography in the project area. The Sesan river bed at the dam site has an average elevation of 40m (m.s.l) and the river bed in the upper reservoir site has an elevation around 55m (m.s.l).

The top soils in the project area are made up of five types namely: acid lithosols, alluvial lithosols, grey hydromorphics, plinthite podzols, and red yellow podzols, see figure 6 for map of soils in the project area.

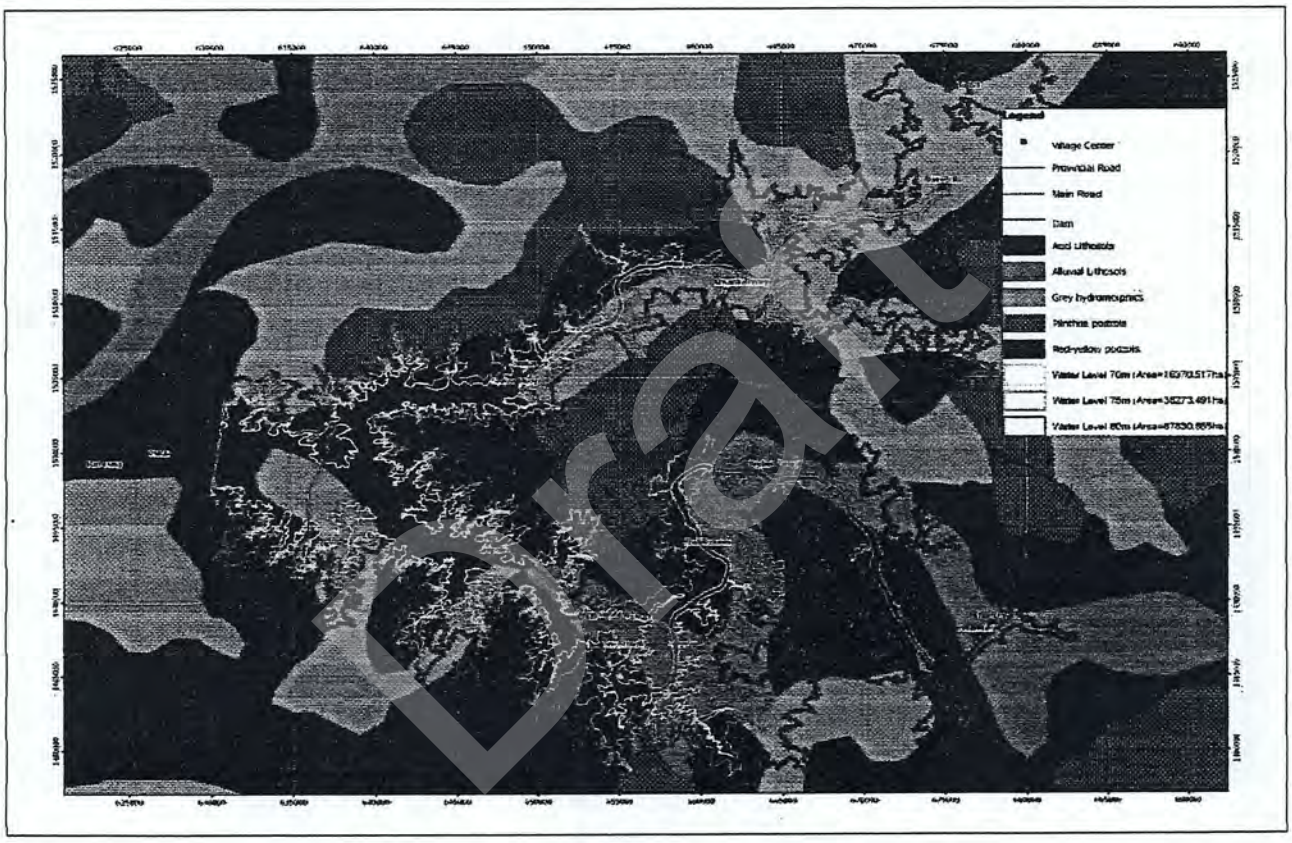


Figure 6: Map of soil type in the project area

4.1.3 Hydrology

4.1.3.1 Surface water

There are three tributary rivers to the Mekong which are located in northeast area of Cambodia namely Srepok, Sesan, and Sekong river which contributes to about 10.1% of the total catchment area and 20.5% of annual flow of the Mekong river, MRC 1978, see figure 7. However the Sesan and Srepok Rivers are the main water sources for the proposed Lower Sesan 2 Hydropower Plant. The Sesan and Srepok Rivers have total catchment areas of 18888km^2 and 30942km^2 respectively (see Figure 8), though the main parts of the catchment areas are located in Vietnam. The total catchment area for the

Lower Sesan 2 project is 49200 km^2, combining the Sesan and Srepok river catchments from the dam site upwards. The total length of each river is 509km and 520km respectively.

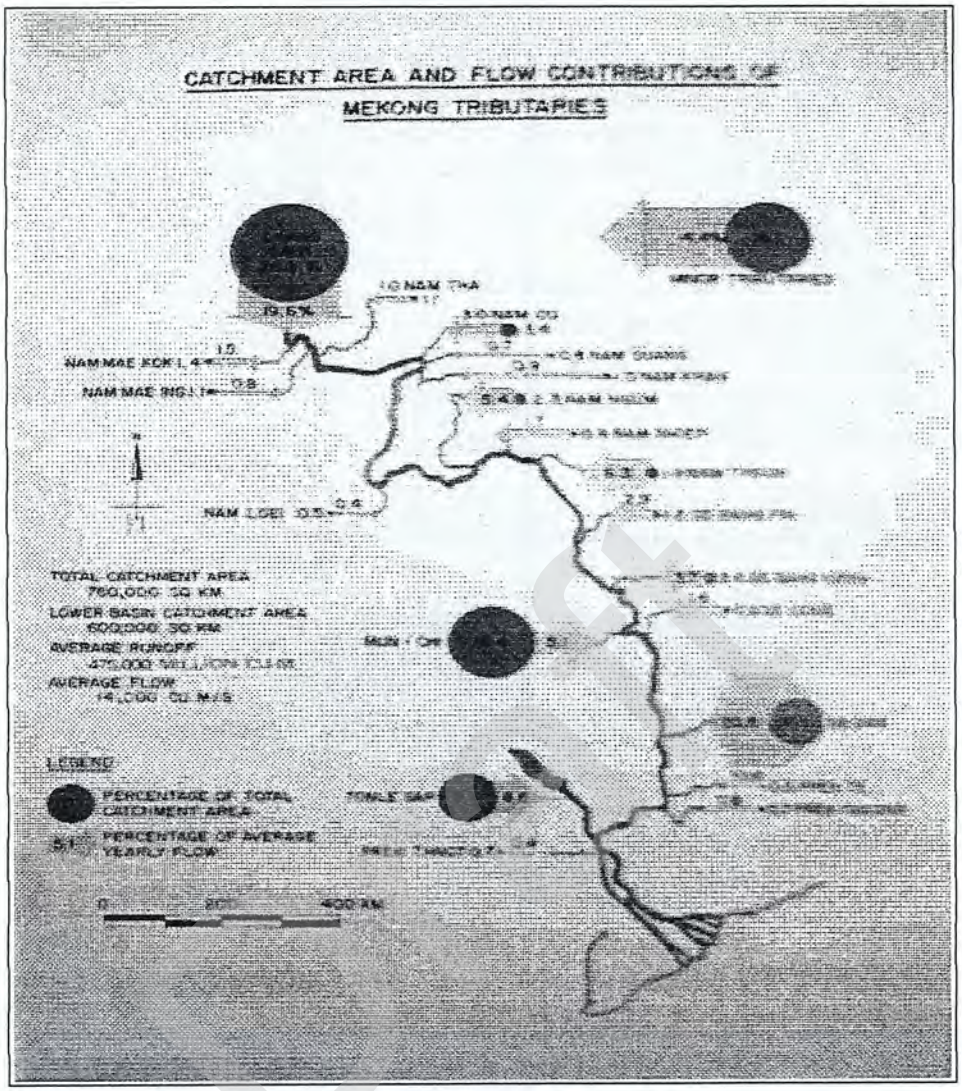


Figure 7: The contribution catchment area and annual flow to Mekong river, Source: MRC 1978.

Figure 8: Catchment area of Se Kong, Sesan, and Srepok river

A-/ Srepok River hydrology

The Srepok River is one of the main tributaries to the Mekong River. It originates in the Southern Highlands in Vietnam and flows into Cambodia territory through the north-east plateau in Rattanakiri and Stung Treng province, and joins with the Sesan River before connecting to the Mekong River in Stung Treng province. The total catchment area is about 30,000 km^2 of which 12,000 km^2 lie in Cambodia. The length of the Srepok River on the Cambodian side from the Vietnamese border to the confluence with the Sesan River is about 245 km. The river width ranges from 400m to 1000m.

Some key hydrological data for the Srepok River are:

- Total catchment area: 30,942km^2
- Maximum flow: 1155 m^3/s, Lomphat station
- Minimum flow 356 m^3/s, Lomphat Station
- Mean flow 667 m^3/s, Lomphat Station

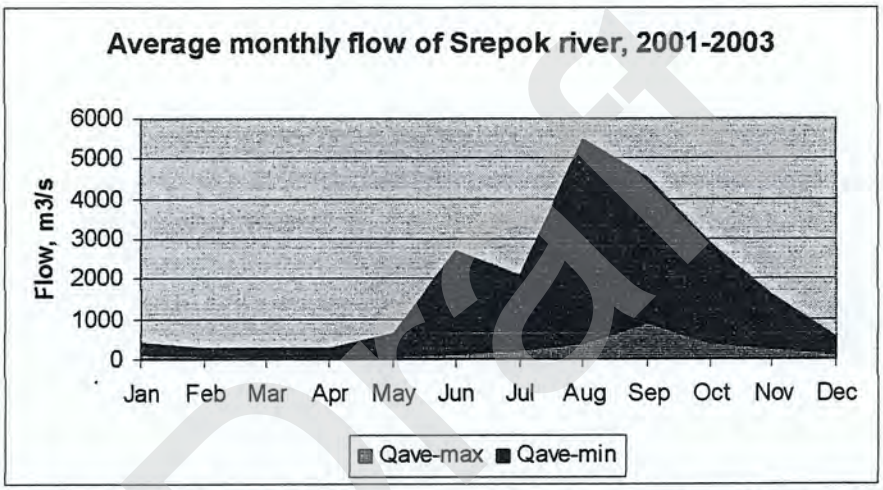


Figure 9: Average monthly flow of Srepok river, Lomphat station, obtained from MoWRAM

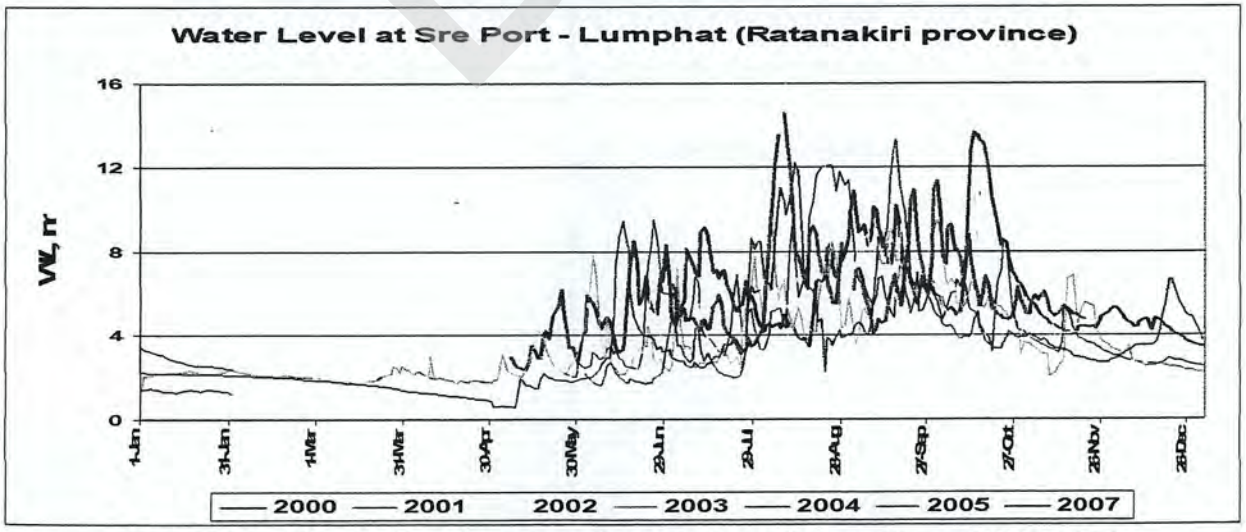


Figure 10: Flooded level in Srepok river, Lomphat station, CNMC-2008

The largest flood events happened in 1973 and 2007 with maximum levels of 77m and 76m (m.s.l) respectively.

The flood event in August 2007 came from a low-pressure area and the tropical storm "PABUK" in the region. The daily rainfalls recorded during the flood period from 01–10 August, 2007 with high intensity rainfall in Rattanakiri and some other provinces are shown in table 3. Figure 10 showed the evidence of the flood in Rattanakiri in August 2007.

Table 3: Daily Rainfall in mm recorded during the period from 01-10 August, 2007

Date	24 hours Rainfall from 01 – 10 August, 2007 of Provinces				
	Koh Kong	Mondulkiri	Preah Vihear	Ratanakiri	Stung Treng
1-Aug-07	11.5	25.0	3.0	57.0	8.6
2-Aug-07	17.0	23.8	0.0	36.4	3.5
3-Aug-07	0.5	57.0	2.0	0.0	5.5
4-Aug-07	**173.6**	**102.0**	0.0	21.2	37.8
5-Aug-07	96.7	68.4	**359.5**	**143.1**	**131.1**
6-Aug-07	7.5	17.8	33.5	9.2	30.1
7-Aug-07	66.5	14.6	0.0	13.4	0.0
8-Aug-07	32.0	11.3	1.0	13.8	0.0
9-Aug-07	61.0	16.0	0.0	5.8	0.0
10-Aug-07	52.2	6.4	0.0	8.2	20.5
Max	**173.6**	**102.0**	**359.5**	**143.1**	**131.1**
Mean	**51.9**	**34.2**	**39.9**	**30.8**	**23.7**

Source: Fourth Session of the Forum on Regional Climate Monitoring, Assessment and Prediction for Asia (FOCRAII).

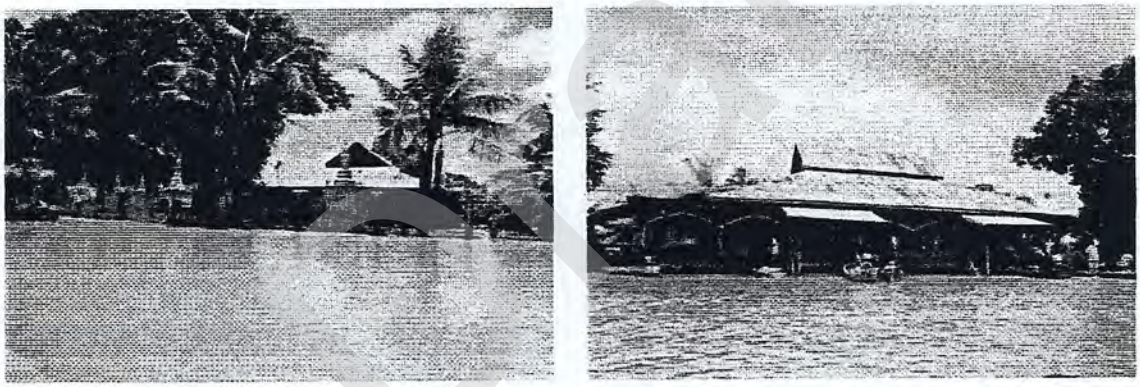


Figure 10: Flash Flood in Rattanakiri on 06 August, 2007, (Source: MoWRAM)

During the large flood in August, 2007 the water levels at the Sre Pok- Lomphat station could not be read because the water was higher (15m) than the staff gauge (14m) as shown in figure 11.

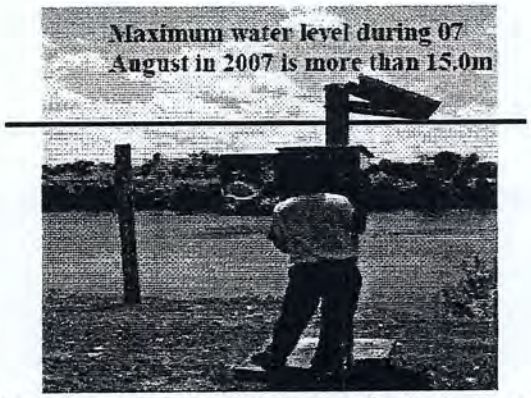


Figure 11: Red line Maximum water level in Lomphat station on the 7th August 2007

However the flow regime of the Srepok river in Cambodia is subject to change due to water releases from the upstream Srepok 4 dam in Vietnam. The release flows for the Srepok 4 dam is max. discharge 282 m^3/s; confirmed discharge 52.3 m^3/s, source Fourth Session of the Forum on Regional Climate Monitoring, Assessment and Prediction for Asia (FOCRAII), Climate and flood in Cambodia, 2007.

The quality of the river water had been measured in the period of the EIA study in dry season (March 2008). The sampling point for the surface water quality examination (based line data) were select in Srepok river, and the location name with sample number is specified and demonstrate in table 4 and figure 5.

Table 4: Surface water quality sampling

Sample No	Location	GPS point	
		X	Y
S3	Upstream of Krabei Chrum village	665403	1498634
S6	Upstream of Srepok Bridge	647038	1492586

The basic parameters for drinking purpose were measured with field testing kit and taking samples to measure in lap in Phnom Penh. The result of the groundwater quality is showed in table 5:

Table 5: River Water Quality Test Result, sampling dated 29-30 March 2008

No.	**Parameter**	**Unit**	**Water Quality Standard in public water areas for bio-diversity conservation, MoE**		**Sample No.**	
			River	lake and reservoir	**S3**	**S6**
1	Temperature	°C			29.2	32.7
2	pH		6.5 – 8.5	6.5 – 8.5	6.60	7.43
3	Conductivity	µS/Cm			71.0	84.0
4	TSS	mg/l	25-100	1-15	3.500	7.000
5	NO_3+N	mg/l			0.032	0.051
6	Tot. N	mg/l		0.1-0.6	0.075	0.072
7	PO4-P	mg/l			0.008	0.007
8	Tot. P	mg/l		0.005-0.05	0.250	0.169
9	DO	mg/l	2-7.5	2-7.5	8.469	8.733
10	BOD_5	mg/l	1-10		1.480	1.480
11	COD	mg/l		1-8	1.360	1.350
12	Chlorophyll	mg/l			0.0005	0.0002
13	Total Coliform	MPN/100ml	< 5000	< 1000	17000	2700

The result of the water quality measurement indicated that the total phosphate concentration in Srepok River slightly exceed the water standard in the reservoir and lake. While the total coliform is higher quality standard of surface water by MoE. Both biological parameter showing exceed the standard it mean that the Srepok river now ready polluted by human waste and animal manure or decay of the microorganism and wildlife in the water.

However the dissolved oxygen in the Srepok river are very high saturate 8.46-8.73mg/l due to shallow water and flowing with many cascade in the river bed. The other parameters are lower concentrate than surface water quality standard in Cambodia.

It can concluded that the water quality in the Srepok river still in good quality.

B-/ Sesan River hydrology

The Sesan River is one of the main tributaries to the Mekong River and lies both within Vietnam and Cambodia. The upper part of the catchment area is located in Vietnam with an area of 11,450km^2 (60%). The lower catchment area located in Cambodia is 6,960km^2 (40%). The river width ranges from 400m to 1000m in Cambodia and has a total length of the 462km, with 210km being in Vietnam.

Some key hydrological data for the Sesan River are:

- Total catchment area: 18,888km^2
- Maximum flow 902 m^3/s , in Veun Sai station
- Minimum flow 377 m^3/s Veun Sai station
- Mean flow 633 m^3/s Veun Sai station

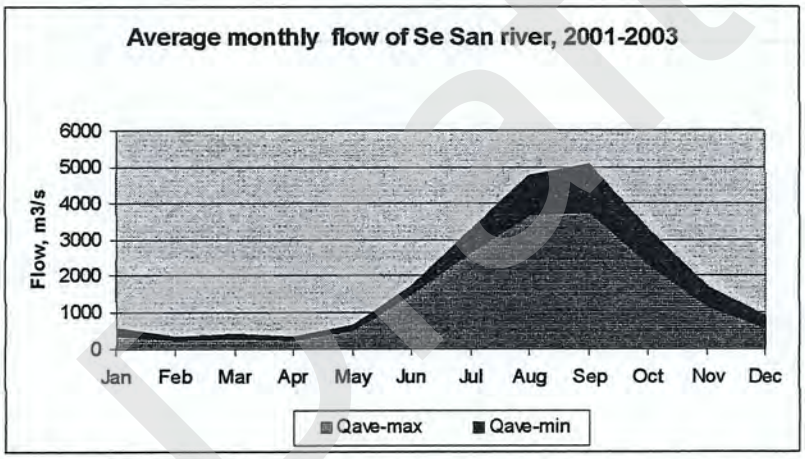


Figure 12: Average monthly flow of Sesan river, Voern Sai station, obtained from MoWRAM

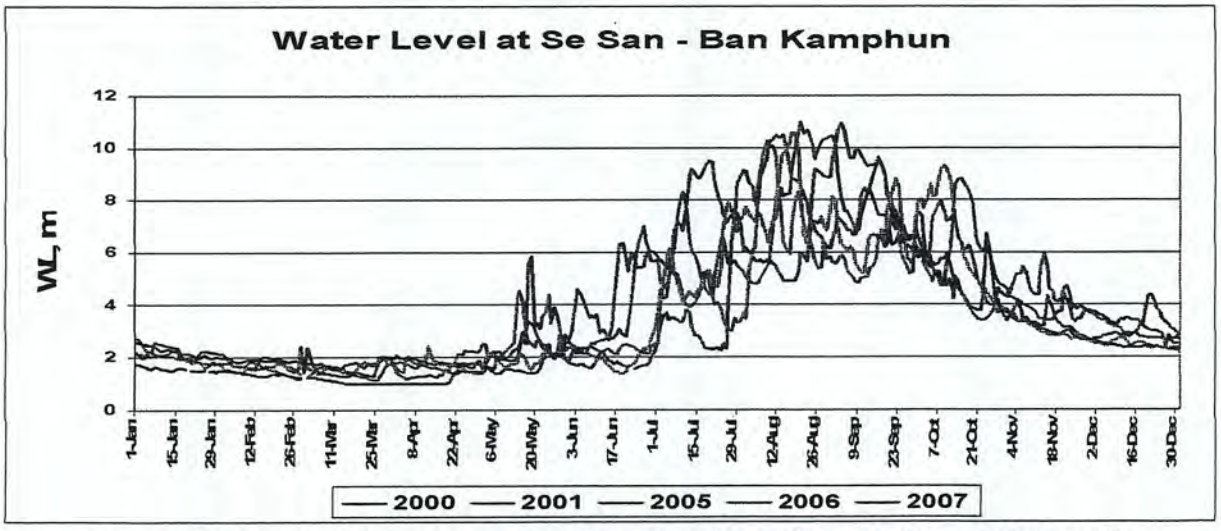


Figure 13: Flooded level in Sesan river, Ban Kamphun station, CNMC-2008

However the flow regime of the Sesan river in Cambodia is subject to change due to the water releases from the upstream Sesan 4 and Sesan 5/1 dams in Vietnam.

Release flows from upstream dams in Vietnam are:

- Sesan 4: 719 m^3/s for 3 units
- Sesan 5/1: confirmed discharge 208.5 m^3/s

Sesan River Water Quality:

The quality of the Sesan River's water was monitored in some stations upstream and downstream of the project site? by the Hydrological Department and River Works of Ministry of Water Resources and Meteorology (MoWRAM), in 2004-2005. The monitoring stations were selected in both Vietnam and Cambodia as described in table 6. The results of the water quality monitoring are shown in table 7.

