

**(5) STUNG TRENG PROVINCE**

**a) General**

Through the map study, it was realized that Stung Treng Province had less potential of micro hydro because of rather flat geography. It was difficult to find potential site that had more than 10 m head like in Kratie Province. Major potential site could be found on the left bank (eastern side) of Mekong River. Right bank (western side) of Mekong River was not surveyed due to less potential and poor accessibility.

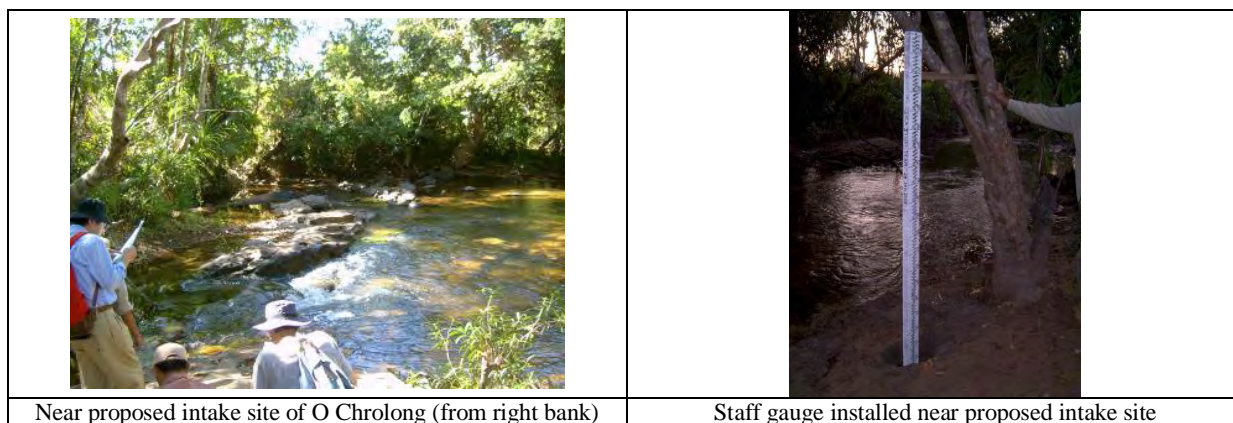
**b) Involvement of DIME**

On January 18, the Study Team visited Stung Treng DIME office to check questionnaire sheets before the Team moved to Ratanak Kiri Province. On January 22, the Study Team visited DIME office again to check and discuss about potential sites. From January 22 to 23, the Study Team, MIME and DIME jointly conducted site survey in Stung Treng. Mr. Nin Soksdai and Mr. Shythat of DIME Stung Treng assisted the site survey.

**c) Site Survey**


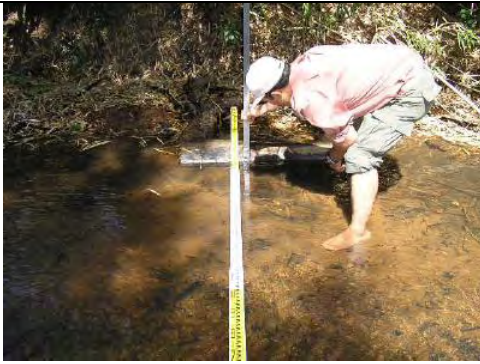
1) O Chrolong (date of survey: January 23 and 24, 2005)

This scheme has a relatively large catchment area of about 128 km<sup>2</sup>. The Study Team conducted discharge measurement and leveling of the scheme on January 23, 2005. Discharge was measured at 0.45 m<sup>3</sup>/sec near intake site, which corresponds to 3.5 liter/sec/km<sup>2</sup>. Taking into account of relatively low rainfall in Stung Treng Province compared with other provinces, this specific discharge is judged dependable. Leveling result shows that the head is about 5m. Though the head is small, considering good amount of discharge, the Study Team installed staff gauge for water level observation. After installation of the gauge, with assistance of DIME, the commune chief was nominated as a gauge reader. Mr. San Socheat of MIME instructed how to read the staff gauge and record on the sheet. Gauge reading was started from the end of January 2005.





2) O Chrop (date of survey: January 24, 2005)

O Chrop River has a very gentle slope with little discharge. As seen in the photographs below, many leaves stack on the surface of the river, proving that the flow is stagnant. On the other hand, judging from riverbank erosion status and water marks, flood water level is supposed to be as high as 4 to 5 m from the dry season water level.

	
<p>O Chrop River looking downstream. Due to slow velocity, many leaves stack on the water surface.</p>	<p>Water depth measurement by MIME staff prior to discharge measurement</p>

3) O Baign Kla (date of survey: January 24, 2005)

O Baign Kla means Tiger Shooting in Khmer Language. This scheme was identified through map study at 1:50,000 scale. The Study Team conducted discharge measurement at about 2 km upstream of its confluence with Mekong River. Discharge was measured at 0.21 m<sup>3</sup>/sec. Due to limit of time and bushy land and dense forest, leveling could not be made. By eye observation, at least 5 m of height can be considered for this scheme.

