Economic Valuation Of Livelihood Income Losses And Other Tangible Downstream Impacts From The Yali Falls Dam To The Se San River Basin In Ratanakiri Province, Cambodia

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EXECUTIVE SUMMARY

The Yali Falls dam is located in Vietnam about 70 km from the Cambodian border. Since late 1996, the dam has severely affected the human livelihood systems of people living along the Se San River downstream of the dam. In four districts of Ratanakiri Province, Cambodia, changes in flow regimes and sudden flooding caused by dam water releases have caused at least 32 deaths due to drowning, ruined rice crops and vegetable gardens, reduced fish catches, and halted gold panning activity. In addition to these impacts, local people have lost fishing equipment, boats, livestock, housing, rice stocks, and other goods.

The purpose of this study is to develop monetary estimates of downstream impacts where possible. It is hoped that a better understanding of the economic values associated with downstream impacts can help to make the scale of losses clearer and inform future discussions about advocacy opportunities regarding the Yali Falls dam and the Se San River basin. This study relies significantly on the data and findings of a report by the Ratanakiri Fisheries Office, which through a rapid rural assessment approach collected information on a wide array of downstream impacts from the Yali Falls dam.[1] In order to quantify the losses described in the Ratanakiri Fisheries Office report, this study collected additional information on livelihood activities and market prices (including barter exchange). Key findings include:

- **Livelihood Income Impacts:** This study estimates that impacts from the dam to livelihood activities resulted in over $2.5 million in lost income in 1999 for 3,434 households in Ratanakiri. On average, livelihood income per household decreased from about $109 per month to $46 per month – a drop of 57 percent. It was not possible to estimate losses for years other than 1999 due to data limitations. However, accounts of flooding impacts in the area since 1996 suggest that annual losses in other years were significant and may have been similar to 1999. It is also important to emphasize that livelihood impacts from the dam may continue for many years in the future. Local people have few alternatives to pre-dam livelihood activities for earning income. Therefore, it is unlikely that local people can make up for much, if any, of lost livelihood income through alternative livelihood activities or other employment.

- **Other Tangible Losses:** This study estimates that local people experienced more than $800,000 in other tangible losses from 1996 to 1999, including lost fishing equipment, boats, livestock, housing, and rice stocks. Local people have faced the difficult situation of replacing these losses in order to earn livelihoods (e.g., replacing fishing equipment in order to fish) at the same time impacts from the dam have reduced their incomes by more than half.

- **Losses Not Quantified In This Study:** The dam has also caused important material and non-material impacts that cannot be quantified in this study either because of data and resource limitations, or because the valuation of such impacts is currently beyond economic methods or morally and ethically controversial. Non-quantified impacts include deaths and illnesses, other livelihood impacts (not addressed above), livestock losses due to suspected water quality problems, and natural resource impacts.

[1] The Fisheries Office, Ratanakiri Province (in cooperation with The Non-Timber Forest Products (NTFP) Project, Ratanakiri Province), *A Study of the Downstream Impacts of the Yali Falls Dam in the Se San River Basin in Ratanakiri Province, Northeast Cambodia*, May 29, 2000.

As a result of livelihood income impacts and other losses caused by the dam, indebtedness and migration appear to have increased significantly in the area. Village leaders reported that many families have exhausted their savings and begun borrowing to meet their needs over the past two years (at interest rates of 60-100 percent per year). Thus far, migration has occurred primarily from Andong Meas district, where at least four villages (and parts of four other villages) have left the area in search of more sustainable livelihoods in upland areas. Villagers in Veun Say district reported that no villages have migrated yet, but many families have sent their older children to Banlung (capital of Ratanakiri) in search of work.

Many of the villagers in Ratanakiri were living at subsistence levels prior to experiencing losses of more than half of their livelihood incomes due to the dam. In the future they will continue to face the prospect of significant losses. With few alternatives to pre-dam livelihood activities, it is unclear how long villagers can withstand the high level of losses and remain living along the Se San River. Unless actions are taken to significantly mitigate downstream impacts from the dam, or to remove the dam and return the Se San River to its natural state, the trend toward indebtedness and migration from the area will increase in the future.

Finally, it is important to point out that the estimates of livelihood income impacts and other losses developed in this study are only for 3,434 households in Ratanakiri Province, Cambodia. Estimates of losses caused by the dam would likely rise dramatically if *all* downstream impacts were assessed, including impacts in Vietnam along the 70 km of the Se San River lying between the dam and the Cambodian border, and impacts in Cambodia downstream of Ratanakiri in Stung Treng Province.

TABLE OF CONTENTS

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I also extend my appreciation to all the people involved with developing the Ratanakiri Province Fisheries Office report, *A Study of Downstream Impacts of the Yali Falls Dam in the Se San River Basin in Ratanakiri Province, Northeast Cambodia*, May 29, 2000. The information on downstream impacts presented in their report served as the foundation for developing economic estimates in this study. In addition, I am grateful to the many people who volunteered their time to review drafts of this study and provide useful and insightful comments. Responsibility for any remaining errors rests with me alone.

ABOUT THE AUTHOR

Bruce McKenney is an independent consultant based in Phnom Penh, Cambodia with eight years of experience in economic and environmental policy analysis. Clients for his work include the Economy and Environment Program for Southeast Asia, World Wide Fund for Nature, U.S. Environmental Protection Agency, Oxfam Great Britain – Cambodia Land Study Project, and Oxfam America. Recent experience analyzing the economic, environmental, and social impacts of dams includes: (1) developing guidance on best practices for financial, economic, and distributional analysis of dams for the World Commission on Dams; (2) developing an alternative economic methodology for evaluating hydropower relicensing actions that better accounts for non-power benefits of rivers for the U.S. Fish and Wildlife Service; and (3) profiling economic activity dependent on the Upper Mississippi River for the U.S. Fish and Wildlife Service. Mr. McKenney holds a B.A. with Honors in Political Science from Brown University and a Master in Public Policy degree from the Kennedy School of Government at Harvard University.

1. INTRODUCTION

The Yali Falls dam project on the Se San River has resulted in serious downstream socio-economic and environmental impacts due to dramatic changes in annual natural flows and sudden flooding caused by irregular, large-scale releases of water from the dam's reservoir. It also appears that water quality downstream of the dam has worsened considerably, though this has not yet been confirmed by water quality sampling.

The thousands of indigenous people living along the Se San River downstream from the Yali Falls dam have experienced significant losses since 1996, when construction of the dam first required manipulation of the Se San River's flows. Although the impacts to indigenous people living along the Se San River within Vietnam have not been assessed at present, a recent study prepared by the Fisheries Office in Ratanakiri Province, Cambodia (in cooperation with The Non-Timber Forest Products Project) provides a detailed account of the impacts to indigenous people living along the Se San River in Ratanakiri Province, Cambodia.[2] The community-based study, which used methods to understand how impacts may have been experienced differentially by gender, surveyed 59 villages in 15 communes of four districts (see Appendix 1 for maps). Findings suggest that the livelihoods of about 3,434 households (roughly 20,000 people) in this area have been severely affected by the dam.