Table 6: Water quality monitoring station location

Country name	Station Name	Coordinates	
		Longitude (E)	Latitude (N)
Vietnam	Pleku	107°28'15"	13°56'30"
Cambodia	Phum Pir	107°26'55"	13°47'29"
	Andoung Meas	107°18'04"	13°52'09"
	Veun Sai	106°49'25"	13°58'34"

Table 7: Result of water quality monitoring in Sesan River (2004-2005)

Date	T°C	pH	Conductivity mS/m	Turbidity NTU	DO mg/L	Coliform bacteria (37°)
Pleiku						
22.05.2004	27.8	7.4	4.0		6.9	9073
20.07.2004	27.8	6.9	3.5	195.0	7.7	2633
20.09.2004	25.6	6.6	2.9	165.0	8.5	703
27.11.2004	24.8	7.1	4.1	26.3	8.7	2840
05.01.2005	22.4	7.2	4.1	15.3	8.7	770
31.01.2005	24.2	7.5	4.3	12.0	8.3	340
26.02.2005	24.7	7.4	4.4	10.0	8.5	1050
01.04.2005	27.1	7.3	4.9	16.0	8.0	753
27.04.2005	27.3	7.3	5.0	24.0	7.6	690
18.05.2005	28.6	7.8	5.0	64.0	7.4	433
Average	***26.0***	***7.2***	***4.2***	***58.6***	***8.0***	***1929***
Phum Pir						
25.05.2004	28.3	7.5	4.5		6.6	11147
23.07.2004	26.3	6.4		8.0		
24.09.2004	26.0	6.8	2.9		8.6	2073
23.11.2004	24.4	6.8	3.7		8.2	80
27.12.2005	21.8	7.6	3.5	10.9	7.5	33
29.01.2005	26.0	7.5	4.0	24.3	8.4	567
24.02.2005	25.3	7.5	5.3	3.4	9.4	2650
31.03.2005	27.9	7.6	4.3	5.1		467
26.04.2005	28.5	7.5	5.1	17.8	7.4	1917
17.05.2005	29.6	7.6	5.0	12.3	8.1	900
Average	***26.4***	***6.9***	***4.2***	***11.7***	***8.0***	***2204***

Andong Meas						
25.05.2004	28.7	7.4	4.0		6.5	683
23.07.2004	27.0	6.5	2.6		7.4	243333
24.09.2004	27.4	6.3	2.9		8.3	1047
23.11.2004	25.4	7.1	3.7		8.1	133
27.12.2004	23.6	6.7	3.5	5.6		52
29.01.2005	24.5	7.4	4.2	13.2	7.4	907
24.02.2005	27.9	7.6	5.2	3.2	9.4	2650
31.03.2005	30.9	7.8	4.2	3.4	7.0	620
28.04.2005	28.9	7.6	5.1	5.4	6.8	860
17.05.2005	30.1	7.5	5.0	4.2	6.9	403
Average	***27.4***	***7.2***	***4.0***	***5.8***	***7.5***	***25069***
Voen Saiy						
26.05.2004	29.4	7.3	3.7		6.2	377
24.07.2004	26.5	6.6	2.6		7.3	226667
25.09.2004	26.5	7.0	2.7		7.8	2983
22.11.2004	26.2	7.3	3.5		7.3	120
26.12.2005	24.4	7.0	3.4	6.3	7.6	25
29.01.2005	26.7	7.7	3.9	13.7	7.7	3060
23.02.2005	29.6	7.9	4.4	3.0	9.3	1525
30.03.2005	31.4	7.8	4.5	3.7	6.4	2433
25.04.2005	31.8	7.8	5.1	4.4	7.6	2033
16.05.2005	32.9	7.9	5.4	3.6	7.9	117
Average	***28.5***	***7.4***	***3.9***	***5.8***	***7.5***	***23934***

Source: Department of Hydrology and River Work, MoWRAM

The previous result of the water quality monitoring in Sesan river indicated that high dissolved oxygen, it gave very good optimistic based for the aquatic fauna and flora growing well. High saturate of oxygen in the river water can maintain the good quality in the river water.

Amount of total coliform were a bit higher than the surface water quality standard in Cambodia, due to some polluted activities from the human being and animal, playing and discharge waste or manure into the water.

The quality of the river water had been measured in the period of the EIA study in dry season (March 2008). The sampling point for the surface water quality examination (based line data) were select in Sesan river, and the location name with sample number is specified and demonstrate in table 8 and figure 5.

Table 8: Surface water quality sampling

Sample #	Location	GPS point	
		X	Y
S1	Upstream of Phluk village	627371	1499631
S2	Downstream of confluent between Sekong and Sesan	610155	1497465
S4	Upstream of Ksach Thmei village	662050	1511247
S5	Upstream of Srekor village	649179	1505146

The basic parameters for drinking purpose were measured with field testing kit and taking samples to measure in laboratory in Phnom Penh. The result of measurement is showed in table 9.

Table 9: River Water Quality Test Result, sampling dated 29-30 March 2008

No.	Parameter	Unit	Water Quality Standard in public water areas for bio-diversity conservation, MoE		Sample No.			
			River	lake and reservoir	S1	S2	S4	S5
1	Temperature	^{0}C			30.4	31.4	29.8	32.8
2	pH		6.5 – 8.5	6.5 – 8.5	7.58	6.28	7.41	6.58
3	Conductivity	µS/Cm			48.2	49.0	44.0	142.0
4	TSS	mg/l	25-100	1-15	3.00	3.00	5.00	11.50
5	NO_3+N	mg/l			0.052	0.066	0.104	0.053
6	Tot. N	mg/l		0.1-0.6	0.157	0.240	0.192	0.141
7	PO4-P	mg/l			0.005	0.005	0.008	0.004
8	Tot. P	mg/l		0.005-0.05	0.181	0.162	0.206	0.156
9	DO	mg/l	2-7.5	2-7.5	7.817	9.068	9.573	7.357
10	BOD_5	mg/l	1-10		1.480	1.480	1.480	1.480
11	COD	mg/l		1-8	1.118	0.372	0.829	0.764
12	Chlorophyll	mg/l			0.0002	0.0002	0.0003	0.0002
13	Total Coliform	MPN/100ml	< 5000	< 1000	22000	35000	17000	11000

Note: MoE- Ministry of Environment

The result of the water quality measurement in table above indicated that the total phosphate concentration in Sesan River slightly exceed the water standard in the reservoir and lake. While the total coliform is very high value than quality standard of surface water by MoE. It mean that the Sesan river now ready polluted by human waste and animal manure or decay of the microorganism and wildlife in the water.

However the dissolved oxygen in the Sesan river are very high saturate 7.35-9.57mg/l due to shallow water and flowing with many cascade in the river bad. The other parameters are lower concentrate than surface water quality standard in Cambodia.

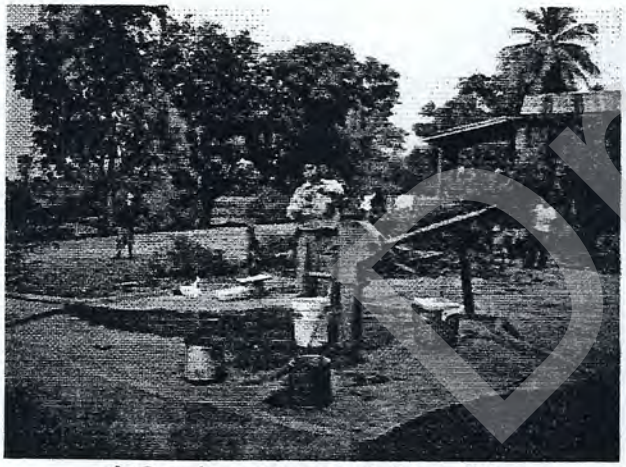
It can concluded that the water quality in the Sesan river still in good quality.

4.1.4 Groundwater

The groundwater source in the project area is found in a deep aquifer between 22-25 m from the ground surface. The groundwater table is 8m in dry season and slightly rises up in wet season and the yield range between 1.5m^3/h to 5m^3/h, according to static level of the existing wells in Krabei Chrum village and Chrub village (along Srepok river) and Ksach Thmei village, Srekor village, and Phluk village (along Sesan river). Table 10 shows the characteristics of the existing borehole wells in the project area. All the borehole wells were equipped with Afridef hand-pump and concrete platform. However some of wells had poor environmental surrounding the platform, pig pool found too close to the well, see figure 14.

Table 10: Characteristic of the existing borehole well

Location of borehole well	GPS point		Characteristic of the well				
	X	Y	Depth (m)	Static level (m)	Yield m^3/h	Year of construction	Environmental remarks
Phluk village, G-1	627325	1499577	32	8	2	1998	Good environment
Phluk village, G-2	626540	1499537	28	8	1.5	2001	Bad environment
Krabei Chrum village, G-3	665263	1498660	30	8	2	2001	Good environment
Ksach Thmei village, G-4	661983	1511235	32	7	2	2006	Bad environment
Ksach Thmei village, G-5	661709	1511759	30	8	2	2006	Good environment
Srekor village, G-6	649180	1505044	36	6.5	0.85	2001	Good environment
Srekor village, G-7	649068	1504876	34	8	1.5	2005	Bad environment
Chrub village, in Chrub primary school, G-8	638803	1483539	28	8	5	2006	Good environment



a) Good environmental condition

b) Bad environmental condition

Figure 14: Environmental condition of the community well

The table above shows that the groundwater source between the Srepok and Sesan Rivers in the project area is settled in the same aquifer. Most of the wells in those villages are situated 40-150 m from the river.

The result of the groundwater quality examination in March 2008 is showed in table 11a and 11b.

Table 11a: Groundwater Quality Test Result, sampling dated 29-30 March 2008

No.	Parameter	Unit	Drinking Water Quality Standard MIME	Sample No.			
				G1	G2	G3	G4
1	Temperature	oC		29	29.7	28.5	30.2
2	pH		6.5 – 8.5	7.12	6.98	6.86	6.81
3	Conductivity	mg/l	1500	660	680	497	470
4	TDS	mg/l	800	505	525	405	395
5	Alkalinity	mg/l $CaCO_3$		332.4	353.7	274.8	269.1
6	NO_2	mg/l	3	0.008	0.003	0.003	0.003
7	NO_3+N	mg/l	50	0.084	0.044	0.064	0.033
8	PO4-P	mg/l		0.008	0.007	0.003	0.018
9	Tot. P	mg/l		0.319	0.281	0.231	0.051
10	Mn	mg/l	0.1	0.010	0.011	0.016	0.013
12	Fe	mg/l	0.3	0.057	0.990	1.443	0.858
13	Tot.Coliform	MPN/100ml	0	130	78	230	68

Note: MIME- Ministry of Industry Mines and Energy

Table 11b: Groundwater Quality Test Result, sampling dated 29-30 March 2008

No.	Parameter	Unit	Drinking Water Quality Standard MIME	Sample No.			
				G5	G6	G7	G8
1	Temperature	oC		31.4	31.7	30.5	30.2
2	pH		6.5 – 8.5	7.04	7.02	6.93	7.02
3	Conductivity	mg/l	1500	467	778	780	970
4	TDS	mg/l	800	345	550	215	670
5	Alkalinity	mg/l $CaCO_3$		261.4	329.3	94.0	484.5
6	NO_2	mg/l	3	0.007	0.004	0.003	0.002
7	NO_3+N	mg/l	50	0.039	0.044	0.415	0.069
8	PO4-P	mg/l		0.021	0.012	0.005	0.001
9	Tot. P	mg/l		0.065	0.046	0.319	0.287
10	Mn	mg/l	0.1	0.006	0.003	0.023	0.008
12	Fe	mg/l	0.3	1.448	3.549	0.114	0.091
13	Tot.Coliform	MPN/100ml	0	110	460	700	390

Note: MIME- Ministry of Industry Mines and Energy

The result of the groundwater quality examination indicated that all the community wells in Krabei Chrum, Khsach Thmei, Srekor, and Phluk village are not safe of biological pollution parameters, total coliform are happened in the well water (68-700 MPN/100ml). The drinking water quality standard clearly specifies that the total coliform shall be zero value. While some of the wells have contaminated of iron concentration 1.4-3.5mg/l.

4.1.5 Geology/Seismology

Based on the geological map scale 1:25000, the foundation rock and soil of the project area comprise (i) Paleozoic group in Devonian-Carbonian system (D-C); (ii) Mezozoic group in Jurassic system with Lower-Middle division (J_{1-2}) and Jurassic system in upper division-Kretarian system J_3-K_1 ; and Kainozoic group in Neogene-Quaternary systems and Ba Mieu Farmation (N_2-Q_1bm).

Rocks of the Devonian-Carbonian group are the most ancient formations in the area of the Lower Sesan 2 HPP which are exposed at 1-4km^2 upstream and downstream of the dam site. The rock of this age is very hard, fine and medium grained sandstone.

The rock in Jurassic system with Lower-Middle division (J_{1-2}) comprises coarse and fragmented sediments that are mainly of conglomerate, breccia, gritstone, and sandstone which is hard rock. The rock of the Jurassic system with upper division-Kretarian system J_3-K_1 is the formation of neutral volcanic andesite, andesitodacite, and dacite, andesite tuff. The rock is dark grey, greenish grey, massive, and hard.

The quaternary porous sediments distributed commonly in the project area comprise deposits originating from aluvium, mix of aluvium-proluvium, deluvium, eluvium with a thickness of 0.5-4m. Along the valleys of Sesan and Srepok rivers are the distributions of two terraces. The first staged terrace consists of loam, sandy loam, pebble, and gravel in the upper part, and laterite mixing with soil in lower part. The second staged terrace consists of laterite, pebble, and gravel.

The geological study result showed in table below, and seismological study found that adjacent to the Lower Sesan 2 Hydropower Plant project area four faults exist as described in table 12.

Physical mechanical properties of the soil

N⁰	Soil type / Property	Ancient alluvial layer (aQIII)	Weathered from late rite deposited sediment (N_2-Q_1)	Weathered from andesite (J-K)	Weathered from sedimental rock (J1-2)	Weathered from Devonian-Carbonian sandy-siltstone
1	Specific gravity g/cm³	2.68	2.67	2.71	2.68	2.69
2	Natural density γ_e g/cm³	1.60	1.65	1.65	1.69	1.70
3	Dry density γ_c g/cm³	1.42	1.31	1.43	1.45	1.47
4	Saturated shear strength φ_{bl} (degree)	18	20	19	19	18
	Cbh (KG/cm²)	0.2	0.20	0.32	0.21	0.21
5	Natural shear strength φ_{tn} (degree)	23	25	22	22	22
	Ctn (KG/cm²)	0.22	0.22	0.36	0.23	0.23
6	Saturated compressive strength a_1-2bh	0.035	0.035	0.038	0.025	0.025
7	Natural compressive strength $a_{1\text{-}2tn}$	0.025	0.022	0.025	0.018	0.018
8	Total modulus of saturated deformation E_{obh}	100	100	80	100	100
9	Total modulus of natural deformation E_{otn}	120	140	100	120	120
10	Coefficient of permeability cm/s	ax10^{-5}	ax10^{-4}	ax10^{-5}	ax10^{-5}	ax10^{-5}

Source: Geological study in feasibility study report

Physical mechanical properties of the rock

N⁰	Type of rock / Property	Gruss, grit of conglomerate, sandstone	Andesite rock	Semi-hard rock N_2-Q_1
1	Specific gravity (g/cm³)	2.7	2.73	2.50
2	Saturated density (g/cm³)	2.68	2.70	2.30

3	Air dry density (g/cm³)	2.67	2.69	2.28
4	Free saturation (%)	0.35	0.35	1.8
5	Forced saturation (%)	0.7	0.6	2.8
6	Coefficients f saturated hardness	4.0	9	1
7	Coefficient of air dry hardness	7.0	10	2
8	Saturated tensile strength (KG/cm²)	55	90	
9	Air dry tensile strength (KG/cm²)	70	100	
10	Saturated compressive strength (KG/cm²)	500	768	80
11	Air dry compressive strength (KG/cm²)	571	866	100

Source: Geological study in feasibility study report

Table 12: Basic characteristics of the main faults zones in and nearby project area

No.	Name of fault	Order	Trend	Length (km)	Depth	Attitude of sliding surface	Dip angle (degree)	Movement mechanism in N2-Q	Nearest distance to the project (km)
1	Buon Ho	2nd	NW-SE and sub-latitude	>300	The depth breaking through the crust	SW	80-85	Right strike-slip	32
2	Sesan river	3rd	NE-SW	140	In the crust	SE	80-85	Right left-slip	41
3	Sem Bok	3rd	NE-SE	>150	The depth breaking through the crust	NE	80-85	Normal right strike- slip	45
4	Ph Leuslup	4th	NE-SE	>100	In the crust	SW	80-85	Right left-slip	70

Source: The preliminary result of seismic hazard assessment at the construction site of lower Sesan 2 Hydropower area, by Department of Seismology Institute of Geophysics, Vietnam

Besides the above faults, one high rank fault was found 100m upstream of the Srepok Bridge which tends NW-SE and continues massing the right edge of the proposed main dam for the Lower Sesan 2 HPP. It is the most important fault to be considered for the project design and construction.

The study on seismic activities in and surrounding the project area shows that one earthquake occurred in 1978 with magnitude M_s= 5.2 degree Richter, according to data observed by seismograph, survey documents, historical documents and information bulletin of the International Seismological Center (ISC). The history of the above earthquake is shown in table 13.

Table 13: Earthquake history for Lower Sesan 2 HPP area and surrounding

No	Original time						Epicenter		Depth	Mag.	Intensity
	Year	Month	Date	Hour	Min.	Sec.	Lat.	Lon.	Km	M	I_o
1	1978	8	02	7	45	1	14.00	106.00	33	5.2	6 ± 0.3

4.1.6 Sedimentation

The average month sediment flow data has been recorded for the past 29 years from 1977/1978 to 2005/2006 at various project sites on the Sesan and Srepok Rivers both in Vietnam and Cambodia.

See appendix of feasibility study report for more details.

- Sedimentation data

Damsite	W_{ll}	W_{dd}	Ws	W_{ll}	W_{dd}	Ws
	10^6 ton/year			$10^6 m^3$/year		
Sesan tributary	1.404	0.552	1.956	1.188	0.355	1.543
Srepok tributary	1.316	0.526	1.842	1.113	0.339	1.452
Lower Sesan 2	2.719	1.078	3.798	2.301	0.694	2.994

Source: Obtained from Feasibility Study Report of Lower Sesan 2 HPP, PECC-1

4.2 Ecological Resources

4.2.1 Fisheries

Information on fisheries for this EIA was collected from both primary and secondary sources. The primary data was collected during a survey during the dry season in early 2008. Secondary data was collected from a number of publications produced over the last decade or so which are referenced where cited. As the primary data was only collected during the dry season and not for a full year's seasonal cycle the secondary data has been relied upon to some extent to fill the gaps particularly during the wet season.

4.2.1.1 Survey and PRA

Eleven villages from four communes that are located along the Sesan and Srepok Rivers in the project area were selected for interviewing and PRA for the fishery study which was undertaken from early February to late of April 2008. The commune and village names are shown in table 14. As part of the PRA focus group discussions were organised to identify fish species, aquatic fauna and flora, and the present conditions including fish movement/migration. Posters of fish, some of reptiles, amphibians, and inundated forest were used. The interviewing form for the fishery study is contained in annex of appendix 2 (Fishery research/study report).

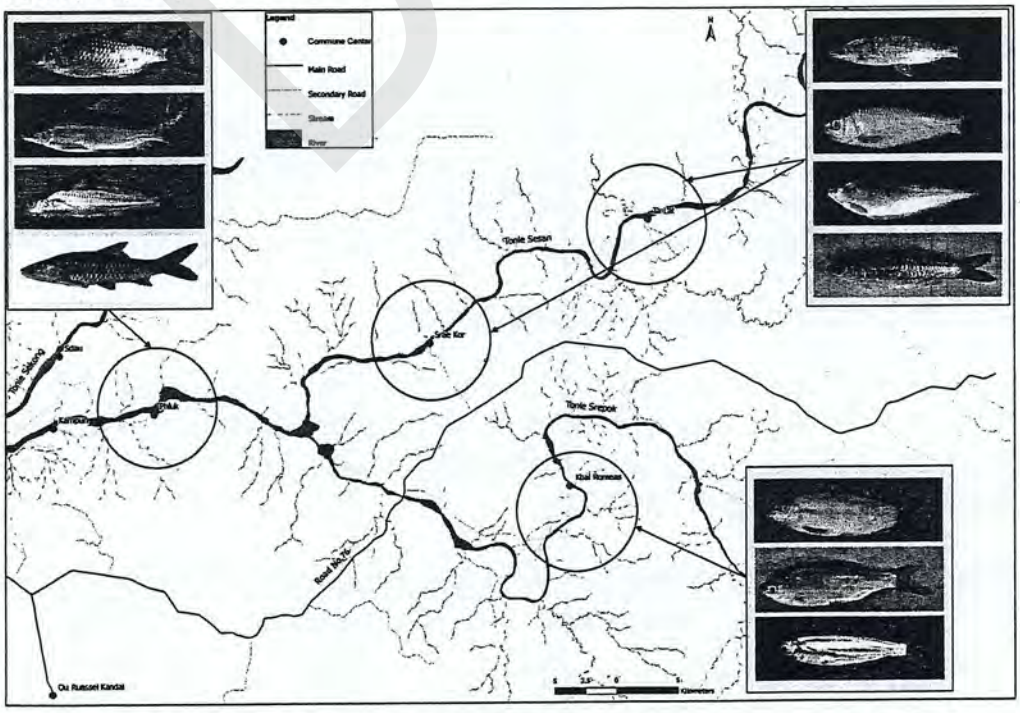


Figure 15: Map of fishery study area (Survey and Fishermen selection)

Table 14: Target villages for conduction PRA

Commune name	Village	River	Fishermen made interview, person	Fishermen attended in PRA, person
Phluk	Phluk	Sesan	25	20
	Ban Boung			
Srekor	Srekor Mouy		31	15
	Srekor Pir			
Talat	Talat		60	20
	Svay Reang			
	Rompot			
	Khsach Thmey			
Kbal Romeas	Sre Sronok	Srepok	37	15
	Kbal Romeas			
	Krobei Chrum			
Total:	**11 villages**		**153**	**70**

4.2.1.2 Study results

a) Fishing Gears and Methods

3 kinds of fishing gears are commonly used in the project area:

- Gillnet (Moang) with mesh size range from 2cm to 17cm, about 95 % of total fishermen family has one to two gillnet, and others have 3 to 10 of gillnet.
- Hook long line (Santouch Ronong), about 50 – 60 % of total fishermen practiced it with 45 to 100 hooks household.
- Cast net (Samnanh), about 50% of villagers use this fishing gear, the mesh size range from 2.5cm to 14cm.

The other fishing gears:

- Drop door trap (Chan) is made from bamboo
- Bamboo-made basket traps (Trou) is made from bamboo
- Horizontal cylinder trap (Lob) is made from bamboo
- Single hook set pole and line (Bangkai)
- Vertical hanging vast trap (Pong) for small fish is made from bamboo

b) Fish Species Recorded from PRA and Survey

The focus group discussions as part of the PRA were undertaken with 70 fishermen from both downstream and upstream of the proposed dam site on the Sesan and Srepok Rivers. 153 fishermen were individually interviewed in total. The villages which were surveyed are shown in Table 15.

Table 15: Target village and number of household selected for fishery survey

River	Location to Dam site	Village name	Size of sample, HH	Remarks
Sesan	Downstream	Ban Boung	6	25 HH
		Phluk	19	
	Upstream	Srekor Mouy	16	86 HH

		Srekor Pir	15	
		Talat	7	
		Svay Rieng	24	
		Khsach Thmei	24	
Srepok	Upstream	Sresranok	10	37 HH
		Kbal Romeas	10	
		Krabei Chrum	17	
Total:			148	

Source: Fishery study in the project area, Feb-May. 2008

The fish species identified by the fishermen were classified by Order, Family and Species following the Fishes of The Cambodia Mekong, 1996. During the study period (Feb-May 2008) 99 fish species were identified to belong to 9 Order and 22 Families, as shown in table 16.