	
<p>Discharge measurement on O Baign Kla River Q = 0.21 m<sup>3</sup>/sec, river width = 6 ~ 7 m</p>	<p>DIME staff Mr. Shythat indicating flood water level about 0.7m higher than the present water level according to the village people</p>

**(6) RATANAK KIRI PROVINCE**

**a) General**

Provincial capital town Ban Lung is located on a plateau in the center of Ratanak Kiri Province. Several rivers are originated from this plateau. Ban Lung town is being developed as a tourism center.





**b) Involvement of DIME**

On January 18, 2005, after arrival at Ban Lung, the Study Team visited DIME Ratanak Kiri for a meeting and exchanged information with DIME staff. Mr. Hem Van Thron (Director) and Mr. Hun Bunthan (Deputy Director) and some other staff joined the meeting to get basic information on existing schemes and potential micro hydro.

**c) Site Survey**





1) Existing O Chum Hydropower Station (date of survey: January 18, 2005)

O Chum Hydropower Scheme with DIME and EdC. O Chum Hydropower Scheme consists of Ochum Reservoir and an existing hydropower station (O Chum II hydropower station) with 1 MW installed capacity. O Chum hydropower scheme is located northwest of Ban Lung. It took about 10 to 15 minutes by car from Ban Lung Town. O Chum hydropower scheme started construction in December 1990 with fund from Cambodian Government. Construction completed in 1993 and operation started. O Chum reservoir is an earth-fill dam having crest length of about 700 m. Stored water in O Chum reservoir is released for power generation at O Chum II hydropower station.

	
<p>Existing O Chum reservoir and its intake tower</p>	<p>Intake weir of existing O Chum II power station</p>
	
<p>Existing O Chum II power station tailrace</p>	<p>2 x Francis turbines 500 kW</p>



2) O Kachang scheme (date of survey: January 19, 2005)

O Kachang waterfall is located southwest of Ban Lung. It takes about 20 to 30 minutes by car to get to the site. The study team conducted discharge measurement at about 1 km upstream of the waterfall. Leveling was also done to survey the head. Photographs of field survey are shown below:

	
<p>O Kachang waterfall (height: 13m)</p>	<p>Discharge measurement upstream of O Kachang waterfall (river width = 6 to 7 m, Q=0.3 m<sup>3</sup>/sec)</p>
	
<p>Checking of GPS coordinates at power house site of O Kachang scheme (right bank)</p>	<p>Checking of flood water level indicated by DIME staff</p>



3) O Katieng (date of survey: January 19, 2005)

O Katieng waterfall is located about 3 km downstream of O Kachang Waterfall. The Study Team conducted discharge measurement and leveling.

	
<p>O Katieng Waterfall (height: 14m)</p>	<p>From O Katieng Waterfall looking upstream</p>

4) O Katieng Downstream (date of survey: January 19 and 21, 2005)









Downstream of O Katieng waterfall, there continues several rapids of about 40 m in total height over the 2 km long river reach. Leveling was made to check the head available for the scheme.

	
<p>Leveling works from O Katieng Waterfall to O Katieng Downstream Scheme - Joint survey of MIME/DIME/JST</p>	<p>Continuous rapid of O Katieng Downstream Scheme (looking upstream)</p>

5) Bay Srok (date of survey: January 20 and 22, 2005)









Bay Srok scheme is located about 25 km southeast of Ban Lung. The scheme was identified through Meritec Study. The scheme is located on O Sien Ler River. Sometimes the scheme is called as “O Sien Ler scheme” or “Seven Cascade scheme” as there are seven cascades of small waterfalls. The Study Team conducted discharge measurement and leveling.

There continues very flat land of more than 30 m in width on the right bank of the river, which provides good route location for headrace channel and head tank. As this location has high potential, the Study Team installed staff gauge for water level observation. At the same time, with help of DIME Director, the Study Team recruited a gauge reader and instructed him how to read and record.

	
<p>Bay Srok scheme on O Sien Ler River (looking upstream)</p>	<p>Intake site (from downstream)</p>
	
<p>Looking right bank, head tank site (near the car)</p>	<p>From right bank looking down O Sien Ler River along proposed penstock route (head is around 30 m)</p>
	
<p>Installed staff gauge near intake site (on the right bank)</p>	<p>Instruction of gauge reading by Mr. Socheat (MIME, left)</p>
	
<p>Center of Bay Srok village with mini-grid distribution line powered by diesel generator</p>	<p>Television set sold in a shop of Bay Srok village</p>

6) O Pyol (date of survey: January 21, 2005)