The Fisheries Office report provides an extensive description of the impacts from the Yali Falls dam that is vital to understanding the wide range of losses experienced by indigenous people living along the Se San River in Ratanakiri Province. It is not the purpose of this study to describe these impacts again. The objective of this study is to develop monetary estimates of these impacts where possible. In particular, this study focuses on developing monetary estimates for two types of impacts: (1) livelihood income impacts – including impacts to rice farming, fishing, vegetable gardening, and gold panning; and (2) other tangible losses – such as lost livestock, fishing equipment and boats, and housing. It is hoped that a better understanding of the economic values associated with these losses can help to make the scale of losses clearer and inform future discussions about advocacy opportunities regarding the Yali Falls dam and the Se San River basin.

It is important to acknowledge upfront that downstream communities are suffering in both material and non-material ways, some of which are difficult or impossible to capture in economic terms. For example, the socio-cultural and psychological effects associated with food insecurity, migration, and community fragmentation are beyond current economic valuation methods. Likewise, no attempt is made to place a value on the numerous lives lost due to the dam because of the controversial moral dimensions involved with such valuation.

This study focuses on the valuation of damages caused by the annual flow changes and sudden flooding from Yali Falls dam water releases, not on suspected water quality problems from dam water releases. No attempt is made to quantify damages caused by suspected water quality problems because water quality testing has not yet been undertaken to confirm water quality problems and more information is needed on the relationship between water quality problems and illnesses and deaths. Moreover, if water quality problems are the cause of 952 deaths and numerous illnesses as estimated in the Fisheries Office study, economic estimates of lost livestock and other impacts would be insignificant compared to the human tragedy.

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[2] The Fisheries Office, Ratanakiri Province (in cooperation with The Non-Timber Forest Products (NTFP) Project, Ratanakiri Province), *A Study of the Downstream Impacts of the Yali Falls Dam in the Se San River Basin in Ratanakiri Province, Northeast Cambodia*, May 29, 2000.

Exhibit 1-1 provides a summary of key impacts caused by the Yali Falls dam based on the Fisheries Office report and research conducted for this study. Impacts are divided into two categories – those quantified in this study and those not quantified for reasons noted above.

Exhibit 1-1
KEY IMPACTS CAUSED BY THE YALI FALLS DAM

Impacts Quantified By This Study	
Impact Category	**Losses for 3,434 households in 59 villages**
Livelihood Impacts Caused By Annual Flow Changes and Sudden Flooding From Dam Water Releases (1999)	2,398.5 ha of paddy and swidden rice
	86 percent reduction in fish catch*
	54 percent reduction in vegetable garden (and tobacco) yield
	100 percent loss of gold panning revenue
Livestock Deaths Caused By Sudden Flooding From Dam Water Releases (1996-1999)	609 buffaloes
	322 cows
	2,293 pigs
	38,867 chickens
	3,559 ducks
Fishing Equipment and Boat Losses Caused By Sudden Flooding From Dam Water Releases (1996-1999)	9,563 gillnets
	129 castnets
	304,006 hooks
	24,192 small basket traps
	5,606 large basket traps
	2,187 funnel traps
	5,247 falling-door traps
	1,173 dugout boats – paddle
	18 engine/motor boats
	1 electric generator
Housing Losses Caused By Sudden Flooding From Dam Water Releases (1996-1999)	37 houses washed away
	Items/possessions in 37 houses washed away
Rice Stock Losses Caused By Sudden Flooding From Dam Water Releases (1996-1999)	44,708 kilos of rice stocks
Impacts Not Quantified In This Study	
Impact Category	**Losses for 3,434 households in 59 villages**
Deaths and Illness (1996-1999)	32 deaths due to sudden flooding from dam releases
	952 deaths due to suspected water quality problems
	Unknown number of illnesses
Other Livelihood Impacts	Food insecurity, malnutrition, and increased vulnerability
	Indebtedness, migration, and community fragmentation
	Lost wild vegetable/plant collection, wildlife hunting
	Potential future loss of livelihood/cultural knowledge base
	Increased domestic conflicts and village disputes
	Reduced river crossing and boat travel due to dangers
	Alternative drinking water sources, reduced bathing/swimming
Livestock Deaths Due To Suspected Water Quality Problems (1996-1999)	4,909 buffaloes
	2,238 cows
	7,854 pigs
	147,709 chickens
	1,670 ducks
	2,448 dogs
Other Agriculture Losses	Agricultural tools (e.g., plows, shovels, hoes)
	Field houses and rice barns
Other Housing Losses	Housing construction materials and household items
Other Natural Resource Impacts	Loss of riverine vegetation, birds, reptiles, wild animals and aquatic life, riverbank erosion, and damage to habitat
	Increased exploitation of forest resources

*In addition to flow regime changes, fish catch impacts may result from water quality problems and other factors.
Source: Fisheries Office study and research conducted for this study

2. DATA SOURCES AND METHODOLOGY

This study estimates livelihood income losses and other tangible losses for 886 households in O'Yadao and Andong Meas districts and 2,548 households in Ta Veng and Veun Say districts – a total of 3,434 households in four districts. The study relies significantly on the data and findings of the Ratanakiri Province Fisheries Office study, which through a rapid rural assessment approach collected important information on a wide array of downstream impacts from the Yali Falls dam. In addition to describing key impacts to livelihoods, the Fisheries Office study provides data on the number of lost hectares of rice, livestock, fishing equipment and boats, and other goods. This information provides the foundation for developing economic estimates in this study.

Overview of Data Collection

In order to quantify losses in monetary terms, this study collected additional information on livelihood activities and market prices (including barter exchange). This information was collected through meetings held from October 9-13, 2000 in Ratanakiri Province with village leaders, villagers, market sellers, and NGO staff. Information collection was made possible by the facilitation and assistance of Hieu Luc of Oxfam America, Phouy Nyok, Chea Phalla, Dam Chanty, and Gordon Patterson of the Non-Timber Forest Products (NTFP) Project, and Say Leuan of the Ratanakiri Rural Development Office. The assistance of NTFP and Rural Development Office staff was especially important because of their previous experience working on the Fisheries Office study and their familiarity with livelihood issues.

Meetings held in support of data collection for this study are summarized below. At each meeting, information on livelihood activities and market prices was collected through open-ended discussions with participants. To help ensure the accuracy of information, data collected at each meeting was crosschecked against information collected from other meetings.

- October 9 – Meeting with NTFP staff and four village leaders (three from O'Yadao district and one from Veun Say district).

- October 10 – An all-day meeting with village leaders from 13 villages representing all four affected districts (three villages in O'Yadao district, five villages in Andong Meas district, two villages in Ta Veng district, and three villages in Veun Say district). Also in attendance was the Deputy Governor of Ta Veng district, Deputy Governor of Andong Meas district, staff from the Ratanakiri Province Fisheries Office, and staff from the Rural Development Office.

- October 11 – Visit to Veun Say market to discuss prices of various goods, livestock, and fishing equipment. Meeting with 20 villagers (11 men, 9 women) representing the villages of Kachon Leu, Kachon Kraom, and Pong in Veun Say district.

- October 12 – Meeting with 12 villagers (10 men, 2 women) representing the village of O'Kawp in Andong Meas district.

- October 13 – Meeting with the Governor of Ta Veng district and staff of NGOs, including CIDSE, Health Unlimited, ICC, and NTFP.