Table 16: Fish species identified by Survey and PRA

Order	Family	Fish Species record in both river	CEPA (2006)
Clupeiformes	Clupeidae	1	**1**
Osteoglossiformes	Notopteridae	3	**1**
Cypriniformes	Cyprinidae	39	**3**
	Cobitidae	3	**57**
Siluriformes	Clariidae	2	**6**
	Bagridae	10	**2**
	Ariidae	1	**11**
	Pangasiidae	7	**1**
	Schibeidae	1	**13**
	Siluridae	10	**1**
Perciformes	Channidae	5	**10**
	Lobotidae	2	**6**
	Polynemidae	1	**2**
	Sciaenidae	1	**1**
	Nandidae	1	**1**
	Anabantidae	1	**1**
	Belontiidae	3	**1**
	Osphronemidae	1	**3**
	Eleotridae	1	**1**
Beloniformes	Belonidae	1	**1**
Synbranchiformes	Synbranchidae	1	**1**
	Mastacembelidae	2	**4**
Pleuronectiformes	Soleidae	1	**1**
Tetraodontiformes	Tetraodontidae	1	**1**
Total		99	**130**

The Cypriniformes Order has the most species from downstream and upstream of the project site including the Srepok river (42 species), followed by Siluriformes Order with 31 species and the Perciformes Order with16 species (Details in annex of appendix 2).

c) <u>Fish Species Caught by Selected Fishermen</u>

The fish in the Sesan and Srepok river upstream and downstream of the project site that were caught by fishermen during early February to March 2008, were identified locally and with analyses in a laboratory of the Royal University of Agriculture, Faculty of Fisheries. The fish catch results are as follows:

- Downstream of the project site on the Sesan river 61 species were found belonging to 6 Order and 16 Families.
- Upstream of the project site on the Sesan river 34 species were found belonging to 6 Order and 11 Families.
- In the Srepok river (in Stung Treng province only) 69 species were found belonging to 8 Order and 20 Families (Details in annex in appendix 2).

The Cypriniformes Order was found with 30 species downstream and 19 species upstream of the project site in the Sesan river, and 32 species in the Srepok river. The Siluriformes Order was found with 19 species downstream and 9 species upstream of the project site on the Sesan river, and 23 species in the Srepok River.

Table 17: Fish species caught by fishermen during the study

Order	Family	Sesan Downstream	Sesan Upstream	Srepork River
Osteoglossiformes	Notopteridae	0	0	1
	Notopteridae	1	1	1
	Notopteridae	1	0	1
Cypriniformes	Cyprinidae	27	17	29
	Cobitidae	3	2	3
Siluriformes	Clariidae	1	1	1
	Bagridae	7	4	8
	Pangasiidae	6	2	7
	Schibeidae	0	0	1
	Siluridae	5	2	6
Perciformes	Channidae	3	2	2
	Belontiidae	1	1	0
	Anabantidae	1	1	1
	Nandidae	1	0	1
	Lobotidae	1	0	1
	Osphronemidae	1	0	1
	Eleotridae	1	0	1
	Gobiidae	0	1	1
Beloniformes	Belonidae	0	0	1
Synbranchiformes	Mastacembelidae	0	0	1
Pleuronectiformes	Soleidae	1	0	1
Total		**61**	**34**	**69**

d) List of Rare Fish Species

Rare fish species were identified through interviews with fishermen in communities in the project area. The interviews were conducted directly with individual fisherman in each village by using fish posters (published by CEPA in 2006). 99 fish species in totoal were identified from the interviews and PRA (focus group discussion), and only 85

species were caught (by the selected fishermen) during the study period. The detail of fish species is described in annex of appendix 2.

The rare fish species were also recorded from interviews and discussions with fishermen. The results from the interviews are shown in table 18. The table is divided into three parts such as upstream of the project site on the Sesan River, downstream of the project site on the Sesan River and Srepok River (in Stung Treng province)

Table 18: Rare fish species

Order	Family	Rare fish species		
		D-S of the project site	U-S of the project site	Srepok
Rajiformes	Dasyatidar	1	1	1
Osteoglossiformes	Notopteridae			1
Cypriniformes	Cyprinidae	6	8	17
	Cobitidae		2	
Siluriformes	Ariidae		1	1
	Pangasiidae	6	7	1
	Schibeidae		1	
	Siluridae		2	1
Perciformes	Channidae	1		1
	Polynemidae	1	1	1
	Sciaenidae	1	2	1
	Osphronemidae			1
	Eleotridae			1
Synbranchiformes	Synbranchidae			1
Pleuronectiformes	Soleidae			1
Total		**16**	**25**	**29**

Table 19: Rare fish species in Sesan and Srepok river

Family	*Scientific name*	Local name
Dasyatidar	*Amphotistius sp*	1- Trey Bawbel
Cyprinidae	*Cirrihinus molitorella*	2- Trey Pakaing
	Mekongina erythrospila	3- Trey Pasi ee
	Lebeo erythropterus	4- Trey Pawa mok moi
	Bangana behri	5- Trey Pawa mok pee
	Probarbus jullieni	6- Trey Trawsak
Pangasiidae	*Pangasius sp.*	7- Trey Pra
Polynemidae	*Polynemus sp*	8- Trey Pream

Note: Downstream and Upstream of project site, in Stung Treng province only

There are 8 rare fish species in the Sesan and Srepok rivers and detail name is described in table 19, within only three species (Mekongina erythrospila/Trey Pasi ee, Bangana behri/ Trey Pawa mok pee and Probarbus species/ Trey Trawsak) were recorded as rare species by CITES and Fisheries Administration (Fish poster in 2005).

Among the 85 fish species captured, 42 species had an occurrence of less than 50 %, see figure 16. This means that 42 species were identified as rare species during the study period.

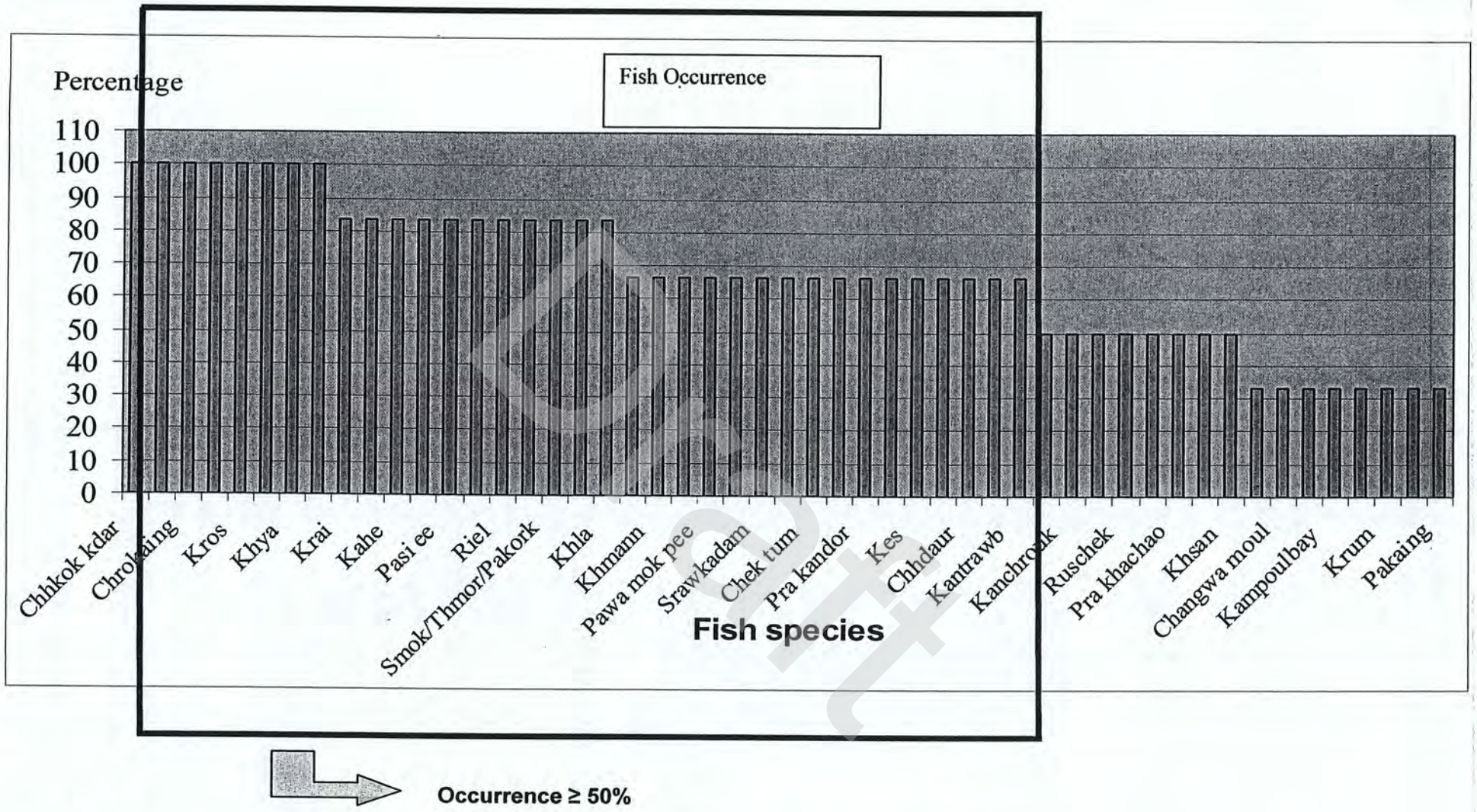


Figure 16: Occurrence of fish species in Sesan and Srepok River

e) Fish Movement

Generally, fish move from downstream to upstream of the project site or vice versa in the early rainy season to find new habitat, spawning, feeding and during the dry season move to deep pools as a dry season refuge (Poulsen et al., 2004 and Sverdrup-Jensen, S. 2002). A fish study report by Baird et al., 2003-2004 indicates that small Cyprinids migrate from Great Lake (Tonle Sap) to the Mekong River, and two Cyprinids (Scaphognathops bandanensis and Mekongina erythrospila) are highly migratory species and other fish species which are also long distance migrators originate from the Great Lake and the Tonle Sap River. The Srepok may have a higher diversity of fish species because it has more deep pools, and fewer migration barriers than Sesan and Sekong. The Vietnamese biologist Dr. Ho Thanh Hai indicates that more than 50 species of fish species from the Mekong migrate far up into Vietnam along the Srepok river, source "EIA on the Cambodian part of Srepok River due to Hydropwer Development in Vietnam", SWECO GRONER , Dec. 2006.

From information from wholesaler interviews during the fish survey it found that fish migrate in May to July from downstream to upstream of the proposed dam site area in the Sesan River, and in June to July to upstream of the project site in the Sesan River and in the Srepork River. The same fish movement was also recorded by Poulsen et al., 2004 and Sverdrup-Jensen, S. 2002.

The fishermen in the project site also explain that in the early rainy season the small Cyprinids migrate from downstream to upstream of the project site. However there are more fish migrations in the Srepok and Sekong Rivers than in the Sesan river due to the habitat condition of the Srepok and Sekong Rivers having many deeper pools and more adjacent wetlands than the Sesan River.

58 fish species of the total fish species caught during the study (87 fish species) are found in both the Sesan and Srepok Rivers (Table 2 in Annex of fish study report, see Appendix 2). Based on the fish movement records both downstream and upstream of the project site it means that about 66% of fish species move to above and below the project area. Moreover the study in the dry season by Poulsen at el., 2002 indicated that most fish spent their time in deep pools of both rivers for breeding/spawning and growing. Various studies by Baird et al (2003, 2004, and 2005) also strongly indicate that large numbers of fish migrate up and down the Sesan and Srepok Rivers each year.

Based on the information from fishermen, the spawning season starts from May to August every year, but some fish species migrate in March such as the Channa species.

Table 20: Fish spawning in the project area, research study Feb-May 2008

			Season of Fish Spawning					
No	**Fish species**	**Scientific name**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
1	Pasee i	*Mekongina erythrospila*						
2	Pra	*Pangasius hypophthalmus*						
3	Po	*Pangasius lamaudii*						
4	Pawamook pee	*Bangana behri*						
5	Proul	*Cirrihnus microlepis*						
6	Kaek	*Morulius sp.*						

7	Krum	*Osteochilus melanopleurus*						
8	Achkok	*Dangila spilopleura*						
9	Riel	*Henicorhynchus lobatus*						
10	Chhlang	*Hemibagrus nemurus*						
11	Chhpin	*Hypsibarbus sp.*						
12	Chdaur	*Channa macropeltes*						
13	Phtouk/Ros	*Channa striata*						
14	Khman	*Hampala dispar*						
15	Chrokaing	*Puntioplites falcifer*						
16	Khya	*Mystus wyckioides*						
17	Chektum	*Bagrichthys macropterus*						
18	Chhkok	*Cyclocheilichthys enoplos*						
19	Rahou	*Channa sp*						
20	Andaing	*Clarius batrachus*						
21	Romeas	*Osphronemus exodon*						

f) Fish Yield / Production

f-1. Catch Estimation by Focus Group (PRA)

Wild fish catch estimation was estimated from the focus group (PRA) in each village by asking about catch, gear use, duration of fishing, how many days per month and how many months per season to estimate the annual yield in the project areas. In generally the people in the project area do fishing 90-310 hours in dry and wet season in various area in downstream and upstream, see detail in fishery study report.

Based on PRA and HH survey by fishery study team in March 2008 indicated 100% of the participants and interviewees have more or less fishing to support daily livelihood beside other job, and different fishing gears were practice in each family. The daily fish catch is 0.5kg/family in dry season and 0.6kg/family in wet season in downstream of Sesan river, 0.2kg/family in dry season and 0.5kg/family in wet season in upstream of Sesan river, and 0.6kg/family in dry season and 0.5kg/family in wet season in Srepok river.

However about 95 % of total family in the commune are fishing, according to village chiefs said. This figure will apply for fish catch estimation in the study.

Table 21: Fishing family in the project area

Village name	Total Family	Fishing family	
		%	#
Downstream of project area			
Phluk	196	95	186
Banh Bung	68	95	65
Total:	**264**		**251**
Upstream of the project area			
Srekor 1	165	95	157
Srekor 2	158	95	150
Talat	72	95	68
Svay Reang	256	95	243
Rompot	53	95	50
Khsach hmey	255	95	242

Total:	**959**		**911**
Srepok River			
Sre Sronok	104	95	99
Kbal Romeas	106	95	101
Krobei Chrum	177	95	168
Total:	**387**		**368**

From table 21 indicated that the total number of the fishing family in the project area is 1530 family.

Table 22a: Fish Catch Estimation by PRA group discussions

No.	Project Areas	Yield in Dry season				Yield in Wet season			
		Daily catch/ family, in Kg	Fishing family	Fishing hour	Total catch, in Kg	Daily catch/ family, in Kg	Fishing family	Fishing hour	Total catch, in Kg
1	Downstream of Sesan	0.5	251	255	32002	0.6	251	250	37650
2	Upstream of Sesan	0.2	911	147	26783	0.5	911	90	40995
3	Srepork	0.6	368	225	49680	0.5	368	310	57040
	Total		1530		108466				135685

Table 22b: Summary Catch Estimation by PRA group discussions

No	Project Areas	Yield in Dry season (t)	Yield in Wet season (t)	Yield per year (t)
1	Downstream of the project site on the Sesan	32.00	37.65	69.65
2	Upstream of the project site on the Sesan	26.78	40.99	67.77
3	Srepok	49.68	57.04	106.72
Total		108.46	135.68	244.14

The total catch estimation in both rivers in the project area is 244.14 tons.

f-2. Catch Estimation in project area (by Logbook)

Two catch sections were selected on the Sesan River (one upstream and one downstream of the project site) and one on the Srepok River for the study of wild fish catch.

- Sesan upstream site: section from Sre Kor commune to Talat village.
- Sesan downstream site: section from Bunh Bong village to Pluk village.
- Srepok River site: section comprising from Sre Sronok village to Krobei Chrum village.

Fishermen were identified and selected to record fish catch data in logbooks to establish a monthly survey of CPUE (Catch Per Unit Effort)/gear/hour/fisherman. A total of 12 fishermen were identified from the Sesan River and six from the Srepok River.

Tables 23a, 23b and 23c: summarise catches per fishing in different catch sections. The four most efficient gears were: Cast Net (Samnanh), Hook Long Line (Santouch ronorng), Gillnet (Morng) and Horizontal Cylinder Trap (Lob).

Table 23a: Catch estimation in upstream of the project site in Sesan in dry Season

No	Fishing Gear	Number of HHs	CPUE (g /h/gear)	Hour/ day	Day/ month	Month/ year	Fish yield (g)	Fish Yield (ton)
1	Morng (100%)	911	3.36	12	20	6	4407782	4.41
2	Samnanh (50%)	456	531.76	2	10	6	29097907	29.1
3	Ronorng (50%)	456	77.16	12	10	6	25333171	25.33
4	Tom (5%)	46	8.89	12	6	6	176662	0.18
							Total	**59.02**

Table 23b: Catch estimation in downstream of the project site Sesan in dry Season

No	Fishing Gear	Number of HHs	CPUE (g/h/gear)	Hour/ day	Day/ month	Month/ year	Fish yield (g)	Fish Yield (ton)
1	Morng (100%)	251	1.2	12	20	6	433728	0.43
2	Samnanh (50%)	126	717.94	2	18	6	19539455	19.54
3	Ronorng (50%)	126	29.31	12	10	6	2659003	2.66
							Total	**22.63**

Table 23c: Catch estimation in Srepok River in dry Season

No	Fishing Gear	Number of HHs	CPUE (g/h/gear)	Hour/ day	Day/ month	Month/ year	Fish yield (g)	Fish Yield (ton)
1	Morng (100%)	368	0.3	12	20	6	158976	0.16
2	Samnanh (50%)	184	770.61	2	15	6	25522603	25.52
3	Ronorng (50%)	184	23.28	12	6	6	1850480	1.85
							Total	**27.53**

Note: HHs: Households

After two months of survey, the catch estimation by logbook was around 81.65 tons (table 23a and 23b) in the Sesan River and 27.53 tons in the Srepork river. The fish yield in upstream of the Sesan river was more than downstream of Sesan and Srepok River in the period of research study (Early of February to late of April, dry season). The total catch in both rivers is 109.28 tons, it means that this fish catch in dry season (2008) is similarly to the fish catch estimated by PRA group discussion (108.46 tons)

From above result can be determined fish catch per family per day as follow:
Fish catch per family per day = Total fish catch (kg)/Total number of fishing family (family)/whole period of dry season/total day per month;

Where:

- Total fish catch 109.28 t = 109,280 kg
- Total fishing family = 1530 family
- Dry season= 6 months
- 1 month = 30 days

Fish catch per family per day = 109,280 kg/1530 family/6*30 days
=0.397 kg/family/day

The catch per day was increased during the wet season, acording to the PRA group discussion result, see table 22a and detail in fish study report.
Therefore the fish catch per year in the project area is 244.14 tons, 109.28 tons in dry season (research study) and 135.68 tons in wet season (PRA). Moreover the fish price obtained from villager in the project site as follow: valuable fish 5$, medium fish 2$ and trash fish 1$ (average cost 2.5$), and the exchange rate 1$=4000 Riel in Stung Treng Market, Mar. 2008.

Annual cost from the fish caught in project area can be ditermine as follow:

	Total catch, kg	Average price, $/kg	Amount, $
Dry season	109,280	2.5	273,200
Wet season	135,680	2.5	339,200
Total:	244,960		**612,400**

f-3. Catch estimation by using CPUE of previous study Baird and Meach 2005

Upstream of the project site, which includes along the Sesan and Srepok Rivers, is not only located in Stung Treng province it is also located in Ratanakiri province. The catch estimation of the upstream of the Sesan and Srepok Rivers was estimated by using secondary data (particularly Baird and Meach 2005).

The total population upstream of the project site along the Sesan River located in Ratanakiri province is 4071 families with 20,035 persons and the total population along the Srepok River located in Ratanakiri province is 1,512 families with 7,571 persons (3S Rivers protection network, 2006).

The CPUE (Catch Per Unit Effort), fishing hours and fishing gear used shown in table 23 were sourced from Baird and Meach, 2005. The total population numbers were sourced from 3S River, 2006.

Table 23: Total catch in the upstream of the project site along the Sesan and Srepok Rivers in Ratanakiri Province[1] (based on Baird and Meach 2005)

Srepok River (Total number of fishing families is 1361 or 90% of total household)					
Fishing gear	**Number Fishing family**	**CPUE (kg)**	**Hour/year**	**Yield/Year (kg)**	**Yield/Year (ton)**
Morng (95 %)	1293	0.082	1564	165824.66	165.82
Ronong (40 %)	667	0.064	189	8068.03	8.07
Bangkai (22 %)	299	0.057	182	3101.83	3.10
Samnanh (7 %)	95	0.13	1.2	14.82	0.01
Total Catch				**177009.34**	**177.01**
Sesan River (Total number of fishing families is 3664 or 90% of total household)					
Fishing gear	**Number Fishing family**	**CPUE (kg)**	**Hour/year**	**Yield/Year (kg)**	**Yield/Year (ton)**
Morng (95 %)	3481	0.082	1564	446431.29	446.43
Ronong (40 %)	1465	0.064	189	17720.64	17.72
Bangkai (22 %)	806	0.057	182	8361.44	8.36
Samnanh (7 %)	256	0.13	1.2	39.94	0.04
Total Catch				**472553.31**	**472.55**

[1]This is assuming 90 % of the total population in villages along the two rivers fishing in Ratanakiri province. This is based on information contained in a number of reports including the SWECO reports for both the Sesan and Srepok Rivers (2006), NGO Forum 2006 and Baird and Meach 2005

The total catch in the Srepok River in Ratanakiri was about 177.01 tons for 1361 families. This means that the catch per day per family is estimated at 0.36 kg/family/day (177.01 tons/1361 families/365 days) or 0.065kg/person/day (177.01 tones/7571 persons/365 days)[2]. The total cost of fish caught was 531,030 $ (177,010 kg *3 $/kg). The average fish price of 3 $/kg was sourced from local people in Ratanakiri, 2008. The average value of catch per family per year therefore is approximately USD 390.17 ($531,030/1361 families).

The total catch in Sesan River in Ratanakiri in 2003/4 was about 472.55 tons for 3664 families. This means that the catch per day per family is 0.35 kg/family/day (472.55 tons/3664 families/365 days). The total cost of fish caught was 1,417,659 $ (472550 kg *3 $/kg). The average fish price of 3 $/kg was sourced from local people in community base in Ratanakiri, 2008. The average value of catch per family per year therefore is approximately USD 387.91 ($1,417,659/3664 families).

Table 24: Summary of annual fish yield in Sesan and Srepok river

Study area	Annual Yield, kg	Price, USD/kg	Cost, USD	#of fishing family	Value of catch per family per year USD
Phluk to upper reservoir site(*)	244,140	2.5	610,350	1530	398.92
Upstream of the reservoir site to Vietnam border in Srepok river	177,010	3	531,030	1361	390.17
Upstream of the reservoir site to Vietnam border in Sesan river	472,550	3	1,417,650	3664	386.91
Total :	**893,700**		**2,559,030**		

Note: (*) Phluk commune (Kamphun village) to Talat commune (Talat village) in Sesan river, and Kbal Romeas commune (Srepok village) to (Krabei Chrum village)

The existing fish catch estimations for families living upstream of the project site are significant and any changes to the fish regime in these areas need to be considered very carefully, the mitigation measure is proposed in Chapter 6 of this report.

f-4. Catch estimation by using CPUE from recent research 2008

Based on the CPUE from the recent reseach study 2008, catch estimation of the fish product in both rivers can be determined and described in following paragraph.

The total catch in Sesan River (Ratanakiri) was about 350.933 tons for 4598 families (90 % are fishing families). The total cost of fish caught was USD 1,052,800.00. The average fish price of 3$/kg was sourced from local people in community base in Ratanakiri, 2008.

The total catch in Srepok river (Ratanakiri) was about 51.473 tons for 1871 families (90 % are fishing families). The total cost of fish caught was USD 154,420.00. The average fish price of 3 $/kg was sourced from local people in community base in Ratanakiri, 2008.