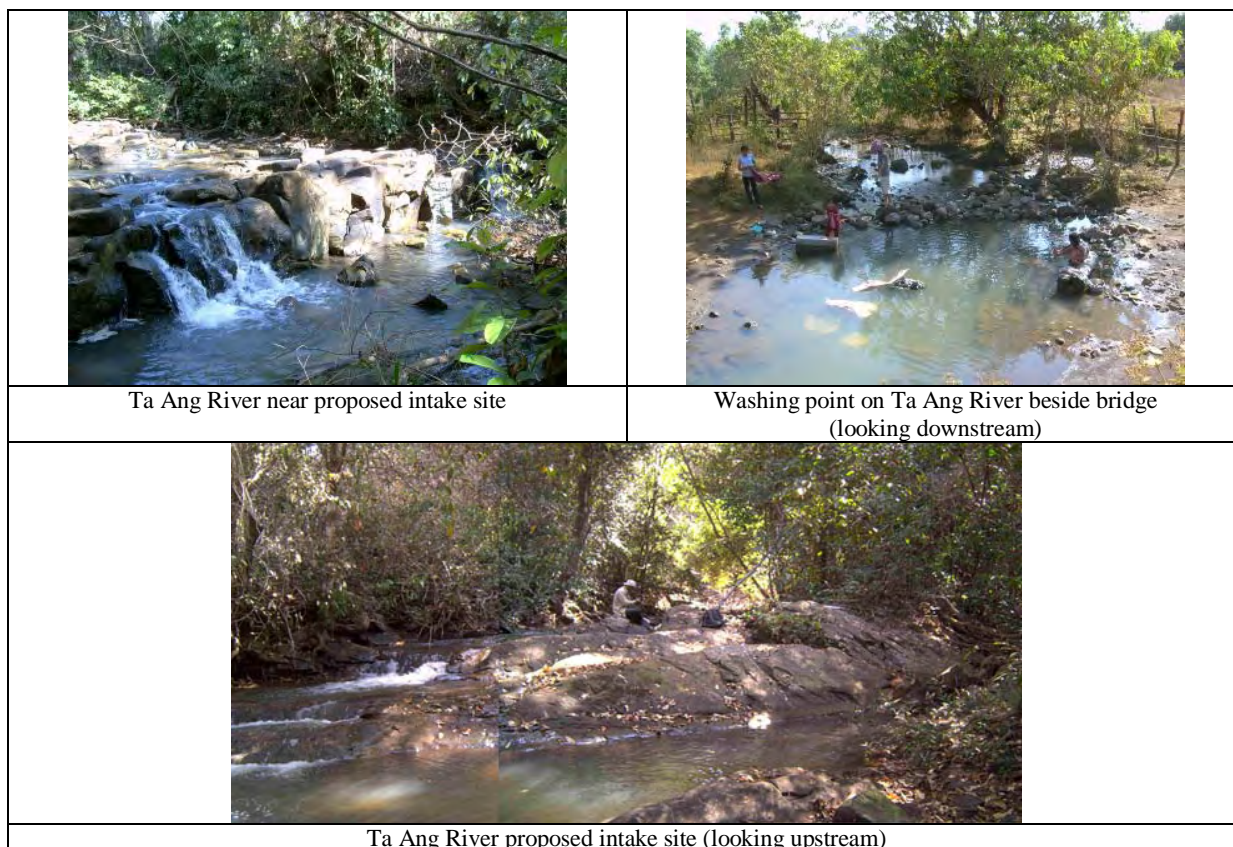
O Pyol scheme is located on tributary of Se San River. From Ban Lung, it takes about two hours by car to reach the Se San River crossing point. After crossing the river by small boat, the road was only accessible by motor bike. The Study Team headed by T. Okamura together with other three members conducted field survey including discharge measurement and leveling.

	
<p>Access road to O Pyol Site</p>	<p>Village of Kachut II, 44 families</p>
	
<p>Only one diesel generator in the Kachut II Village</p>	<p>Discharge measurement upstream of O Pyol waterfall</p>
	
<p>Near proposed intake site, river width is 4 to 5 m, bedrock exposed over the river width</p>	<p>O Pyol waterfall from downstream (height: 13 m)</p>
	
<p>Leveling works at the bottom of waterfall</p>	<p>Ferry boat crossing Se San River (river width =about 330m)</p>

7) Ta Ang (date of survey: January 22, 2005)

Ta Ang scheme is located about 15 km south-west of Ban Lung. This Scheme was proposed by Meritec Study. Mr. Kawato of the Study Team and Mr. Hun Bunthan (Deputy Director of DIME Ratanak Kiri) conducted field survey, consisting of discharge measurement and leveling.

The discharge at 40m upstream of the intake site was measured at 0.07 m<sup>3</sup>/s. Due to limit of time leveling was conducted from intake site to approximately 250m downstream, almost middle of intake and powerhouse sites. The measured head by leveling was 10m.



**(7) MONDUL KIRI PROVINCE**

**a) General**

Through map study, Mondul Kiri Province is found to be one of the most prospective provinces blessed with micro hydro potential. In Senmonorom town (provincial capital), interviews were made to DIME and Seila Program to get information on potential sites and local conditions in the province.

**b) Involvement of DIME**

On January 26, 2005, the Study Team visited DIME Mondul Kiri Office. After a short meeting with DIME Director Mr. Kung Piset, one of their staff Mr. Sen guided the Study Team for two full days. For the