Information For Developing Estimates of Livelihood Income Impacts

For the 3,434 households studied, "income" is primarily derived from four livelihood activities – rice farming, fishing, vegetable gardening, and gold panning. For the purposes of this study, "income" is defined as the gain in consumption or money received from a livelihood activity. For example, if a family's rice yield has a market value of $500, then that is the family's income from rice farming whether they consume the rice or sell/exchange it.

Local people may also supplement their income through other activities, including wild vegetable/plant collection and wildlife hunting, though these activities appear to be less important pursuits in comparison to the four main livelihood activities noted above. Due to limited data and resources, this study does not estimate the income value of these supplemental activities or the impact of the dam upon them. Total livestock losses due to the dam, which could be considered lost livelihood income (i.e., livestock raising), are instead captured under "other tangible losses" (see below) because data are not available on an annual basis.

Exhibit 2-1 provides a general calendar-year schedule for rice farming, fishing, vegetable gardening, and gold panning activities before the impacts of the Yali Falls dam began. It should be noted that the time period and intensity of each livelihood activity varies somewhat across districts, villages, and ethnicities, and depending on the weather.[3] The purpose here is only to provide a simplified calendar year illustrating the seasonality of livelihood activities that can serve as a reference when considering livelihood impacts.

Exhibit 2-1
Calendar of Livelihood Activities For A Typical Year:
O'Yadao and Andong Meas Districts and Ta Veng and Veun Say Districts ("X" denotes times of activity)

District	Livelihood Activity	Month of the Year*											
		1	2	3	4	5	6	7	8	9	10	11	12
O'Yadao and Andong Meas Districts	Rice Farming**					X	X	X	X	X	X	X	
	Fishing – High Season			X	X								
	Vegetable Gardening	X	X	X	X					X	X	X	X
	Gold Panning		X	X	X								
Ta Veng and Veun Say Districts	Rice Farming					X	X	X	X	X	X	X	
	Fishing – High Seasons***				X	X					X	X	
	Vegetable Gardening	X	X	X	X					X	X	X	X
	Gold Panning		X	X	X								

* While seasonal patterns vary somewhat from year to year, the wet season typically takes place from about June to November (Month 6 to 11), and the dry season extends from about December to May (Month 12 to 5).
** Rice farming includes mixed rice/vegetable farming.
*** The vast majority of fish are caught during high seasons, though low levels of fishing continue year-round.

In collecting livelihood information, an effort was made to take into account the variance in livelihoods from one village to another, and from year to year. However, available resources did not allow for the collection of village-specific information for all 59 villages. Village leaders and NGO staff suggested that data generally be grouped according to typical activities in O'Yadao and Andong Meas districts (upstream areas) compared to Ta Veng and Veun Say districts (lowland areas).

[3] Ethnic groups in the four districts include Brao, Chinese, Jarai, Kachok, Kavet, Khmer, Kreung, Lao, Lun, and Tampuan.

While livelihood information could be improved with a more in-depth study of village-specific livelihoods, crosschecking of the data used to develop estimates in this study suggests that it is reasonably accurate across all villages, though activity may vary somewhat from village to village. Below is a description of key information for the development of pre-dam and post-dam (1999) livelihood income estimates.

Rice Farming Before The Dam

- On average, households in O'Yadao and Andong Meas districts grow one crop of rice on 1-2 hectares (ha) of land each year. Yields range from 2-4 tonnes per ha with an average yield of 3 tonnes per ha.

- On average, households in Ta Veng and Veun Say districts grow one crop of rice on 2-2.5 ha. Yields range from 2.4 tonnes to 3.6 tonnes per ha with an average yield of 3 tonnes per ha.

- All households in all four districts were assumed to grow rice. The average price of unmilled paddy rice is about 400-450 riels per kilo (3,900 riels = $1); unmilled swidden rice tends to have a somewhat lower price of about 350-400 riels per kilo. This study assumed a price of 400 riels for all unmilled rice.

Rice Farming After The Dam (1999)

- The Fisheries Office study reports the following losses of rice crops due to flooding from dam water releases in 1999:
  - O'Yadao and Andong Meas districts lost 192.5 ha of paddy rice and 42 ha of swidden rice.
  - Ta Veng and Veun Say districts lost 1,602.5 ha of paddy rice and 561.5 ha of swidden rice.

Fishing Before The Dam

- In O'Yadao and Andong Meas districts about 80 percent of households fished during the high season, which typically occurs during March-April. On average, each household caught from 250 to1,000 kilos of fish during the high season. People fish infrequently at other times of the year so the catch was assumed to be 0 to 100 kilos for the low season.

- In Ta Veng and Veun Say districts about 80 percent of households fished year-round, with high seasons typically occurring in April-May and October-November. The total catch from both high seasons was about 1,000 to1,200 kilos of fish per household. The catch from low season fishing was typically about 200-300 kilos per household.

- The price of fish prior to the dam was about 2,000 riels per kilo. Due to the severely reduced catch in recent years, the price of fish has increased to about 5,000 riels per kilo.

Fishing After The Dam (1999)

- Due to the lack of catch, lost equipment, and the dangers of sudden flooding, villagers in O'Yadao and Andong Meas districts report that they have stopped fishing on the Se San River. However, it is likely that some very low level subsistence fishing continues. Therefore, the 1999 fish catch is estimated to have been 0 to 100 kilos per household.

- In Ta Veng and Veun Say districts, the annual total fish catch has fallen to an average of about 200-300 kilos per household.

Vegetable Gardening Before The Dam

- The value of vegetables (including tobacco) to the average household in O'Yadao and Andong Meas districts was roughly 700,000-800,000 riels per year before the dam.[4] This estimate represents the total value of vegetables consumed, sold, or exchanged. Villagers suggest that all households did vegetable gardening before the dam.

- The value of vegetables to the average household in Ta Veng and Veun Say districts was roughly 300,000-400,000 riels per year before the dam. This estimate represents the total value of vegetables consumed, sold, or exchanged. Villagers report that all households did vegetable gardening before the dam.

Vegetable Gardening After The Dam (1999)

- Households that used to make vegetable gardens along the riverbanks of the Se San River after water levels began to drop at the end of the rainy season no longer do so because of the threat of floods from dry season water releases from the dam. Only limited vegetable gardening is now practiced by 803 households in O'Yadao and Andong Meas districts and 1,030 households in Ta Veng and Veun Say districts.

- Income earned from selling or exchanging vegetables dropped for affected households in O'Yadao and Andong Meas districts to about 100,000 riels per year. Likewise, income for affected households in Ta Veng and Veun Say decreased to about 50,000 riels per year.

Gold Panning Before The Dam

- The gold panning season typically used to take place for 2-4 months between January and April. About 70-100 percent of households in O'Yadao and Andong Meas districts panned for gold during this time for an average of 3-4 days per week. In comparison, only about 0-50% of households in Ta Veng and Veun Say districts used to pan for gold, typically for about 2-3 days per week.

- The average amount of gold panned per day was about 1-3 "houen" per household in O'Yadao and Andong Meas districts and about 1 houen per household in Ta Veng and Veun Say districts. On average, traders give 8,000 riels for one houen of unrefined gold.

[4] Throughout this study, "vegetable" gardening is defined broadly to include tobacco.