Table 25: Total catch of the Sesan and Srepok River, by using the CPUE (Catch per unit Effort) and fishing hours were used the source from recent research and total population was used the source from MoI, 2007.

[2] These figures in reality are likely to be higher as due to lack of fishing data for the Srepok River the figures have been based on the Sesan catch figures. It is commonly accepted that the fish numbers in the Srepok are higher than the Sesan due to better habitat.

Subscribe of 90 % of the total population in upstream of reservoir site are fishing families					
Srepok River (The total family is 1684 families, data 2007, MoI)					
Fishing gear	**Fishermen Number**	**CPUE (g)**	**Hour/year**	**Yield/Year (g)**	**Yield/Year (tone)**
Morng (95 %)	1600	0.3	2880	1382145	1.382
Ronong (40 %)	674	23.28	864	13547932	13.548
Bangkai (22 %)	370	57	182	3843131	3.843
Samnanh (7 %)	118	770.61	360	32700281	32.700
Total Catch				51473489	51.473
Sesan River (The total family is 4138 families, data 2007, MoI)					
Fishing gear	**Fishermen Number**	**CPUE (g)**	**Hour/year**	**Yield/Year (g)**	**Yield/Year (tone)**
Morng (95 %)	3931	0.3	2880	3396635	3.397
Ronong (40 %)	1655	23.28	432	16647085	16.647
Bangkai (22 %)	910	57	182	9444531	9.445
Samnanh (7 %)	290	770.61	1440	321444981	321.445
Total Catch				350933231	350.933

Summary of annual fish catch and its cost estimation in project area

	Total catch, kg	Average price, $/kg	Amount, $
a) By PRA group discussion			
Dry season	108,460	2.5	271,150.00
Wet season	135,680	2.5	339,200.00
Total:	244,140		**610,350.00**
b) By research (February-May 2008)			
Dry season	109,280	2.5	273,200.00
Wet season	135,680	2.5	339,200.00
Total:	244,960		**612,400.00**

Summary of annual fish catch and its cost estimation in upstream of project area

Upstream of project area	Total catch (kg)	Fish price, $/kg	Total Cost, $
A) By using the CPUE (Catch per unit Effort) and fishing hours were used the source from Meach and Baird, 2005 and total population was used the source from 3S River, 2006.			
Sesan River	472550	3.00	1,417,650.00
Srepok River	177010	3.00	531,030.00
Total:	649560		**1,948,680.00**
B) By using the CPUE (Catch per unit Effort) and fishing hours were used the source from recent research (February-May 2008) and total population was used the source from MoI, 2007.			
Sesan River	350933	3.00	1,052,800.00
Srepok River	51473	3.00	154,420.00
Total:	402406		**1,207,220.00**

Table 25a: Summary of annual fish yield in Sesan and Srepok river (counting 100% loss)

Study area	Annual Yield, ton	Price, USD/kg	Cost, USD	#of fishing family	Value of catch per family per year USD
Phluk village to Svay Rieng village (Ranak Kiri border) and Srepok Bridge to Krabei Chrum village (Ratana Kiri border)	244.960	2.5	612,400.00	1530	400.26
In Sesan river, Upstream of Svay Rieng village (Ranak Kiri border) to Vietnam border	350.933	3	1,052,799.00	3664	287.34
In Srepok, Upstream of Krabei Chrum village (Ratana Kiri border) to Vietnam border	51.473	3	154,419.00	1361	113.46
Total :	**647.37**		1,819,618.00		

Table 25b: Summary of annual fish yield in Sesan and Srepok river (counting 66% loss*)

Study area	Annual Yield, ton	Price, USD/kg	Cost, USD	#of fishing family	Value of catch per family per year USD
Phluk village to Svay Rieng village (Ranak Kiri border) and Srepok Bridge to Krabei Chrum village (Ratana Kiri border)	161.67	2.5	404,175.00	1530	264.17
In Sesan river, Upstream of Svay Rieng village (Ranak Kiri border) to Vietnam border	231.62	3	694,860.00	3664	189.65
In Srepok, Upstream of Krabei Chrum village (Ratana Kiri border) to Vietnam border	33.97	3	101,910.00	1361	74.88
Total :	427.26		1,200,945.00		

Note: * According to the fish movement results

g) Fishing Activities and Consumption

The people who live along the Sesan and Srepok Rivers depend on farming, fishing, forest by-products and animal raising (buffalo and cattle). These activities play a very vital role for their livelihoods, but fishing activity now has become vital for villagers in the project area, and also upstream and downstream of it.

In general fishermen spend their time from 2 to 4 hours per day on fishing activities and then they do other jobs although some fishing gears such as Moang, Santouch Renong and Tom are used between 8 to 12 hours/day, because these fishing gears are kept a long time in the water (fishermen interview in the project site 2008).

Based on the information from interviewing, fishermen spend between 10-25days/month in wet season and 14-24 days/month in dry season depending on fishing gears, see figure 17. The number of fishing days was not very different from both seasons even though in the wet season they are also busy with rice production activities.

The fishermen in the study area can catch fish in average of 0.5 to 5.5 kg/day in the wet season and 0.5 to 3.1kg/day in the dry season. The villagers consumed fish at least 0.5 kg/day/family and the maximum 3.1kg to 5.5 kg/day/family (fishermen interview in the project site 2008).

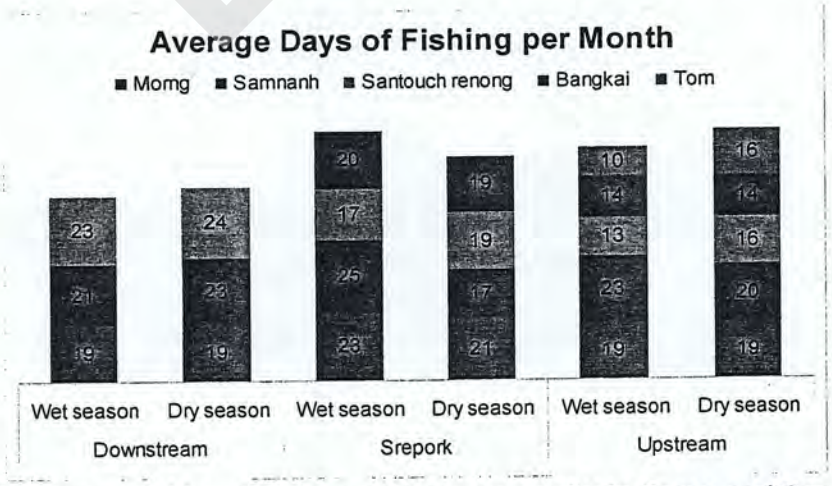


Figure 17: Average fishing day per month in community in Sesan and Srepok rivers

h) Fish yield

Figure 18 shows the fish yields per day/household for the study area upstream and downstream of the project site on the Sesan and Srepok Rivers. Fish yield upstream of the project site of the Sesan River was lower than downstream of the Sesan River and along the Srepok river.

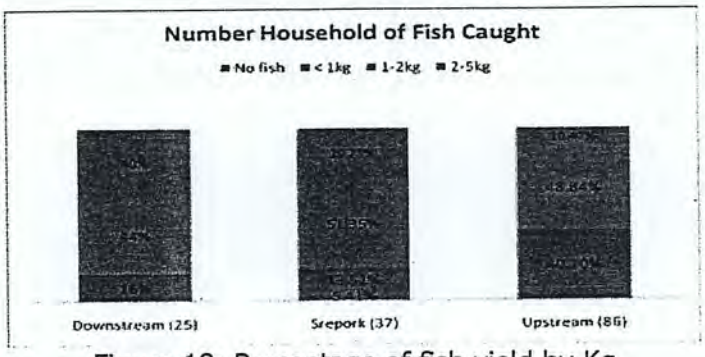


Figure 18: Percentage of fish yield by Kg

The villagers will sell fish if they catch more than 2 kg/per/day to get some money for household expense such as for health care, ceremony and food (source from 2008 study interviewes). Figure 19 shows that 100 % of fishermen sold fish where the yield was 2-5kg/day/family. No sold if the yield is less than 1kg/day/family as they use this for daily household consumption (fishermen interview in the project site 2008).

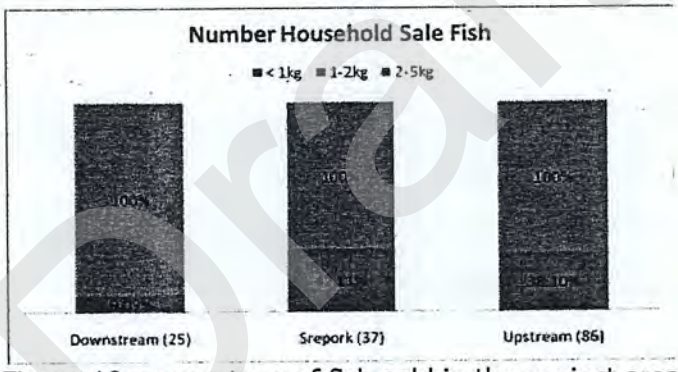


Figure 19: percentage of fish sold in the project area

i) Conclusions

The results of the present study (February - May 2008) indicate that the fish species recorded in the project area are 9 Order, 22 Family and 99 species by PRA and survey, and 6 Order, 21 Family and 87 species. Only three fish species (*Mekongina erythrospila*, *Bangana behri* and *Probarbus sp*) were recorded as rare species in general of Mekong River by CITES.

Fish do move from upstream of the project site to downstream for seasonal spawning, feeding, new habitat and dry season refuge.

0.19 kg/person/day is eaten by fishermen in the main stream of Mekong River (Sverdrup-Jensen, S 2002) but the fishermen in the project area ate fish only 0.08 kg/person/day. Fish yield in the project area in the dry season is decrease because of fish habitats were reduced (deep pools were filled up with sand, silt and rock by erosion in rainy season that impact to dry season refuge and feed lost (rock algae), and increase of turbidity in the river (Ian G. Baird et al., 2005). The fish used for household consumption is very important for villagers in the project area because fish provided high quality of protein and helps poor people from having to buy meat for daily food.

4.2.2 Aquatic biology

There are 30 kinds of inundated forest recorded along the Sesan and Srepok River. Some of the inundate trees and herbs were used as traditional medicine by villagers, fed by some fish during the wet season. Inundated forest plays a very important role in fish habitat such as for fish spawning in rainy season, feeding and escaping from predators (CEPA, 2005-2006). Table 26 showed in detail of inundated forest in the project area. The picture of some inundated forest in the proposed reservoir were attached in annex 2.

Table 26: List of inundated forest in the project area

No	Khmer Name	Lao Name	Scientific Name	Used
1	Romdeng	Kok khey	*Alpinia galanga*	Tree size: 0.01 m, high: 1.5m, Nov-Decem has flower, Feb-March fruit ripe, Flower and fruit ate by Trey Romeas and Trey Chhpin.
2	Rey Teuk	Kok Khey khelao	*Homonoia riparia*	Tree size: 0.1 m, high: 1.5 m, Feb-March fruit ripe, Flower and fruit ate by Trey Romeas and Trey Chhpin.
3	Tros	Kher Ben	*Conbretum trifliatum*	Tree size: 0.05 m, high: 2 m, has purple flower and fruit ate by Trey Romeas and Trey Chhpin.
4	Rang Teuk	Ka Dounnam	*Barringtonia acutauqula*	Tree size: 0.8 m, high: 7 m
5	Chhke Tuoy	Kok Khan kong	*Mallotus anissopodus*	Tree size: 0.3-0.4 m, high: 4-5 m, fruit ate by non scale fish.
6	Vor Ta an teuk	Kher Taan		
7	Phnom Phneng	Kok Huoloeung	*Hymenocardia*	Tree size: 0.1 m, high: 2-3 m.
8	Tonlea	Kok phak kum		Tree size: 0.3-0.4 m, high: 3-4 m, white brown of tree, white flower, big fruit about 0.05 m and ate by Trey Romeas and Trey Chhpin.
9	Kdol	Kok Khan Leoung	*Nauclea orientalis*	Tree size: 0.3-0.5 m, high: 5-10 m, fruit eat by Trey po Trey Chhpin, Trey Ke...
10	Chrey Krem	Kok Haihert	*Ficus racemosa*	Tree size: 0.3-0.5 m, high: 4-6 m, fruit eat by Trey Romeas, Trey Chhpin, Phkar kor...
11	Vor Savmav	Kheou Nhunhhang	*Passiflora foetida*	Tree and fruit eat by Trey Romeas, Trey Chhpin, Trey Traw cheakdamrey...
12	Lvea Chek	Mak Der	*Nauclea orientalis*	Tree size: 0.3-0.5 m, high: 5-10 m, fruit eat by Trey Romeas, Trey Chhpin, Trey Po, Trey Ke...
13	San Dan	Kok Kdan	*Garcinia lourreiri pierre*	Tree size: 1.5-2 m, high: 3-5 m
14	Svay Teuk	Kok Samphor	*Grewia sinuata*	Tree size: 0.2-0.4 m, high: 3-4 m, fruit eat by Trey Romeas, Trey Chhpin, Phkar Kor, Sraw kakdam...
15	Chanlos Teuk	Mak Huotnam	*Lepisanthes rubigignosa*	N/A

16	Kror Bao	Mak Kabao	*Hydnocoarpus*	N/A
17	Beng Teuk	Kok Hai	*Litsea pierrei*	N/A
18	Vor Nonoung prey	Khoeu Makkhum	*Luffa aegytiaca*	N/A
19	Vor Pdaoteuk	Khoeu Vaynam	*Calamus godfroyi*	N/A
20	Chhe Tealteuk	Kok Njornam	*Dipterocarpus alatus*	N/A
21	Pring Teuk	Kok Makvakhao	*Eugenia cineria*	N/A
22	Mean Teuk	Kok meannham	*Dimocarpus longan*	N/A
23	Thkov	Kok Kou	*Anthocephanlus chinensis*	N/A
24	Rom Denhteuk	Kok kasev	*Elaeocarpus lanceifolius*	N/A
25	Kanhnje Baydach	Say Sou	*Capparis micracantha*	N/A
26	Anh Chanhteuk	Kok Seav		N/A
27	Kror Muoch	Sum Soy	*Antidesma acidum*	N/A
28	Bay Kdang	Kok Khaohem	*Lemaireocereus*	N/A
29	Dang Keabkdam	Kok Maokhon	*Antidesma ghaesembilla*	N/A
30	Russey Khley	Kok Maylai	*Bambusa bambos*	N/A

Source: 3S River Network, Feb. 2008, Meach Mean

4.2.3 Wildlife

4.2.3.1 Habitat characteristics

The habitat extends largely on the southern part of the Srepok River and it is a vast habitat which connects to two protected areas which are managed by the MoE: the Lomphat Wildlife Sanctuary in Rattanakiri Province and Phnom Prich Wildlife Sanctuary; and the Seima Biodiversity Conservation Area (SBCA)[1] in Mondulkiri Province which is a Protected Forest and is managed by the Forest Administration. The two protected areas and SBCA Protected Forest are upstream of the proposed sites for resettlements in the Lower Srepok River. Furthermore, the catchments continue expending into the southern Vietnam where it is considered as trans-boundary forest area. Therefore, the forests cover a large area in the eastern part of Cambodia and southern Vietman and this gives favorable conditions for large populations of wildlife, especially large animals

[1] *Seima Biodiversity Conservation Area (SBCA) is the protected forest established in 2002 and managed by Forestry Administration (FA) which is under decree of the Ministry of Agriculture, Forestry and Fisheries. The total size of the conservation area is 3,034km². Currently, there are two protected forests established and under management from FA and these areas are namely; Seima Biodiversity Conservation Area and Mondulkiri Protected Forest. Additionally, two protected areas were designated under Royal Degree on November 1993 and they are managed by Ministry of Environment. Both protected areas and protected forests have been under several researches and surveys. Most surveys/researches have been done through cooperation between donors funded projects/programs with the Ministry of Environment and MAFF.*

such as Kouprey (*Bos sauveli*), Asian Elephant (*Elephas maximus*), Tiger (*Panthera tigris*), Eld's Deer (*Cervus eldii*), and so on. However, this habitat is also damaged and fragmented due primarily to the roads have been built through such habitat. Additionally, the obtained information also addressed about the social forest land concession outside protected areas can be seen as a vast conversion for development and go along with other land grabbing for speculation *(CEPA per.com, 2008)*. However, certain maps indicate about area of Social Forest Land Concession (SFLC) were not revealed in relation to how large of the areas have been used under such concession.

According to the key informants interviewed in Srekor commune there has been a decline of wildlife in the area for the last ten years. In addition, signs of animal disturbance, for instance, digging, grazing, animal dung and salty soils, were not found within the transect line for the resettlement areas. The proposed sites for resettlement can be accessed easily so that the disturbance will be high to wildlife in the area. There is an ox-cart trail that is used for wood transportation and provides more access into deep forest for hunting as well. Hunting activities were continued in form of daily food, without controlling or monitoring from the competent authorities, see figure 23. The large wild animals such as Banteng, Gaur, Deers and wild-pigs were usually poached. The gunfire was heard in the forest around the villages at night time and most hunting was for food and local consumption except products from tiger and bear which was made for sale, according to chief of commune in Srekor.

a) Catchments

As aforementioned, the Lower Mekong Dry Forest Ecoregion (LMDFE) in the northeast and eastern part of the country covers in provincial territories of Stung Treng, Rattanakiri and Mondulkiri Provinces. The catchments raised for discussion at this time being, may address on the areas of Rattanakiri and Mondulkiri Provinces where they locate at the upper part of the proposed resettlement areas, reservoir, and dam site of the Lower Sesan 2 HPP project.

There are four protected areas and two protected forests are considered as the upper catchments of this Dam Project. These protected areas are namely; Lomphat Wildlife Sanctuary (LWS), and Virachey National Park (VNP) in Rattanakiri province while in Mondulkiri province consists of Phnom Prich Wildlife Sanctuary (PPWS), and Seima Biodiversity Conservation Area (SBCA). Within these catchments, there have been several researches/surveys done in relation to ecological and wildlife surveys. Further information is in the appendix for the list of mammals, birds, reptiles and amphibians as well as plant species. The results from those surveys have been identified and found several species of wildlife populations, especially large mammals are globally threatened species. These catchment areas especially areas under protection are likely the last strongholds for wildlife populations and its habitat. However, it is generally said the management systems either inside and/or around the protected areas or protected forests are significantly important for conservation. Lack of appropriate plans and go along with limited financial assistance can lead to critical issues to survive certain species of globally endangered species like elephants, Banteng, Guar and primates and so on. Ideally, corridors between protected areas (PAs) linkage to protected forests (PF) should be established in order to provide more habitat available for the movement or migrating of wildlife within this area, LMDFE area in particular. Additionally, any proposed development inside the PAs and/or PFs should be critically considered or

otherwise options elsewhere can be beneficial to conservation vs. development perspectives.

b) Reservoir area

There is uncertain data existing in relation to the surveys/researches within the reservoir area. However, recent filed observations were conducted randomly through dialogues with elderly people and local hunters indicated that the presence of the large animals, such as Banteng, Gaur, Asian Elephant, Bear and primates are nearly absence or rarely seen but small animals like wild-pigs mouse-deer and other reptiles (monitor lizards and turtles) are often seen and these animals are under threats from local consumption.

c) Resettlement areas

There is not solid evidence about the wildlife presence within the areas of resettlements, based on the filed observations and discussion with key informants. However, forest birds likely occur commonly within such forest type, especially Hill Myna, Hornbills, and Woodpeckers and so on. Forest conditions likely support to the wildlife habitat but due to these areas are close to the existing villages and easily access have resulted in large disturbance. For instance, selective loggings are considered as major causes and tracks provide more accessible for other human activities such as hunting in area vicinity, and land grabbing. The proposed areas for resettlements may needs certain development of infrastructures such as roads, health centers, and other necessary facilities within/inside the resettlement areas in order to ease public accessibility in and out.

d) Downstream area

There are uncertain data existing in relation to the previous surveys in the downstream area. The area supposed to be downstream for the resettlements of the Dam Project is mostly located in Stung Treng territory of the Lower Sesan and Lower Srepok Rivers. According to recent observations and dialogues with key informants in the targeted areas of the resettlements and other involved stakeholders indicated that most existing forest area are given for a so-called Social Forest Land Concessions (SFLC). The purposes of the SFLC are used for agro-industrial crops such as cassava, rubber plantation, cashew trees, and other tree plantations. These types of land uses are unlikely to be favorable for wildlife and its habitats. In addition, the proposed resettlements of the Dam Project may have some significant effects to the downstream, especially fish migration/movements. However, it is unlikely to impact directly to the loss of forest habitats and threat to wildlife at the downstream, especially large wild animals.

4.2.3.2 Mammal

There have been many surveys done in the river catchments in Stung Treng and Rattanakiri Provinces that show concrete evidence of the presence of large wildlife, especially the globally threatened species of Banteng, Gaur, Gibbons, Bears, Elephants

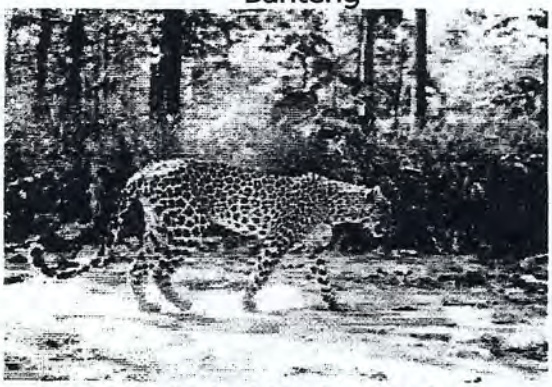
and other endangered species of large birds and so on. Previous surveys indicate that LMDFE in the northeast and eastern part of the country is internationally recognized and as global biodiversity assets for support of large wild animals as listed in the IUCN Red Data Book as threatened with global extinction (IUCN, 2003). The large mammals include *Kouprey*, tiger, Asian elephant, Banteng, wild water buffalo, eld's deer, golden cat, fishing cat, black bear and gibbons.

At the Srepok resettlement sites, there was no significant evidence of wild animals, especially large animals occurring within the transect line. Signs of animal digging from wild-pig, grazing from cattle (Banteng, Gaur or Deer) and other disturbance from animals were not seen. There was not place for salty soil found during the surveys at the transect site. However, forest birds, especially bulbuls, woodpeckers, hornbills, sunbirds, and mynas are still common in this forest. Due to human activities access through this area can give evidence of disturbance to wildlife. There are several trails/tracks inside the forest area that allow more access for hunting. A few lizards (water monitors) were sold in the village while the study team passed through. In addition, the status of wildlife and wood products has been in strong decline for the last ten years (*Phork, ranger to Virachey National Park per.com*). However, large wild-animals such as Banteng (*Bos javanicus*), Gaurs (*Bos gaurus*), Bears, Elephants and Gibbon are still at large elsewhere in the northeast and eastern Cambodia but they are under pressures from human disturbance.

In figure 20 showed some photo of the wildlife that taken by trap-photograph in previous and present study, WWF "Greater Mekong-Cambodia Country Programme: Biodiversity Vision for the Lower Mekong Dry Forest Ecoregion", 2006, and WWF "Greater Mekong Cambodia Country Programme, Unpublished report on wildlife tracks and sights in the catchments in the northeast and eastern part in Mondulkiri Protected Forest and Srepok Wilderness Area", 2008.

Banteng

Gaurs



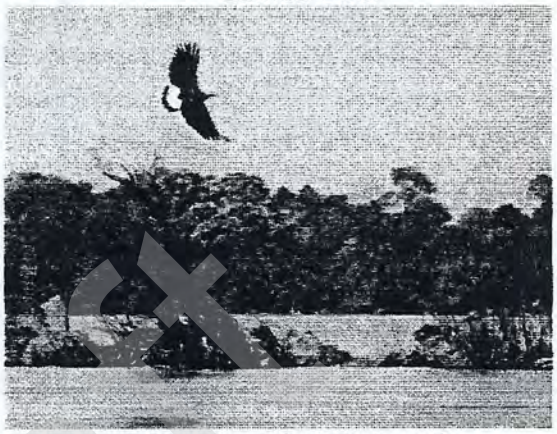
Indochine Leopard

Black Bear

Tiger

Samba Deer

White-shouldered Ibis



Grey headed Fisheagle

Figure 20: Some photo of wildlife in the project area taken in previous study (2003-2006)

4.2.3.3 Birds

11 species of wild birds are found along the Sesan and Srepork River and some species eat fish in the river for some species. Table 27 showed the present birds in the project area.

