

CHAPTER VI

6. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The aim of this chapter is to determine the environmental impacts of the project on the natural and social resources that may occur during project pre-construction, construction, and operation. Based on the negative impacts identified through environmental screening mitigation measures are then developed.

As part of the screening of the potential environmental impacts the study team used the environmental checklist in the EIA guideline of ADB 2003 for Hydropower projects (see Annex 4). Based on the results of the environmental and social field investigations and the baseline environment for the project area (refer Chapter 4) the potential environmental impacts that are expected to occur by the project's activities are described in this chapter. The mitigation measures for each impact are designed to reduce the impacts as much as possible.

Each environmental impact is described followed by recommended mitigation measures for the different project phases: pre-construction, construction and operation.

6.1 Negative Impacts

6.1.1 Project design/Pre-construction phase

- **Project site**

The proposed dam site is located on the Sesan river 1.5km downstream of its confluence with the Srepok River in Sesan District, Stung Treng Province. The dam crest is proposed to have a height of 83m (msl) or 40m from the river bed and be 8km in length which will result in a reservoir area of approximately 33,500 hectares inundating agricultural land, forest area, grasslands, shrubland, and other land uses in the Sesan district, especially Phluk, Srekor, Talat, and Krabei Chrum communes. It will also inundate large tracts of both the Sesan and Srepok Rivers (between 40-60km length of each river). The reservoir area lies within the Lower Mekong Dry Forest Eco-region which is internationally recognized as being globally important. The project also lies within Important Bird Areas classified by BirdLife International as containing important bird habitat which supports a number of rare and endangered birds. Four proposed re-settlement areas of around 5000ha which will be either totally or partially flooded by the reservoir will also encroach on some forest areas and open up access to them. One of the resettlement areas is located immediately adjacent to the Lomphat Wildlife Sanctuary protected area. The reservoir site and proposed settlement areas will cover some areas of land and forest concessions that have already been permitted in the Sesan district.

The land around the project site is relatively flat thus making the proposed reservoir area very large. To minimize the significant environmental and social impacts the dam height should be minimized as far as possible. A reduction of only a few metres in dam

height results in significant reductions in the inundation area saving forest areas, villages and the need for large scale resettlement. There are two alternative dam sites, and use of either site will cause significant environmental impacts but the site further upstream (Site 1) will slightly reduce the reservoir size and also allow some downstream cascades to remain for tourism so the proposed dam site furthest upstream should be the preferred site.

Moreover the project site risk with the earthquake due to the result of geology and seismology study.

➤ *Mitigation measure*

The alternative Site 1 dam shall be the preferred site and the dam height shall be minimized as far as possible to minimize the flooded forest area, agricultural land, existing land concessions, and the existing settlement areas of the four communes in Sesan district. Reasons for the final minimum height of the dam and why it cannot be lower will be provided and made publically available.

The new resettlement areas shall be selected where impacts on the social and environmental resources in the area are minimized. Further consideration will be given to the proposed locations of the relocation areas in this respect, particularly where they encroach on ecologically sensitive areas and are near a protected area.

The design shall include the protection factor to the earth quake in the area. Planning and budgeting for emergency aid and compensation to the affected people, if dam collapse by such natural disaster.

▪ **Design**

Based on the feasibility study report, the Lower Sesan 2 HPP will be designed for a full supply water level in the reservoir of 75m (m.s.l). So the reservoir will submerge total area of 30,574ha or 305.74km², within the area include agricultural land, forest area, grasslands, shrubland, and other land use area. The environmental impact concern to the reservoir size is many thousand hectares of forest and agricultural land will be damaged and lost. With FSL of 75m the national road #78 will be submerged about 7km of length and 0.5-14m depth, while the Srepok Bridge will be completely submerged, about 9m under the water surface. This will result in a new road being built around the reservoir which will add around a further 60km in road distance between dam site to Talat commune and connect to existing NR #78.

In addition some part of villages in four communes (Phluk, Srekor, Talat, and Kbal Romeas) of Sesan district will be flooded and need to resettle to new area, due to the proposed reservoir site with FSL of 75m. Some land conflict will be occurred between the project with land and forest concessions companies.

➤ *Mitigation measure*

The project design shall be minimize the flooded level in order to reduce flooded area. Do so it can reduce: damaging forest, loss agricultural land, number of resettlement

households of the four communes in Sesan district, impact on land and forest concessions.

Detour road and new bridge construction is required to compensate road and bridge lost by the project. The company responsible for all expenditure for this construction and the quality of the road and bridge shall be similar or better than the existing once.

The alignment of the detour road of the national road shall be selected in where is not adversely impact to natural and social resources in the area.

▪ **Dams**

Any dam constructed across rivers will have a very high impact on fish movement/migration up and down the rivers. Either of the two alternative dam sites on the Sesan River will stop the fish migration in both rivers because the feasibility study report for the dam design does not include any structures for fish passage or other methods to prevent the impact on the fish in Sesan and Srepok Rivers. Even if there were structures proposed the difference these would make to migrating fish is unknown.

Due to the previous fish study specified that Sekong, Sesan, Srepok, Tonle Sap and Great Lake, and Mekong delta make up one interconnected fish habitat system. For instance the fish study report by Baird et al., 2003-2004 indicated that small Cyprinids migrate from Great Lake (Tonle Sap) to Mekong River, and two Cyprinids (*Scaphognathops bandanensis* and *Mekongina erythrospila*) are highly migratory species and others fish species are long distance migrators originate from the Great Lake and the Tonle Sap River. Srepok may have a higher diversity of fish species because it has more deep pools, and fewer migration barriers than Sesan and Sekong, by Vietnamese biologist Dr. Ho Thanh Hai, more than 50 species of fish species from Mekong migrate far up in Vietnam in the Srepok river with distance of more than 300km.

Therefore a dam across the Sesan River will impact not only the fisheries in the area but also the fisheries in the Mekong downstream, Mekong delta, as well as in Tonle Sap Lake too. It is estimated that around 66% of the fish species which occur along the Sesan and Srepok Rivers (over 99 species of fish have been identified in these rivers) move up and down the rivers through the project site each year. It is very likely that the dam will stop all these fish going up/down the rivers in the future impacting not only on the ecology of the rivers but on the diets and livelihoods of the 30,000 people or so living in villages on the rivers upstream of the dam site. It is estimated that each family may consume as much as US\$200-400 worth of fish each year.

➤ *Mitigation measures*

Adequate annual compensation based on the value of fish lost will be provided to families which live along the Srepok and Sesan Rivers which are predicted to be impacted by the loss of fish because about 95% of their daily protein consumption is depending on the fish from the rivers¹. The compensation may be given in terms of

¹ according to HH interviews and PRA focus group discussion during the fishery study in Feb-May 2008

livelihood improvement initiatives but full annual compensation will be given by the project owner until it can be shown that any livelihood initiatives are being successful and are sustainable. This determination shall be made by an independent evaluator.

Agricultural support program shall be provided to the affected people with adequate period that can sustainable livelihood of the people there. The programs include (i) animal raising such as cattle, chicken, duck, and other animal; and (ii) agricultural extension projects including rice, vegetables, and other crop production.

- **Access road construction**

Construction of access roads and bridges/culverts to the project site need to be included in the design stage. Some environmental items will be affected due to road and bridge construction, due to heavy traffic from transporting of construction materials to the project site, clearing forest for the new access road to the project site, borrow pit development, noise, vibration, water supply, water quality, and drainage systems.

The route of the access road will branch off from National Road #78 or connect from the Phluk village road to the dam and power house site. The National Road #78 is not yet a sealed road but it is under study by a Chinese company which is expected to rehabilitate the road next year. The Phluk village road is a dirt road and most of the bridges are small and not strong and is only used for small vehicles and motorbikes at the moment.

If the project selects the Phluk village road to be improved and used for the project access road this will cause significant environmental impacts compared to the construction of an access road from NR #78.

- *Mitigation measures*

The access road branching off from National Road #78 would be much more feasible in terms of technical, environmental, and economic aspects and this shall be the preferred option.

The company shall select appropriate alignments and design to avoid/reduce damage or risk to natural resources such as forest, wildlife, aquatic fauna and flora, and to avoid any risk to social resources in the area. An environmental assessment shall be made for the access road route for the approval of the Ministry of Environment before the commencement of any access road construction.

- **Quarry(s)**

A quarry(s) is required for construction materials and will need to be big quantity due to the project size (main dam length about 8km, height about 40m above river bed). Rock quarry and soil bank-filling materials will be selected from the reservoir site in front of the dam site as shown on the project lay out map of the feasibility study report.

However the project quarries will not likely cause significant negative impacts to the natural resources in and around the project area as they are located in the reservoir area. The main potential impacts will come from cutting forest for the open quarry, blasting rock, and access road construction. The impacts of most concern are soil erosion, sedimentation, noise, vibration, and air pollution.

➤ *Mitigation measures*

The extraction of rock and soil activities such as blasting and excavation shall be limited of noise and air pollution in compliance with the air and noise standards of MoE in Cambodia.

Drainage systems with retention pond at the quarry site(s) shall be provided to protect sediment laden water flowing into Sesan river. An erosion and sediment control plan for the quarry site and project site as a whole shall be prepared by the company. The plan shall include details of methods and equipment to be used to prevent erosion and control sediments.