Gold Panning After The Dam (1999)

- All gold panning in the four districts has stopped. Villagers fear sudden floods and/or are discouraged from digging holes for gold because irregular water fluctuations often fill the holes, ruining their efforts.

Opportunity Cost of Labor

In estimating livelihood losses, it is necessary to consider the local people's "opportunity cost of labor" – the value of possible alternative productive employment or livelihood activities. That is, livelihood losses should be calculated *net* of alternative employment opportunities. For example, if a dam caused someone to lose a job paying $100 per month, but this person still had the opportunity to find a new job paying $80 per month, the loss to this person is equal to the net loss of $20 per month, not the gross loss of $100 per month.

Markets in Ratanakiri are not well developed and there are few if any employment or other product alternatives to traditional livelihoods. Moreover, due to the seasonality of livelihood activities, if one activity can no longer be pursued because of the dam, it is generally not possible to engage in another activity of significant productive value. For example, local people no longer pan for gold during the dry season, but this activity cannot be replaced by growing another crop of rice at this time because rice can only be grown during the rainy season (see above, Exhibit 2-1: Calendar of Livelihood Activities for a Typical Year). Due to the lack of alternative employment and productive activities, and the seasonality of traditional livelihoods, the opportunity cost of labor in the four districts is expected to be close to zero. For the purposes of this study, it is assumed to be zero.

Information for Developing Estimates of Other Tangible Losses

To estimate other tangible losses caused by the dam, such as lost livestock and fishing equipment, it was necessary to collect information on "replacement costs" (e.g., the market cost of replacing losses). Similar to the collection of livelihood information, an effort was made to take into account the potential variance in market prices from one village to another, and from season to season. However, village leaders suggested that prices are generally similar throughout the area, though some prices in O'Yadao and Andong Meas districts differ slightly from those in Ta Veng and Veun Say districts. Where prices differ significantly, these differences are noted.

Exhibit 2-2 shows price information for tangible losses estimated in this study. Price information was collected for high, low, and average market prices for a range of livestock and goods. In some cases, it was also necessary to collect information on the typical proportion of different types of livestock/equipment in the total population/equipment category. For example, the Fisheries Office study estimates that 322 cows were lost due to flooding, with no distinction made between male and female cows. Villagers value male and female cows differently, so in addition to data on market prices, information was collected to establish the typical proportion of male cows compared to female cows in the population. Village leaders suggest that about 75 percent of all cows are female. Therefore, when developing estimates, this study assumes 75 percent of the cows lost due to flooding were

female. A similar approach is taken for estimating values for some types of lost fishing equipment (e.g., gillnets and hooks).

Exhibit 2-2
List of Prices for Tangible Losses Estimated In This Study

LOSSES/ IMPACTS (Currency of Price)	Prices in O Yadao and Andong Meas Districts			Prices in Ta Veng and Veun Say Districts			As a Percentage of Total Population/ Equipment Category[a]
	Low	High	Best/ Average Estimate	Low	High	Best/ Average Estimate	
Lost Livestock							
Buffalo (chi)[b]	3.5	6.5	5	3	6	4.5	100%
Cows – Female (chi)	2	3.5	2.75	1.5	2.5	2	75%
Cows – Male (chi)	3.5	5	4.25	2	4	3	25%
Local Pigs[c] (riels)[d]	150,000	300,000	225,000	150,000	300,000	225,000	24%
Local Piglets (riels)	15,000	30,000	22,500	15,000	30,000	22,500	56%
"Chinese" Pigs (riels)	300,000	500,000	400,000	300,000	500,000	400,000	6%
"Chinese" Piglets (riels)	60,000	70,000	65,000	60,000	70,000	65,000	14%
Chickens (riels)			6,000			6,000	40%
Chicks--Baby (riels)			1,000			1,000	60%
Ducks (riels)			9,000			9,000	30%
Ducklings--Baby (riels)			1,000			1,000	70%
Lost Fishing Equipment							
Gillnets--Small (riels)	50,000	70,000	60,000	50,000	70,000	60,000	60%
Gillnets--Large (riels)	90,000	150,000	120,000	90,000	150,000	120,000	40%
Castnets (chi)	1	2	1.5	1	2	1.5	100%
Hooks--Small (riels)[e]			1,000			1,000	95%
Hooks--Big (riels)	3,000	5,000	4,000	3,000	5,000	4,000	4%
Hooks--Longlines (riels)	20,000	40,000	30,000	20,000	40,000	30,000	1%
Small Basket Traps (riels)			5,000			5,000	100%
Large Basket Traps (riels)	10,000	20,000	15,000	10,000	20,000	15,000	100%
Funnel Traps (riels)			60,000			60,000	100%
Falling Door Traps (riels)	30,000	60,000	45,000	30,000	60,000	45,000	100%
Canoe (riels)	150,000	250,000	200,000	150,000	250,000	200,000	100%
Motor Boat--5.5hp (riels)	300,000	480,000	390,000	300,000	480,000	390,000	50%
Motor Boat--8hp (riels)	500,000	700,000	600,000	500,000	700,000	600,000	50%
Lost Houses, Items In Houses, and Rice Stocks							
Houses Washed Away ($)[f]	400	800	600	400	800	600	100%
Items in Houses Lost ($)			800			800	100%
Rice Stocks (riels)[g]			400			400	100%

[a] For some loss categories, such as cows, pigs, and gillnets, more than one type of animal/net exists.
[b] 1 chi = $32
[c] 80% of all pigs are local pigs, 20% are "Chinese" pigs; 70% of all pigs are piglets, 30% are adults (60kg).
[d] 3,900 riels = $1
[e] Small hooks are sold at 30,000 riels for 30.
[f] Based on an average house of 6x7 meters.
[g] Average of unmilled paddy and swidden rice prices.

3. LIVELIHOOD INCOME IMPACTS

The Yali Falls dam has severely affected downstream human livelihood systems in Ratanakiri Province. Changes in flow regimes and sudden flooding caused by the dam have ruined rice crops and vegetable gardens, reduced fish catches, and halted gold panning activity. As a result, villagers report that indebtedness has increased sharply over the past two years and some villages have migrated away from the Se San River in search of alternative livelihoods.

Livelihood income impacts are estimated for 886 households in the upstream districts of O'Yadao and Andong Meas, 2,548 households in the lowland districts of Ta Veng and Veun Say, and in total for 3,434 households in the four districts. Impact estimates are presented as *total* income losses and *average* income losses per household. While this approach allows for an assessment of the "typical" losses per household, actual losses are likely to have been uneven with some households experiencing significant losses and others being less affected.

Livelihood Income Impacts for 886 Households in O'Yadao and Andong Meas Districts

As shown in Exhibits 3-1 and 3-2, 886 households in O'Yadao and Andong Meas have seen a sharp decline in their livelihood income. Prior to the dam, households earned about $90 per month on average.[5] In 1999, livelihood income was only about $37 per month on average, a drop of almost 60 percent. Since few alternatives to pre-dam livelihood activities exist for earning income, it is unlikely that villagers can make up for much, if any, of lost income through alternative livelihood activities or other employment.