Table 27: List of bird in the project area

No	Khmer Name	Scientific Name	English Name
1	Kok	*Egretta garzetta*	Little Engret
2	Morn Teuk	*Amaurormis phoenicuru*	White-breasted water hen
3	Pro Vek	*Dendrocygna javanica*	Lesser whistling duck
4	Tro Dok	*Leptoptilos dubius*	Greater Adjuntant
5	Kror Sa	*Ardea cinerea*	Grey Heron
6	Kaek Teuk	*Phalacrocorax niger*	Little Cormorant
7	Roneal Sor	*Mycteria cinerea*	Milky Stork
8	Traw Yong	*Threskiornis melanocephalus*	Black-headed Ibis
9	Ork Trey	*Ichthyophaga humilis*	Lesser Fish Eagle
10	Ty Tuy	*Bubo nipalensis*	Spot-bellied Eagle Owl
11	Kreal	*Grus antigone*	Sarus Crane

Source: Obtained from villager and Tan Sehta and Colin Poole, 2003)

4.2.3.4 Reptiles

Based on the information from villagers there are turtles, many kind of snakes, crocodile (saw by the fishermen in Phluk village, Phluk commune), and other species are present in the project area. These species are now rarely to see.

4.2.3.5 Present status of terrestrial ecology

As addressed from the previous researches/surveys within the LMDFE[2], there are existing problems and issues have continued to increase the biodiversity loss in the northeast and eastern Cambodia. Both inside the protected areas and outside the protected areas have been under threat from unsustainable exploitation of natural resources, and wildlife hunting in particular. If one looks at the whole area of the northeast and eastern Cambodia as a part of Lower Mekong Dry Forest Ecoregion (LMDFE) which includes the resettlement areas, there are several existing issues and problems considered as key factors in leading to natural resource depletion. The issues are described in following:

a) Logging and non-timber forest products collection

Most researches undertaken have identified logging and collection of non-timber forest products as major issues and causes of biodiversity loss and resulting in degradation for wildlife habitat in particularly.

The whole forest area in northeast and eastern Cambodia was previously under logging concessions except the protected areas but they have been under illegal logging too. At the present legally logging from the land concession in Sesan district is more concern to the forest and wildlife habitat lost. For instance five land concession companies in operation of clearance and logging in their compound area, see figure 22 (map of land concession in the project area). Habitat loss represents the greatest long term threat to the integrity of biodiversity throughout the forest of the Lower Mekong. The selective loggings are being continued of small-scale operation but widespread in the forest where the products can be extracted availability.

Effects of direct loss of large trees might be of only minor consequence to the majority of large mammals and bird communities. However, indirect effects of logging, particularly increased access to remote areas, could be much more severe and affect a much larger range of the natural community (*Robert Timmins & Ou Rattanak et.al, 2001*). In addition, the associated activities of woodcutters and NTFPs collectors also involve in hunting, fishing and land grabbing because of the accessible favors through tracks/trails available into the forest. Those activities are harmful and disturb to wildlife. Most NTFPs products within the Lower Mekong Dry Forest are resin of the large trees (Dipterocarpus species). Non-timber forest products (NTFPs) consist of wild-fruits, vegetable, honeys, rattan, bamboo and parts of plants for traditional medicines and they are extracted for support livelihood.

[2] *Most surveys/researches activities have been conducted under cooperation between Government Institutions of the Ministry of Environment and Forest Administration with the donors-funded programs such as World Wide Fund for Nature (WWF), BirdLife International, The World Conservation Union (IUCN) and other associated activities.*

Therefore, in conclusion, logging and collecting NTFPs which are associated with other activities of hunting and resource exploitation have resulted in continuing to significantly harm biodiversity, especially through the overexploitation of natural resources.

b) Land use change

The survey team saw several signposts of land grabbing and encroachment was seen within the survey sites and in the vicinity of the resettlement areas. Threats from conversion of forest land into non-forest land are widespread in northeast and eastern Cambodia including the resettlement sites, especially where the forest area can be easily accessed. Existing tracks/trails and roads built during the logging concession time have resulted in forest clearance for variety of land use forms and being considered as significant impacts to forest loss of wildlife habitats in particularly.

The social forest land concession (SFLC) [3] can also significantly affect land use impacting wildlife habitat. Additionally, a huge conversion of forest land along the roadsides of national road No. 78 and adjacent roads have another contributed to direct loss of wildlife habitat. Furthermore in the Lower Sesan 2 HPP project area have five economical land concessions and one forest concession in full right development in certain period of licensing from MAFF and CDC of RGC. Figure 21 demonstrated the forest and land concession with company name, total area, and location.

Figure 21: Clearance along the roadsides, downstream of Lower Sesan River

In addition, recent developments of the village roads where they are connected from the main roads have also resulted in jeopardizing and/or fragmenting the habitat and leading to large-scale potential of encroachment, for instance, settlement, agricultural land and often involve in speculation as well. The forests today are being diminished and divided into isolated areas. As results, such encroachment have involved in commercial interests of speculation. A continued loss of habitat in addition to capture/hunting may leads to the eventual extinction of the large animals of the globally threatened species within the next decade.

[3] *There are several forest areas in Stung Treng, Ratanakiri and Mondulkiri provinces that have been granted as social forest land concessions by the Royal Government of Cambodia (RGC). Most of SFLCs have been used for agro-industrial crop developments such as cassava, and monospecies planting of cashew trees, and tree plantation (eucalyptus and acacia sp) as well as rubber plantations.*

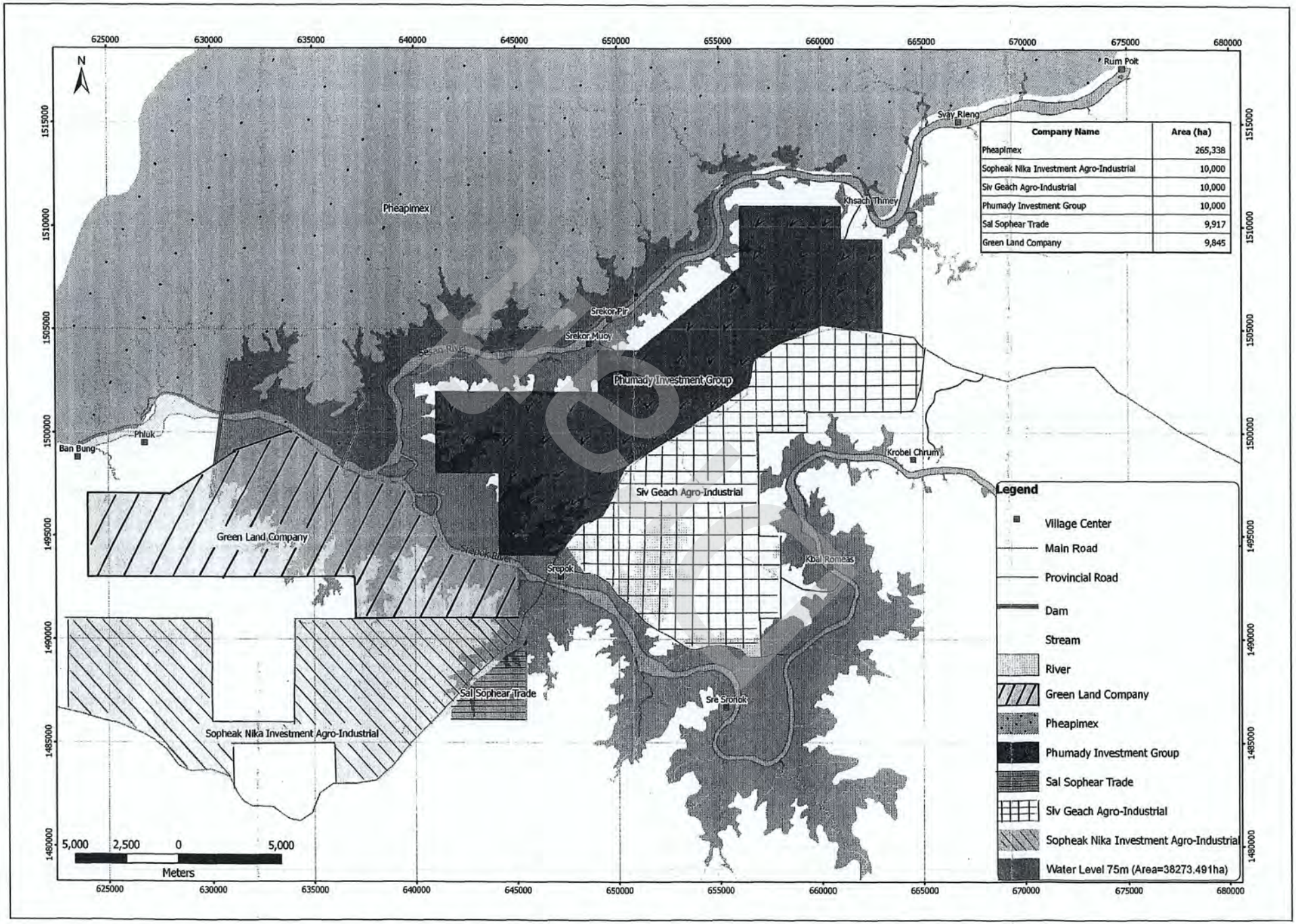


Figure 22: Map of forest and land concession in the project area, data obtained from FA 2007

c) Human activities

Impacts caused by human activities can be considered as adversely effects to environment and resource depletion. A slash and burn of shifting cultivation and other forms of clearance for land, for instance, killing trees by pruning bark around the tree base and then kept for a while before setting fire. In addition, inflow of local migrants from elsewhere may lead to land expansion for settlements and agricultural land and eventually involved in land speculation because of opportunity of land business are lucrative at the present.

Furthermore, mining exploitation, occurs inside the Phnom Prich Wildlife Sanctuary, Mondulkiri province where locate at upstream of Srepok River is another significant effects to cumulatively accelerate the habitat loss in the area. Random clearance of forest and digging for gold mining has resulted in fragmenting habitats. In addition, the excavating of gold mining underneath the forests could be resulting in landslide and damage to forest as well. The pollution can be another indication which associated with environmental consequences of water quality. The gold miners in this forest area they also involve in hunting for their food (*Vichaboth, per.com, 2008*). However, no any reports of environmental impact assessment (EIA) of the gold mining exploitation are obtained. Such situations observed within the proposed resettlement areas are mostly indicated certain activities caused by human activities such as land clearance for ownership. Several signposts for land grabbing inside the resettlements were clearly seen. As earlier indication, the purposes of land grabbing and/or other kinds of conversion of forest land are certainly involved in speculation of commercial interests as well.

d) Hunting

Current hunting levels for some species in northeastern Cambodia have increased from previous decades and the already relatively small population of Banteng, Gaur and Asian Elephants could decline at even faster rates (*Robert Timmins & Ou Rattanak et.al, 2001*). The large wild-animals of the ungulate population such as Banteng, Kouprey, Gaur, Wild Water Buffalo, Eld's Deer and other carnivores have faced direct persecution from hunting and limited habitats to escape from those threats. Additionally, high market values of wildlife products for food and folklore of medicinal power have resulted to wildlife declination. The state of wildlife population in the northeast and eastern Cambodia is the greatest immediate threats (*Biodiversity vision for the Lower Mekong Dry Forest Ecoregion, WWF Greater Mekong, Cambodia Program, 2006*).

Findings from surveys show proof that hunting for local consumption of small species are still at large the in villages of the survey sites, see figure 23. Fresh and dried meats and other wildlife products are available at the market and restaurants in provincial town of Stung Treng province (*CEPA, per.com, 2008*).

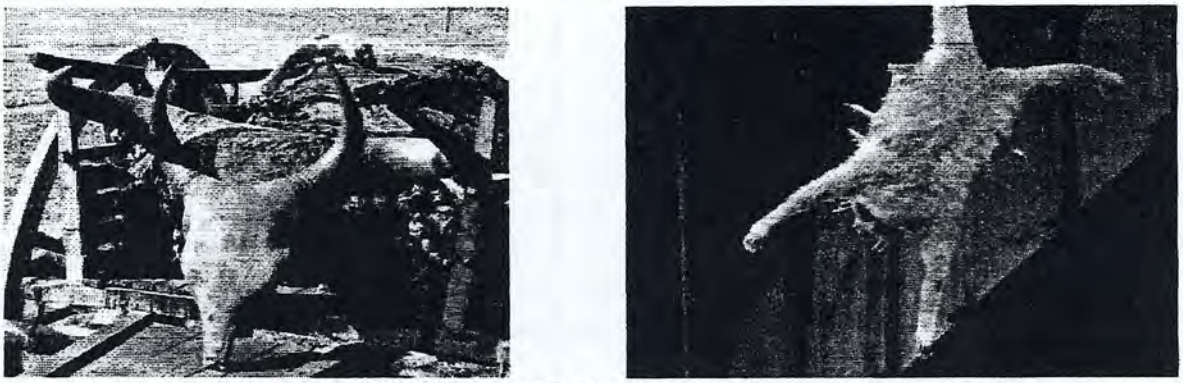


Figure 23: Wildlife hunting in Northeast area of Cambodia

4.2.4 Forests

In Sesan district territory is abundant of forest with covered of 90.5% (JICA 2003) of the total district areas. The forest type includes deciduous dipterocarp forest, Semi Evergreen Forest, Evergreen Forest, Woodland Deciduous, and Woodland Evergreen. Figure 24 showed forest type in project area. All the air photo sheets are available in electronic file in annex of the report.

There are 45 sheets of air photos were taken in the project area in the period of the study (Feb-May 2008) to proof the condition and type of the forest, see figure 24.
Characteristic of the air photo:

- Color aerial photo of the area with resolution of 0.3m;
- Geo-referencing the photo sheet, and unit in meter;
- One sheet of photo size equivalent of 1km^2;
- Coordination system: UTM, zone 48, Datum: Indian 60, Spheroid Everest 1830.

The EIA study team conducted forest survey/count at field with field assistant from the local people in community base. Total forest sampling is 18 samples were selected in reservoir site, construction site, and resettlement areas with total area of 33,000m^2.
Two type of sample size:

- Type 1 for FS-1 to FS-8, sample dimension 20m x 50m = 1000m^2
- Type 2 for FS-9 to FS-18, sample dimension 50m x 50m = 2500m^2

The geographical location of the each sampling point is showed in table below and figure 25: (Map of forest survey sampling)

Sample #	GPS point		Sample #	GPS point	
	X	Y		X	Y
SF-1	646301	1502222	SF-10	669191	1516746
SF-2	646291	1502032	SF-11	663065	1510993
SF-3	646860	1503362	SF-12	662762	1511545
SF-4	662708	1513244	SF-13	644744	1504573
SF-5	662677	1512067	SF-14	644770	1504836
SF-6	628131	1499296	SF-15	655717	1501468
SF-7	628269	1498801	SF-16	655661	1501238
SF-8	627775	1499266	SF-17	646827	1491441
SF-9	669182	1516433	SF-18	646971	1491327

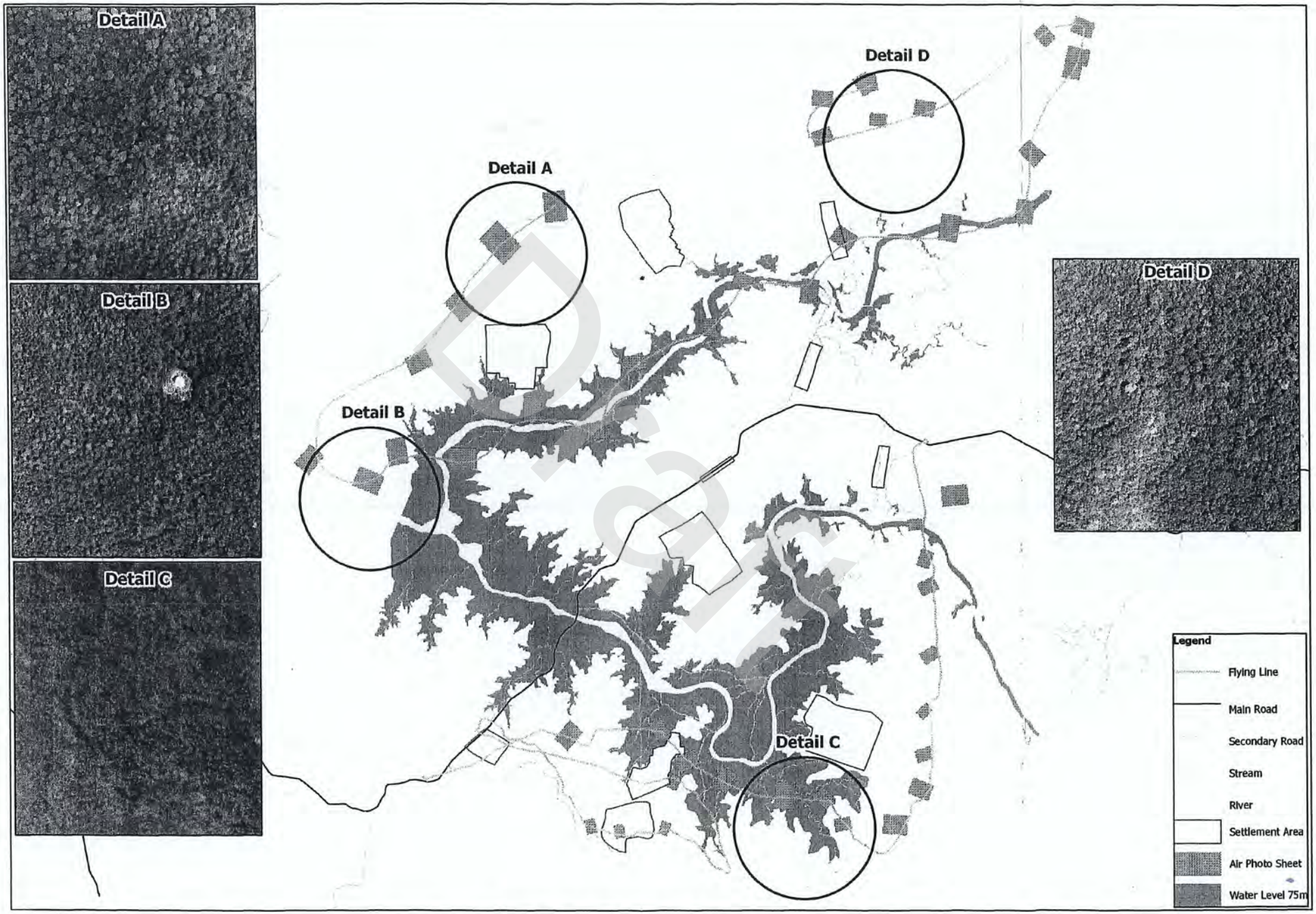


Figure 24: Map of forest type in the project area

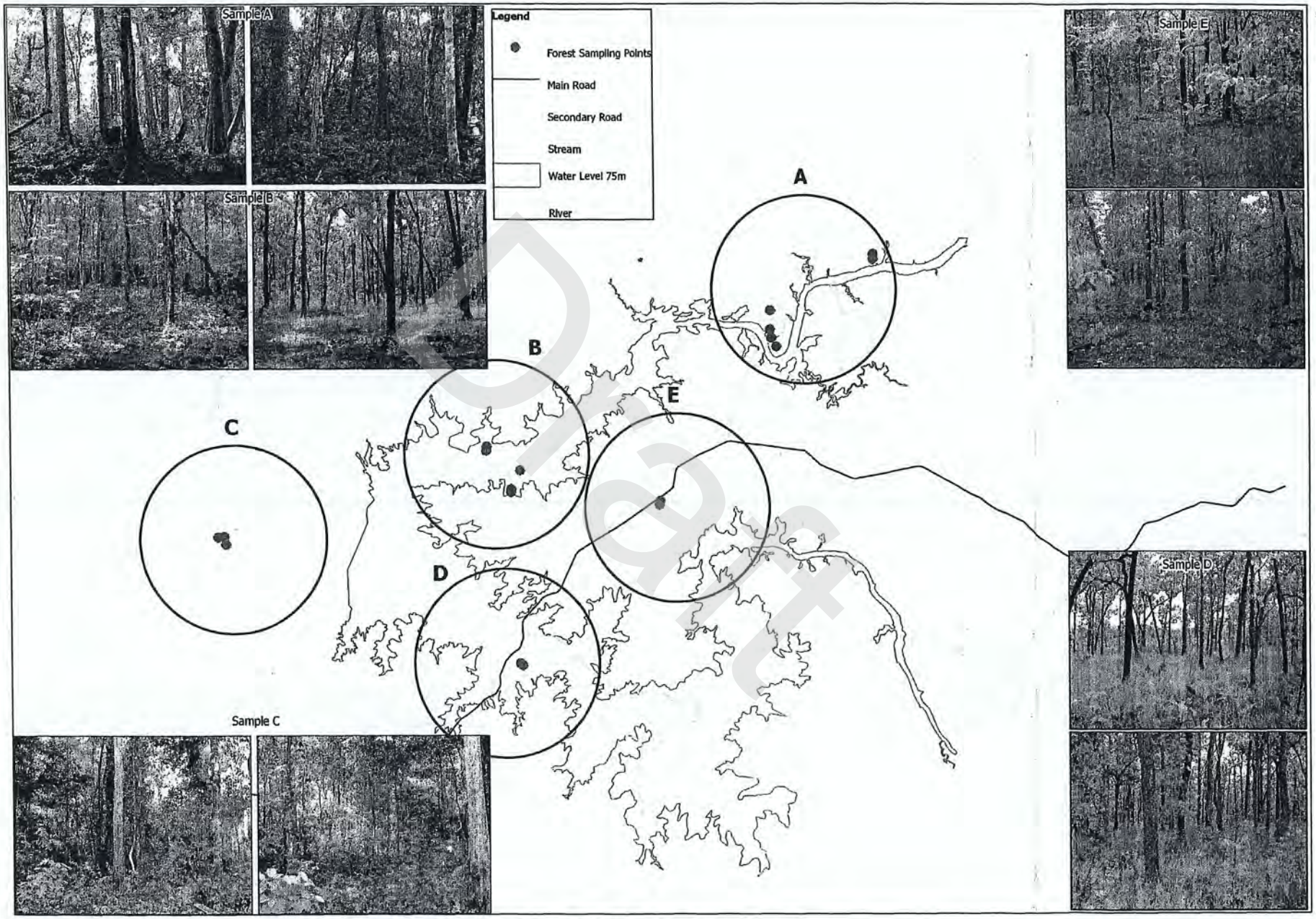


Figure 25: Map of Forest survey sample

The format for forest survey/count is showed below, and the result of the field count is attached in annex 3.

Sample No.:.....

ឈ្មោះគំរោង: សិក្ខាសិទ្ធភាពគំរោងវារីអគ្គិសនីសេសានក្រោមទី២ ក្នុងប្រទេសកម្ពុជា

Project Name: ***Feasibility Study for Lower SESAN 2 Hydropower Project***

ការសិក្សាអំពីព្រៃឈើ Forest study

ប្រភេទព្រៃឈើ Type of Forest:.....

GPS: X:..... ទំហំផ្ទៃដីដែលសិក្សា Sample size: .....m x.....m = ...m^2

Y:..... រូបថត Photo:.....កាលបរិច្ឆេទ Date :.....

ល.រ No.	ឈ្មោះឈើ Name of tree	មុខកាត់ឈើ Diameter								សរុប Total
		50-100 mm	200 mm	300 mm	400 mm	500 mm	600 mm	700 mm	.....	
	សរុប Total :									

In figure 26 shows a sparse density of the mature trees (circumference measured is bigger than 40cm or Diameter at Breast Height (DBH) is bigger than 12.7cm), wichi represent in the deciduous dipterocarp forest. Within this tree density give more open space and ground under-story covers with short bamboo and other vegetable for animal diet for prey and it is also favorable for carnivorous species to hunt its preys, according to field Survey, April 2008. However it also provides suitable habitat for animals of preys to escape and for their home.