▪ **Land conflict**

The proposed reservoir of the Lower Sesan 2 HPP will submerge some land concessions and forest concessions in the area which already have a license and are in operation. The reservoir will flood five land concessions and one forest concession to varying degrees depending on the FSL of the reservoir. Some other land concessions in the project area are awaiting licenses. The submerged area of the land concessions and forest concessions with the FSL 75m is shown in Table 54.

Table 54: The submerged area of land concession and forest concession with FSL 75m

Forest and land concession	Company Name	Flooded area, ha
Forest concession		
1.	Pheapimex	3,940.235
Land concession		
1.	Grand Land Company	2,911.917
2.	Siv Geach Agro-Industrial	1,479.557
3.	Phumady Investment Group	1,467.522
4.	Sopheak Nika Investment Agro-Industrial	516.474
5.	Sal Sophear Trade	84.053
Total		10,399.758

➤ *Mitigation measures*

The Lower Sesan 2 HPP (project) executive company shall provide clear information on the flooded areas to each land and forest concession company in the period of the project detail design.

The project executive company together with MIME shall cooperate with the responsibility institution on the land concession and forest concession, e.g MAFF, MLMUPC, and local authority, to solve the land conflicts before project construction.

▪ Resettlement

Based on the field investigation and measurement by resettlement study team in Feb.-Apr. 2008, the amount of the Project Affected Households (PAH) or Affected Peoples (APs) are similar whether the alternate dam sites 1 or 2 are constructed with a FSL of 75m. The project will damage houses, garden/orchard, residential land, rice field, water supply facility (well), and other households properties and community facilities such as schools, pagodas, worship places, and others that caused by the reservoir flood and by project lay out (dam site, powerhouse, and other project components). Around 5000 people comprising 1000 households will be affected by the flooded area with a dam FSL of 75m. Moreover the people in the project area are mostly made up of ethnic groups including Phnong, Kavet, Cha Rai, Krung, Prov, and Lao-Khmer. Therefore the resettlement for these people is a very major issue to be considered in the project preparation and design.

Table 55 clearly indicates that the project will affect all four communities in the Sesan district. In Srekor commune 100% of the villagers will be affected and lose their properties with a project design with a FSL of 75m. This commune would also be submerged 100% even with a FSL of 70m. The Kbal Romeas commune is the second most affected commune to be damaged by the project: about 96% of the total households will lose their houses and other properties with a FSL of 75m; about 33% of households will suffer damage to their houses and properties with a dam FSL of 70m. 41% of the total households of Talat commune will lose their houses and other properties with a FSL of 75m.

There are a few households in Phluk commune which will also need to be relocated due to the project.

It is noted that with a dam FSL of 70m, 100% of households in Srekor commune and 33% of households in Talat commune would need to be relocated to re-settlement areas. However the remaining households would still face high risk from surcharge water or floods in the Srepok river. In August 2007 the community along the Srepok river including Kbal Romeas commune were flooded, the flooded level was about 76m compared to mean sea level and the higher level of the existing settlement areas in Kbal Romeas commune are around 75m, flooded period is about one week without any dam/ barrage cross the river. If the Lower Sesan 2 HPP is developed, then the flooding period upstream of the dam site will be long period than the past flooded.

In addition, the proposed new resettlement areas for the displaced people will affect forest concession areas. The proposed areas in North-Side of Sesan river conflict with forest concessions. The proposed resettlement area alternative 1 for Kbal Romeas village will affect a land concession of the Siv Geach company. The proposed resettlement area alternative 2 for Kbal Romeas village will affect to deciduous forest in the area.

Table 55a: Project affected households and affected peoples (in year 2007)

No.	Location	HH	Total Person	Affected by project					
				FSL 70m		FSL 75m			
				PAH	APs	%	PAH	APs	%
1	Commune Kbal Romeas	470	2191	157	768	33	453	2109	96
1.1	Kbaychrum village	196	854				186	803	95
1.2	Village Kbaromeas	117	569	0	0		110	538	94
1.3	Village Sesnok	109	541	109	541	100	109	541	100
1.4	Village Chrop	48	227	48	227	100	48	227	100
2	Commune Talat	648	2892	0	0	0	267	1229	41
2.1	Village Khosachthmei	267	1229				267	1229	100
2.2	Village Svayrieng	256	1153				0	0	
2.3	Village Rongpot	53	192				0	0	
2.4	Village Talat	72	318				0	0	
3	Commune Sreko	332	1418	332	1418	100	332	1418	100
3.1	Village Sereko 1	173	719	173	719	100	173	719	100
3.2	Village Sereko 2	159	699	159	699	100	159	699	100
4	Commune Phluk								
	Village Phluk								
	Damsite 1	188	824	7	29	4	7	29	4
	Total dam site 1	1638	7325	496	2215	30	1059	4785	65

Source: Field investigation and measurement by Resettlement Study Team, Feb-Apr 2008

Table 55b: Project affected households and affected peoples (Focus in year 2011)

No	Commune, Village	Investigation		Actual state at 75,00 m		Backwater and safety (1m)		Actual state - 2007		Natural raise(*)		Mechanics raise(**)		Household separate (***)		Forecast- 2011	
		HAH	Indivi	HAH	Indivi	HAH	Indivi	HAH	Indivi	HAH	Indivi	HAH	Indivi	HAH	Indivi	HAH	Indivi
1	Kbaromeas commune	470	2191	267	1 306	186	803	453	2 109	87	548	45	211	91	676	2 869	
1,1	Kbaychrum village	196	854			186	803	186	803	36	209	19	80	37	277	1 092	
1,2	Kbaromeas village	117	569	110	538			110	538	21	140	11	54	22	164	732	
1,3	Sesnok village	109	541	109	541			109	541	21	141	11	54	22	163	736	
1,4	Chorop village	48	227	48	227			48	227	9	59	5	23	10	72	309	
2	Talat commune	648	2892			267	1 229	267	1 229	51	319	27	123	53	398	1 671	
2,1	Khosathmei village	267	1229			267	1 229	267	1 229	51	319	27	123	53	398	1 671	
2,2	Svayrieng village	256	1153														
2,3	Prongpot village	53	192														
2,4	Talat village	72	318														
3	Sreko commune	332	1418	332	1 418			332	1 418	63	368	33	142	66	495	1 928	
3,1	Sreko 1 village	173	719	173	719			173	719	33	187	17	72	35	258	978	
3,2	Serko 2 village	159	699	159	699			159	699	30	182	16	70	32	237	950	
4	Phluk commune	188	824	7	29			7	29	1.	8	1	3	1	10	39	
4,1	Phluk village (*)	188	824	7	29			7	29	1.	8	1	3	1	10	39	
	Total	1638	7325	606	2 753	453	2 032	1 059	4 785	202	243	106	479	212	1 579	6 507	

Legend: (*) Household follow: 6%/year; Individual follow: 8%/year

(**) 10% number of investigation in 2007

(***) 20% number of investigation in 2007

The proposed resettlement areas for Sre Sranok village especially the alternative 2 site, will affect wildlife habitats which is under a study program of WWF. In addition the new alignment of the detour of NR #78 is currently crosses this alternative 2 area, leading to significant impacts for wildlife habitats in this area.

➤ *Mitigation measures*

New resettlement places are needed to be developed at appropriate locations and with an appropriate size for the number of people to be displaced and be of an equivalent quality or better to what they have at the present. The new resettlement sites shall be located where no adverse impacts on the natural and social resources occur.

The resettlement activities shall be done with peaceful discussion with the people who are to be displaced with proper measurements of the affected properties, and reasonable compensation reflecting the real costs in the local market. A resettlement action plan is required detailing the resettlement areas, the reasons for their locations and how and when resettlement will occur. Effective compensation shall be made to the affected people before the commencement of construction activities.

In addition the compensation and resettlement activities shall be carried out in accordance with the results of the study which is described in Resettlement Report (separate report that prepare by PECC-1 study team).

6.1.2 During construction phase

a) Impact on Physical Resources

▪ Impacts on hydrological regime

The water flow in the Sesan river downstream will change due to the dam construction. The construction/rehabilitation of the access roads to project site may also cause blockage of natural drainage in the area. There are some small engine boats which navigate up and down the Sesan river through the proposed dam site that the local people frequently use for transportation means from village to village and sometimes to Stung Treng town, and the period of dam construction may disturb navigation activities. However impacts on the hydrological regime of the Sesan river is relatively small compared to the operation stage.

➤ *Mitigation measures*

The construction of a diversion canal at dam sites shall be provided with adequate capacity to release water to downstream avoiding big changes of flow in the river, and can be temporary used for navigation of small engine boats

Adequately provide drainage systems along the access roads to project site which do not inhibit water flow nor release pollution/sediment into watercourses.

▪ Impacts on water quality

The water quality downstream of dam site in the Sesan river will be reduced during construction stage due to cutting of forest, earth works, potential disposal of waste into the river course or on the open spaces nearby, especially the spilling of fuel, lubricants, and other toxic materials from construction machinery/vehicle and construction work. Improper management of human waste from project workers can also give a high pollution level in the river and a high risk of health impact on the people using downstream water which includes the Provincial centre of Stung Treng.

