A Study of the Downstream Impacts of the Yali Falls Dam in the Se San River Basin in Ratanakiri Province, Northeast Cambodia

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Executive Summary

1) Between April 15 and May 15, 2000 a community-based study of the downstream environmental and socio-economic impacts of the Yali Falls dam in Viet Nam was conducted in all the villages situated along the Se San River in Ratanakiri Province, Northeastern Cambodia. 59 villages in 15 communes and four districts were surveyed. People from nine different ethnic groups participated in the survey, and men and women were interviewed in separate groups.

2) It was determined that approximately 20,000 people in 3,500 families in Ratanakiri Province have experienced serious ecological and socio-economic impacts as a result of the over US$ 1 billion Yali Falls dam, which is expected to produce 720 MW of power and is situated on the mainstream Se San River approximately 70 km from the border with Cambodia. Construction of the dam began in November 1993, and is expected to be fully commissioned by 2001, with some electricity being produced beginning in 2000.

3) Local people first observed negative impacts from the Yali Falls dam in late 1996, when large amounts of water were released from the dam's 64.5 km2 reservoir, causing massive downstream flooding in Ratanakiri. Since then, rainy season flooding believed to have been caused by water releases from the dam has damaged agricultural crops and flooded villages along the Se San River in Ratanakiri every year, although floods in the upper part of the basin being have been much less severe than those in lower parts.

4) Locals have also been impacted by irregular dry season water level fluctuations, which are characterised by extreme highs and lows, and rapid changes in water levels. Massive surges of water over 2 metres high have caused serious damage downstream, including large amounts of riverbank erosion. Dry season gardens have been flooded, and a number of other dry season activities, including gold panning and foraging for food and fishing have been severely disrupted. At least 32 people have been drowned because of rainy and dry season flooding caused by the dam, and large numbers of livestock have drowned.

5) The water quality in the Se San River has seriously deteriorated, although it is not yet clear why, since no detailed water quality surveys have been conducted. However, it appears that the water quality problems have originated with the Yali reservoir, which may be contaminated with toxic blue green algae, or possibly other toxic elements. The river has become turbid and smells bad.

6) Local people report that serious human health problems have resulted from changes in water quality in the Se San River, which local people bath in and drink. Although it is not entirely clear how many people have died as a direct or indirect result of changes in water quality, locals report that 952 have perished since the problems began over four years ago, and that water quality has been the

cause of all or most deaths. Many others have survived river associated ailments, which include itchiness, bumps and eye irritation after bathing in the water, and stomach problems, respiratory problems, throat and nostril irritation, dizziness and vomiting after ingesting the water. Massive amounts of domestic animals have also died since the water quality problems began, although it is difficult to determine to what extent death has resulted from declines in water quality. However, wild animals have been also been found dead near the Se San River, and villagers are convinced that most domestic animal deaths are associated with declines in water quality in the Se San River.

7) Irregular fluctuations in the Se San River have seriously affected riverine vegetation, birds, reptiles and various aquatic life forms whose lifecycles are dependent on the natural rhythm of the Se San River.

8) Native fish, fish habitat and riverine fisheries have been severely impacted by changes in the hydrological regime and water quality. Fish catches have reportedly declined drastically, which has badly affected villagers, who are highly dependent on fishing for food and income. Although all fish species have apparently been impacted, large fishes may have apparently been affected more. Fish diseases have also increased. The rapidly rising waters, which occur without warning, have washed away large numbers of fishing gears and boats.

9) The overall downstream impacts of the Yali Falls dam have severely disrupted human livelihood systems along the Se San River. Therefore, local people have had to increase wildlife trading, the collection of non-timber forest products, and general forest exploitation. The imbalance caused by dam impacts has negatively affected terrestrial resources, since local people have few alternatives.

10) Although both men and women have suffered a great deal, women have reportedly been impacted more than men, and are especially upset about the impacts. Indigenous women appear to have been affected more than ethnic Lao women, although all women have been greatly affected.

11) More research needs to be conducted, especially with regards to water quality and human and animal health. In addition, more studies regarding the impacts of the dam on wildlife and fisheries need to be conducted, and there is a critical need for additional research regarding the impacts of the Yali Falls dam in the Se San River Basin in Stung Treng Province, and parts of Viet Nam below the dam.