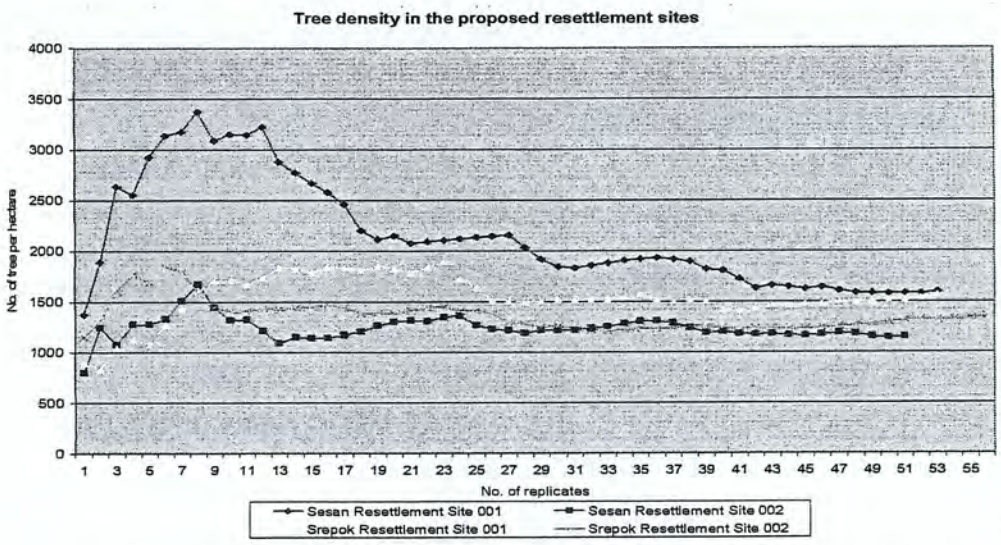


Figure 26: Tree density in the deciduous dipterocarp forest

Major types of forest

Generally, the major forest types in the northeast and eastern Cambodia are classified as dry forest of deciduous dipterocarp forest (DDF) but also include other habitat types such as mixed deciduous forest (MDF), and semi-evergreen forest (SEF), and evergreen forest (EF). The flora species occur in this forest type is not as much diverse as other forest types, for instance, mixed evergreen and evergreen forests. However, such forest type supports variety of large wild animals and its preys because of it covers a huge size in the northeast and eastern part of the country which has a relatively low population density.

111 tree species was determined from the forest study on 18 samples in the project area and all tree species name are described in annex 2. Common tree species found in the project area list in table 29.

Table 29: Common tree species in the project area

No.	Local name	English name	Family name	Scientific name
1	ខ្លុង		DIPTEROCARPUS TUBERCULATUS	DIPTERACARPACEAE
2	ឈើក		COMBRITACEAE	TERMINALIA TOMANTASA
3	ផ្ទឹក	Teng,Meranti	DIPTERACARPACEAE	SHOREA OTUSA
4	រាំងភ្នំ		DIPTERACARPACEAE	PENTACME SIAMENESIS
5	ស្រឡៅ		LYTHRACEAE	LAGERSTROEMIA SPP
6	សុក្រម		MIMOSACEAE	XYLIA DOLABRIFORMIS
7	រកា		BOMBACACEAE	BOMBAX SP

8	ស្វែង		SAPINDACEAE	STRYCHNOS NUX-VOMICA
9	ស្នាក្របី		MYRISTICACEAE	KNEMA CORTICOSA
10	ច្រាំដំឡឹង		COMBRITACEAE	TERMINALIA MUCRONATA
11	ខ្លាវ		RUBIACAEA	ADINA CORDIPOLIA/ DIPTEROCARPUS TURBINATUS
12	ល្វេ			
13	ធ្នង់	PADAUK	PAPILIONACEAE	PTEROCARPUS PEDATUS
14	កណ្ដោល		MYRTACEAE	CAREYA SPAERICA

The result of the forest count in the period of EIA study (February- May 2008) is showed in table 30.

Table 30: Counted forest in project area

Semi-Evergreen Forest										
No. of Sample	Area	Number of tree with different diameter								Total
	m^2	50-100 mm	200 mm	300 mm	400 mm	500 mm	600 mm	700 mm	.....	
FS-3	1000	1	7	19	7	0				34
FS-4	1000	29	12	9	9	3	2			64
FS-11	2500	13	12	13	10	1				49
FS-12	2500	12	15	17	11	7	1			63
FS-13	2500	63	42	19	13	2	2			141
FS-14	2500	21	11	26	19	8	2	1		88
Total	12000	139	99	103	69	21	7	1		439
	10000	***116***	***83***	***86***	***58***	***18***	***6***	***1***		***366***
Evergreen Forest										
No. of Sample	Area	Number of tree with different diameter								Total
	m^2	50-100 mm	200 mm	300 mm	400 mm	500 mm	600 mm	700 mm	.....	
FS-9	2500	16	15	18	21	15	6	6		97
FS-10	2500	23	24	21	13	4	2			87
Total	5000	39	39	39	34	19	8	6		184
	10000	***78***	***78***	***78***	***68***	***38***	***16***	***12***		***368***
Deciduous Forest										
No. of Sample	Area	Number of tree with different diameter								Total
	m^2	50-100 mm	200 mm	300 mm	400 mm	500 mm	600 mm	700 mm	.....	
FS-7	1000	12	10	7	4					33
FS-5	1000	51	9	3			1			64
FS-6	1000	17	11	8	8	2				46
Total	3000	80	30	18	12	2	1			143
	10000	***267***	***100***	***60***	***40***	***7***	***3***			***477***
Woodland Forest										
No. of Sample	Area	Number of tree with different diameter								Total
	m^2	50-100 mm	200 mm	300 mm	400 mm	500 mm	600 mm	700 mm	.....	
FS-15	2500	27	19	18	8	5	4	5		86

FS-16	2500	29	26	26	18	5	0	2		106
Total	5000	56	45	44	26	10	4	7		192
	10000	***112***	***90***	***88***	***52***	***20***	***8***	***14***		***384***
Woodland Deciduous										
No. of Sample	Area	Number of tree with different diameter								Total
	m^2	50-100 mm	200 mm	300 mm	400 mm	500 mm	600 mm	700 mm	.....	
FS-17	2500	80	30	20	12	7	1	2		152
FS-18	2500	30	52	49	16	0	0	0		147
Total	5000	110	82	69	28	7	1	2		299
	10000	***220***	***164***	***138***	***56***	***14***	***2***	***4***		***598***

From the forestry survey found that the forest in the project area is deteriorated quantity and quality, small diameter and valuable trees are remaining, due to uncontrolled pressure from the human activities, land development, and other.

The proposed reservoir of the Lower Sesan 2 HPP will submerge some kilometer square of forest area along the Sesan and Srepok rivers. The proposed resettlement sites will damage many thousand forest area too. Figure 27 showed the forest area that will submerge in the reservoir site and forest area will damage by new resettlement areas for the PAH/APs.

As everyone known forest play important role in cleaning atmosphere (absorb CO_2 and produce O_2), habitat of wildlife, protecting storm and erosion, domestic and industrial use, and use for ecotourism development. Some environmental values can be calculated from the biomass of each kind of the forest. Based on the present situation of the forest in the project area can be determined its biomass as following:

In reservoir site

Reservoir Area (with Water Level 75m)				Biomass calculation	
Forest Type	**Area (ha)**	**30% in land/ forest concession, ha**	**Forest loss in reservoir area, ha**	**Aboveground Biomass for Various Tropical Forest (Ton DM/ha)***	**Total Biomass (DM), ton**
Woodland Evergreen	42.070	12.62	29.45	70	2,061.43
Woodland Deciduous	832.629	249.79	582.84	85	49,541.43
Deciduous Forest	23,093.027	6,927.91	16,165.12	120	1,939,814.27
Semi Evergreen Forest	3,516.545	1,054.96	2,461.58	200	492,316.30
Evergreen Forest	248.192	74.46	173.73	300	52,120.32
Total	**27,732.463**	8,319.74	19,412.72		**2,535,853.74**

In settlement site

Settlement Area				Biomass calculation	
Forest Type	**Area (ha)**	**50% in land/ forest concession, ha**	**Forest loss in resettlement area, ha**	**Aboveground Biomass for Various Tropical Forest (Ton DM/ha)***	**Total Biomass (DM), ton**
Woodland Deciduous	226.651	113.33	113.33	85	9,632.67
Woodland Evergreen	1.499	0.75	0.75	70	52.47

Deciduous Forest	4,618.677	2,309.34	2,309.34	120	277,120.62
Semi Evergreen Forest	1,556.919	778.46	778.46	200	155,691.90
Evergreen Forest	102.652	51.33	51.33	300	15,397.80
Total	**6,506.398**	3,253.20	3,253.20		**457,895.45**

Note: * Source: IPCC Guideline for National Greenhouse Gas Inventories, 1996; page 5.27 and 5.28

The proposed resettlement sites at the Sesan River are located on the northern side of the river, and they are a few kilometers away from the riverbank. This area is located in between the Sesan and Sekong Rivers and also extends north and north-eastward towards the Virachey National Park in Rattanakiri Province. Virachey National Park covers and supports a vast size of forest types including semi-evergreen and evergreen forest and it extends to the far northeast into the mountainous central Annamites in Vietnam. It is also adjacent to the Xe Pian protected area in Laos in the far north. The whole area can be considered as trans-boundary of the LMDFE of the Indochinese countries. In addition, the forest habitats support a large population of wildlife, in particularly the globally threatened species[4] of large mammals and other endangered species for conservation values.

The forest area of the resettlement site was previously under a logging concession of large-scale operation so that large trees of high commercial value have been logged and fragmented habitats. Currently, the forests at the Sesan resettlement sites are disturbed because trails/tracks provide easy access within the area. The negative impacts from human activities can be an indicator to address on wildlife disturbance within the area in which go along with rampantly selective logging.

In the Srepok resettlement area, it is found that the entire forest area in and around the Srepok resettlement area is characterized by deciduous dipterocarp forest, and the understory species are dominated by shrubs, subshrubs, and short bamboo. The trees which occur within this habitat are relatively sparse and small in circumference but the larger size of girth are under selective cutting especially species with high commercial values for construction materials. Generally, within such habitat of deciduous dipterocarp forest has average height in between 7.5m to above 18m of the canopy trees. The emergent trees have average height of approximately 23m.

[4] *Globally threatened species include a population of large animals such as Banteng, Gaur, Elephant, Wild Water Buffalo, Tigers, Bear, Eld's Deer, Sambar Deer, Gibbons, Pangolins, group of primates as well as group of birds, for instance, Ibises, Storks, Fisheagles, Vultures, Peafowl and so on. For further detailed in the attached Appendix.*

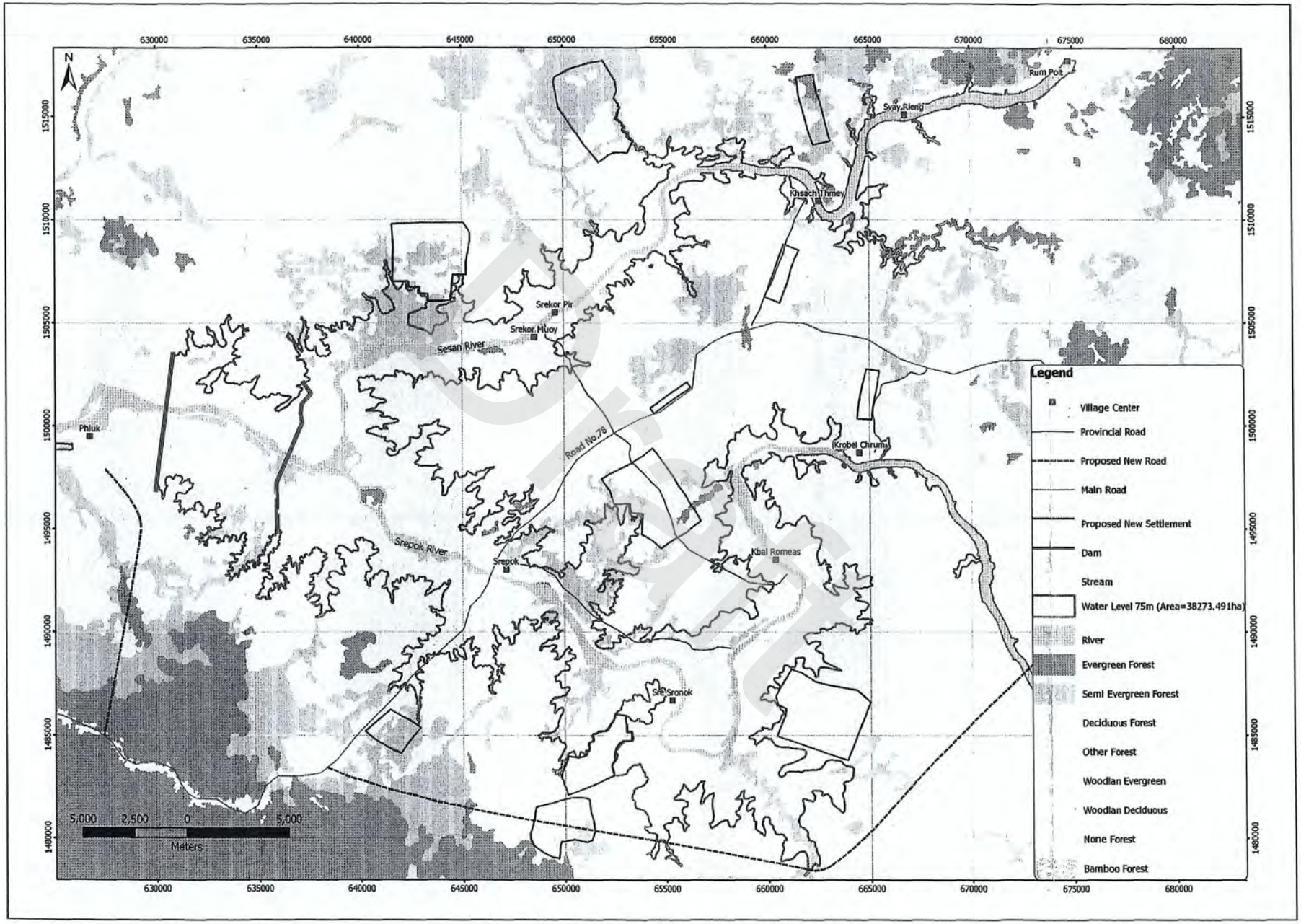


Figure 27: Map of forest area will impact by project

Forest products and by-product

The collection of NTFPs of resins, honey and wild-fruits in the resettlement areas is not so much but selective logging can be seen as a rampant activity. Noises from chainsaws being operated during the day time were heard by the study team. Hidden woodpiles with covered of leaves can often be found in the forest and at places where the wood can be easily transported out.

The KCC study team found that the collection of non-timber forest products (NTFPs) such as resins, wild-fruits and honey are not so active in the project area but selective logging is undertaken in according to field observation. Several tracks/trails give more access into the deep forest for logging and wildlife hunting as well. Noises from chainsaws could be heard in the forest and woodpiles were visible when the KCC study team was working in the areas. The selective logging of precious wood and the first quality wood for local consumption is still prevailing in the vast forest.

The species in the family of Dipterocarpaceae is the dominant species which occur in this forest type. The deciduous dipterocarp forest typically has open canopy and individual tree stand sparsely and the tall species consists of *Dipterocarpus obtusifolius, Dipterocarpus tuberculatus, Dipterocarpus intricatus, Hopea ferra, Hopea odorata, Shorea obtusa Shorea siamensis, Pterocarpus pedatus, Dalbergia bariensis*. Understory is dominated by grassy, shrubs and subshrub and short bamboo, indicated from survey and *(C. Daltry & Frank Momberg, Cardamom Mountains; Biodiversity Survey, 2000)*.

4.2.5 Rare or endangered species

In period of field survey did not meet the terrestrial wildlife rare and endangered species, but information gain from key informant in communities in Srekor and Talat indicated that many terrestrial wildlife still presenting in the project area especially in dense and far from village settlement. From the fish study in Sesan and Srepok rivers in Feb.-May 2008 found rare fish species that list in table 19 in point 4.2.1. 2.

Moreover in the previous and ongoing study by WWF and WFF specified that in Northeast and eastern of Cambodia have many kind of wildlife including rare and endangered species. In table 31 list of the rare/vulnerable and endangered species which include the rare species in the project area like gaur, banteng, etc.

Table 31: List of rare/vulnerable, and endangered species in the Northeast and Eastern Cambodia

No.	Local names	English and (scientific names)	Status
A) Mammal			
1	Damrey	Asian elephant (*Elephas maximus*)	EN (IUCN)
2	Kla thom	Tiger (*Panthera tigris*)	EN (IUCN)
3	Kla porpork	Clouded leopard (*Neofelis nebulosa*)	VU (IUCN)
4	Kla khmom thom	Asiatic black bear (*Ursus thibetanus*)	VU (IUCN)
5	Kla loeng meas	Asian golden cat (*Catopuma temminckii*)	N-t (IUCN)
6	Krobey prey	Wild Water Buffalo (*Bubalus arnee*)	EN (IUCN)
7	Romang	Eld's Deer (*Cervus eldii*)	VU (IUCN)

8	Tun soarng	Banteng (*Bosjavanicus*)	EN (IUCN)
9	Sva Kravat	Douc Langur (*Pygathrix nemaeus*)	EN (IUCN)
10	Torch mokort	Pileated Gibbon (*Hylobates piletus*)	VU (IUCN)
11	Torch thporl loeng	Yellow-cheeked Gibbon (*Hylobates gabriellae*)	VU (IUCN)
12	Phe kbarl sampoet	Eurasian Otter (*Lutra lutra*)	VU (IUCN)
13	Khteng	Gaur (*Bos gaurus*)	VU (IUCN)
14	Sva angkort	Stump-tailad Macaque (*Macaca arctoides*)	VU (IUCN)
15	Sva pream	Silvered Langur (*Semnopithecus cristatus*)	NT (IUCN)
16	SamporchKampingdong	Owston's Civet (*Hemigalus owstoni*)	VU (IUCN)
17	Kam brok slarb thom	Particoloured Flying Squirrel (*Hylopetes alboniger*)	EN (IUCN)
18	Kam brok thom	Black Giant Squirrel (*Ratufa bicolor*)	II (CITES)
19	Sva tros	Pig-tailed Macaque (*Macaca nemestrina*)	VU (IUCN)
20	Chhke prey	Dhole (*Cuon alpinus*)	VU (IUCN)
21	Brama	East-Asian Porcupine (*Hystrix brachyura*)	VU (IUCN)
B) Bird			
1	Kreal	Sarus Crane (*Grus antigone*)	
2	Kngor yak	Giant Ibis (*Pseudibis gigantea*)	
3	Kngor cham krom kors	White-shouldered Ibis (*Pseudibis davisoni*)	
4	Trar dok Thom	Greater Adjutant (*Leptoptilus dubius*)	
5	Trar dok toch	Lesser Adjutant (*Leptoptilus javanicus*)	
6	Roneal sor	Milky Stork (*Mycteria cinerea*)	
7	Angkort khmao	Black-necked Stork (*Ephippiorhynchus asiaticus*)	
8	Krar sa	Wolly-necked Stork (*Ciconia episcopus*)	
9	Kngork bai torng	Green Peafowl (*Pavo muticus*)	VU (IUCN)
10	Sdech kolith	Siamese Fireback (*Lophura diardi*)	NT (IUCN)
11	Morn tor bai torng brorphes	Germain's Peacock Pheasant (*Polyplectron germaini*)	VU (IUCN)
12	Keng korng toch	Oriental Pied Hornbill (*Anthracoceros albirostris*)	II (CITES)
13	Keng korng thom	Great Hornbill (*Buceros biconis*)	NT (IUCN)
14	Po vang	Wreathed Hornbill (*Aceros undulatus*)	II (CITES)
15	Ror art khmom	Oriental Honey-buzzard (*Pernis ptilorhyncus*)	II (CITES)
16	Stang rorlok	Black-shouldered Kite (*Elanus caeruleus*)	II (CITES)
17	Ak kbarl brorphes	Grey-headed Fish Eagle (*Ichthyophaga ichthyaetus*)	NT (IUCN)
18	Ak toch	Lesser Fish Eagle (*Ichthyophaga humilis*)	NT (IUCN)
19	Tmart khmao	Cinereous Vulture (*Aegypius monachus*)	NT (IUCN)
20	Ak pus prey	Crested Serpent Eagle (*Spilornis cheela*)	II (CITES)
21	Ror art tunsay	Eastern Marsh Harrier (*Circus spilonotus*)	II (CITES)
22	Stang slarb chhek	Shikra (*Accipiter badius*)	II (CITES)
23	Stang slarb srouch	Collared Falconet (*Microhierax caerulescens*)	II (CITES)
24	Smorgn	Darter (*Anhinga melanogaster*)	NT (IUCN)
25	kok krung thom	Great Egret (*Casmerodius albus*)	III (CITES)
26	Kok krung	Intermediate Egret (*Mesophoyx intermedia*)	III (CITES)
27	Kok kou	Cattle Egret (*Bubulcus ibis*)	III (CITES)
C) Reptile			
1	Kror per phnom	Siamese Crocodile (*Crocodylus siamensis*)	CR (IUCN)
2	Ondek kbal thom	Big-headed Turtle (*Platystemon megacephalum*)	EN (IUCN)
3	Ondek bit mok	Indochinese Box Turtle (*Cuora galbinifrons*)	CR (IUCN)
4	Ondek prich	Elongated Tortoise (*Indotestudo elongata*)	EN (IUCN)
5	Ondek bit mok snok khmao	Asian Box Turtle (*Cuora amboinensis*)	VU (IUCN)
6	Ondek sakal	Malayan Snail-eating Turtle (*Malayemys subtrijuga*)	VU (IUCN)
7	Ondek kaoek	Black Marsh Turtle (*Siebenrockiella crassicollis*)	VU (IUCN)
8	Ondek krorbey	Yellow-headed Temple Turtle (*Hieremys annandalii*)	EN (IUCN)
9	Korntheay a sy	Asian Softshell Turtle (*Amyda cartilaginea*)	VU (IUCN)

10	Korntheay kbarl chheb	Asian Giant Softshell Turtle (*Pelochelys cantorii*)	EN (IUCN)
11	Pus tlann toch	Burmese Python (*Python molurus bivittatus*)	N-t (IUCN)
12	Ansorng	Water Monitor (*Varanus salvator*)	II (CITES)
13	Tror kuth	Bengal Monitor (*Varanus bengalensis*)	I (CITES)
14	Pus thlann thom	Reticulated Python (*Python reticulatus*)	II (CITES)
15	Pus prey kandol	Common Rat Snake (*Ptyas mucosus*)	II (CITES)
16	Pus vek rorneam	King Cobra (*Ophiophagus hannah*)	II (CITES)
17	Pus vek krorbey	Monocled Cobra (*Naja kaouthia*)	II (CITES)
18	Pus vek dam bok	Indochinese Spitting Cobra (*Naja siamensis*)	II (CITES)

4.2.6 Protected areas

The national park Virakchey located in North-East of the reservoir site with distance of 100km upstream of the project site. The Lumphat wildlife centaury is located in South-East of the project site with distance of 10 kilometers from upstream of proposed reservoir boundary of Lower Sesan 2 HPP. However inside the proposed reservoir had one community forest called "Nak-Ta Karakan" where situated behind Srekor Mouy and Srekor Pir village. The total area of this community forest is 2003ha, obtained from Chief of community forest Mr. Fhoeun Heng.

Figure 28 showed the protected area in Cambodia and the project area.