High turbidity or laden water and floating waste such as wooden leaves/branches will cause lower dissolved oxygen in river water, and high turbidity and floating waste such as drilling mud and silt/suspended particle cause lower dissolved oxygen in water too. The sediment laden water will occurred for a long distance due to the Sesan river flow speed which averages 3m/s. Any poor water quality (high turbidity, sedimentation, oil and grease pollution) will mainly affect aquatic life and waterusers downstream of project site.

The poor quality of river water in construction period will affect downstream domestic water supply of Phluk community as well as the Stung Treng water supply. The communities in downstream will spend some more money for treating water, especially Stung Treng Town water supply. The poor water quality will directly affect to people health who use Sesan river water with out treating, particularly the people in Phluk commune who are concerned about the health affects of using untreated water, e.g skin and eye infection, diarrhea, etc.

Any poor water quality will also affect to the water cascades in Phluk village where local tourists come to play/relax. Any high turbidity and laden water would stop most of the tourists coming to play in this area.

➤ Mitigation measures

The cutting of forest and earth works shall be done in the dry season to reduce soil erosion and waste flushing into the river. If construction is not completed in dry season appropriate erosion and sediment control measures (retention pond and blue fine mesh cloth/plastic) shall be put in place to avoid sediment laden discharges from the site during the wet season.

The project construction company shall educate the workers not to dispose waste into the water course, and provide adequate waste management facilities including sanitation latrines in the construction sites and camps. The company shall make sure that all waste generated from humans and from construction activities will be properly collected and disposed in compliance with the sold waste management regulation/guideline of Cambodia.

Water quality examination upstream and downstream of the project site shall be done regularly to ensure the quality of water during construction does not seriously impact aquatic wildlife and human beings who use the Sesan river water downstream of the project.

▪ **Impact on Ambient Air**

Cutting and Burning forest/vegetation in the construction site and in the reservoir areas (before flooded) will pollute the ambient air in the area. The emissions from construction machinery, dust and smoke from the blasting rock will affect air quality. Transportation of construction materials to the project site will cause pollution to the ambient air too. The construction of dam, access road, and detour road will release much noise and vibration from forest cutting, construction machinery, and project vehicles. Dust, noise and vibration will mostly affect to the human health and wildlife near by the project site and along the project access road and detour road.

Forest fires caused by careless project staff, wildlife hunters, and land reclamation for occupation or plantation in the area will also pollute the atmosphere in the project area as well as in the region.

➤ *Mitigation measures*

For the forest type such as evergreen forest and valuable wooden trees shall not be burnt and shall be used for appropriate uses. Consequently the company will cooperate with the Forestry Administration to collect timber and improve it for use for some purpose or sale to the market rather than burning it in order to reduce air pollution.

The implementing company or contractor will cut and burn wooden branches/leaves and non-valuable trees in accordance with the Cambodian safety standard or give to local villagers for firewood for cooking.

Good quality construction machines emitting the lowest possible air pollution shall be used to protect air quality in the project area.

The company will use appropriate blasting material and techniques so no high pollution is emitted to the air.

▪ **Geology/Seismology**

The result of geological and seismological study found that in adjacent of the Lower Sesan 2 HPP area presented of four faults namely Buon Ho, Sesan River, Se Bok, and Ph Leuslup fault. The result of seismological study in and surrounding the project area specified one earthquake occurred in 1978 with magnitude $M_s = 5.2$ degree Richter, according to data observed by seismograph, survey documents, historical documents and an information bulletin of the International Seismological Center (ISC). The Lower Sesan 2 HPP implementation is at risk from seismic/earthquake activities due to dam construction and a reservoir with millions of cubic meters of water storage capacity.

The geological condition at alternative dam site 1 is - favorable andezite rock (exposed at riverbed) with high stability to support concrete and abutments with a homogeneous overburden layer which is suitable for dam embankments. The condition at alternative dam site 2 is not so favourable, it contains - unconformable N2-Q1 sediment, Quaternary Sediment unconformable located on rock of J1-2 formation and in the

riverbed, a silt layer is located under tens meter of water, its thickness is 2-5m covered on conglomerate rock of J1-2 formation which would mean for the spillway area and concrete dam located on riverbed, consolidation grout would be required to treat its foundation.

However the whole project area is affected by faults which are a negative factor for the hydropower dam construction site.

➤ *Mitigation measures*

The main dam of the Lower Sesan 2 HPP shall be built where there are favourable geological conditions such as those for alternative dam site 1 (upstream site) to avoid high risk of damage or collapse.

All physical structures including the main dam shall be designed with high resistance to seismic activity in the region (noting the magnitude of the earthquake in 1978 was 5.2 on the Richter scale).

b) Impacts on Ecological Resources

▪ Impacts on forest and wildlife habitat

During the construction stage many thousands of hectares of forest in the project area will be submerged. With an FSL of 75m the reservoir will flood 23093ha of deciduous forest, 3516ha of semi-evergreen forest, 248ha of evergreen forest, and thousands of hectares of other forest areas and grassland. Many hectares of forest will be damaged/lost by the project construction access road and detour road as well as development of the resettlement areas. Loss of wildlife habitat in the proposed reservoir area, along the access road and detour road, and other construction sites of the project will occur.

The proposed resettlement sites also will affect the forests and wildlife habitat. Based on the project lay out of the proposed resettlement sites a total of about 4,618ha of deciduous forest, 1,556ha of semi-evergreen forest, 102ha of evergreen forest, and hundreds hectares of other forest will be damaged/lost.

Encroachment of construction workers into the forest in terms of land reclamation and burning forest for hunting would affect forest and wildlife habitat too.

The impact on the forest and wildlife habitat will be significant due to the loss of many thousands of hectares of forest and wildlife habitat because of the project. Based on the money conversion from the forest loss by the project (the value of sustainable management of natural forest per year) is USD 2.85 million and the non-timber product is USD 0.49 million. This figure excluded the areas of forests which will be flooded in the forest concession and land concession licensed companies.

➤ **Mitigation measures**

The cutting forest shall only be done within areas of the project site where construction activities are required. Strictly ban construction workers from encroaching into the forest for hunting or cutting forest.

Reforestation in open spaces nearby the project area or in an area agreed by FA shall be undertaken during the project construction and operation stages to compensate for the area of forest lost due to the project. The company shall also make a contribution to strengthen the forest and wildlife habitat conservation program in the area including incorporation and contribution budget to the FA and other conservation agency to protect the forest and wildlife in and around the project area. One forest-seeding-station shall be provided near the reservoir site. This shall be detailed in a Reforestation and Conservation management plan which described in mitigation program with proposed budget (see Annex 6).

▪ **Impacts on wildlife**

The project will flood many thousands of hectares of forest which are habitats for local wildlife. Moreover the proposed reservoir will flood the habitat of sandbar birds, according to the research study focus on Bird species as well as Black-bellied Term (*Sterna Acuticauda*), River Tern (*Strerna Aurantia*), River Lapwing (*Vanellus duvaucelii*), Great Thick-knee (*Esacus recurvirostris*), , Small Pratincole (*Glareola lactea*), and Little Ringed Plover (*Charatrius dubius*) (Worldwide Fund for Nature (WWF), Feb-May 2003). At the proposed Srepok resettlement sites forest birds especially bulbuls, woodpeckers, hornbills, sunbirds, and mynas were found and are still common in this forest (wildlife study in the project area by Bansok, Mar-May 2008). Due to human access through this area there is also evidence of disturbance to wildlife.

The 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. 11 species of wild birds are found along the Sesan and Srepok River (detailed description in chapter 4). The construction activities in the proposed resettlement area for Sresranok village will affect terrestrial wildlife such as Eld's Deer, Dhole, Banteng, and Vulture, according to the result of a study of WWF (2007-2008). The construction activities in the proposed resettlement area for Srekor commune will affect the terrestrial wildlife in the area, due to loss of their habitat from clearing the forest for new resettlement places and noise/vibration from building the community facilities in the new settlement and other construction activities.

Many development and human being activities are pressuring wildlife habitat and wildlife already, e.g forest and land concession implementation and wildlife hunting, so the impact to wildlife caused by the project construction will be moderate due to existing disturbance but loss of habitat in the reservoir and resettlement site areas, noise and vibration from the construction machinery, blasting rock, cutting forest, and potential encroachment into forest/wildlife habitat by construction workers will still cause impacts.

➤ *Mitigation measures*

The reservoir area shall be minimized as far as possible (see above)

The cutting of forest shall only be done in areas required for construction activities.

The locations of the resettlement sites shall be not be located in areas of valuable habitat where rare and endangered species may be present

Strictly ban construction workers from entering the forest for hunting or cutting forest.

▪ **Impact on aquatic biology and fisheries**

Project construction will affect the aquatic biology and fisheries in the Sesan river downstream and potentially upstream of the project site. Drilling for foundation construction, earth filling the dam site, potential leaking of oil/grease from construction machines, and improper waste management on the project site can cause deterioration of water quality with high turbidity and sedimentation/siltation, lower dissolved oxygen, toxic material, oil and grease floating.

Such impacts would damage the river bottom aquatic life. High turbidity in the water will reduce the dissolve oxygen in the river. The lower dissolve oxygen, high content of oil and grease, and toxic parameters in the water will impact to aquatic wildlife and fish because they can not grow, breed, or survive.

The impact to the aquatic biology and fisheries in the construction stage should be moderate provided river flows and water quality are maintained through protection measures.