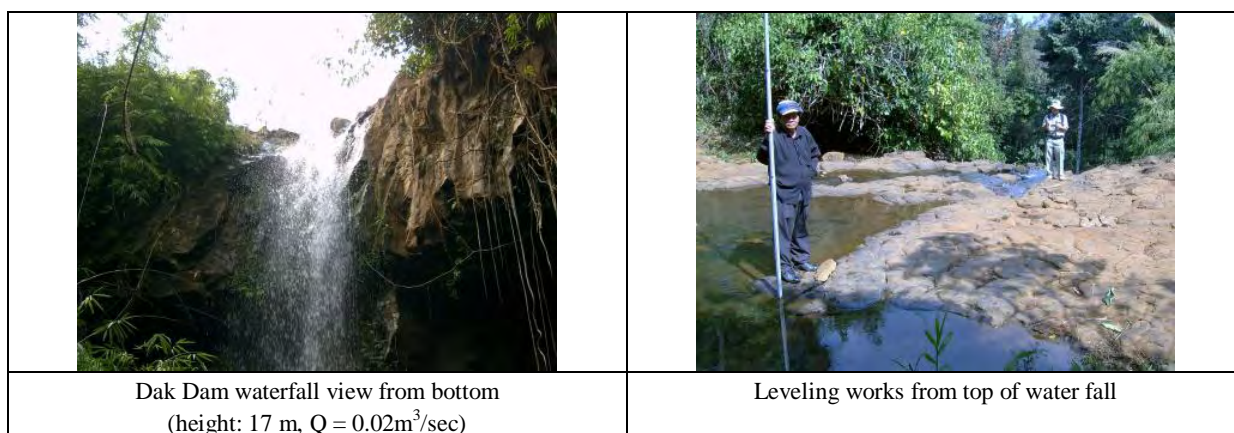


first day, the Study Team conducted site survey to O Dak Dam Scheme about 15 km southeast of Senmonorom town, and several existing schemes in Senmonorom town. For the second day, site survey was conducted on Bu Sra waterfall and its nearby villages and O Phlai schemes.

**c) Site Survey**

1) O Dak Dam (date of survey: January 26, 2005)

After getting information from DIME and Seila Program, the Study Team visited O Dak Dam scheme located about 15 km southeast of Senmonorom town. There was a waterfall with a small discharge having catchment area of about 4 km<sup>2</sup>. Discharge measurement showed that discharge was 0.02 m<sup>3</sup>/sec. After discharge measurement, leveling was done along right bank of the waterfall. Height difference was 17 m and estimated dry season power output is 2.3 kW.







2) Bu Sra (date of survey: January 27, 2005)

Road between Senmonorom town and Bu Sra waterfall was used to be a terrible one, but it is now being improved by a private company as part of tourism development. It took about one and half hour by 4WD car to get to Bu Sra waterfall. Bu Sra waterfall consists of 2 steps of waterfall, of which the first one is 23 m and the second one is 42 m in height. Discharge was measured in a small stream between the first and the second waterfall, to be 0.15 m<sup>3</sup>/sec. According to DIME staff Mr. Se, there is one more step of waterfall but the location is several km downstream of the second waterfall.

By harnessing the 65m head and 0.15 m<sup>3</sup>/sec discharge, 67 kW power generation may be possible even in the dry season. However, Bu Sra waterfall is also a very important tourism resource. Therefore development using all the water would affect the tourism resources.



	
<p>Road between Senmonorom and Bu Sra waterfall being improved by private company</p>	<p>Bu Sra waterfall, the first waterfall of 23 m high</p>
	
<p>Discharge measurement in between the first and second waterfall, <math>Q = 0.15 \text{ m}^3/\text{sec}</math></p>	<p>Bu Sra waterfall, the second waterfall of 42 m high</p>

After site survey of the waterfalls, the Study Team conducted village survey in Bu Sra commune. Interview was made to a restaurant owner and commune chief. According to the interview, the following information was given:

**Result of interview in Busra Commune**



Numbers of household: 765 (7 villages); Major crops: rice, coffee, pepper, pea

There are totally 27 own generators in 7 villages. One of them has 5 kW capacity, which consumes diesel fuel 4 liter/night (18:00 to 22:00). Considering diesel fuel price of 3,000 riel (0.75 \$)/ liter, it costs about 90\$ per month for fuel cost.

About 10% of commune people are using electricity by connecting neighboring own generator and pay some amount of money to the owner. Commune's request with priority is 1) road construction, 2) electricity, 3) hospital construction, 4) irrigation water supply for crops in dry season.

3) O Phlai (date of survey: January 27, 2005)

On the way from Senmonorom town to Bu Sra waterfall, the road crosses a big river called O Phlai. The river width is about 50 m where the road crosses the river with 0.1 to 0.2 m depth. Due to limitation of time, only discharge measurement was conducted. The result was  $0.33 \text{ m}^3/\text{sec}$ . The result is far better than that of Bu Sra. From map study, there are two locations with around 20 m head. Though further leveling survey is necessary to confirm the head, approximately 90 kW each is possible to develop. Generated electricity can be sent to Bu Sra commune and nearby villages.

	
<p>Heavy equipment for road improvement crossing O Phlai River (looking downstream)</p>	<p>Discharge measurement was made at deep pool part of O Phlai River by DIME staff Mr. Se, <math>Q = 0.33 \text{ m}^3/\text{sec}</math></p>

## (8) KOH KONG PROVINCE

### a) General

Koh Kong province has a lot of hydropower potential sites in multiple scales. Considering the scarcity of population, it is essential to identify micro hydro site combined with villages nearby, that is demand - supply balance. With inputs from the Study Team's GIS Expert, the Study Team checked distribution of villages and number of households. As a result, the Study Team selected Thmabang District of Koh Kong Province as a target for site survey. Koh Kong Province is located at southwestern edge of Cambodia. It takes one full day to get to Koh Kong (provincial town) from Phnom Penh. It is necessary to cross 4 rivers by ferry boat. If the timing of getting on ferry is good, it only takes 5 hours from Phnom Penh to Koh Kong.