12) The people living along the Se San River in Ratanakiri Province are suffering immensely, and many demand that the dam be broken. More than anything, they long for the Se San River to return to normal. They also feel that they should be fully compensated for the impacts that they have experienced, and that if impacts cannot or are not alleviated, they should receive compensation on a continual basis. They are adamant that the Se San 3 dam, which the ADB is planning to fund 20 km downstream from the Yali Falls dam, should not be built.

Figure 1.

1) Introduction

Large-scale hydropower development is well known for causing serious environmental and social impacts the world over (McCully, 1996; Goldsmith and Hildyard, 1984). While considering the impacts of hydroelectric dams is already complicated when a large dam is situated in the same country where its impacts are being felt, the situation becomes even more complex when a hydroelectric project is located in one country, but many of its most serious impacts are being felt in another (Barrow, 1998).

The Se San River is one of the largest tributaries of the Mekong River. With its origin in the Central Highlands of Viet Nam and the southern-most part of Laos, the mighty river flows through mountainous areas in Viet Nam's Dak Lak, Gia Lai and Kon Tum Provinces before entering northeast Cambodia, where it moves into relatively lowland areas. It winds from east to west through Ratanakiri Province and into Stung Treng Province, where the Sre Pok River, another large tributary of the Mekong River, converges with it. The widened river then continues east until it flows into the Se Kong River, which itself intersects with the Mekong River not far downriver at Stung Treng town. The Se San Basin has a drainage area of 17,100 km2, including 11,000 km2 in Viet Nam and 6,100 km2 in Cambodia (ADB, 1995). The Se San and Sre Pok Rivers contribute 10.4 percent of the flow of the Mekong River at Stung Treng town (Halcrow, 1999; TERRA, 1999a), and the Se San, Sre Pok and Se Kong Rivers provide 16.7 percent

Figure 2. Ratanakiri Province

of the Mekong River flow at the provincial capital of Kratie, which is situated downstream from Stung Treng town (TERRA, 1999b).

In November, 1993 the construction of the 720 MW Yali Falls dam began on the Se San River in Gia Lai Province, central Viet Nam (Vietnam News, 28 July 1998), approximately 70 km upriver from the international border with Cambodia (see Figure 1). The cost of the dam, which is the largest ever built in the lower Mekong basin, has been estimated to be US$ 1 billion (Quinn and Dapice, 2000), and the Russian and Ukraine Governments are the main financers of the project, along with the Government of Viet Nam. Other countries, such as Switzaerland, Sweden and Japan have provided technical support, and the Interim Mekong Committee helped plan and coordinate the project (TERRA, 1999b).

By at least mid-1996 the Se San River was being manipulated and held back for construction purposes, and the main dam was closed and its 64.5 km2 reservoir began filling up in 1998 (Vietnam News, 28 July 1998). However, the hydropower facility has only just begun operating (BBC Worldwide Monitoring 2000; Deutsche Presse-Agentur 2000), and all four of its turbines are not expected to be fully functional until 2001 (Quinn and Dapice, 2000). Still, the closing of the dam, and subsequent irregular releases of large amounts of water from its reservoir downriver, have seriously altered the hydrological regime and the water quality of the Se San River downstream from the dam. Unusual and dramatic fluctuations in river levels along the Se San River have caused major downstream environmental and socio-economic impacts in Cambodia. These impacts have been especially serious for the many indigenous peoples living along the Se San River in Ratanakiri Province. However, until very recently the construction of the Yali Falls dam has received little regional or international press coverage, and little is known about the dam in Cambodia. There are four Districts in Ratanakiri Province situated adjacent to the Se San River. O Yadao is approximately 70 km from the Yali Falls dam, Andong Meas is about 110 km away, Ta Veng is approximately 150 km from the dam, and Voen Say is estimated to be 200 km from the project.

This report summarises the results of a field survey of all the villages situated adjacent to the Se San River in the four districts of O Yadao, Andong Meas, Ta Veng and Voen Say, in Ratanakiri Province, Northeast Cambodia (see Figure 2). Fifty-nine villages populated by peoples from 9 different ethnic groups were surveyed over a 21 day period between April 25, 2000 and May 15, 2000. Four additional villages situated along a major tributary of the Se San River, the O Lalay Stream, in Kok Lak Commune, Voen Say District, Ratanakiri Province, were briefly surveyed on May 23-24, 2000, as they are also affected by severe changes in water levels in the Se San River. The Fisheries Office and the Agriculture, Fisheries and Forestry Department, Ratanakiri Province, initiated the study. Local representatives of Virachey National Park, Ministry of Environment, the Ratanakiri Provincial Rural Development Department and the Ratanakiri Provincial Police Department also participated in the survey, as did various district and commune level government officials, and large numbers of rural people. Oxfam and Padrigu Consultants (Sweden) provided funding for the study, and the Non-Timber Forest Products (NTFP) Project, Ratanakiri Province, helped facilitate the research.