➤ *Mitigation measures*

Appropriate erosion and sediment control measures (retention pond and blue fine mesh cloth/plastic) shall be put in place to avoid sediment laden discharges from the construction site partially during the wet season.

The project construction company shall educate the workers to not dispose waste into the water course, and provide adequate waste management facilities including sanitation latrines in the construction sites and camps. The company shall make sure that all waste generated from humans and from construction activities will be properly collected and disposed in compliance with the sold waste management regulation/guideline of Cambodia.

Illegal fishing activities from the project staffs and workers are banned.

c) Impact on Social and Economic Development

▪ **Impact on water supply**

The project construction may impact on the quality of the water supply of the community downstream of the project site particularly the Phluk community water supply and the Stung Treng town water supply. The treatment cost of the Stung Treng town water supply may increase to meet the drinking water quality standard.

➤ *Mitigation measures*

Appropriate erosion and sediment control measures (retention pond and blue fine mesh cloth/plastic) shall be put in place to avoid sediment laden discharges from the construction site during the wet season.

The project construction company shall educate the workers do not dispose waste into the water course, and provide adequate waste management facilities including sanitation latrines in the construction sites and camps.

Water quality monitoring both above and below the dam site and at Phluk village and Stung Treng town shall be regularly undertaken by the construction company. In the event water quality standards fall as a result of dam construction activities the company shall pay for provision of potable water to any affected villages and pay for any increased costs for the treatment of water at Stung Treng town.

▪ **Impact on roads and bridge**

During the construction period the project will impact on the existing roads and bridges in the area especially along national road #78 and the bridges along the road. The heavy transportation of construction materials and mobilization of machinery to the construction site may cause damage to the road surface and/or the bridges along the road ways. Moreover the Srepok Bridge and 7Km of NR #78 will be submerge in the proposed reservoir.

National road #78 is scheduled to be rehabilitated in 2009 and is expected to be finished before the Lower Sesan 2 construction stage commences.

➤ *Mitigation measures*

Frequently monitor and maintain all roads that will be used for the project including access roads, to make sure they remain in good repair during the construction period. Any damages caused by construction traffic shall be immediately repaired at the cost of the construction company in consultation with the local road authority.

Improve the stretch of national road #78 that will be used for the project, if it is not improved before the project Lower Sesan 2 HPP construction stage.

Any access roads shall bypass any dense population areas and/or deteriorated bridges to avoid damaging of community facilities.

Construction of bridge and road at least equivalence to quantity and quality lost by the project, the road and bridge shall be connect the new settlement of Srekor and Talat village to NR #78. And the cost of the construction will be borne from project owner.

- **Impact on navigation**

At present some small engine boats are navigating up and down the Sesan river through the proposed dam site which the local people frequently use for transportation from village to village and sometimes to Stung Treng town. The period of construction dam may disturb navigation activities.

- *Mitigation measures*

Provide navigation route for the small engine boats in the diversion canal that proposed by the project in construction stage.

Confirm to the boat operator/villagers the navigation route at dam site during the construction stage. Navigation signs at of the entry and exit of the diversion canal shall be provided by the company.

- **Impact on land use**

The project will damage and change the land use condition in the area due to the project construction such as dam construction, resettlement area clearing/construction, detour road and other project component construction.

Based on the FSL 75m the reservoir will submerge 28969ha of forest, 1290ha of agricultural lands, and 266ha of shrubland and grassland of the Sesan district. It means that the Lower Sesan 2 HPP will impact land use in Sesan district. About 7086ha of land will be taken up by the new resettlement sites which comprise 4618ha deciduous forest, 1556ha semi-evergreen forest, 102ha evergreen forest, and 228ha woodland forest. It means that the total area of existing land use of 7086ha will be changed to residential land and agricultural land in the resettlement sites.

- *Mitigation measures*

Limit the size of the reservoir area as much as possible (see also above)

Limit of the size of the resettlement areas based on actual need and extra land reclamation near by the resettlement area is strictly banned.

- **Impact on agricultural development**

During construction of the dam especially when the reservoir is filled with water to reach 75m (m.s.l) the total flooded area will be 33563ha, 1290ha of which is agricultural land which is equal to 24.7 % of the agricultural land in the whole Sesan district. According to the agricultural department of Stung Treng province, the total agricultural land of Sesan district is 5220ha of which 4950ha is wet rice field with a high yield of 3.12 tonnes per hectare. The result of the social survey (Mar.-Apr. 2008) in the four communes of the Sesan district showed that the rice production ranges from 1.5 to 2 ton per hectares. The project will adversely impact agricultural

development. Rice production of about 2000-3000 tonnes/year will be lost in the period of the construction and period of re-settlement of the PAH/APs.

Besides losing rice production the project will also impact other crops like corn, banana, cashew nut, and many kinds of fruit trees such as mango, coconut, papaya, milk-fruit, jack fruit, orange, tamarind, etc,. Moreover many thousand hectares of agro-industrial in land concessions will be flooded by the reservoir also.

➤ *Mitigation measures*

The filling of the reservoir shall only occur after harvesting of agricultural products in the reservoir site to minimize agricultural losses.

The company shall arrange the agricultural land in new settlement areas in time to PHA/APs so that they can continue rice planting in the next season after finishing agricultural activities in the previous places.

Any losses of agricultural production during the construction period shall be compensated for by the construction company.

d) Impacts on Cultural Resources and Quality of Life

▪ Impact on local culture

Most of people in the project area are made up of ethnic groups include Jarai, Lao, Kreung, Phnong and Prov and each have their own culture. The project may have cultural conflict if the project recruits staff during construction from outside the local area who have different cultures. Some activities from project staffs such as being noisy, encroaching into worship forest/places, and have bad faith/are against the local believe/culture can cause impact on the local people and ethnic group culture in the project area. There have not however been any cultural sites identified in the project area.

➤ *Mitigation measures*

The construction company shall educate the project workers and staffs to respect the culture of the local people as well as the regulation and law of RGC on religion or believe and other discipline concerning to culture, tradition, and civilization and shall take strong action on any employees showing disrespect for local ethnic cultures.

▪ Impacts on public health

The project may affect community health due to project construction activities. Deforestation/burning, transportation of construction material, blasting noise and vibration may affect the health of workers and people in the community, especially Phluk and Chrop community. However the impact is unlikely to be significant due to the dam site being far from the settlement areas of communities except with potential

impacts on health from water quality as discussed above. The main health affect includes water related disease such as skin and eye infection, and diarrhea..

The company will also recruit staff from outside the local area to work for the project so the project may affect local people's health through transmission of social diseases such as HIV/AIDS, syphilis, etc., and also drug use and trafficking.

➤ *Mitigation measures*

The water quality in the Sesan River shall be maintained as discussed in water quality above.

The Company will follow all safety working standards. Tools and equipment shall be provided to protect against any dangers to project staff as well as to local people.

Treatment and protection shall be provided, e.g. health facilities, medicines, and medicine/doctor for examination and treatment of project staff and local people to avoid the spread of disease between people.

Good collaboration with health institutions in Sesan district, Stung Treng province and central levels to protect against any transmission of disease in and around the project area.

Company will cooperate with police and local authorities to protect against drug use or, trafficking in and around the project area.

e) Other Impacts

▪ **Blasting**

Blasting rock for dam material and access road construction may affect wildlife and ambient air quality due to emission of noise, vibration, and air pollution. Blasting may cause danger to the human being, villagers or wildlife hunters or fishermen, who inter to/near the blasting area.

➤ *Mitigation measures*

Blasting must be undertaken within limits taking consideration of the area to avoid high risk to wildlife and human beings in the area.

The company shall provide or broadcast to local authority as well as community about blasting schedule (date and time) to avoid any dangers to people and domestic animals. Blasting shall only be done in day time.

▪ **Construction of Road and Bridge**

Construction of the access road, detour road (NR #78), and bridge will impact the environmental and social resources in the area. The impacts include clearing forest for the new access road, detour road, and bridge construction site, borrow pits for material to be used for the road, dust, noise and vibration from the construction machinery. Noise and vibration can disturb terrestrial wildlife. Dust can affect people's health.

Construction of the new access road, and detour road may also affect the natural drainage system due to block water way, soil erosion, laden water, and high turbidity/sedimentation in the river. Traffic problems may occur during construction period.

➤ *Mitigation measures*

Clearing forest must be done only within right of way areas of the road where required for construction activities.

Adequately provide drainage systems to all access roads that will be used for the project to avoid any blockage of water runoff in the area.

The construction machinery used shall limit emissions of pollution air and noise. Watering on the road surface during construction in dry season shall be undertaken.

Traffic signs and traffic facilitators shall be provided at road and bridge construction sites.

▪ **Traffic**

Traffic congestion and traffic accidents may happen on the national road #78 and access road to the project site caused by transportation of construction materials for the project construction. Heavy traffic from the project vehicle may also cause damage to the roads.

➤ *Mitigation measures*

Adequate traffic signs shall be provided along the national road #78 and project access roads.

Educate project drivers in order to limit speeds through settlement areas or dense population places.

Monitor conditions of roads for signs of wear and tear and repair as necessary.

▪ **UXO and Toxic chemical**

Due to the project area used to be a battle field of the war in the region, between United State Administration and Indochin Socialist Party (corridor of Hochiminh road), so may remains of bomb/UXO and toxic chemical used by the US airforce. High risk to the worker and local people will be occurred in construction period.