### b) Involvement of DIME

On February 10, late in the afternoon, the Study Team visited Koh Kong DIME office to have some basic information on potential sites in the province. Mr. Tay Sareun (Deputy Director) and Mr. Say Hay (Chief of staff) welcomed the Study Team and explained missions of DIME.





Site Survey started from February 11. Mr. Say Hay (DIME) and Mr. Veun Chhin (Deputy Governor of Thmabang District) fully assisted the Study Team for site survey.

### c) Site Survey

#### 1) Tatai downstream (date of survey: February 11 and 14, 2005)



From provincial town Koh Kong, it is necessary to cross Tatai River once near its river mouth by ferry boat to get to Kokir Chrum village near Tatai downstream scheme. There is a waterfall in Tatai River about 30 minutes walk from Kokir Chrum village. The Study Team conducted discharge measurement, leveling, and site check from intake site to powerhouse site.

Discharge was measured at  $0.28 \text{ m}^3/\text{sec}$  and head between intake and power house was 32 m. With the features, it may be possible to generate 62 kW even in the dry season. With this capacity it is possible to distribute electricity to more than 600 households.

	
<p>Waterfall at Tatai downstream scheme</p>	<p>Technology transfer from MIME staff to DIME staff on how to measure height using clinometer and distance meter</p>
	
<p>Leveling works between intake and waterfall</p>	<p>Power House site (near big rock at the left side)</p>

2) Tatai upstream (date of survey: February 12, 2005)

Tatai River upstream scheme is located about 5 km from Kandal village. The first one km of the road was accessible by car, but due to road collapse by erosion, the rest of the road was by walk. As a result of discharge measurement and leveling the head was measured at 28m but discharge was only 0.03 m<sup>3</sup>/sec. Possible power generation is only 6 kW in the dry season.


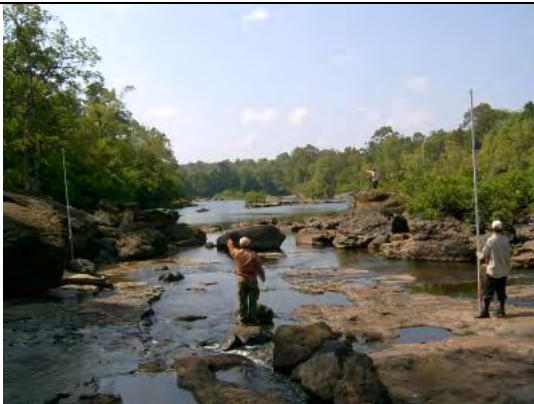


	
<p>Leveling works at Tatai upstream scheme (about 100 m downstream of proposed intake site, looking downstream)</p>	<p>Continuous steep riverbed of Tatai upstream scheme, but discharge was only 0.03 m<sup>3</sup>/sec.</p>

3) Stung Chhay Areng (date of survey: February 13, 2005)