2) Methodology

The methodology used to conduct the field survey of the downstream impacts of the Yali Falls dam in Viet Nam on the Se San River in Ratanakiri Province was based on techniques commonly utilised in Rapid Rural Assessment (RRA). The survey team attempted to facilitate the participation of local government officials and villagers in all aspects of the study. However, due to the large number of villages that needed to be visited during the survey, it was impossible to be fully participatory in all aspects of the study. Nevertheless, special care was taken to be culturally sensitive during field investigations, and local counterparts able to speak Jarai, Tampuan, Kachok, Brao, Kavet, Kreung, Lao and Khmer facilitated interviews using all the local languages of the people interviewed, with the exception of Chinese.

A preliminary plan for the study was prepared in February 2000, after the Fishery Office of Ratanakiri formally requested assistance in conducting a village-level survey of all the communities situated along the Se San River in the province.

A literature review related to hydropower development in the Se San River Basin, and particularly downstream issues related to the Yali Falls dam, was conducted in March and early April 2000, in preparation for the field survey. A draft questionnaire for the study was also prepared at the time, based on knowledge of local circumstances and available information regarding the reported impacts of the Yali Falls dam in Ratanakiri Province.

On April 24, 2000 a pre-study planning workshop was held at the Ratanakiri Province Agriculture, Forestry and Fishery Department in Ban Lung town. Members of the study team, as well as district government representatives and senior Agriculture, Forestry and Fishery Department officials from Ratanakiri Province, participated in the workshop. Logisitical and financial issues related to the study were finalised, and the content of the field study questionnaire was reviewed and agreed upon by all.

On April 25, 2000 the principal study team of 12 people, including three women and four indigenous peoples originating from the Se San River Basin in Ratanakiri, traveled to the field. The study team conducted the first village interviews as a single group, using the agreed upon questionnaire. The three women in the group conducted interviews with female villagers separately from the nine male members, who interviewed village men. After having conducted the first set of interviews in Lom and O Kop Villages, Andong Meas District, it was clear that while the questionnaire was generally suitable for the purposes of the study, it required some alterations in order to make it simple enough to be useful for interviewing indigenous peoples. For example, some questions were found to be repetitive, while others that required villagers to quantify the monetary value of impacts proved to be largely unworkable in the primarily subsistence-oriented villages in the study area. Moreover, it soon became evident that the Yali Falls dam has been causing impacts along the Se San River in Cambodia for longer than had previously been recognised. This made it necessary to alter the questionnaire further to consider this critical point.

The full team then separated into two teams. Each independently visited different villages along the Se San River. In each village, each of the two groups further separated into two sub-groups based on gender. In each village visited, as many men and women as were available were interviewed in single groups based on gender. In other words, two interviews were conducted simultaneously in each village – one with the women and one with the men. The questionnaire used for interviewing both groups was the same, although some questions had to be varied to fit the linguistic and cultural situations in individual communities. Moreover, the individual capacity of different villages and ethnic groups had to be carefully considered during the interview process. Twenty major questions were posed in each interview, although each major question included a number of more detailed questions embedded within it. An English translation of the questionnaire used is included as Annex 1, although it should be noted that additional questions were added in the field, and some were removed as well.

In addition to visiting villages, the survey team collected anecdotal information about a number of villages that were reportedly impacted by the Yali Falls dam, but had already moved away from the Se San River due to impacts at the time of the study, or are situated in Stung Province. These communities were not visited.