Exhibit 3-1
Average Impacts Per Household To Livelihood Income For 886 Households In O'Yadao And Andong Meas Districts

Livelihood Income	Rice	Fishing	Vegetable Gardening	Gold Panning	Total	Monthly Average
Before The Dam	$461.54	$276.92	$201.28	$146.46	$1,086.20	$90.52
After The Dam (1999)	$380.10	$20.51	$42.09	$0	$442.70	$36.89
Income Loss (1999)	$81.44	$256.41	$159.19	$146.46	$643.50	$53.62
Percentage Loss	17.6%	92.6%	79.1%	100%	59.2%	59.2%

Exhibit 3-2
Total Impacts to Livelihood Income For 886 Households In O'Yadao And Andong Meas Districts

Livelihood Income	Rice	Fishing	Vegetable Gardening	Gold Panning	Total	Monthly Average
Before The Dam	$408,924	$245,351	$178,334	$129,764	$962,373	$80,198
After The Dam (1999)	$336,769	$18,172	$37,292	$0	$392,233	$32,686
Income Loss (1999)	$72,155	$227,179	$141,042	$129,764	$570,140	$47,512
Percentage Loss	17.6%	92.6%	79.1%	100%	59.2%	59.2%

Due to the dramatic loss in livelihood income, many villagers have exhausted all savings and begun borrowing to meet their needs. Villagers in O'Kawp village, Andong Meas district, reported that all families in their village are in debt. For example, one man noted that he recently borrowed 50,000 riels worth of rice from a rice trader and needs to pay back 80,000 riels worth of rice by next year. Other villagers have borrowed at similar rates from traders,

[5] This estimate is in line with findings of the most recent Cambodia Socio-Economic Survey, which estimates that the average rural income in Cambodia is about $82 per month. National Institute of Statistics, Ministry of Planning, *Report on the Cambodia Socio-Economic Survey 1999*, Phnom Penh, Cambodia, p. 59.

market sellers, and police. One woman who lost several buffaloes in floods caused by dam water releases has borrowed two buffalo from a friend to plow her fields for rice and vegetables, an illustration of how livestock losses can affect livelihoods. Villagers noted that many families are more than 1 million riels in debt.

Others villagers have left the area in search of more sustainable livelihoods. Villagers in O'Kawp village reported that of the 12 villages surveyed in Andong Meas district for the Fisheries Office study, four villages have remained by the Se San River, four villages have migrated away to upland areas, and parts of four other villages have also migrated away. In addition, many families now leave the area during the rainy season to live in upland areas where they can grow rice and vegetables without the threat of flooding from the Se San River. They return to their villages in the dry season. Beyond the fragmenting effects on village communities, this temporary migration during the rainy season can cause other problems. For instance, villagers in O'Kawp noted that the only person trained in public health migrates to upland areas during the rainy season, so people remaining in the village have no one to consult when they have health problems.

Livelihood Income Impacts for 2,548 Households in Ta Veng and Veun Say Districts

Exhibits 3-3 and 3-4 show the sharp decline in livelihood income experienced by 2,548 households in Ta Veng and Veun Say due to the dam. Prior to the dam, households earned about $116 per month on average.[6] In 1999, livelihood income was only about $66 per month on average, a drop of 57 percent. With few alternatives to pre-dam livelihood activities for earning income, it is unlikely that villagers have been able to make up for much, if any, of the lost income.

Exhibit 3-3
Average Impacts Per Household to Livelihood Income for 2,548 Households in Ta Veng and Veun Say Districts

Livelihood Income	Rice	Fishing	Vegetable Gardening	Gold Panning	Total	Monthly Average
Before The Dam	$716.16	$553.85	$92.31	$23.31	$1,386.23	$115.52
After The Dam (1999)	$455.44	$82.05	$60.18	$0	$597.67	$49.81
Income Loss (1999)	$261.32	$471.80	$32.13	$23.31	$788.56	$65.71
Percentage Loss	36.5%	85.2%	34.8%	100%	56.9%	56.9%

Exhibit 3-4
Total Impacts to Livelihood Income for 2,548 Households in Ta Veng and Veun Say Districts

Livelihood Income	Rice	Fishing	Vegetable Gardening	Gold Panning	Total	Monthly Average
Before The Dam	$1,826,304	$1,411,210	$235,206	$59,394	$3,532,114	$78,683
After The Dam (1999)	$1,160,461	$209,063	$153,339	$0	$1,522,863	$31,172
Income Loss (1999)	$665,843	$1,202,146	$81,867	$59,394	$2,009,251	$47,512
Percentage Loss	36.5%	85.2%	34.8%	100%	56.9%	56.9%

[6] The income estimate for Ta Veng and Veun Say of $115 per month is somewhat higher than the income estimate for O'Yadao and Andong Meas of $89 per month. Villages located in the floodplains of Cambodia (e.g., villages in Ta Veng and Veun Say) typically have higher incomes than villages located in upland areas (e.g., villages in O'Yadao and Andong Meas). According to the Cambodia Socio-Economic Survey 1999, the average income for households located in plains areas is about $118 per month compared to about $84 per month for households located in mountainous areas (p. 59).

Similar to households in O'Yadao and Andong Meas, it appears that many villagers in Ta Veng and Veun Say have exhausted all savings and begun borrowing to meet their needs. Villagers in Kachon Leu, Kachon Kraom, and Pong villages in Veun Say district reported that all families are now in debt with most beginning to borrow in 1999. They suggested that families typically borrow 50 kilos of milled rice (equal to about 50,000 riels), and they must pay back 240 kilos of unmilled rice (equal to about 96,000 riels) the following year. Noting how dam water releases have cause a steep reduction in their fish catch, and the loss of vegetables and rice, local people reported that household consumption of fish and vegetables has dropped dramatically. Households have thus far maintained their usual consumption of rice by borrowing when necessary. However, reductions in fish and vegetable consumption have likely resulted in increases in malnutrition.

Migration due to dam impacts appears to be greater in the upper parts of the Se San Basin (Andong Meas and O'Yadao districts) than in the lower parts of the basin (Ta Veng and Veun Say districts). Villagers in Veun Say district reported that many households are now sending older children to Banlung (capital of Ratanakiri) in search of work, but as yet no villages have migrated away from the Se San River. However, they noted that many families now move upland temporarily during the rainy season to do swidden agriculture, returning to their villages in the dry season.

Livelihood Income Impacts for 3,434 Households in All Four Districts

Exhibits 3-5 and 3-6 summarize the annual livelihood income losses for 3,434 households in O'Yadao, Andong Meas, Ta Veng, and Veun Say districts as a result of downstream impacts from the Yali Falls dam. Total losses were over $2.5 million in 1999, or an average of about 58 percent of livelihood income per household. Lost fishing accounted for more than half of these losses, but all livelihood activities have been significantly affected.