➤ *Mitigation measures*

De-mining shall be done before earth work, especially in construction site and quarries. The project owner shall do good cooperation with local de-mining authority CMAC or other local de-mining agency to deal on this issue.

Treated of soil where founded the toxic chemical remain.

6.1.3 During operation phase

a) Impacts on Physical Resources

▪ Impacts on hydrological regime

The water flow in Sesan river downstream of the project site will be changed due to project operation. The design discharge of proposed project is 2119.2m³/s and the firm discharge is 466.7 m³/s. However the Sesan river has annual flow as following: $Q_{\min} = 377 \text{ m}^3/\text{s}$; $Q_{\text{mean}} = 633 \text{ m}^3/\text{s}$; $Q_{\max} = 902 \text{ m}^3/\text{s}$.

Downstream of power house the water will be released at a constant flow of 466m³/s during operation periods. So downstream of project site will not have the frequent peak flows in the wet season as it does currently, and the aquatic fauna and flora will be submerged during operation periods in the dry season. Sometimes the powerhouse will stop running for a while particularly in the dry season when there is a shortage of water in the reservoir. During these times downstream of project site will have a very small water flow. The fluctuation of water downstream of the dam site will occur during the operation stage. The Sesan river already artificially fluctuates to some extent due to the Yali dam in Vietnam.

Moreover the flow regime of the Sesan and Srepok rivers in Cambodia will be changed in the future due to water releases from other upstream dams in Vietnam including the Sesan 4, Sesan 5/1 and Srepok 4 dams. Release flows from upstream dam are:

- Sesan 4: 719 m³/s for 3 units
- Sesan 5/1: confirmed discharge 208.5 m³/s
- Srepok 4: max. discharge 282 m³/s; confirmed discharge 52.3 m³/s

➤ *Mitigation measures*

The company should provide as close to pre-dam flows as possible to ensure keeping the ecosystem of the stream alive and so not to have a high negative impact on the aquatic fauna and flora downstream and upstream of the project site.

Adequately notify authorities and downstream communities of the water release schedule to avoid any harm to the properties on the river bank and life of human being as well as animals.

Monitoring of aquatic fauna and flora downstream of the project area shall be continuously carried out during operation stage. If adverse impacts are identified the project owner shall take the necessary steps to reverse the problem.

▪ **Impact on water quality**

The water quality in the reservoir and downstream of the power house may be changed during operation stage. During the first 1-3 years of operation the water in the reservoirs may be poor due to decay of forest or vegetation and small animals that

and some remains of communities facilities and graves are trapped in the flooded reservoir area. Low dissolved oxygen, high pollution of biological and nutrient parameters, or eutrophication phenomena (bloom of aquatic weeds) will likely occur. However the water quality in the reservoir will recover to some extent in years 4-5 of the operation period. Low dissolved oxygen and bad smell in the water will likely occur downstream of power house but for a short time so only a small affect is expected based on the natural recovery of the stream. The communities downstream include Phluk and Stung Treng commune will get high impact on their water supply sources particularly during the first 4-5 years.

The water quality may also deteriorate due to water in the reservoir if optimum conditions to breed and grow pathogenic bacteria, viruses, and host or vector related diseases (snails, mosquitos, etc.). In addition the disposal of waste into the river course or on the open space nearby the water course from operation staff can pollute the water of the Sesan river too.

The poor water quality in the reservoirs and consequently in the Sesan river will directly affect aquatic wildlife, terrestrial animals and people's health who use the water. The indirect affect to the wildlife and human beings can be caused by disease transmission such as malaria, dengue fever, Schistosomiasis, etc. Previous research found by the KCC team in early 2008 that the people in Phluk commune who use the Sesan river in the area were already infected with Schistosomiasis disease.

➤ *Mitigation measures*

Cut and clear all forest and vegetation in proposed reservoir areas before the reservoirs are filled (theoretically) to maintain the water quality as existing condition. However clearance all the tree in the reservoir is not feasible due to large area of forest and possibility to lead to other environmental disaster such as forest fire and cobon dioxis (CO2) volume

In practical for the hydropower plants in Vietnam the mitigation applied for the reservoir are:

1-Exploitation of valuable trees for other use

2- Clean village (slide of presentation) and graves

3- Clearance all biomass in the 1Km in front of dam site

4- Looking for toxic chemicals remaining from the war (1960-1975) and treatment

This will assist to protect water quality in the reservoir and avoid high pollution of biological and nutrient parameters.

Educate the workers not to dispose waste into the water course/reservoir, and provide adequate waste management facilities including sanitation latrines on the project site.

Regularly monitor and investigate the water quality in the reservoirs and downstream of project site. Take quick action to improve the water quality in case of poor quality affecting the environment/people or breeding of diseases host/vector bloom in the

water, especially the control of the Schistosoma bacteria in the area. This includes the provision of potable water to any affected communities and paying for any increased costs for treating water for the Stung Treng water supply.

Frequently conduct research on the breeding of diseases host/vector bloom in the reservoir and downstream of project site especially Schistosoma bacteria, and conduct health examination and provide protection and treatment on Schistosomiasis disease if found in the project area. The company shall cooperate in term of technical and financial with health service agencies/institution in Stung Treng province to deal with any health problems that cause by the project activities in operation stage.

- **Impact on climate**

The big reservoir site (335.6km²) of the Lower Sesan HPP may impact on the climate in the area. Forest loss and a big water surface in reservoir area of the projects will lead to a change in precipitation and temperature in the area. Less precipitation and a little higher temperature may be occurred in the whole area.

The project area is on the edge of the North-East plateau of Cambodia and may affect to the ambient air. The changing temperature in the area may affect the ecosystem in the area, and the result may affect wildlife, human beings, and aquatic biology. The increasing of temperature (may be 0.5 to 1°C) may cause negative impact to the ecosystem in the area but the impact is expected to be relatively small.

- *Mitigation measure*

Good collaboration with Forestry Administration and forest conservation/protection institutions in the area to control and manage the forests including replanting forest where possible to tolerate/balance the climate and precipitation in the area.

Good collaboration with the local authorities in Sesan district and Stung Treng province to protect any encroachment into the forest such as cutting and burning for hunting or land occupation illegally.

- b) **Impacts on Ecological Resources**

- **Impacts on wildlife habitat and wildlife**

The project will affect the wildlife as described in the impacts during construction phase. The large and deep water (1-7km width, 30-50km length, and 20-35m depth) in the reservoirs will be an obstacle to wildlife migration in the area. The resettlement areas for Srekor village, Sresranok village, and for Krabei Chrum village will make pressure on the wildlife habitat and wildlife near by due to encroachment from the villagers.

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.

Based on the results of previous research in the Sesan and Srepok river catchments in Stung Treng and Ratanakiri Provinces there is 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. Other studies have indicated that big animals such as wild-pig, dhole, deer, tiger, and other species are present in the area and therefore the impacts to wildlife will be notably moderate to high.

➤ *Mitigation measures*

Strictly ban the encroachment to the forest/habitat of the wildlife in terms of new reclamation for land occupation or hunting particularly around the resettlement areas.

Ban hunting wildlife hunting in the area,.

In cooperation with wildlife protection agencies for a wildlife protection program at local and national level, the project implementing company shall contribute in technical and budget terms to protect the wildlife habitat and wildlife in and around the project area.

▪ **Impacts on aquatic biology and fisheries**

The Lower Sesan 2 HPP project will impact to the movement of aquatic biology especially fish in the Sesan and Srepok Rivers due to the dam construction across the river and the project operation. All aquatic fauna and fish will not be able to migrate through the dam site. No fish-passage structures are included in the original design of the feasibility study report and the effectiveness of fish passage structures for this dam are unknown.

At the moment the annual fish yield in both the Sesan and Srepok Rivers is around 893.7 tons according to the fish studies in 2005 (Baird) and 2008 (Feb-May) in Phluk commune to the Vietnam border (see detailed results in chapter 4 of this report). Therefore the fish yield particularly upstream of the dam site will decrease in both rivers because the dam will interrupt all fish movement both up and downstream. According to the KCC research study in Feb-May 2008 it indicated that 58 fish species of the total fish species caught (87 fish species) are found in both Rivers (Table 2 in annex of fish study report). Based on the fish record that downstream and upstream of the project site in the Sesan River and in the Srepok River many fish move/migrate, it means that about 66% of fish species in the rivers move from below to above the dam site and vice versa. In the dry season many fish spend their time in deep pools of both rivers for breeding/spawning and growing.

There are 8 rare fish species in the Sesan and Srepok rivers as described in Table, and three species (Mekongina erythrospila/Trey Pasi ee, Bangana behri/ Trey Pawa mok pee and Probarbus species/ Trey Trawsak) were recorded as very rare species by CITES and Fisheries Administration.

Some aquatic fauna and flora in downstream of dam site in the Sesan river may be affected due to hydrological regime change, however the degree of the potential

impacts can not be known because there is not data about fauna & flora species data related to the water regime in the stream.