After completing field investigations, the whole survey team met and reviewed the results of the research. After the basic conclusions of the study had been agreed upon, the survey data was compiled, and Khmer and English language versions of the report were prepared. During the reporting phase of the study, the survey team solicited comments and expert opinion from sources in various fields in order to improve the accuracy of the survey results, as well as the analysis of the survey results. However, it should be noted that it was not possible to receive exact and entirely accurate statistics in some of the villages visited, because some things could not be easily recalled four years after the fact, and no records had been kept at the village, commune or district levels. Therefore, some statistics may represent slight overestimates, while others are likely to represent underestimates. In most villages, locals suggested that the statistics they provided were more likely to represent underestimates than overestimates. We tried, of course, to get the most accurate information possible, and we believe that most of the data collected is relatively accurate and "in the ballpark".

3) Results

3.1) General Information About the Human Population Living Along the Se San River in Ratanakiri Province

Although it has not been possible to determine the exact number of people living along the Se San River in Ratanakiri Province, it is estimated that almost 20,000 people included within approximately 3,500 families are presently living along the river. While the female population in ethnic Lao villages is much higher than the male population, there are generally more males living in Jarai, Kachok, Tampuan, Brao and Kreung communities. There are nine different ethnic groups living along the Se San River in

Ratanakiri Province, the smallest of which is ethnic Khmer. There are no predominantly Khmer villages located along the Se San River in Ratanakiri, although there are a few Khmer Kho villages located next to the Se San River just downstream from Ratanakiri in Stung Treng Province. Only one ethnic Chinese village is found in Voen Say District (see Table I for details of demographic breakdown of the human population located along the Se San River in Ratanakiri).

3.2) Irregular Hydrological Patterns Along the Se San River in Ratanakiri Province

People from all the communities situated along the Se San River in Ratanakiri Province have reported that the hydrological regime of the river has been very irregular since October and November 1996, when a massive flood occurred in all the communities next to the Se San River in the province. Himel and Nhem (1997) reported that floods in September 1996 were caused by a tropical storm centred over the top of the watershed in Viet Nam and Laos. However, long after the effects of that storm had subsided, there were even more intense floods in October and November (Himel and Nhem, 1997). A large amount of agricultural land was inundated, causing a massive amount of damage. While villages situated adjacent to the upstream part of the Se San River in Ratanakiri were flooded for only 36 hours, villages in lower parts of the basin were inundated for many days. It is believed that the massive and rapid floods that occurred in October and November (water rose many metres over just a few hours) were the result of water releases from a diversion dam built to facilitate the construction of the main Yali Falls dam. It is not entirely clear why such a large amount of water was released from the dam, since Viet Nam did not report the releases. However, the headman of a village in Andong Meas District, who visited the dam site in Viet Nam and has friends living near the dam, reported that the dam broke because the high quality Japanese cement that was supposed to be used for its construction was sold by the dam construction managers, who replaced it with low quality Vietnamese cement. This low quality cement was apparently not strong enough to hold the dam together. Government officials in Ratanakiri Province believed, at the time of the floods, that they had resulted from water releases from the Yali Falls dam (Himel and Nhem, 1997).

Apart from causing a massive amount of damage in Cambodia, including some human drowning and a considerable amount of domestic animal drowning, villagers from Se San Commune, O Yadao District, reported hearing rumours that at least 30 villagers living along the Se San River in Viet Nam were also killed at one location during the dam associated 1996 floods. These villagers were apparently digging for gold near the Se San River when massive amounts of water began flowing downstream. Unable to run away quickly enough, they climbed trees to try to escape the flood. However, since they had been digging under the trees that they climbed, the roots were weakened, and as the water rose, the trees toppled over, causing everyone to drown. It has not been possible to obtain more details regarding this incident, and villagers are unclear as to exactly where the tragedy occurred.

Although the rainy season floods of 1997, 1998 and 1999 were not as severe as in 1996, rainy season flooding over the last three years is believed to have been at least

partially the result of water releases from the Yali Falls dam. The floods were the lowest in 1998, were a little higher in 1997, and were the highest since 1996 in 1999. To understand the nature of rainy season flooding in the Se San Basin in Ratanakiri, it is important to recognise that the geography of the Se San River Basin in the province is characterised by relatively steep river gradients and hilly terrain along the river in the upper part of the basin in O Yadao. As the river flows downstream, the Se San gradually becomes less sloped, and by the time it reaches the lower part of the basin in Voen Say District, it is flanked by relatively flat lowland terrain, although there are no wide flood plains anywhere adjacent to the Se San River in Ratanakiri (Himel and Nhem, 1997). This explains why there has been no rainy season flooding along the Se San River in O Yadao District and upper parts of the Se San River in Andong Meas District since 1996. However, in the lower parts of the Se San River in Andong Meas, rainy season flooding occurred in 1996 and 1999. Moving downstream, to Ta Veng and Voen Say Districts, rainy season flooding has occurred every year since 1996, with the most severe flooding occurring in the extreme downstream parts of Voen Say District, near the border with Stung Treng Province.