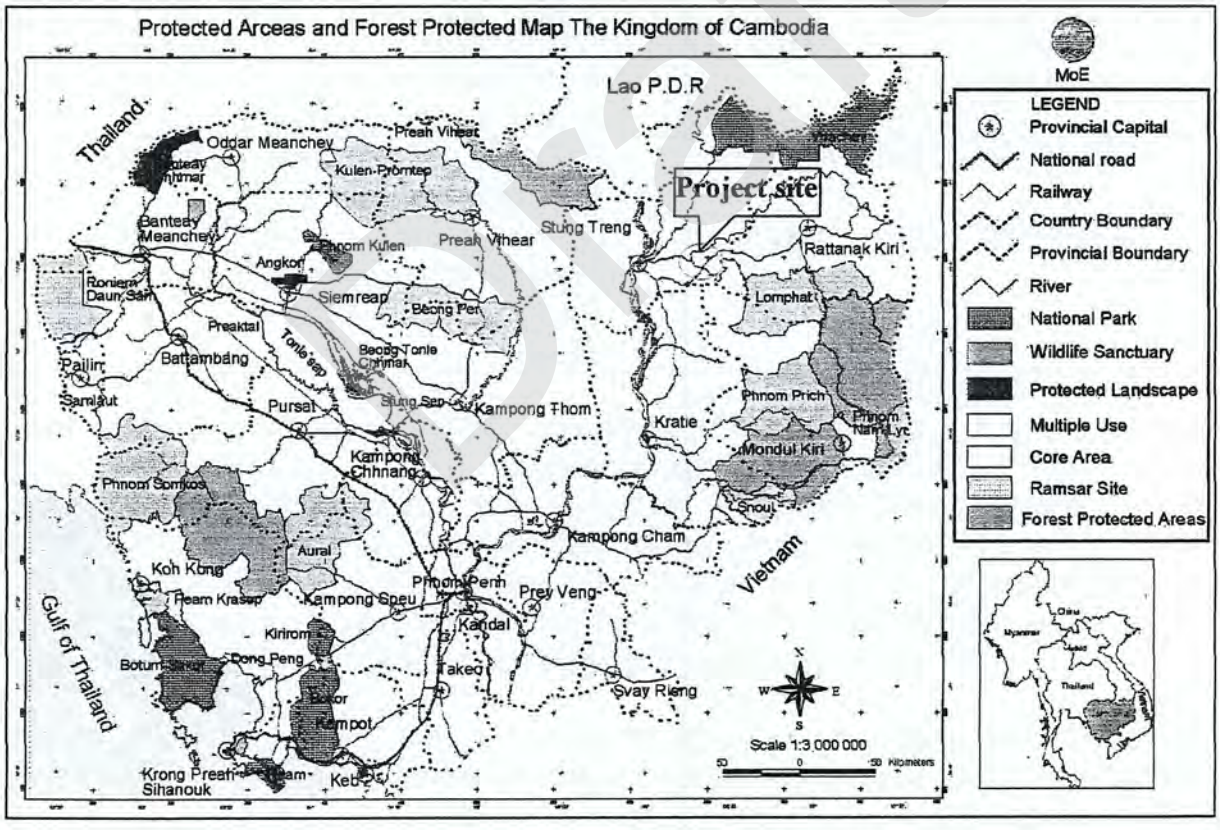


Figure 28: Map of protected area

4.3.1 Economic development

4.3.1 Industry

About 190 handicraft are operating in whole Stung Treng province within one handicraft licensed from MIME, 59 licensed from DIME, and 130 handicrafts as family operation without licensing. Foods and furniture production are more common of the handicrafts activities in the province. There is not factory or major industry activities in Stung Treng province.

At the present the mineral development are more potential for the industrial development in province. For instance three small construction materials (laterite/soil, sand, and gravel) in Presh Bat commune in Stung Treng district, and five exploration licenses company on metallic and coal mineral in territory of Sesan, Siem Pang, and Thalaborivath district.

Table 32: Five exploration licensed company in minerals development in Stung Treng.

No.	Company name	Mineral type	Location	Status
1	Try Pheap	Iron	Thalaborivath district	Exploration
2	An Mardy	Coal	Talat commune, Sesan district	Exploration
3	Indochin Resources Ltd.	Metallic	Kachok Bung Ngingkang and Poung Peay, Siem Pang district	Exploration
4	KENERTEC Co.Ltd	Metallic	O'Koing Kang, Thalaborivath district	Exploration
5	KENERTEC Co.Ltd	Metallic	Phnum Kon Hy, Thalaborivath Stung Treng and Cheb Preash Vihear	Exploration

However due to the minerals map of Cambodia, 1960s?, showed that in upper part of the reservoir site, in Talat commune, presented of coal deposit. At the moment a private company do an exploration on coal mineral deposit in the upper part on the Talat commune in between Stung Treng and Rattanakiri province border (in O'Krala Pos area), according to the vice chief of Talat commune, Mr. Hol Bunnath. In 1960 the Cambodian workers about 100 person were sent to this area for explorating coal, and in 1976-1977 in Khmer Rouge regime this resources had exploited 1.5 years, he added.

The investigation work and processing of data show that the mineral resources in the framework of Lower Sesan 2 Hydropower reservoir are considerably poor, expressing in following types:

- Metallic group: there are only polymetallic and gold mineralization points.
- Group of additive materials: occurrences of iron laterite using as cement additive.
- Group of construction materials: this is relatively multiple group including small-scale deposits of facing stone, brick and tile clay, quartz sand of high quality, and dimension stone and gravel for concrete.

Table 33: Minerals deposit / ore point in the Lower Sesan 2 Hydropower reservoir and adjacent areas

No.	Type of mineral resources	Scale	Coordinates of center point
1	Sand, gravel	Small scale deposit	X= 357055.9423; Y= 1530947.9399 Absolute height: <75m full flooded
2	Sand, gravel	Small scale deposit	X= 354592.0896; Y= 1529095.7469 Absolute height: <75m full flooded
3	Iron laterite	Mineralization occurrence	X=333481.7891; Y= 1530947.9399 Absolute height: <75m full flooded
4	Brick and tile clay	Small scale deposit	X= 338186.6353; Y=1513583.7819 Absolute height: >75m no flooded
5	Polymetallic sulphide	Mineralization occurrence	X= 339544.7990; Y= 1511223.5177 Absolute height: <75m full flooded
6	Iron laterite	Mineralization occurrence	X= 338186.6353; Y= 1513583.7819 Absolute height: >75m no flooded
7	Iron laterite	Mineralization occurrence	X= 323314.2402; Y= 157561.6648 Absolute height: <75m full flooded
8	Iron laterite	Mineralization occurrence	X= 137524.1496; Y= 1505732.1485 Absolute height: <75m full flooded
9	Polymetallic sulphide	Mineralization point	X= 139698.5689; Y= 1505539.8042 Absolute height: <75m full flooded
10	Construction stone	Small scale deposit	X= 132657.3780; Y= 1503996.2960 Absolute height: <75m partly flooded
11	Construction stone	Small scale deposit	X= 314070.6230; Y= 1499516.4660 Absolute height: <75m full flooded
12	Polymetallic gold	Mineralization occurrence	X= 136814.6391; Y= 1499103.9530 Absolute height: <75m full flooded
13	Construction stone	Small scale deposit	X= 314254.2510; Y= 1496566.3440 Absolute height: <75m full flooded
14	Iron laterite	Mineralization occurrence	X= 321715.8187; Y= 1494456.3846 Absolute height: <75m no flooded
15	Facing stone	Mineralization occurrence	X= 321376.7324; Y= 1493912.2992 Absolute height: <75m no flooded
16	Brick and tile clay	Small scale deposit	X= 329747.5643; Y= 1488696.6980 Absolute height: <75m full flooded

Source: Prospecting and Evaluation of Mineral Resources of the Lower Sesan 2 HPP, May 2008

Refer to geological mapping and minerals resources prospecting, some mineralization points/deposit of polymetals and gold found in form of sulphide-bearing veins and micro-veins of quartz, hydrothermal altered zones on the basement made by low-grade-sulphide-bearing effusive andesites. The content of polymetallic Cu-Pb-Zn group is low, rarely seen accompanying gold and silver in the samples. The scale of those points is not big. The detail of minerals resources in the project site (reservoir site) had described in "*SUMMARY REPORT ON STUDY, PROSPECTING AND EVALUATION OF MINERAL RESOURCES OF THE LOWER SESAN 2 HYDROPOWER RESERVOIR*".

4.3.2 Infrastructure

4.3.2.1 Water supply and Sanitation

Water source of the Stung Treng town water supply is pumped from Sesan river, downstream of project site. Currently the daily production is 1000 m^3 per day, 15 hour supply per day, but the demand is 1500 to 2000m^3/day. The water charge is 1500Riel/m^3 (0.37$/$m^3$) and the coverage area is about 40% only.

All the families in the project area use the rivers (Sesan and Srepok) as source for domestic water supply. However, very few families use hand-dug wells and borehole wells for their water supply. According to KCC's field study team 2007, the quantity of water consumption per capita is approximately 47 liters per day which includes drinking, cooking, washing and bathing. Meanwhile, more than 95% of water is boiled prior to drinking.

Pig raising is a major water consumer (which is particularly relevant if there is any planning for resettlement). Based on field study it found that on the average basis, the amount of water consumption per pig per day is about 31 liters. Meanwhile, of the total population in the project area, 41.3% households raise 1-2 pigs from1-2, and 24.1% raise 3 pigs or more. The number of pigs raised is based on family economic and traditions. Other domestic animals like cows, oxen and buffalo are not included in water consumption because these animals are released to graze freely.

The number of pour flush latrines in each commune is shown in table 1.12. Of the communes, only Srekor has a lot of pour flush latrines, 38.4% of total families, followed by Talat 5%, Kbal Romeas 4.1%, Sre Angkrorng 0.6% and Phluk 0.4%, respectively. The higher the percentage of the latrines in the communes indicates better living standards and knowledge about health care in their families. Where people do not have toilets they normally dispose household wastes around the house compound. Also, no proper drainage or solid waste management was found in the project area. Thus, sanitation facilities are still considered to be poor and are in need of development.

4.3.2.2 Power sources and transmission

There are two small scale electrical supplier that in operation under private and public (Electrial du Camboge, EDC), fuel feeding generator. The electricity supply in Stung Treng town (EDC) is covered only 70% of the town area, and the charging rate is 1220Riel/kWh. Two very small hydropower plants with capacity around 5-10KW, one in O'Pong Mon and other one in Siem Bok, private operation.

The result of the household survey in project area found that the power sources use in community is different from the urban area. In following paragraphs clearly indicated the power sources used in each commune:

- In Talat, all people use firewood for cooking and for lighting use torches (about 50% of households) or kerosene and/or diesel lamps (about 40% of

households). The remaining 10% of households use electricity from generator. This means that within this commune, only people in Khsach Thmey village mainly use electricity for lighting.

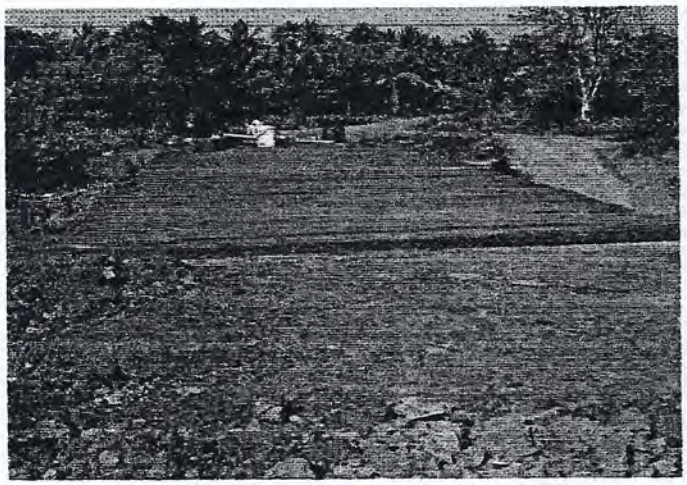
- In Srekor, people also use firewood for cooking and for lighting use torches (about 10% of households) and kerosene or diesel lamps (about 80%.of households). The remaining households (around 10%) use their own battery and/ generator.
- In Phluk, it is not different from the above-two communes. People completely use firewood as a source of cooking, while sources of lighting are torch 15%, kerosene or diesel lamps 65%, own battery and/ generator around 10% and electricity about 10%.
- In Kbal Romeas, people also use firewood 100% as a source of cooking, , while sources of lighting are torch 10%, kerosene or diesel lamps 25%, own battery and/ generator around 15% and electricity about 50%. Thus, the relatively more affluent households use electricity within this commune. This is due to the fact that 3 out of 4 villages have electric generators and also price for its consumption is affordable for local people.
- In Sre Angkrorng, it is the same as other communes in the project area. People also use firewood 100% as a source of cooking, while sources of lighting are torch 10%, kerosene or diesel lamps 60%, own battery and/ generator around 10% and electricity about 20%.

4.3.3 Transportation

4.3.3.1 Road networks

Stung Treng road are improving, from earth road become laterite and Makadam/ bituminous pavement. In 2008 the DPWT of Stung Treng will construct 5Km Makadam road in Stung Treng town. However in the district level the road network are limited of quantity and quality.

The infrastructure in the project area is being improved, but road networks to some villages is still poor (the road to Svay Rieng, Rumpoit, and Talat in particular). This means that roads in some villages are completely inaccessible during the rainy season. However a main laterite road to each commune center (figure 29). Since the road networks connecting one village to another in some communes are poor, the Sesan River is frequently used for travel and transportation by some villagers. Motorbikes are mainly used in transportation of people and in transporting goods wherever road access to villages is available.



a) Bridge is being constructed in Phluk

b) Main laterite road to Kbal Romeas

Figure 29: The main laterite road to each commune center

4.3.3.2 Airport

One local air port only in Stung Treng province, it located about 4km Eastside of the Stung Treng town and still in operation. However this airport not active currently, only few small air crafts landed per month when the national road not well functioning. Since the national road finished improvement the air craft was rare to land in the Stung Treng airport.

4.3.3.3 Harbor

There is one ferry station in front of Stung Treng town and use to carry out the passengers and vehicles cross Sesan river, but now stop functioning due to Sekong Bridge put in operation in April 2008. Beside the above ferry station no other harbor in the Sesan and Srepok river, except small boat that community use to cross one village to other village.

4.3.3.4 Navigation

Based on information obtained from the Stung Treng Province Department of Public Works and Transport (PDPWT), Mr. San Nou, Deputy Director, indicated that if possible a lock for boats to pass through to go upstream and downstream of the dam should be constructed. However nowadays few 1.5-3 tones boats transport goods along the Sesan everyday as they stopped sailing since the national road # 78 has been improved, commune vice chief in Phluk.

The study team has conducted a boat traffic count at three different stations:

(1)- Sesan downstream of dam site
(2)- Sesan upstream of dam site
(3)- Srepok upstream of dam site

Table 34 shows the result of the traffic count from 31 January to 15 February 2008. The detailed traffic count sheet is given in Annex 2.

Table 34: (Boat) Traffic count

Date	Phluk station (1)		Srekor station (2)		Kbal Romeas station (3)	
	Up	Down				
31-Jan	54	25	23	18	7	6
1-Feb	54	26	20	20	6	6
2-Feb	51	37	17	13	5	8
3-Feb	48	36	14	12	8	8
4-Feb	84	56	18	15	7	6
5-Feb	80	56	20	18	6	6
6-Feb	94	46				
7-Feb	102	52				
8-Feb	91	90				
9-Feb	90	88				
10-Feb	85	83				
11-Feb	71	87				
12-Feb	85	101				
13-Feb	92	86				
14-Feb	87	85				
15-Feb	75	80				
Total	1243	1034	112	96	39	40
Average	78	65	19	16	7	7

Note: The traffic count is done in day time only (6:00 AM to 6:00 PM)

The survey team found that most of the boat traffic in both the Sesan and Srepok Rivers is used for family transportation with a normal load of less than 1 ton and travel from village to village. However a few goods transportation boats with a maximum load of 1.5 tons still navigate both rivers but during the wet season only, according to the Commune chiefs. In Table 2 shows the navigation activities both downstream and upstream of the proposed dam site as follows:

- Phluk station (1) 7kms downstream of the dam site on the Sesan River: most of the villagers here use small engine boats. There are 65-78 boats in operation, for daily transportation of people and goods from village to village and to Stung Treng town. Within the above figure 10-15 boats passed through the proposed dam site to the villages up stream, according to the Commune vice chief of Phluk Commune.
- Srekor station (2) 23kms upstream of the dam site on the Sesan river: there are a small number of small engine boats (16-19 boats) that operate in Srekor commune for daily transportation of people and goods from village to village.
- Kbal Romeas station (3) 35kms upstream of dam site in Srepok river: a few small engine boats (7 boats) operate in Kbal Romeas commune.

4.3.4 Land use

The land use of the Sesan district is abundant of forest with total area of 244,380ha or 90.4% of the land area of district, while the agricultural land is 6,021ha or 2.2% only, and the other land uses are small area, see detail land use type in table 35 and figure 30.

Table 35: Land use type of Sesan district

Land Use Type	Area (ha)	Percentage (%)
Agricultural lands	6,021	2.2
Forest covers	244,380	90.4
Grasslands	3,911	1.4
Shrublands	8,269	3.1
Soils and Rocks	222	0.1
Water Features	7,533	2.8
Total	**270,337**	**100.0**

Source: JICA 2003, based on landsat (TM) 2000

However due to the project lay out of Lower Sesan 2 HPP, the land use in the three commune in Srekor, Talat, and Kbal Romeas will submerged in the reservoir. The detail of flooded area of each land use type is showed in table 36. Figure 30 demonstrated the land use submerge and damage by the project.

Table 36: Land use will submerge in reservoir with FSL 75m

Water Level 75m	
Land Used Type	**Area (ha)**
Agricultural lands	1,290.558
Forest covers	28,969.495
Grasslands	218.714
Shrublands	47.392
Soils and Rocks	48.109
Water Features	2,989.653
Total	**33,563.921**

Paddy field per household in the project area is varies from one commune to another. Based on the field research, it is found that paddy field holdings ranged from 0.5 ha to 12 ha. All of the interviewed households reported that they have their own land holdings, which do not belong to their parents or rent from others. Table 37 presents the distribution of households owning paddy fields by different sizes. Altogether, in the project area, 2.8 percent hold 0.5 hectare or less, 21 percent hold from more than 0.5 to less than 2 hectare, 59.1 percent hold 2 and 4 hectares and 17.1 percent hold more than 4 hectares. The other 10 households don't occupy paddy field because they are new comers or settlers as shown in Table 1.6. Regarding to ownership, based on the field study, mostly land ownerships occupied have no official land title. However, they are duly recognized by local authorities at village, commune and district levels.

Table 37: Paddy field holdings

The project area	>0-0.5ha	>0.5-<2ha	2-4ha	>4ha	Total
Number of household (HH)	5	38	107	31	181
Percentage (%)	2.8	21	59.1	17.1	100

In reminding that the project area use to be a target battle field in war between United State Administration and Indochin Socialist Party (corridor of Hochiminh road). So the remains of bomb/UXO and toxic chemical used by the US airforce are presented.

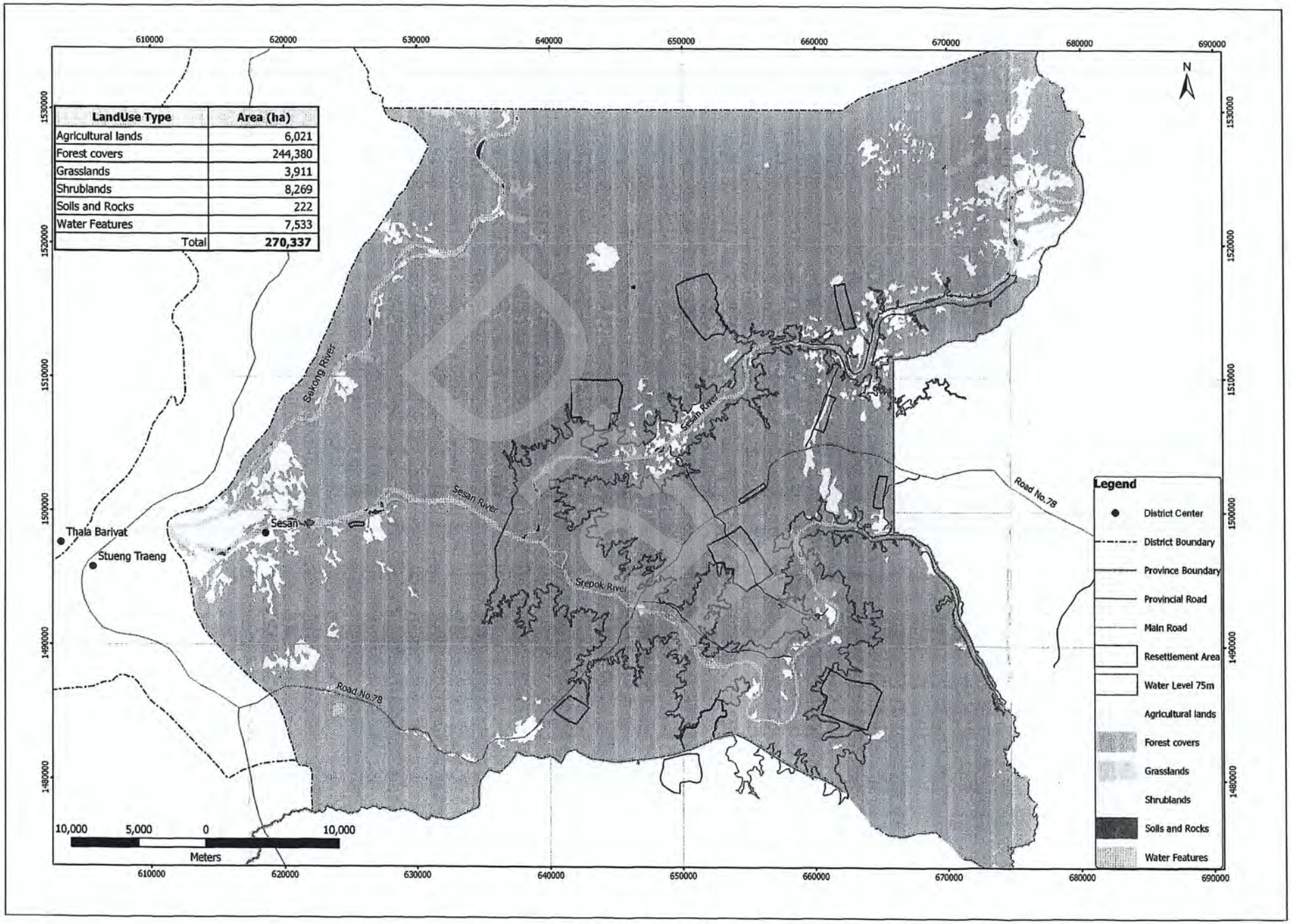


Figure 30: Land use map of Sesan district

Table 38 presents the distribution of households owning different size of crop plant land. As a result from the study team interviews, 13.7 percent hold 0.5 hectare or less, 44 percent hold from more than 0.5 to less than 2 hectare, 34.2 percent hold 2 and 4 hectares and 7.7 percent hold more than 4 hectares. The other 74 households don't occupy crop land. It is similar to paddy field, almost all the crop land have no ownership certification. Regarding to ownership, based on the field study, mostly land ownerships occupied have no official land title. However, such kinds of lands are also duly recognized by local authorities at village, commune and district levels.

Table 38: Crop plant land holdings

The project area	>0-0.5ha	>0.5-<2ha	2-4ha	>4ha	Total
Number of household (HH)	16	52	40	9	117
Percentage (%)	13.68	44.44	34.19	7.69	100

4.3.5 Agricultural development

The total agricultural land in Sesan district is 5220ha, within 4950ha wet season paddy field and 270ha upland agricultural field. Sesan is one of main rice storage of Stung Treng province, data obtained from director of agricultural department. The upland agricultural field includes (i) mobile cultivation practice: upland rice, corn, cassava, banana etc.; (ii) fixed cultivation practice: mango, pineapple, cashew nut, banana etc.

According to the field study it found that along the Sesan and Srepok Rivers, people are engaged in rice production, known as upland rice, and crop production for a season per year. Thus, no rice and/or any crop productions are cultivated during the dry season period. This doesn't mean that there is no irrigation facility during the dry season, but rather lack of means to irrigate their fields or it may be their custom to just cultivate only one season. The practices of upland rice are generally divided into two categories: shifting and permanent cultivation. Shifting cultivation involves clearing forest to plant rice and other crops for 2-5 years before rotating/moving to another place. In most cases, farmers clear areas that were previously cultivated but have been left fallow for several years. Permanent cultivation involves growing rice in the same area every year, typically a small plot of land located nearby farmer's houses (McKenney B. and Prom T. 2003). Since shifting cultivation is no longer practiced, the main practice currently is only permanent cultivation.