➤ *Mitigation measure*

Three different methodologies can be considered for reducing fish impact in both rivers that cause by the project:

- *Fish research center in large scale shall provide, produce of same fish species as present condition in the area before the project implementation and deliver to up and down stream of the project site with equivalence or more than amount quantity that can give the yield as present condition (before the project).*
- *(OR) Fish research center in medium scale shall provide with aquaculture system training (fish feeding in cage in the river), produce the fish seed as present in the area and provide to villagers in upstream of the project.*
- *(OR) Provide agricultural support programs such as (i) animal raising such as cattle, chicken, duck, and other animal; (ii) agricultural extension projects including rice, vegetables, and other crop production. The company will responsible for all budget including technical training and providing seed in the appropriate period that all the villagers who living along the both river can adopt with changing of food supply (fish) and their daily livelihood and that the practices employed are sustainable.*

▪ **Impact on rare or endangered species**

The project will adversely damage the aquatic rare species especially fish namely Mekongina erythrospila (Trey Pasi Ee), Bangana behri (Trey Pawa Mok Pir) and Probarbus species (Trey Trawsak), due to the project (dam) will completely interrupt the movement route in both rivers, water regime change, and too deep water in the reservoir.

Due to the big/long/deep reservoir the project will impact not only on the aquatic fauna and flora rare species but also on the rare and endanger species of terrestrial wildlife in the area as well as in the Northeast Plateau of Cambodia which is a main wildlife habitat in the country. The impact on the rare and endanger terrestrial wildlife and bird species include Kouprey, tiger, Asian elephant, Banteng, wild buffalo, golden cat, fishing cat, black bear, gibbons, (Tradock) , (Kngor), peacock (Kngoik), (Tmat). Based on the present condition of the wildlife habitat and wildlife in the area it can be said that there will be impacts on the terrestrial wildlife and birds.

➤ *Mitigation measures*

Cooperation with MAFF/FA to produce as the same fish species as presently exist in the area for consumption up and down stream of the project site with the equivalent or more quantity than presently or use other methodologies that can protect the rare and

endangered fish species in both rivers. The budget for covering the mitigation measure here is response by the project implementing company.

Cooperation with wildlife conservation agencies and contribute the budget to protect wildlife habitat near by the project area including bird habitat.

c) Impact on Social and Economic Development

▪ Impacts on livelihoods

The water level in the reservoir will damage forests and agricultural land of Srekor, Talat, Kbal Romeas, and Phluk communes. With the FSL of 75m the reservoir will completely destroy 28,969.49ha of forest and 1,290.55ha of agricultural land which is equal to 24.7 % of the agricultural land of the whole Sesan district. Besides losing forest and agricultural land the project will create a barrier and a large and deep reservoir that will reduce the fish catch production in both rivers, especially in upstream of the project site as many of the fish currently caught are migratory fish.

Moreover with a dam FSL of 75m 100% of total households (or 332 HH) in Srekor commune, about 96% of the total households (or 453 HH) in Kbal Romeas commune, and 41% of the total households (or 267 HH) of Talat commune will be affected by the project due to loss of houses, agricultural land, crop, and other properties. All of the PAH will be resettled in resettlement areas as proposed by project and agreed by APs (the details of how the resettlement will occur etc is covered in resettlement study report and is not the subject of this report).

The people living along Sesan and Srepok rivers are depending on farming, fishing, collecting forest by-products and animal raising (buffalo and cattle) for their livelihoods. These activities play very vital role in their daily livelihood in the project areas, but fishing activity now has become vital for villagers in the project area, upstream and downstream. In the project operation period indirect impact to the livelihoods of the people living in upstream and downstream of the Sesan and Srepok river will be occurred, due to the aquatic/fish resources and forest resources change. Approximately 300,000 people in upstream and downstream of the project area that considered as indirect affected people, see table 56.

Table 56: Indirect affected people

District	Commune	Village name	Total family	Population	Female
A. Downstream of the project site					
Stueng Traeng	Preah Bat	Ba Chong	245	1316	667
		Preaek	802	4155	2041
	Stueng Traeng	Trapeang Pring	325	1712	833
		Kandal	309	1643	814
		Spean Thma	345	1758	870
		Thma Leak	182	921	483
	Srah Ruessei	Leu	163	826	411
		Srae Pou	352	1816	918
		Sameakki	Hang Khou Ban	160	874
	Sesan	Samkhuoy	Samkhuoy	116	522
Hang Savat			141	583	278
Ba Daeum			137	570	273

	Kamphun	Sesan	75	349	169
		Ban Mai	97	396	201
		Kamphun	345	1625	836
Sub-Total:			3794	19066	9511
B. Upstream of the project site					
Veum Sai	Hat Pak	Lam Pat	13	52	35
		Veun Hay	61	383	184
		Hat Pak	174	965	518
	Phnum Kok	Tiem Kraom	79	351	182
		Kok Prov	65	308	146
		Kok Lav	59	329	159
	Pa Kalan	Kampong Cham	82	451	236
		Pa Kalan	154	878	502
	Veun Sai	Ka Lan	156	1058	533
		Thmei	45	265	124
		Pak Kae	66	381	181
		Veun Sai	126	743	374
	Ban Pong	Hvang	283	1417	769
		Pong	177	1047	553
	Kok Lak	La Meuy	128	544	280
		Rak	135	649	324
		Trak	51	263	142
		La Lai	77	404	217
	Ka Choun	Tiem Leu	81	365	191
		Ka Choun Kraom	99	463	223
		Ka Choun Leu	93	579	314
Koun Mom	Trapeang Chres	Sangkum	72	323	153
		Srae Pok Thum	173	1746	873
	Serei Mongkol	Srae Pok Touch	130	511	267
		Neang Dei	41	153	79
	Srea Angkrong	Phum Muoy	91	448	225
		Phum Pir	113	582	312
Andoung Meas	Mai Hie	Tang Chi			
		Dal			
		Tang Se			
	Nhang	Nhang			
		Ka Chut	67	290	147
	Ta Lav	Nay	68	313	131
		Ta Lav	93	574	284
		In	57	395	183
		Ka Nat	155	684	349
		Kate	52	379	193
Lumphat	Chey Otdam	Ka Nong	53	409	199
		Ou Kan	68	381	188
		Srae Chhuk	101	527	269
		Sam Kha	74	347	173
		Dei Lou	150	723	342
		Thmei	160	800	405
Ou Ya	Sesant	Lumphat	186	896	412
		Ka Tang	57	195	92
		Pa Dal	96	453	265

Dav		Phi	91	495	265
Ta Veang	Ta Veang Leu	Chan	41	160	81
		Chuoy	81	377	193
		Ta Bouk	99	450	222
		Bangket	63	300	155
		Sanh	42	174	88
		Ke Kuong	53	203	112
		Rieng Vinh	48	233	126
		Phlueu Thum	46	185	100
		Phlueu Touch	50	189	95
		Ta Veang	206	1017	503
	Ta Veang Kraom	Tumpuon Reung Thum	104	466	235
		Kaoh Pong	10	48	23
		Sieng Say	55	220	128
		Pha Yang	53	230	112
		Ta Ngach	24	105	55
		Phav	141	622	297
		Tumpuon Reung Touch	57	216	96
		Vieng Chan	32	115	63
	Kaoh Nheaek	Nang Khi Loek	Kaoh Meayeu Leu		
Tuol					
Ou Buon Leu		Ou Buon Leu			
		Antreh			
Sub-Total:			5669??	29409??	14959??
Total:					

Source: Commune profile, 2007. Data obtained from MoI

From the KCC research in Feb-May 2008, fish catch is approximately 0.39 kg/family/day during the dry season (109 tone/1530 families/6months/30days) or 0.08kg/person/day (109 tones/7,544 persons/6months/30days). In a previous study by Meach and Baird, 2005, the fish catch is estimated at 0.5 kg/family/day. 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 consume fish at least 0.5 kg/day/family with a maximum of 3.1kg to 5.5 kg/day/family (KCC survey Feb-May 2008).

The results from the fishery research indicate that the annual fish yield is approximately 244 tons in the project area (Phluk to upper reservoir site), 177 tons upstream of the dam site on the Sesan river (Talat village to Vietnam border), and 472 tons upstream of the dam site along the Srepok river (Sre Ang Krang village to Vietnam border) and if converted into monetary terms, the total annual fish yield in whole both rivers from Phluk village to the Vietnam border is USD 2.56 million.

Annual total livelihood obtain from the forest products in the project area will be equal to the total number of households in the project area 1677 HH multiply with ((USD 167 + USD 424) /2) /year = USD 494,715 per year.