The rainy season flooding in the downstream parts of the Se San River Basin in Ratanakiri has occurred more times each year than in the upper parts of the basin, and for longer periods of time. In 1997 and 1998, rainy season flooding occurred twice each year in lower parts of Voen Say District, while in 1999 some villages reported being flooded three times. Some of these floods were over 2 metres high inside the villages, causing considerable hardship for local people. Moreover, the duration of floods has been longer in the lower parts of the basin. While 1999 floods in Andong Meas lasted for only 3 days, they occurred for over a week in Ta Veng, and for over 20 days in some villagers in western Voen Say. Figure 3 is a conceptual map that illustrates how the flattening of the landscape of the Se San Basin has caused increased flooding in the western part of Ratanakiri.

Villagers claim that flooding used to occur in the Se San Basin before the Yali Falls Dam was constructed, but that the nature of floods has changed considerably in recent years. To begin with, the timing of flooding no longer coincides with periods of heavy rains in the upper part of the basin, as used to be the case. Moreover, floods used to occur, on average, only once every five to seven years, not every year, as is presently the case. Still more, during years that floods occurred, they generally only happened once during the peak part of the rainy season, and generally lasted only for a few days. Villagers claim that this type of flooding was often beneficial, since floods were rarely high, and did not cause a lot of damage to crops. Short-term flooding helped deposit rich silt in agriculture areas, and paddy rice crops were often particularly good after these short floods. However, over the last four years the floods have been long and high, resulting in massive crop losses. They have also sometimes occurred at the end of the rainy season, when flooding was previously unknown. Villagers have observed that water levels rise much quicker than before. They are convinced that the flooding is a result of water releases from the Yali Falls dam, combined with natural water runoff from tributaries downstream from the reservoir. The 1993 Environmental Impact Assessment (EIA) for the Yali Falls dam pointed out that if water levels in the reservoir are allowed

to reach high peaks, there is a risk that flooding could occur in Kon Tum town (Electrowatt, 1993b). This may be part of the reason why water has been released from the reservoir during peak parts of the rainy season, although it is difficult to know for sure, since Viet Nam has not provided detailed historical information to Cambodia regarding water releases.

Local people have noticed irregular dry season hydrological patterns in the Se San River since early 1997. River levels were particularly low in 1997 and 1998. Although wide water level fluctuations were not observed in those years, villagers nonetheless observed that the hydrological regime was irregular during both dry seasons. However, starting at beginning of 1999, and continuing through the dry season of 2000, local people have noticed massive fluctuations of the Se San River on a daily basis. The problem has been especially severe in 2000. Although villagers have been unable to predict when the water will rise and fall, they have all reported that the water generally rises every 7 to 10 days, before dropping and rising again. However, in some cases large water fluctuations have occurred as frequently as every 3 days, and sometimes changes have taken place after as many as 20 or more days. The unpredictability of water level changes has baffled, frustrated and frightened local people. While villagers used to expect small water level increases after rain fell in upper parts of the basin, they are now experiencing large increases when the sky is clear upstream. Moreover, when rain clouds are seen upstream, water levels often drop.

Local people report that in recent years massive surges of water have been regularly rolling downstream, due to releases from the Yali reservoir. In O Yadao, these surges are regularly 2 to 3 metres high, although they are progressively smaller downstream. In Voen Say, they are generally less than a metre high. These waves are very powerful and extremely dangerous, and have caused people to be very fearful of them, especially in O Yadao and Andong Meas, where they are highest. There, the surges have been compared to a mat being rolled up. River levels often go up many metres over just a few minutes, or about an hour, in bother lower and upper parts of the basin, and as this occurs, the character of the river changes dramatically.

Water surges have caused considerable damage and loss of life in recent years, and a large number of boats have been overturned. For example, the boat two young children from Pa Dawl Village were paddling overturned after they were caught by a surge of water as they tried to return home from their parent's swidden fields. Both drowned. In another incident in Chouay Village, Ta Veng District, a boat carrying a village teacher was overturned by a surge of water. Luckily, nobody died, but all the village's school materials, including books and pencils, were lost.