Rain-feed upland rice is considered as the dominant crop, transplanting from June and harvesting from October to December. The harvesting period is dependent on rice varieties. For instance, early rice is normally harvested after planting for a three-month period, while the late rice is always harvested after planting for a six-month period. The secondary crops are planned in the form of mixed farm. Such kinds of crops are grown without irrigation. This means that although the rice fields are close to the Sesan and Srepok Rivers, but they completely depend on rainwater. Due to its dependence on rainfall, upland rice is transplanted during the wet season and harvested during the end of rainy season or when the rains end, depending on rice varieties and other factors such as rainfall regime, climate conditions. In most upland

fields, mixed crops are the planting of rice and a range of other crops including corn, sweet potato, cassava, mung bean, sesame, vegetables and others.

Table 39: Rice yields by commune

Commune	Rainy season rice yields, (Ton/Ha)
Talat	2.0
Srekor	1.5
Phluk	1.8
Kbal Romeas	1.5
Sre Angkrorng	1.0

Source: Commune profiles, 2007

The rice yields vary from commune to another as shown in table 39, depending rice species, agricultural practice, types of soil and others. The high rice yields in any commune imply rice soil in that commune. Agriculturally, the darker soils are more fertile than red soils, locating further away from the river, most likely once covered by forest, are better for rice paddies and fruit orchards. Riverside villagers mostly reported that their paddy land was enough to provide them with adequate food in most years. Field observations found a general pattern and distribution of mixed crops throughout the landscape in association with the Sesan River. Fruit orchards were quite far from the river and they are more common among villages near the Sesan and Srepok Rivers, providing additional source of income, while home gardens were nearby homesteads and between houses and the rivers (SWECO 2006). Those crop plants are classified into three categories: plants grown in the home gardens, crop/food plants located behind the houses (backyards), and plants that used to be cultivated nearby river bank and/or along river bank slopes (Table 40).

Table 40: List of crop plants and fruit trees in the project area

Plants grown in the home gardens		Crop plants and fruit trees located behind the houses (backyards)		Plants that used to be cultivated nearby river bank and/or along river bank slopes	
Local Name	Name	Local Name	Name	Local Name	Name
Ampel	Tamarind	Ampel	Tamarind	Ampov	Sugar cane
Chek	Banana	Ampov	Sugar cane	Kh'toem Sor	Spring onion
Chi Angvong	Mint	Chek	Banana	L'mut	Species of Sapotaceae
Chi Kraham	Basil	Chi Angvong	Mint	L'ngo	Sesame
Chi Vansuy	Coriander	Damlong Chhvea	Sweet potatoes	Lpov	Pumpkin
Doerm Dong	Coconut tree	Damlong Kor	Cassava	Mnors	Pineapple
Doerm Ko	Bombax	Doerm Dong	Coconut tree	Mtesh	Chili
Doerm Toekdoh Ko	Milk fruit	Deum Ko	Bombax	Ov Loek	Water melon
Kh'nol	Jackfruit	Doerm Toekdoh Ko	Milk fruit	Pot	Corn
Kh'toem	Spring onion	Kh'nhei	Ginger	Sla	Betel nut
Kroch Chhma	Lemon (lime)	Kh'nol	Jackfruit	Spey	Lettuce
Kroch Pursat	Orange	Kroch Pursat	Orange	Svay	Mango
Kroch Thlong	Pomelo	L'hong	Papaya	Svay Chanti	Cashew
L'hong	Papaya	L'mut	Species of Sapotaceae	Thnam Chuok	Tobacco
L'mut	Species of Sapotaceae	L'ngo	Sesame	Trab Kdeb	Aubergine
Mien	Longan	Mien	Longan	Trakuon	Morning glory

Mlou	Peper betel	Sandaek Bay	Mung bean	Trav	Taro
Mtesh	Chili	Seda	Pomelo		
Nonong	Long gourd - 2 (smooth surface)	Sloek Krey	Lemon grass		
Rumchek	Pandan	Speu	Corambole		
Rum dénh	Galanga	Spey	Lettuce		
Sandaek Kuo	Long bean	Svay	Mango		
Sla	Betel nut	Svay Chanti	Cashew		
Sloek Krey	Lemon grass	Thnam Chuok	Tobacco		
Speu	Corambole	Trav	Taro		
Spey	Lettuce				
Svay	Mango				
Svay Chanti	Cashew				
Trob	Species of Solaneaceae				
Trabaek	Guava				
Trab Kdorko	Aubergine				
Tralach	Long gourd - 1 (hairy)				
Trasak	Cucumber				

Note: These crop plants and fruit trees were reported by villagers, recorded during the field studies and compiled here as alphabetically local name order. However, some crops were difficult to determine its names because they were called in Lao language.

NGO working on agriculture in Sesan district are:

- DPA (Development Partner in Action)
- Forestry Community
- Fishery Community
- PFD (Project ends in the middle of 2007)
- VSO (Focus on health)
- CEPA

4.3.6 Tourism facility

There are some natural and social resources serve for tourism development in Stung Treng province. It was abounded on many kind of forest in whole province territory and some habitats wildlife including terrestrial and aquatic wildlife (dolphin in Mekong river, Ramsar site in Stung Treng). Temples and ancient pagoda presented in some districts, for instance Presh Ko Temple in Thalaborivath.

Concerning to the project area one temple name Pu Temple is located in Kamphun village, Phluk commune, Sesan district where downstream of proposed dam site for the Lower Sesan 2 HPP.

Many small cascades exists in Sesan and Srepok river, and some are given potential for the tourism development, especially cascade in Phluk village and cascade O'Chab in Kamphun village in Phluk commune of Sesan district where downstream behind the dam site of Lower Sesan HPP. At the present both cascades in Phluk commune are very attractive to the national tourists.

Recently due to 100% security and transportation infrastructures ready improved, and natural resources abundance especially forest and fish, the Stung Treng province was

engaged many national and international tourists to come and visit. It can said that Stung Treng is one potential place of eco-tourism.

4.4 Social and cultural resources

4.4.1 Population

Administratively, Stung Treng province consists of 5 districts with 34 communes and 128 villages. According to data available at the province, by the end of the year 2007-2008 the province will have 98374 persons (Table 41). Population density will be 8.19 persons per square kilometer.

Table 41: Population Statistics in Stung Treng 2007

No	Items	Districts					Total
		Stung Treng	Sesan	Siem Bok	Talat	Siem Pang	
1	Number of commune	4	7	7	11	5	34
2	Number of village	17	22	17	44	28	128
3	Number of household	5524	2716	3220	4650	3096	19206
4	Total Population	27220	12961	18358	25080	14755	98374

Source: Annual statistical book of Stung Treng province 2007-2008

The project area is located in is Sesan districts. This district has geographically borders with Siem Pa district in Northern, Mondulkiri province in Southern, Stung Treng district in Western, and Rattanakiri province in Eastern. The population in project area are described in table 42.

Table 42: Population in the project area in the year 2007

Commune	Village name	# Family	Population	Female	Family size
Talat	Talat	72	359	180	5.0
	Rum Poit	53	221	111	4.2
	Svay Rieng	256	1172	601	4.6
	Khsach Tmey	255	1163	585	4.6
Srekor	Srekor Muoy	165	749	376	4.5
	Srekor Pir	158	728	372	4.6
Phluk	Phluk	196	803	402	4.1
	Ban Bung	68	289	147	4.3
Kbal Romeas	Krobei Chrum	177	798	407	4.5
	Kbal Romeas	106	538	265	5.1
	Sre Sronok	104	529	245	5.1
	Chrub	259	1419	712	4.1
	Total	1869	8768	4403	

Source: Commune profiles, 2007

Ethnicity and religion

This section provides information about religions and ethnicity as derived from profiles of the communes and household surveys by the study team respectively. Although there are several different ethnic groups living in the villages along the Sesan and Srepok Rivers (SWECO 2006 studied in the Sesan and Srepok Rivers and 3S River Protection Network 2007), there are very few found in the project area. Those that are in the project area include Jarai, Lao, Kreung, Phnong and Prov. Figure 31 shows the percentage of the ethnic minority groups interviewed in the project area. Up and downstream of the project area however are large numbers of ethnic groups particularly Lao and Phnong as well as Khmer people.

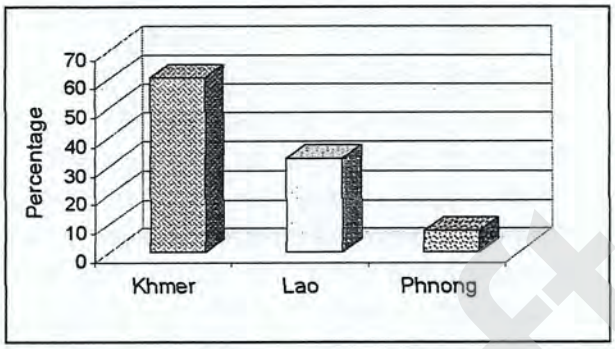


Figure 31: Ethnicity in the project area

Although some ethnicities like Jarai, Lao, Kreung, Phnong and Prov were reported by 3S Rivers Protection Network 2007 in the project area, some could not be met and interviewed during the field study as they were busy. Therefore, the interviewed persons were only Khmer, Lao, and Phnong. The highest percentage in the project area is Khmer, contributing around 60% of the total interviewed people, followed by Lao living almost all in Srekor (contribute about 33%), and Phnong living mostly in Kbal Romeas village (contribute approximately 7%).

4.4.2 Health facility

In Talat commune, there is no health center. If there are patients in the commune, they must travel a very long distance to provincial health center in Stung Treng. On average, the distance from Talat commune to the health center is about 128 km (Talat commune profile 2007). This indicates that no health facilities are currently provided for this commune. In Srekor commune, there is also no commune health center. On average, the distance from Srekor commune to the provincial health office is approximately 90 km (Srekor commune profile 2007). In Phluk commune, there is no commune health center; the nearest is the Kamphun commune health center. On average, the distance from Phluk commune to the Kampun health center is 8.5 km (Phluk commune profile 2007). It is thus quite easy for the people of Phluk commune to get to health services. The distance from Kbal Romeas commune to the nearest health center is about 40km (Kon Mom health center, Rattanakiri province).

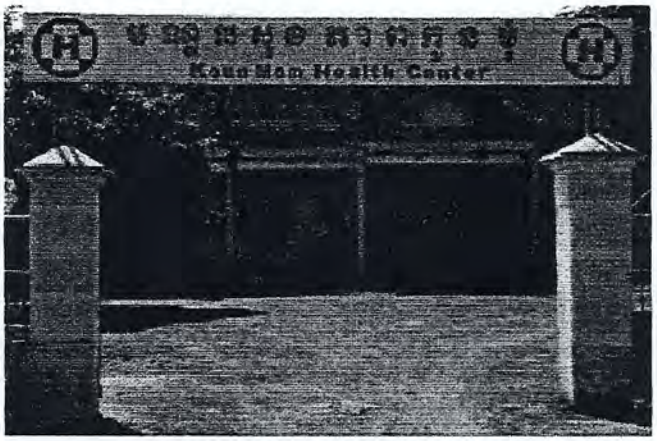


Figure 32: Health center in Koun Mom District, Rattanakiri Province

All the communes in project area have very limited if any health services. Consequently, some people use local medical plants for their treatments. Meanwhile, women giving birth depend mostly on traditional birth attendants. Since there is no commune health center in the project area, many key informants such as village chiefs, deputy village chiefs, and village elders were asked about health matters. As a result, it was found that water-related diseases and mosquito borne ones are common. Water–related diseases include simple diarrhea, severe diarrhea, dysentery, skin infections etc, while mosquito borne ones include malaria, and eye diseases. Illnesses are reported to be experienced by most households throughout the year.

Table 43: Major diseases recorded in the project area

No	Disease	Health center	
		Kampun	Koun Mom
1	Simple diarrhea	80	249
2	Severe diarrhea	0	0
3	Malaria	78	10
4	Dengue fever	0	0
5	Skin infection	102	15
6	Eyes diseases	43	21

Source: Health center, 2007

Available health data was obtained in Kampun and Sre Angkrorng communes, where data on major diseases was recorded as shown in Table 1.11. However, in Kampun, the data on major diseases couldn't represent health condition in Phluk, but it just gives background of the general health status. Thus, the major diseases in Phluk are absolutely lower than what is shown in the table 1.13 because the table shows the data on both communes: Phluk and Kampun. The most common diseases in Phluk are skin infection, followed by simple diarrhea, malaria and eyes diseases, respectively. The most occurred diseases in Sre Angkrorng are simple diarrhea. Eyes diseases, skin infection, and malaria are less contributed in the commune as well. Simple diarrhea is generally attributed to the lack of sanitation and clean water source.

Based on data from the field survey it found that the most common diseases are dysentery followed by skin diseases, typhoid, malaria, and cholera respectively. Basically, the dysentery infection is often passed on through improper hygiene. One of the most common causes of dysentery is not washing the hands after defecating in

toilet or around bush located not far from houses. Skin diseases were also high at the time of study. It seems to be hard to conclude the cause of such diseases whether from daily use of water or something else, but one of the most likely causes is lack of hygiene. The other diseases are common occurring everywhere throughout the country.

4.4.3 Education facility

Education sector is being improved, resulting of growing slowly. The education level and literacy rates amongst women are usually much lower than that of men. Also, differences between urban and rural areas have been found to be significantly different (CIPS 2004). Since education is one of the most important sectors, it is necessary to highlight it, reflecting back from the project area.

However, prior to providing a description of illiteracy rates, it should be focused attention on school facilities. In view of this, no high school was found in the project area. However, there are two secondary schools were found in Sre Angkrorng and Srekor communes. In Srekor, the secondary school is close to its villages, and it will be impacted by the dam if constructed. On the other hand, in Sre Angkrorng, the distance from its villages to the Trapaingkrahom secondary school is approximately 22 km. This school will not be likely to be impacted by the dam, but it is mentioned here just to acknowledge about the educational facility in the project area. In all communes, there are primary schools (Table 44). The number of primary schools depends on the location of those villages. For instance, in Kbal Romeas; since the distance from one village to another is far, primary school is consecutively constructed in all villages in order to facilitate education facilities in the commune.

Table 44: Number of schools and teachers

Commune	Primary School	# of classroom	Secondary School	# of classroom
Talat	4	21	0	0
Srekor	1	7	1	5
Phluk	2	12	0	0
Kbal Romeas	4	32	0	0
Sre Angkrorng	1	4	0	0

Source: Stung Treng provincial department for education, 2007

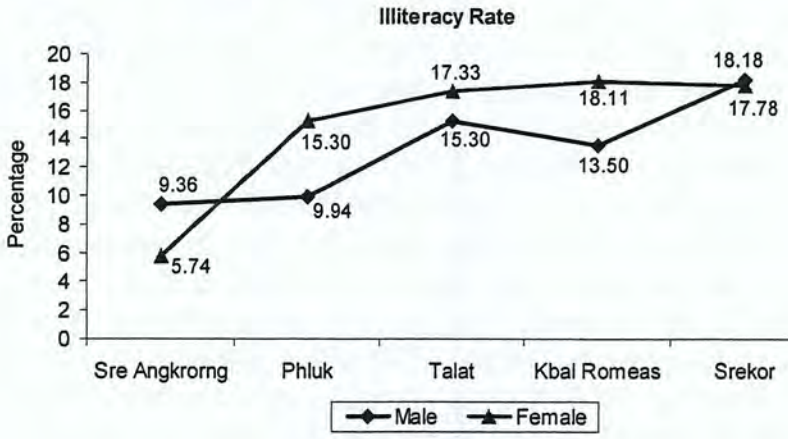


Figure 33: Illiteracy rates according to gender and the communes

Figure 33 presents information on illiteracy and level of education according to genders. The illiteracy rates were calculated from the male and female population having ages 15 - 60 years in each village, respectively. However, the percentage of female illiteracy is higher than male one in three communes: Phluk, Talat, and Kbal Romeas. The percentage of both male and female is similar in case of Srekor since this commune is mostly Lao population, resulting has no significantly different illiteracy between male and female. However, it is quite different in Sre Angkrorng that male illiteracy is higher than female. On the country basis, the education level and illiteracy rates among women are in the whole country very much higher than those among men. Average percentage of illiteracy rates in all communes is explained in figure 34.

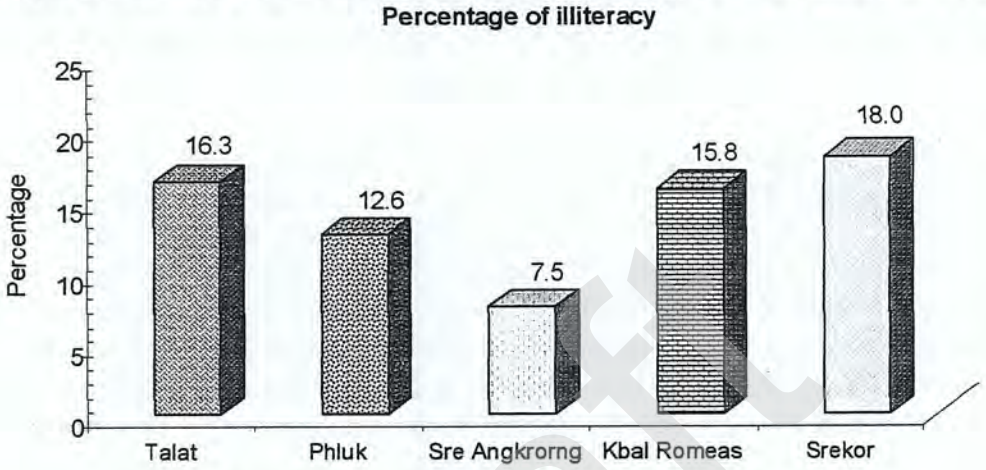


Figure 34: Percentage of illiteracy in the project area

Although there are many primary schools in the project area, the number of students continuing their education in secondary school and high one are very few. Generally they dropped down the schools when they finished grade 1-5 or only primary school. As a result, percentage of illiteracy is high. The figure 34 shows average percentage of illiteracy rates of male and female in each commune. In Sre Angkrorng, the percentage is so small 7.5% compared to that of others. On one side, it may be due to the fact that the commune is close to the Trapaingkrahom secondary school in Koun Mom district center, the place where is about 22 km from the commune. On the other side, it may indicate that parents have valued their children's study since the early time so that children are able to study more. In addition, after graduating primary school, school boys/girls are able to continue their studying at secondary level. Obviously, many school boys/girls are studying at the secondary school. In Phluk, the average percentage is 12.6%. This may be due to this commune is near provincial town, the place where is many schools located. Thus, education facilities may be better than that of other communes in the project area so that literacy rate is high. In Kbal Romeas, the percentage of illiteracy is 15.8% higher than the two communes as described above. This is due to the fact that basic facilities of education is lower than that of those two communes, while the other reason may be due to parents pay less attention on study of their chidren, and poverty. Some of families within the commune are minority groups such as Phnong, Prov, Kreung, Kavet, and Tampuon, respectively. This may contribute to higher illiteracy in the commune. In Talat, the percentage of illiteracy is also high 16.3%. This is because of the commune has only primary schools. One of the major aspects is that parents have never valued and cared of their children's study.

Also, irregular teaching and lack of teachers are key roots of high illiteracy rate. In Srekor, the percentage of illiteracy is higher 18% than that of other communes in the project area. This is due to the fact that almost all families are Lao so that they prefer not to learn Khmer. On the other hand, the educational levels of respondents are as expressed in figure 35.

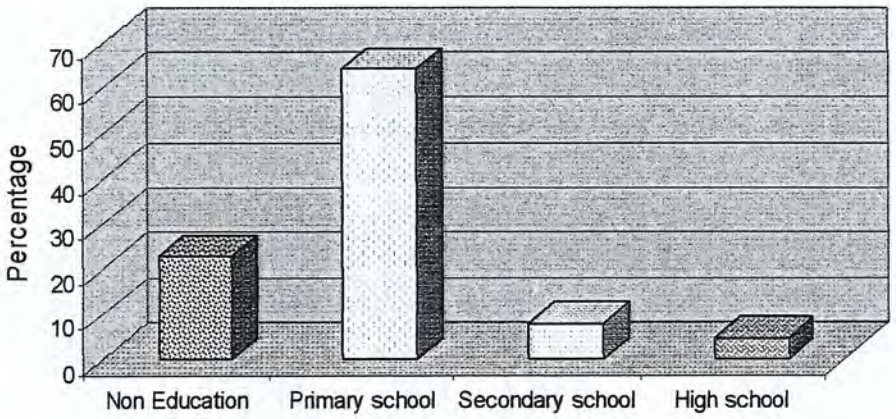


Figure 35: Percentage of educational levels of respondents

The figure 1.7 shows that very few respondents, mostly household head, studied only in secondary schools and high ones. However, the percentage of their educational levels is high in primary school. Even so, most respondents used to study just only grade 1-2. This indicates that although they used to study in such levels, they could not read and/ or write as well. Thus, it is quite similar to non-education respondents.

The high illiteracy rate can be explained by several reasons. One of the most important reasons is the tradition. It is conventional that in most cases parents don't value and/or care of their children's study, while the other reasons include poverty, irregular teaching due to lack of teachers, and long distances to secondary school and high school. Poverty is considered as one of the root causes. This is due to the fact that those children were always involved in some forms of work, even if they were studying in order to support family's works and/or to earn extra income to supplement daily livelihood. Of this, it significantly contributes to the low level of education in the project area.

4.4.4 Socio-economic condition

Prior to understanding socio-economic condition, it is necessary to know of livelihood in advance. A livelihood is defined as consisting of the capabilities, assets, including both material and social resources, and activities required for a means of living (DFID, 1999). A livelihood is however sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resources (DFID, 1999). Livelihood diversification is regarded as the ways in which individuals and households change their ways of earning an income and surviving (IMM, CFDO and CBNRM LI. 2005).

In Cambodia, livelihood diversification is the most important and a part of life in rural

areas. It not only provides earnings to supplement family's usually inadequate main income source but also reduces the risks arising from relying on single source of earning (Ellis 2000). People in the project area and up and downstream of the project area are however no different from rural areas elsewhere in the country. That means that they have traditionally engaged in agriculture, depending on a range of activities to secure food and income which include rice, other field crops, home gardening, and livestock production, fishing, forest product collections, wage labour, and small-scale traders and others. Table 45 shows that main occupation in the project area is 88 percent as farmer, while other includes government employees, workers and so on. The main secondary occupation is mostly fishermen.

Table 45: Main occupations of people and monthly income

Main occupation	Percentage	*Monthly income*	
	%	*Riel*	*USD*
Worker at private companies / factories	0.5	*135800*	*33.95*
Government employee	11.0	*84100*	*21.03*
Small shop owner	0.5	*131200*	*32.81*
Farmer	88.0	*133900*	*33.48*
Total	100		

Exchange rate in June 2008, US$ 1 = 4000 Riel

Table 46: Second occupations of people

Second occupation	Percentage	*Monthly income*	
	%	*Riel*	*USD*
small-scale trader/business	16.3	*193000*	*48.25*
Fishermen	41.9	*150800*	*37.70*
Motor taxi driver, Transportation service	5.2	*83300*	*20.83*
Non timber product , Timber logging	13.6	*290500*	*72.63*
Other	23.0	*87500*	*21.88*
Total	100		

Exchange rate in June 2008, US$ 1 = 4000 Riel

Apart from regular cultivation of rice and crops and raising animals, villagers are dependent on (i) Salary or wages from government/NGO employment, (ii) Fishing, (iii) Manual labor, (iv) Income from selling livestock, (v) Income from selling rice and/or grain (vi) Non-timber forest products such as collecting resin and other forest resources (NTFP), (vii) Transportation service provider by boat, pedestrian tractor and in some cases by car, and (viii) Other miscellaneous incomes from other means, such as renting out assets. Total income for a full year period was thus calculated from each source as defined above and combined together. Interviewees were asked to recall their incomes from all possible sources during the past twelve months with a clearly identified reference point (January to December 2007).