Exhibit 3-5
Average Impacts Per Household to Livelihood Income for 3,434 Households in O'Yadao, Andong Meas, Ta Veng, and Veun Say Districts

Livelihood Activities	Rice	Fishing	Vegetable Gardening	Gold Panning	Total	Monthly Average
Before The Dam	$650.91	$482.40	$120.43	$55.08	$1,308.82	$109.07
After The Dam (1999)	$436.00	$66.17	$55.51	$0	$557.69	$46.47
Income Loss (1999)	$214.91	$416.23	$64.91	$55.08	$751.13	$62.59
Percentage Loss	33.0%	86.3%	53.9%	100%	57.4%	57.4%

Exhibit 3-6
Total Impacts to Livelihood Income for 3,434 Households in O'Yadao, Andong Meas, Ta Veng and Veun Say Districts (1999)

Livelihood Activities	Rice	Fishing	Vegetable Gardening	Gold Panning	Total	Monthly Average
Before The Dam	$2,235,229	$1,638,389	$413,540	$189,157	$4,476,315	$373,026
After The Dam (1999)	$1,497,230	$209,063	$190,630	$0	$1,896,924	$158,077
Income Loss (1999)	$737,999	$1,429,326	$222,910	$189,157	**$2,579,391**	$214,949
Percentage Loss	33.0%	87.2%	53.9%	100.0%	57.6%	57.6%

As further illustration of how livelihoods have changed due to the dam, Exhibit 3-7 provides a summary of income from each pre-dam livelihood activity as a percentage of total pre-dam income, and income from each post-dam livelihood activity (1999) as a percentage of total pre-dam income.

Exhibit 3-7 Pre-Dam and Post-Dam (1999) Income From Livelihood Activities As A Percentage of Total Pre-Dam Income for 3,434 Households in O'Yadao, Andong Meas, Ta Veng, and Veun Say Districts					
As a Percentage of Total Pre-Dam Income	**Rice**	**Fishing**	**Vegetable Gardening**	**Gold Panning**	**Post-Dam Income Loss**
Pre-Dam Income	49.7%	36.9%	9.2%	4.2%	
Post-Dam Income (1999)	33.3%	5.1%	4.2%	0%	57.4%

Estimates of impacts to livelihood income are for 1999 only. Although it was not possible to estimate losses for other years due to data limitations, accounts of flooding impacts in the area since 1996 suggest that annual losses in other years were significant and may have been similar to 1999 (see Fisheries Office study for information on flooding occurrences). More importantly, with few alternatives to current livelihoods, local people face the prospect of continuing livelihood income losses in the future. The trends toward increasing indebtedness and migration from the area will likely continue unless actions are taken to significantly mitigate downstream impacts from the dam or to remove the dam and return the Se San River to its natural state.

4. OTHER TANGIBLE LOSSES

In addition to the livelihood impacts discussed above, sudden flooding due to dam water releases has resulted in significant losses of the accumulated capital wealth of local people, including lost livestock, fishing equipment and boats, agricultural tools, housing and household items, and rice stocks. This section estimates the monetary costs associated with these losses from 1996 to 1999 – the period for which the Fisheries Office study collected data on losses. Similar to livelihood impact estimates, tangible losses are estimated as average losses per household. While this approach allows for an assessment of the "typical" losses per household, actual losses are likely to have been uneven with some households experiencing significant losses (e.g., housing) and others being less affected.

Lost Livestock (Due To Sudden Flooding From Dam Water Releases)

Exhibit 4-1 shows information on the value of livestock lost due to sudden flooding from dam water releases for 1996-1999. Hundreds of buffalo and cows, and thousands of pigs, chickens, and ducks have been lost. Their market value (i.e., cost of replacement) is approximately $200,000, or about $60 per household. In general, flooding impacts on livestock have been more pronounced in the lower areas of the Se San Basin (Ta Veng and Veun Say districts), which is consistent with reports that flooding in those areas has been more severe with inundation lasting several days at a time (see Fisheries Office study).

Exhibit 4-1 Value of Livestock Lost Due To Sudden Flooding From Dam Water Releases (1996-1999)									
Types of Losses*	**O'Yadao and Andong Meas Districts (886 Households)**			**Ta Veng and Veun Say Districts (2,548 Households)**			**All Four Districts (3,434 Households)**		
	Number Lost	Total Value of Loss	Average Loss Per Household	Number Lost	Total Value of Loss	Average Loss Per Household	Total Number Lost	Total Value of Loss	Average Loss Per Household
Buffaloes	70	$11,200	$12.64	539	$77,616	$30.46	609	$88,816	$25.86
Pigs	349	$8,922	$10.07	1,944	$49,697	$19.50	2,293	$58,618	$17.07
Chickens	3,199	$2,461	$2.78	35,668	$27,437	$10.77	38,867	$29,898	$8.71
Cows	13	$1,300	$1.47	309	$22,248	$8.73	322	$23,548	$6.86
Ducks	646	$563	$0.64	2,913	$2,540	$1.00	3,559	$3,103	$0.90
Total		**$24,446**	**$27.59**		**$179,537**	**$70.46**		**$203,983**	**$59.40**
* See Exhibit 2-2 for information on the livestock prices used to develop these economic estimates.									

Fishing Equipment and Boat Losses

As described in the Fisheries Office study, local people often set fishing nets and traps at night and retrieve them the following morning. When water levels rise quickly due to dam water releases, this fishing gear can be washed away. Dugout canoes have also been lost when water levels rise rapidly and owners have no opportunity to tie them higher up on the riverbank. Most fishing equipment and boats have been lost during the dry season when villagers did not expect rapid increases in water levels.

As shown in Exhibit 4-2, fishing equipment and boat losses from 1996 to 1999 have been significant – about $560,000 in total losses or, on average, about $163 in losses per household. Losses have been greater in Ta Veng and Veun Say where there has traditionally been greater fishing activity.

Exhibit 4-2
Value of Fishing Equipment and Boats Lost Due To Sudden Flooding From Dam Water Releases (1996-1999)

Types of Losses*	O'Yadao and Andong Meas Districts (886 Households)			Ta Veng and Veun Say Districts (2,548 Households)			All Four Districts (3,434 Households)		
	Number Lost	Total Value of Loss	Average Loss Per Household	Number Lost	Total Value of Loss	Average Loss Per Household	Total Number Lost	Total Value of Loss	Average Loss Per Household
Gillnets	2,182	$52,480	$59.23	7,281	$181,686	$71.31	9,563	$234,166	$68.19
Castnet	103	$4,944	$5.58	26	$1,248	$0.49	129	$6,192	$1.80
Hooks	8,460	$3,059	$3.45	259,546	$106,851	$41.94	304,006	$109,910	$32.01
Sm Basket	3,230	$4,141	$4.67	20,962	$26,874	$10.55	24,192	$31,015	$9.03
Lrg Basket	127	$488	$0.55	5,479	$21,073	$8.27	5,606	$21,562	$6.28
Funnel Traps	260	$4000	$4.51	1,927	$29,646	$11.64	2,187	$33,646	$9.80
Falling Door	755	$8,712	$9.83	4,492	$51,831	$20.34	5,247	$60,542	$17.63
Canoes	269	$13,795	$15.57	904	$46,359	$18.19	1,173	$60,154	$17.52
Motor Boats	1	$127	$0.14	17 + generator	$2,478	$0.97	18 + gen.	$2,605	$0.76
Total		**$91,745**	**$103.55**		**$468,046**	**$183.69**		**$559,792**	**$163.01**

* See Exhibit 2-2 for information on the fishing equipment and boat prices used to develop these economic estimates.

Housing, Household Items, and Rice Stock Losses

In addition to livestock, fishing gear, and boats, local people have had their houses, household items, construction materials, field houses, rice barns, rice stocks, and agricultural tools washed away by dam water releases. Exhibit 4-3 provides estimates for the loss of 37 houses, the possessions within them, and rice stocks. Due to data limitations, it was not possible for this study to develop economic estimates for lost field houses, rice barns, construction materials, agricultural tools and other household items.