Local people who used to sleep on sand bars and islands in the middle of the Se San River in the dry season when on fishing trips have largely abandoned the practice. A large number of people from various villages having been surprised by rapid rises of water at night, and have barely been able to escape with their lives. Boats and fishing implements are generally lost. This problem is especially acute in upper parts of the Se

San River in Ratanakiri, although it is still a problem as far downstream as the border with Stung Treng.

At least 32 people, including a large number of children, have been drowned by the surges and rainy season flooding in Ratanakiri since the hydrological problems in the Se San River first began (see Table II). For example, during the first dam caused floods in 1996, the water levels rose so quickly that at elderly woman was unable to escape from a field house she was staying in. As the water levels rose, and the place she was staying in started to become submerged, she tried to swim for her life, but did not make it to dry land and drowned. In Chan Village, in Ta Veng Village, a 3 year old girl and her mother were washing in the river on a dry season morning when they were surprised by a sudden surge of water, which washed the girl away and drowned her before her mother could come to her rescue. The body of the child could not be recovered.

It has been roughly estimated that over 612 buffaloes, 322 cows, 2389 pigs, 3559 ducks and over 40962 chickens have been drowned or lost due to dry season and rainy season flooding since 1996 (see Table II). In fact, actual losses may be higher than those recorded by villagers, since it was generally not easy for local people to remember exactly how many animals had drowned, and detailed records were not kept, especially for small livestock. Some communities also decided not to include juvenile chickens in their counts, which has further deflated the figures. Most animals drowned during rainy season flooding, although a considerable number were also swept away by dry season surges.

Many people, especially women, are very fearful of the powerful surges, and many now avoid going to the river. Unusually high water levels make boat travel difficult using handmade dug out canoes. It also makes crossing the river difficult, and villagers who have crossed the river to go to their fields or to collect non-timber forest products, often return to the river to find water levels much higher than when they crossed it a few hours earlier.

Rapid rises in water levels have been particularly frustrating because although they have sometimes occurred during the day, they mostly take place during the night, or just before dawn, when people are asleep and unable to prepare for the massive onslaught of water. Up until April 2000, villagers had never received any official information about the existence of the Yali Falls dam, although most had heard rumours about it for between two and five or six years. As might be expected, villagers living nearer to Viet Nam have known about the dam for longer than those living nearer to Stung Treng Province (see Table V). Up until April 2000, neither villagers nor local Government, from the provincial level down, had ever received any notification regarding the timing of water releases from the dam. However, in April 2000 they were notified that water would be released around the end of April. However, the timing of the release was unclear, and ended up being largely useless to villagers (see Table V). Since then, in May 2000, water levels have continued to fluctuate widely, but no further warnings have been forthcoming from Viet Nam (*pers. obs.*, study team, May, 2000).

Apart from having to face large and rapid increases in water levels, local people have also been troubled by rapid declines in water levels. In O Yadao, villagers claim that water levels rise as much as 7 or more metres in a day, and drop about the same amount in a day. However, in Voen Say the situation is somewhat different. There, water levels are said to rise quickly and many metres in a day, but generally drop much more slowly. This is not surprising, considering what is known about hydrological patterns in river basins, and the characteristics of the Se San River in Ratanakiri. When water levels are very low, local boat transport is very difficult, since sometimes there is almost no water left in the river.

3.3) Water Quality Problems in the Se San River in Ratanakiri Province

Water storage in reservoirs induces physical, chemical and biological changes in the stored water (Bergkam *et al.*, 2000), and can cause various kinds of water quality problems when water is released downstream (Bergkam *et al.*, 2000; Schouten, 1998; McCully, 1996). In Ratanakiri, local people are apparently facing serious problems related to changes in the quality of water in the Se San River. They report that water quality has deteriorated greatly since 1996. When surges of water come downstream, the water is a reddish colour and very turbid. Moreover, villagers also report that when water levels first rise, the river often smells bad, like a stagnant water hole where buffaloes have been wallowing. The smell is, however, more pronounced in O Yadao and Andong Meas than it is in Voen Say, and villagers in Voen Say have reported that the water smells bad there as well. Local people often describe the water as being mud-like when it first rises, and it is much more turbid than it has ever been before. It becomes somewhat clearer as water levels begin to drop, but is still characterised by villagers as being darkish, and similar to stream water full of rotten leaves. The Se San is certainly not the relatively clear river that villagers used to know.