Due to the project the community will lose forest, agricultural products (rice, fruit trees, other crops and vegetations), jobs (boat operators), and decrease of fish production which is very important food (after rice) for the people in the project area as well as in Stung Treng and Rattanakiri province upstream and downstream of the dam site. Therefore the impact on the livelihoods of the people living upstream of the

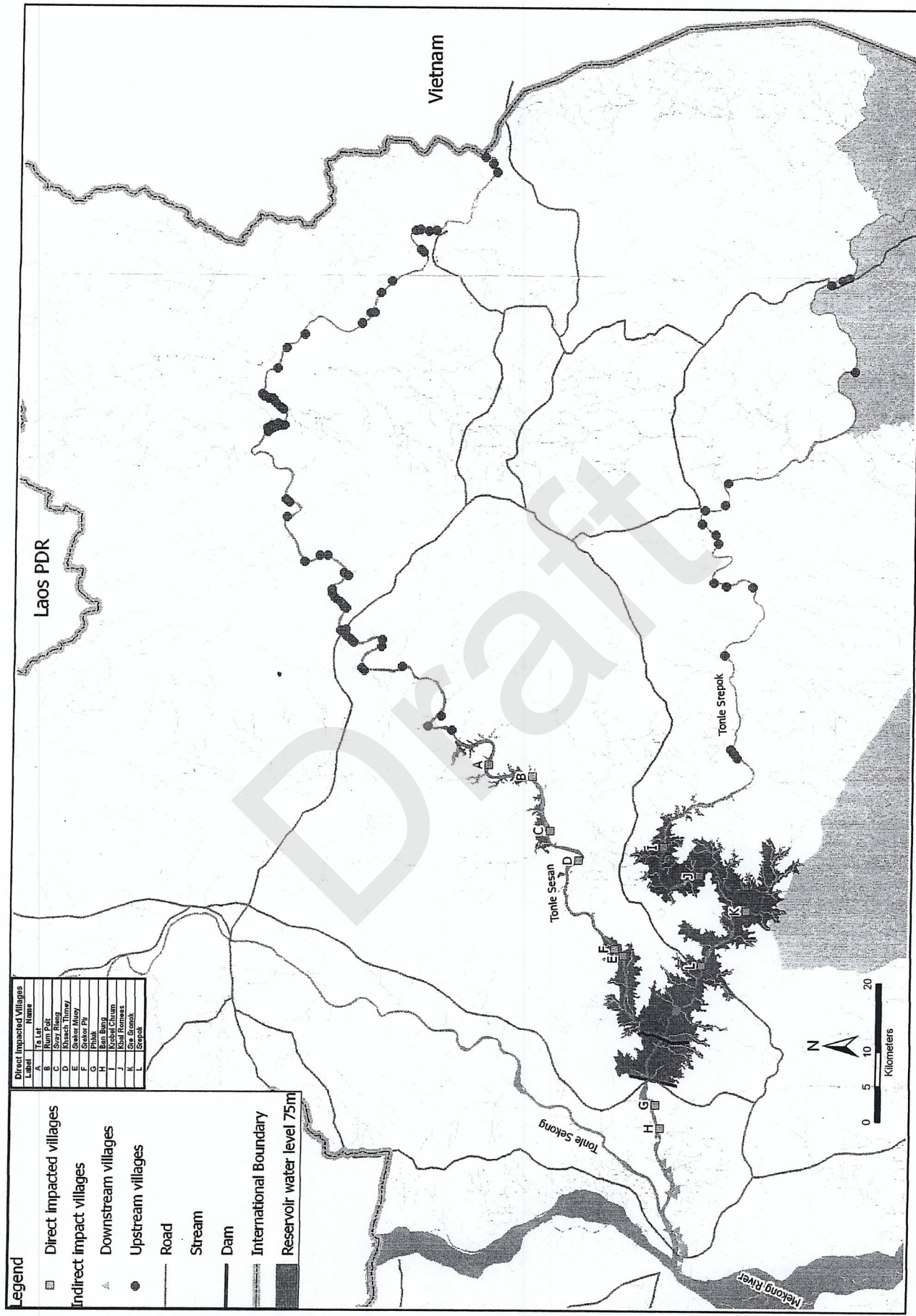


Figure 30-1: Indirect and direct affected communities

Draft



dam site is very significant. Indeed from the KCC social survey in Feb 2008, 85% of people interviewed in the proposed project area indicated that they did not want the dam constructed as it would affect their lives so much.

The project will affect to livelihoods of the community downstream also in terms of health affect (poor water quality), decreasing fishing production, destroying vegetable gardens on the river bank or shoreline of the river, and some time damaging of properties or killing animals and villagers because of changing flow regimes and sudden flooding caused by water releasing from dam during operation.

➤ *Mitigation measures*

The project executive company will be responsible for compensation to the direct PHA (in project area) and indirect PHA (upstream and downstream of the project area including communities along the both rivers in Ratanakiri province). The compensation shall be provided for strengthening livelihoods through programs such as new career capacity building, small business fund providing, agricultural system development programs, and other community development fund providing. The annual compensation fund for the above description shall be equivalence at least to total annual fish cost in both rivers (USD 2.56 million). If the programs can be demonstrated to be successful and sustainable by an independent evaluator the amount of compensation being paid by the company may be reduced accordingly

Appropriate training courses or new skills and income restoration shall be provided to PHA and APs (boat operators and fishermen for example). The cost for training and income restoration will be borne from the project executive company. The number of PHA and APs are counted based on the resettlement study result in separate report by PECC-1.

Regularly control the water quality in the reservoir to avoid adverse affect cause by aquatic weed bloom or grey algae bloom, pathogenic bacteria and virus breeding in the reservoir to protect the health of downstream communities.

Adequately and timely disclosure of a water releasing schedule to downstream communities to avoid any risk to health, properties, and lives.

▪ **Impact on water supply**

The releasing of water from the project in operation stage will affect the water supply downstream especially Phluk community and Stung Treng town and also the ecology of the river. The water quality will also be affected if the water in the reservoir becomes contaminated. The affect from poor water quality or quantity will lead to economic loss for families due to the health risk and high cost of water supply.

➤ *Mitigation measures*

Regularly control the water supply from the reservoir to avoid adverse affect caused by poor water quality and quantity particularly from aquatic weed, algae bloom, pathogenic bacteria and virus breeding in the reservoir.

Take timely action to protect any high risk of water quality events in the reservoir; the primary treatment method shall be applied in the reservoir, and other approach/method shall be provided to recover water quality in the reservoir. Ensure an adequate environmental flow is maintained downstream of the dam at all times.

- **Impact on tourism facility**

The project will impact on tourism facilities downstream of the dam, especially the cascades in Phluk commune. Due to the water release from the project about 446m³/s it will change the flow regime downstream and will be higher in the dry season and the cascade in Phluk commune where there is high potential for the tourism development will be submerged in the water.

- *Mitigation measures*

The company shall cooperate with local authorities and tourism department of Stung Treng to find other tourism places near by the project area and improve/develop to subsidize the cascade lost by the project.

d) Impact on Cultural Resources and Quality of Life

- **Impact on community facilities**

In full operation stage all the community facilities in the reservoir area including a school, pagoda, wells, community meeting house, roads, and bridges will be destroyed but will be re-established in the relocation areas.

- *Mitigation measures*

Adequate community facilities shall be provided with similar or better standards in both quantity and quality to the PHA or APs in the re-settlement areas and in existing communities near the project area.

- **Impact on public health**

The water released from the dam will give high risk to people and animals and may damage community properties during the operation period. Sometimes the powerhouse will stop running for a while particularly in the dry season when there is a shortage of water in the reservoir, so downstream of project site will have a very small flow. At these times some human and animal activities will likely occur in the river or on the river bank. When the power house starts to run again the water flow and water level downstream of power house will quickly rise up and can be a danger to humans and animals. However the tailwater pool at outlet of the powerhouse has an important role to reduce the peak water flow. Also, as described above, the water quality of the river may deteriorate particularly during the first five years or so with a high potential to affect the health of downstream water users.

The project may affect people who play in the water of the reservoir because the water in the reservoir is very deep (20-40m) and the poor water quality in the reservoir will also be impact to human health.

The project may affect community health in operation stage such as transmission of the social disease such as HIV/AIDS, syphilis, etc., if project operation staffs have social disease and they have sexual communication with the local people. Drug injection and trafficking from project staff in the local community can also adversely affect the people.

➤ *Mitigation measures*

Adequately disclose information to the people about anything harmful from the project activities to avoid health affects and ensure that project staff do not transmit disease into the local community;

Health care posts shall be provided in communities near the project site to check the project staff's and local community health and treatment if any health problems are found. Good collaboration with the health institutions in Sesan district, Stung Treng province and central level shall be established to protect any transmission of disease in the project area.

The company shall cooperate with police and local authorities to protect against drug use and drug trafficking and alcohol abuse in the project area.

Adequate safety signs will also be installed around the reservoir and dangerous places for the attention of local people and tourists.

Adequate disclosure of the operation schedule (water release from the project) to the community downstream shall be made to avoid any harmful to the properties and live.

6.2 Cumulative Impacts

The Lower Sesan 2 HPP (hydroelectric dam) project will contribute to the cumulative impacts of dam development in the region particularly from the combination of hydropower plants upstream of the dam site as list table 57.

Table 57: Hydropower projects in the Lower Mekong Basin, capacity over 10MW

On the river	Project name	Project status	Country
Sesan	1 Upper Kontum	Planning	Vietnam
	2 Plei Krong	Under construction	Vietnam
	3 Sesan 3	Under construction	Vietnam
	4 Yali	Operation since 2002	Vietnam
	5 Sesan 3A	Under construction	Vietnam
	6 Sesan 4	Under construction	Vietnam
	7 Sesan 5/1	Planning	Cambodia
	8 Sesan 2	Studying	Cambodia
Srepok	9 Srepok 4	Planning	Vietnam
	10 Srepok 3	Planning	Vietnam
	11 Dray H' Linh 1	Operation	Vietnam
	12 Dray H' Linh 2	Planning	Vietnam
	13 Buon Kuop	Under construction	Vietnam
	14 Buon Tua Srah	Under construction	Vietnam
	15 Duc Xuyen	Planning	Vietnam
	16 Lower Srepok	Planning	Cambodia

Source: Mekong River Committee (MRC), Feb. 2008



Figure 38: Hydropower project in the Lower Mekong Basin, Feb. 2008

The cumulative impacts from the above hydropower plants can be described in following parameters:

- **Impact on hydrology**

The flow regimes in both the Sesan and Srepok rivers will change as a result of the dam developments depending on the releases of water from each project. The main affect of the changing flows is downstream of the dam sites, especially in Cambodia. Fluctuation of water levels in the rivers is already happening with adverse affects on downstream ecology and people living near the rivers.