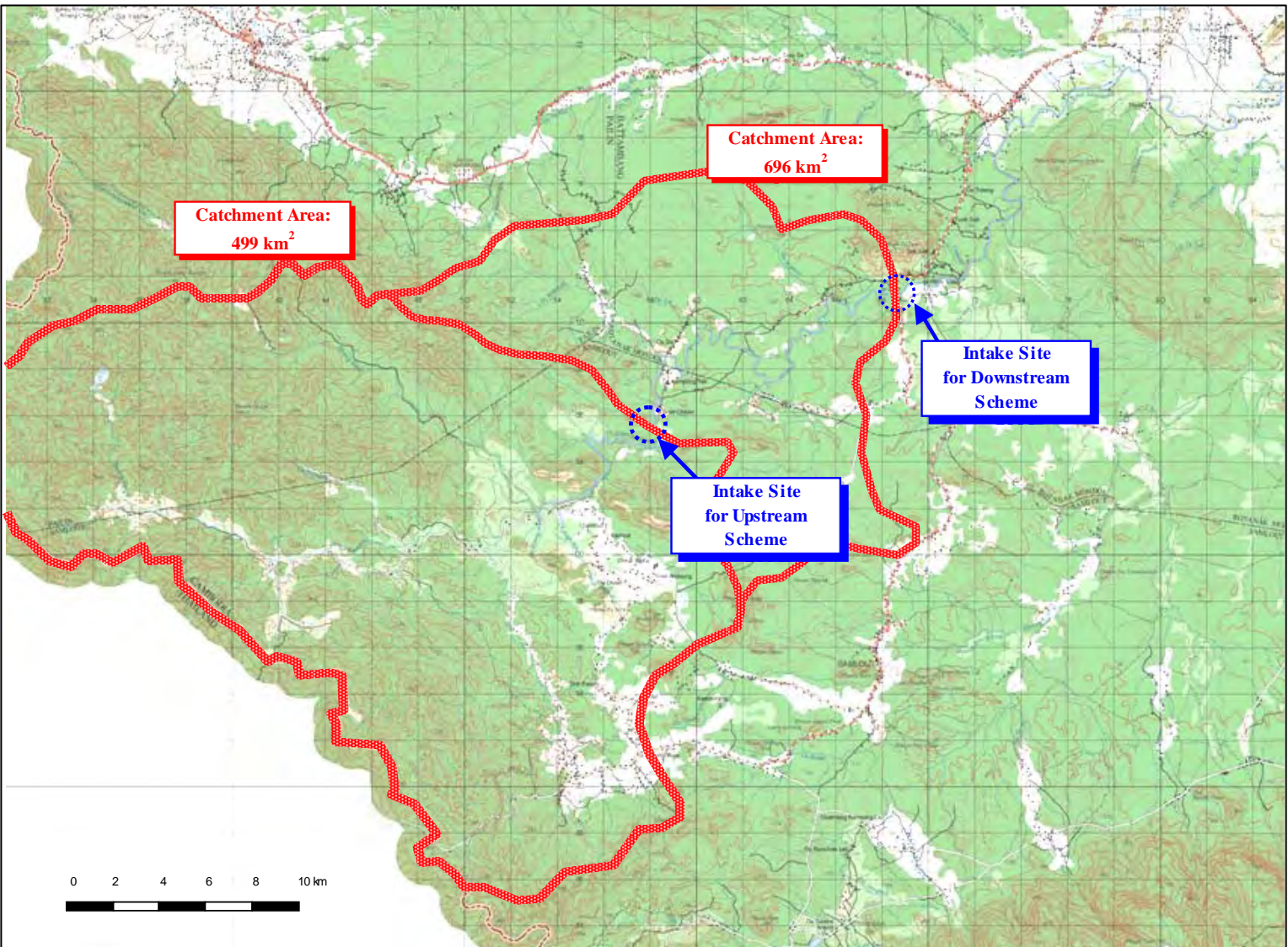
After staying one night in Kokir Chrum Village, the Study Team conducted site survey to Chhay Areng scheme. Due to collapse of the road between Kokir Chrum and Chhay Areng, access was only possible by motor bike. It took about two hours from Kokir Chrum to Chhay Areng. On the way, the Study Team found several parts of the road improved using national budget (Seila Program).

On Chhay Areng River, discharge measurement and leveling were conducted. Though catchment area of Chhay Areng at measured point was 890 km<sup>2</sup>, discharge was only 0.37 m<sup>3</sup>/sec, which corresponds to 0.4 liter/sec/km<sup>2</sup>. The head was measured at 5.6 m. With these features, considering flood water level around power house, only 4 to 9 kW is possible to generate.

There are some other potentials identified by map study. These sites were not visited due to time limit and the fact that during night time, there is a danger of wild animals like tiger or crocodile attacking people. Therefore the Study Team decided to leave Chhay Areng River around 3 o'clock to return to Kokir Chrum village before dark.