Exhibit 4-3
Value of Housing, Household Items, and Rice Stocks Lost
Due To Sudden Flooding From Dam Water Releases (1996-1999)

Types of Losses*	O'Yadao and Andong Meas Districts (886 Households)			Ta Veng and Veun Say Districts (2,548 Households)			All Four Districts (3,434 Households)		
	Number Lost	Total Value of Loss	Average Loss Per Household	Number Lost	Total Value of Loss	Average Loss Per Household	Total Number Lost	Total Value of Loss	Average Loss Per Household
Houses (and items inside)	13	$15,600	$17.61	24	$28,800	$11.30	37	$44,400	$12.93
Rice Stocks (in kilos)	14,500	$1,487	$1.68	30,208	$3,098	$1.23	44,708	$4,585	$1.34
Total		**$17,087**	**$19.29**		**$31,898**	**$12.52**		**$48,985**	**$14.26**

* See Exhibit 2-2 for information on the housing, household items, and unmilled rice prices used to develop these economic estimates.

Although calculating the average loss per household is necessary as an input to overall estimates, averaging in this case may mask the acute losses experienced by the 37 families who lost their homes. In particular, local people complained bitterly about losing family heirlooms such as wine jars and ceremonial gongs. In many villages wine jars and gongs are passed down from one generation to the next generation. While a typical wine jar may sell in the market for as low as about $8, local people noted that most families possess more decorative wine jars that are several generations old. When lost, these heirlooms cannot be replaced. Regarding ceremonial gongs, local people in Veun Say district noted that they no longer know how to make ceremonial gongs so lost gongs cannot be replaced.

Total Tangible Losses

Total tangible losses due to sudden flooding from dam water releases occurring from 1996 to 1999 were about $800,000, or about $237 per household (see Exhibit 4-4). Losses were twice as severe for households in Ta Veng and Veun Say ($266 per household) compared to O'Yadao and Andong Meas ($133 per household). As noted above, due to data limitations these estimates do not include losses of field houses, rice barns, housing construction materials, agricultural tools, and other household items washed away in flooding.

Exhibit 4-4
Total Tangible Losses Due To Sudden Flooding From Dam Water Releases (1996-1999)

Types of Losses*	O'Yadao and Andong Meas Districts (886 Households)		Ta Veng and Veun Say Districts (2,548 Households)		All Four Districts (3,434 Households)	
	Total Value of Loss	Average Loss Per Household	Total Value of Loss	Average Loss Per Household	Total Value of Loss	Average Loss Per Household
Livestock	$24,446	$27.59	$179,537	$70.46	$203,983	$59.40
Fishing Equipment and Boats	$91,745	$103.55	$468,046	$183.69	$559,792	$163.01
Housing (and Items) and Rice Stocks	$17,087	$19.29	$31,898	$12.52	$48,985	$14.26
Total	**$133,278**	**$150.43**	**$679,482**	**$266.67**	**$812,760**	**$236.68**

* See Exhibit 2-2 for information on the prices used to develop these economic estimates.

It is important to highlight that the significant tangible losses experienced by households are *in addition* to losses of livelihood income. Households face a difficult task to replace lost livestock and fishing equipment (which may be necessary for earning their livelihood) when at the same time their incomes have been reduced by more than half. Caught in this dire situation, many local people have exhausted their savings and fallen into debt, and/or decided to migrate away from the Se San River.

5. KEY IMPACTS NOT QUANTIFIED IN THIS STUDY

In addition to the losses quantified above, the Yali Falls dam has caused material and non-material impacts that cannot be quantified because of data and resource limitations, or because the valuation of such impacts is currently beyond economic methods or morally and ethically controversial. These impacts include deaths and illnesses, other livelihood impacts (not addressed above), livestock deaths due to suspected water quality problems, and natural resource impacts.

The inability to quantify these impacts does not diminish their significance to local people. Indeed, the loss of human life due to the dam is the most important impact of all, but this study does not attempt to quantify this loss because of the controversial moral dimensions involved with such estimates.[7] To ensure that non-quantified impacts are also taken fully into account when considering the magnitude of impacts to local people, these impacts are summarized below based on findings of the Fisheries Office study. For a more detailed description of these impacts, please refer to the Fisheries Office study.

Deaths and Illnesses

The Fisheries Office study estimates that sudden flooding from Yali Falls dam water releases has caused at least 32 deaths due to drowning from 1996 to 1999 – 9 deaths in O'Yadao and Andong Meas districts and 23 deaths in Ta Veng and Veun Say districts. Even more striking, the Fisheries Office study reports, "according to villagers, approximately 952 people have died as a result of diseases they believe to be directly associated with water quality, and more specifically the Yali Falls dam." These deaths represent about five percent of all the population of the 59 villages surveyed.

In addition to deaths, local people reported many illnesses that they believe have been caused by drinking water from, and/or bathing and swimming in, the Se San River. The most common problems from drinking Se San River water reported by villagers include stomach aches, vomiting, diarrhea, respiratory problems, throat and nose irritation, dizziness, and coughing. Problems from bathing and swimming in the Se San River include intense itchiness, bumps and infections, and eye irritation. In both cases, villagers report that problems more commonly occur after water levels first rise, suggesting that water releases from the dam are the cause.

Since water quality testing has not yet been conducted, suspected water quality problems cannot be confirmed. If the Se San River water is found to be toxic, more research will also be needed on the relationship between the identified water quality problems and potentially

[7] It should be recognized, however, that in court cases around the world assessing the "value of life" is commonplace where deaths have been caused by negligence (as is the case with deaths caused by the Yali Falls dam).

associated deaths and illnesses. Due to the potentially enormous scale of the human tragedy, water quality testing of the Se San River should be an immediate (next dry season) priority.

Other Livelihood Impacts

Although this study estimates the impacts of the Yali Falls dam to villagers' major livelihood activities (i.e., rice farming, fishing, vegetable gardening, and gold panning), villagers also undertake other activities to support their livelihoods, such as wild vegetable/plant collection and wildlife hunting. These smaller scale activities are not quantified in this study due to limited information and resources.

Beyond these income-generating activities, there have also been a host of other impacts to local peoples' way of life, from reduced river crossing and boat travel to changes in diets. Quantification of these impacts is beyond current economic valuation methods. Although it is not possible to capture the wide range of these impacts here, the Fisheries Office study provides a detailed description of a number of these impacts and some of the more important issues are discussed below.

- **Food insecurity, malnutrition, and increased vulnerability –** As noted above, villagers report that their fish and vegetable consumption has decreased significantly since impacts from the dam began in 1996. This change in diet has likely resulted in higher levels of malnutrition and increased vulnerability to disease. With the constant threat of dam water releases ruining their rice crops, and their savings exhausted, villagers also worry greatly about having enough food to eat.