- *Mitigation measure*

Good collaboration, cooperation and coordination between the Vietnamese and Cambodian Governments and all implementing project owners to manage the flow regimes of the rivers to avoid any harmful affects or water right conflicts to downstream users.

- **Impacts on climate**

The impact on climate in the total catchments of both rivers may cause a moderate impact on the climate in the area due to the combination of reservoir areas. Forest loss and a big water surface in each reservoir of the projects will lead to a change in precipitation and temperature in the area. Less precipitation and a little higher temperature will occur in the region particularly on the Kontum Plateau in Vietnam and Northeast Plateau in Cambodia.

- *Mitigation measure*

Good collaboration with Forestry Administration and environmental agencies in both Vietnam and Cambodia, and other conservation/protection institutions in the area to control and manage the forests including replanting forest where possible to prevent climate change in the region.

- **Impacts on water quality**

The water quality in both rivers will deteriorate from year to year due to the construction and operation of all the above hydropower plants. High turbidity, grey algae, and scum are already occurring downstream of the existing dams.

- *Mitigation measure*

Good collaboration, cooperation and coordination between Vietnam and Cambodia Governments and all implementing project owners to monitor and manage the water quality to avoid adverse impacts to the downstream community water supply and aquatic fauna and flora.

- **Impacts on forest and wildlife habitat**

Many thousands of hectares of forest including evergreen forest, semi-evergreen forest, shrub land grassland in the both river basins will be damaged/destroyed due to

the construction of the hydropower projects in the region. Therefore the cumulative impact on the forest and wildlife habitat is very high.

➤ *Mitigation measure*

The cutting of forest shall be done within limits of the project sites only required for construction activities, and strictly ban construction workers and operation staff of the projects from entering into the forest for hunting or cutting forest.

Reforestation in open spaces nearby the project areas shall be considered in the project construction and operation stage. The companies shall consider also for contribution and strengthening the forest and wildlife habitat conservation programs in the region.

Good collaboration with Forestry Administration and Conservation Agencies in both Vietnam and Cambodia, and other conservation/protection institutions in the area to control and manage the forest.

▪ **Impacts on aquatic wildlife and fish**

Dam construction and operation along both rivers will have a very high impact on the aquatic wildlife and fisheries. Most of the fish yield and fish species in the both rivers are already decreasing year to year, and may be all fish species will disappear if good management or protection of fisheries does not occur.

The combination of the dams on the Sesan and Srepok rivers cause impacts on fish yield and fish species not only in these two rivers but also in the Mekong River downstream, the Tonle Sap Great Lake, and the Mekong delta.

➤ *Mitigation measure*

Establish large scale fish research centers for each project to try and produce the same fish species as present conditions provide in the area so fish numbers up and down stream of the project sites are the equivalent or more than existing yields. The introduction of exotic species that may prey on native species must be absolutely avoided.

All project owners shall cooperate with each other to share information and approaches on fishery programs particularly those that achieve good results and collaboration with fisheries administrative departments of both governments shall occur.

▪ **Impacts on downstream livelihoods**

All the hydropower plant projects on the Sesan and Srepok rivers are affecting livelihoods of the community downstream especially in Rattanakiri province in Cambodia. And the same issues will continue to the community downstream in Stung Treng province particularly when other dam projects in Vietnam (about 10 projects) and Cambodia (2-3 projects) are put into operation. The cumulative impacts on communities' livelihoods that are caused by the combination of hydropower plants in

both rivers include: health risks with poor water quality in rivers, significant decreasing fish production, destroying vegetable gardens on the river bank or shoreline of the river, and some time damaging of properties or killing animals and villagers because of changing flow regimes and sudden flooding caused by water releasing from dam in operation phase, forest areas used for NTFP collection.

➤ *Mitigation measure*

Good cooperation between both Vietnamese and Cambodia Governments to protect communities from any risks that are caused by the projects upstream. Each project owner will responsible for compensation in term of monetary and other livelihood support to the PAH and APs that cause by their project. The project owners could also collaborate with each other and develop joint cumulative impact compensation measures for people downstream of the dam sites who are affected by the changes caused by the dams.

6.3 Positive Environmental Impacts

▪ Electrical Power

The project will install electrical turbines with a capacity of 400 MW and produce a total energy output of 1953.9 GWh per year according to the feasibility report study. It will be able to respond to the Cambodian energy requirement in year 2018 (based on the master plan study 2006), or before then depending on the present feasibility study that is being carried out by EVN/PECC-1.

The electrical power from the Lower Sesan 2 HPP Project will provide a sustainable power supply at a cheaper price than presently which will be provided to all kinds of consumers for industrial, domestic, agricultural, and other uses in Cambodia and the remaining power will be sold to neighboring countries, especially Vietnam and Laos.

▪ Rural Infrastructures

The project will construct new access roads to the project site, a detour road and bridge on the eastern part of the Sesan river to connect the resettlement areas of the Srekor and Khsach Thmei villages. The project also will construct all community facilities in the resettlement areas including schools, pagodas, village roads, community wells to the equivalent number and standard or better than the ones which will be destroyed in the villages that will be flooded.

▪ Employment

The project will provide jobs to Cambodian workers especially to local people in the community during constructions stage. Based on the construction schedule the project will recruit the workers as following:

Construction year	2010	2011	2012	2013	2014
No of person	500	2000	3000	3000	1000

Several hundreds to several thousand Cambodian people will have the opportunity to work for the project in a 4-5 year construction period.

- **Tourism**

The natural resources in and around the project area are an abundance of forest and wildlife, and the improvement of infrastructures roads, culverts, bridges, and other infrastructure from the Lower Sesan 2 HPP Project may increase potential value of the ecotourism in Sesan district as well as in Stung Treng province. Moreover the project infrastructure itself also can contribute as a physical structure attracting local and international visitors to visit the hydropower plant and play and fishing in the reservoir.

- **Income**

The project will create income for the local and national people due to provision of jobs in the construction and operation stages. Also some people can make money from their own businesses that are related to the project activities, for example they can be a contractor for small scale work that the company may sub-contract to them. The people can also earn money from selling their products in the local market particularly to construction workers and tourism activities.

- **Economic**

The total investment cost of the project is about USD 840.7 million which is a big private contribution input for Cambodia development infrastructure to support the Country's economic growth in coming years. The output through an annual energy production of 1953.9 GWh will give a positive impact to the economic development of Cambodia through activities including industry/ handicraft, agriculture, and tourism in the area as well as in the whole country. Profit will also likely be made from the export of surplus electricity which could be substantial. The company will also pay taxes to the RGC through contract agreements and obligations according to the investment law of Cambodia.

6.4 Summary of key environmental impacts and mitigation measures

The environmental impacts as a result of the construction and operation of the dam will be substantial particularly on the ecology of the area and on the livelihoods of people who particularly live along the Sesan and Srepok Rivers both upstream and downstream of the proposed dam site.

The impacts will be principally:

- the flooding of land for the reservoir causing loss of some valuable habitat for rare and endangered animal species.
- the flooding also requires the establishment of at least four resettlement areas and relocation of around 5000 people which will impact on habitat through not only the development of the resettlement areas but also increasing access to some valuable habitat areas. The realignment of NR#78 will also create similar impacts.
- the construction of the dam itself which will make a barrier and stop the movement of migratory fish which currently move through the dam site providing significant fish supply to people living in villages both upstream and downstream of the dam site
- changes in both the quantity and quality of water downstream of the dam site particularly impacting on river ecology, people's health and areas of tourist interest
- traffic impacts particularly from construction traffic
- seismic risk to dam structure
- Risk with the remaining UXO and toxic chemical in the project area
- local climate change
- a major contribution to the cumulative impacts of dams in the river catchments which are already causing environmental problems in the catchment areas

The suggested mitigation measures are:

- Minimize the reservoir area as much as possible by reducing the height of the dam as much as possible
- Appropriately site the resettlement areas away from areas of important habitat
- Adequately compensate people along the rivers who will particularly suffer fish loss as a result of the dam on an annual basis. This may be done in terms of livelihood improvement initiatives.
- Strictly monitor both water quantity and quality from the dam to ensure sufficient quantity and quality of water to ensure downstream water users' health is not adversely affected and maintain the ecology of the river and provide compensation measures if the dam causes health/ecological affects as a result of poor water quality or quantity from the dam
- Ensure all traffic related to the project obey road rules and any damages to roads are repaired quickly
- Ensure the dam is built to withstand significant seismic shock so it does not collapse in the event of an earthquake.
- Ensure the earth work can be started after de-mining.
- Provide compensatory measures for tree loss and combating climate change by replanting trees equivalent in type and number to those lost
- Collaborate with other dam operators in the catchment to reduce and manage the dams' cumulative impacts.