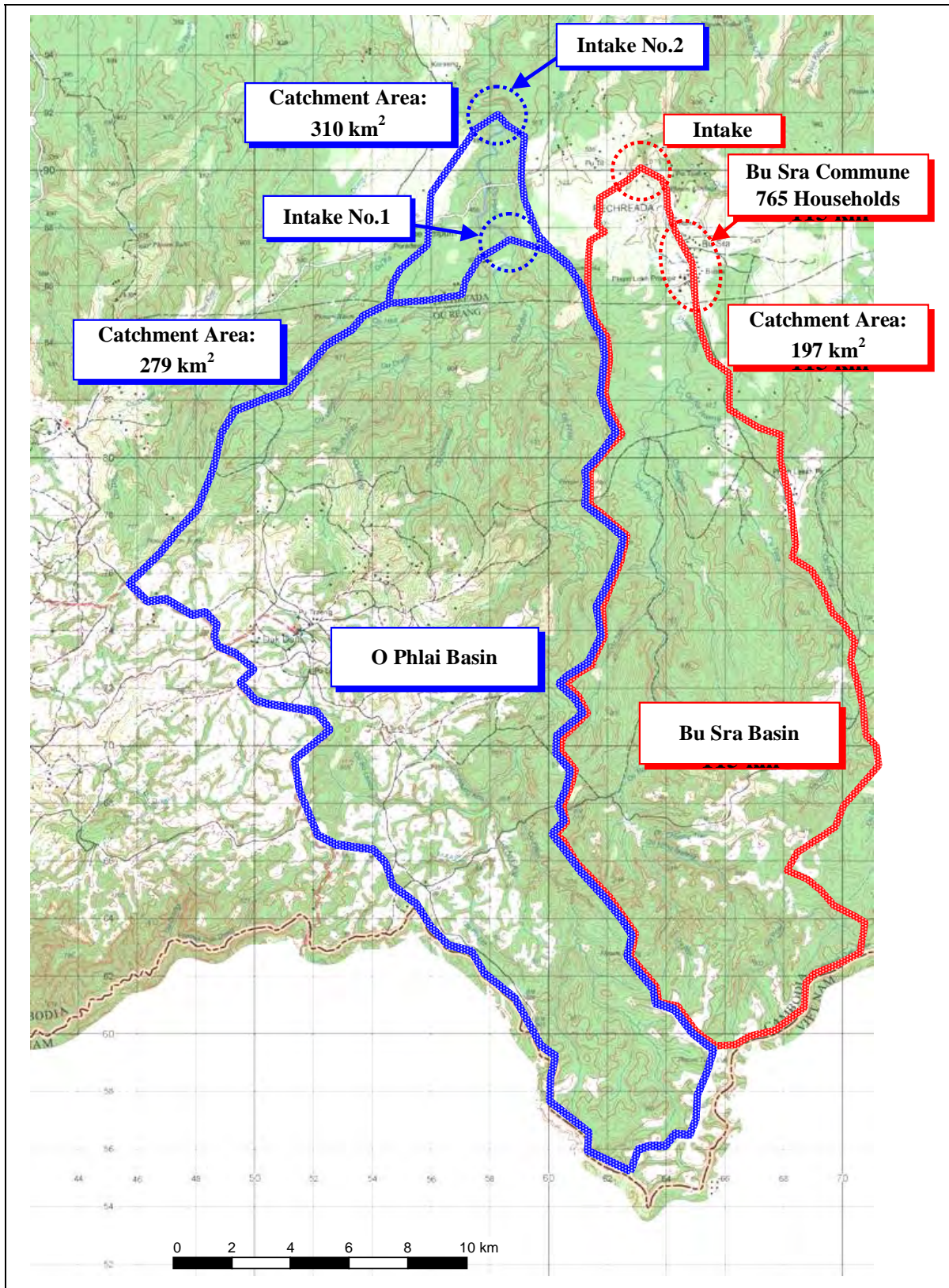
	
<p>Road improvement works by Seila Program (on the way from Kokri Chrum village to Chhay Areng River)</p>	<p>Leveling works at Chhay Areng river (view from upstream)</p>
	
<p>Discharge measurement work by MIME staff on Chhay Areng River</p>	<p>A small waterfall about 3 m high on Chhay Areng River</p>