- **Indebtedness, migration, and community fragmentation –** Impacts from the dam have resulted in sharp increases in borrowing by local people, as described above. Annual interest rates on these loans, which appear to be in the range of about 60-100 percent, are an additional cost borne by local people. Migration of villages and parts of villages has already occurred in O'Yadao and Andong Meas districts, as local people seek more sustainable livelihoods in upland areas beyond the flooding of the Se San River. Although significant migration in Ta Veng and Veun Say does not appear to have taken place yet, families are being fragmented as older children are being sent to Banlung in search of work. Villagers also reported an increase in domestic conflicts and village disputes (see Fisheries Office study).

- **Future loss of livelihood/cultural knowledge base –** It is difficult to capture in a brief summary the potential impacts of the dam on the livelihood and cultural knowledge base of local people. Clearly, when local people migrate away from the Se San River to upland areas, they face the task of developing a new livelihood knowledge base. However, impacts on the livelihood knowledge base of villagers continuing to live along the riverbanks are occurring as well. As an example of such an impact, villagers in Andong Meas district discussed the importance of the "rey," an insect that used to appear along the riverbanks of the Se San once a year. According to villagers, the appearance of the rey was used as a seasonal time reference; its appearance signaled to villagers that it was time to begin rice farming. Now villagers report that the rey no longer appears along the riverbanks making it difficult for them to determine when they should begin rice farming.

Lost Livestock Due To Suspected Water Quality Problems

Local people suspect that thousands of their livestock have died as a result of bathing in or drinking poor quality water from the Se San River. For example, a villager in Andong Meas district told of how he watched three of his cows bathe in the Se San one morning and then later that day all three cows died. The Fisheries Office study found that villagers believe over 4,909 buffaloes, 2,228 cows, 7,854 pigs, 147,749 chickens, 1,670 ducks, and 2,388 dogs have died of unusual diseases since water quality problems began in 1996. However, as noted in the Fisheries Office study, it is difficult to know how many of the animal deaths are associated with water quality problems and how many may be due to increased outbreaks of animal diseases occurring during the same time period. Conducting water quality testing could provide important information on the possible relationship between water quality problems and the animal deaths.

Natural Resource Impacts

The Yali Falls dam has caused a multitude of natural resource impacts, including riverbank erosion, the loss of aquatic life, riverine vegetation, reptiles, birds, and wild animals, and damage to the habitat that sustains these wildlife and vegetation. In addition, impacts to traditional livelihoods have resulted in an increase in wildlife hunting and the exploitation of forest resources as local people seek alternative ways to support themselves. For a more detailed discussion of natural resource impacts, see the Fisheries Office study.

6. SUMMARY OF FINDINGS

The Yali Falls dam has severely affected downstream human livelihood systems in Ratanakiri Province. Changes in flow regimes and sudden flooding caused by the dam have ruined rice crops and vegetable gardens, reduced fish catches, and halted gold panning activity. In addition to these impacts, the loss of livestock, fishing equipment, and boats due to sudden flooding has significantly reduced the means by which local people can undertake livelihood activities. The combination of a reduction in traditional livelihood activities, a lack of alternative livelihood possibilities, and the loss of "capital" (e.g., fishing equipment and boats) that people use to pursue livelihoods, has caused enormous hardship for local people. As a result, villagers report that indebtedness has sharply increased over the past two years and some villages have migrated away from the Se San River in search of more stable livelihoods.

- Local people have experienced a sharp decline in their livelihood income due to the Yali Falls dam. Annual livelihood income per household in 1999 was only about 40 percent of pre-dam income.
    - Average livelihood income per household for 886 households in O'Yadao and Andong Meas districts has dropped from about $89 per month before the dam to about $35 per month in 1999 – a decline of 60 percent. Fishing and gold panning have ceased and vegetable gardening has been severely affected.
    - Average livelihood income per household for 2,548 households in Ta Veng and Veun Say districts has fallen from about $116 per month before the dam to about $66 per month in 1999 – a drop of 57 percent. Fish catches have

declined dramatically and rice crops have been significantly affected by flooding.

- The total livelihood income loss for 3,434 households (all four districts) was over $2.5 million in 1999, with reduced fish catches accounting for more than half of the loss. Although it was not possible to estimate losses for other years due to data limitations, accounts of flooding impacts in the area since 1996 suggest that annual losses in other years may have been similar to 1999 (see Fisheries Office study for information on flooding occurrences). Moreover, local people will continue to experience these severe livelihood income losses for the foreseeable future.

- In addition to livelihood income losses, sudden flooding from dam water releases has resulted in more than $800,000 in other tangible losses, including lost livestock, fishing equipment and boats, housing, and rice stocks.

- As a result of livelihood income and other tangible losses, indebtedness and migration appear to have increased significantly over the past two years.

  - Village leaders reported that many people in their villages have exhausted all savings and begun borrowing to meet their needs. Villagers from three villages in Veun Say district and one village in Andong Meas district reported that all families in their villages are in debt. Annual interest rates in the range of about 60-100 percent represent an additional cost of the dam borne by local people.

  - At least four villages (and parts of four other villages) in Andong Meas district have migrated away from the Se San River in search of more sustainable livelihoods in upland areas. Families in Ta Veng and Veun Say districts are sending their older children to the provincial capital of Banlung to look for work.

7. SUGGESTIONS FOR NEXT STEPS

- **Test the water quality of the Se San River and investigate the relationship between water quality results and reported deaths and illnesses.** The Fisheries Office study found that villagers believe 952 people have died due to illnesses related to water quality problems caused by the dam. Investigating potential water quality problems through water quality testing during the next dry season should be a high priority.

- **Conduct impact studies of other areas affected by the Yali Falls dam.** The estimates developed in this study only encompass downstream impacts in four districts of Ratanakiri Province, Cambodia. Since the Yali Falls dam is located in Vietnam about 70 km from the Cambodian border, it is quite possible that downstream impacts in Vietnam have been more severe than those in Ratanakiri. It is also possible that impacts from the dam have been significant in Stung Treng Province downstream from the four districts studied in Ratanakiri. If impact studies of these areas are conducted in the future, strong consideration should be given to integrating the economic analysis of impacts into the overall study design from the beginning, as this approach can be a more effective for collecting information and developing estimates than undertaking economic analysis at a later stage.

- **Investigate technical options for mitigating downstream impacts.** Recognizing that decommissioning and removal of the Yali Falls dam may be the "first-best" solution for affected families and villages in Ratanakiri, it may also be worthwhile to investigate other possible options for mitigating downstream impacts of the dam. For example:

  - Is it possible to operate the dam in a run-of-the-river mode or can operation of the dam be changed in some manner to better simulate natural flows?
  - Can the current "warning system" for dam water releases be improved to ensure such warnings are provided and local people receive them with an adequate lead time?
  - Can flows and water releases be better controlled, in terms of their flow rates, maximum size, and timing (seasonal and day/night), to improve the livelihood conditions and potential of people living downstream?

- **Conduct more in-depth study of livelihood activities and assess potential livelihood alternatives if downstream impacts continue.** Due to limited time and resources, this study was unable to conduct detailed research on livelihood activities. A more extensive study of livelihood activities (especially fishing) would help to improve the basis from which estimates are developed in this study, and could provide important information for future studies undertaken in support of advocacy regarding management of the Se San River basin. In addition, if efforts to mitigate downstream impacts or remove the dam fail, more comprehensive livelihood information may prove useful as a basis for assessing options to assist affected villagers rebuild their livelihoods.