### 3. PROJECT MAP OF PROSPECTIVE MICRO HYDRO SCHEME



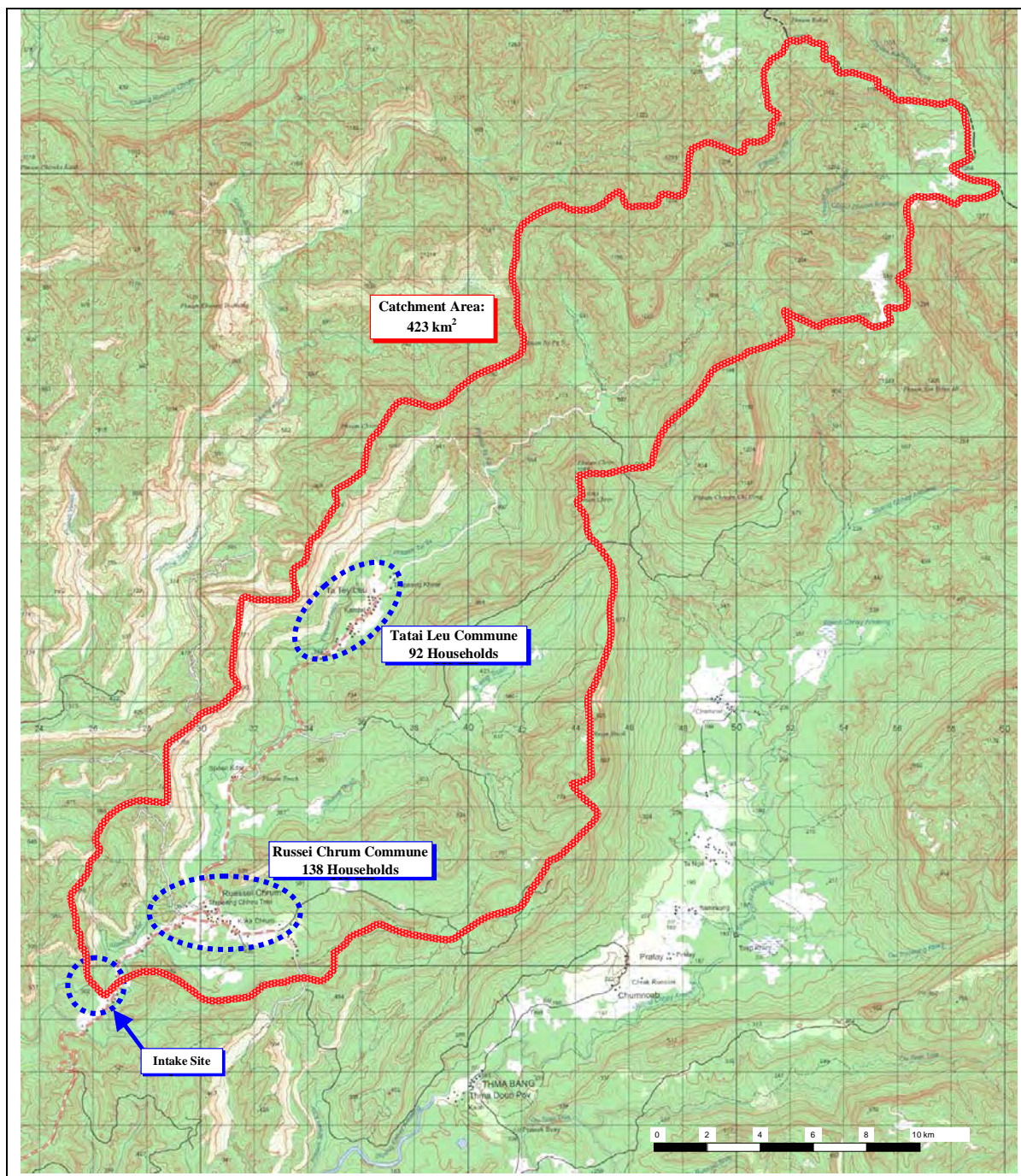
Source: JICA Study Team

Figure AP-A.3.1 Project Map of Prospective Micro Hydro Scheme Stung Sangke Upstream and Downstream Schemes (Battambang Province)



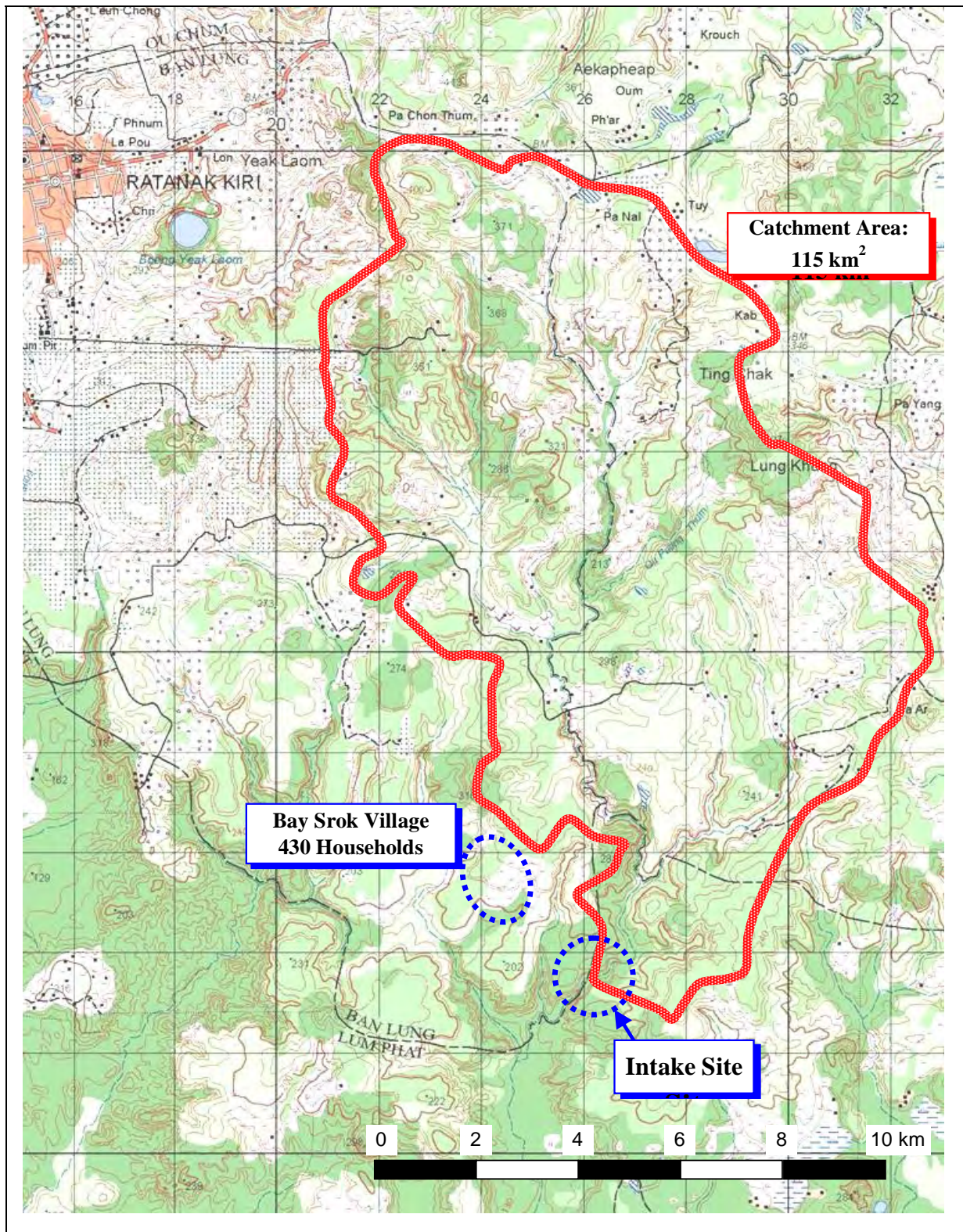
Source: JICA Study Team

**Figure AP-A.3.2 Project Map of Prospective Micro Hydro Scheme Bu Sra & O Phlai Schemes (Mondul Kiri Province)**



Source: JICA Study Team

**Figure AP-A.3.3 Project Map of Prospective Micro Hydro Scheme Tantai Downstream Scheme (Koh Kong Province)**



Source: JICA Study Team

**Figure AP-A.3.4 Project Map of Prospective Micro Hydro Scheme Bay Srok Scheme (Ratanak Kiri Province)**