It is unclear whether non-turbid or turbid water is being released from the Yali reservoir. If non-turbid water is being released, the "hungry water" effect (see McCully, 1996) may be causing erosion and scouring downstream. Another factor that is certainly contributing to increased downstream erosion and turbidity in the water relates to the large size of the water surges that are being released from the reservoir over short time periods. The shear force of the water is obviously inducing increased erosion, although the exact amount has not been determined, since no studies regarding this problem have been conducted. Whatever the case may be, locals report serious downstream erosion along the Se San River in Ratanakiri Province. For example, in O Yadao one approximately 5 ha island in the middle of the Se San River reportedly disappeared after a large surge of water washed it away.

Water quality releases from dam reservoirs are also largely dependent on whether water is released from the top of the reservoir or from the bottom (Bergkam et al., 2000; Schouten, 1998; McCully, 1996). It is presently unclear what the case is with the Yali Falls dam. However, since the turbines have only recently been installed (BBC Worldwide Monitoring, 2000), water has probably been released up until now via the main spillway, which judging from photographs of the dam taken in November, 1999,

takes water from the top of the reservoir. If this is the case, it is likely that a large amount of algae, which generally grows at upper levels of reservoirs, has been released downstream (see Bergkam et al., 2000; McCully, 1996). It is unclear what level of the reservoir water will be released from once the dam is fully operating.

It is possible, although somewhat unlikely, that highly turbid waters from the reservoir are being released from the reservoir using a technique designed to reduce sedimentation in the reservoir. This practice of "sediment sluicing" involves drawing down a reservoir at the start of the flood season and then allowing as much sediment-laden water as possible to pass through the dam before it has a chance to settle. In those cases, the sudden release of tonnes of sediment can be disasterous for downstream biota. Therefore, even though reservoirs generally trap sediment, they can also cause unnaturally large amounts of sediment to be released downstream over short periods, causing various serious downstream ecological impacts (Bergkam *et al.*, 2000).

Changes in water temperatures can also cause serious impacts in relational to ecological systems. In South Africa, the Gariep Dam has caused changes in water temperatures as far as 130 to 180 km downstream, and the Hume dam on the Murry River in Australia has altered water temperatures 200 km downstream (Bergkam *et al.*, 2000). Impacts in the Colorado River in the USA have been recorded as far as 400 km downstream from the Glen Canyon Dam (McCully, 1996). Therefore, temperatures could easily be impacted as far downstream as Ratanakiri, in terms of the Yali Falls dam, which is about 70 km from the border with Cambodia. However, no studies have been conducted regarding this issue, and no baseline data was collected before the Yali Falls dam was built.

3.3.1) Human Health and Water Quality Problems

It is unclear exactly how much changes in water quality has impacted the health of local people who swim in the river, and drink the water boiled and not boiled. However, almost all the people living along the Se San River report a rapid decline in human health since the water quality problems were first noticed in 1996. One of the most common health problems relates to local people bathing and swimming in the river. Locals often experience intense itchiness, bumps and infections on their skin, and eye irritation. These problems are especially acute shortly after water levels rise, and river turbidity increases. These symptoms never occurred before the dam was built. It is notable that most of the members of our study group personally experienced these same problems after bathing in the Se San River during the field research period.

Many of the ethnic minority people living along the Se San River are especially vulnerable to skin problems. Local people often do not use soap, and cannot afford to buy it. Secondly, they often only have one set of clothes, and so cannot wash them often, and must sometimes wear wet clothes after washing them, increasing the chance of bacterial skin infections. Thirdly, their clothes are generally made of synthetic materials, which are not good for allowing the skin breath, and can promote bacterial skin diseases and infections. Therefore, local people are already prone to skin diseases, and this makes

them particularly vulnerable to being impacted by poor quality water released from the Yali Falls reservoir (*pers comm.,* Dr. Christelda Pais, May, 2000).

Local people have also reported many other serious health problems apparently associated with the consumption of water from the Se San River. Again, problems are generally the most serious around the time when water levels first rise. Stomach aches, diarrhea, respiratory problems, throat and nose irritation, dizziness, vomiting and coughing are the most commonly reported ailments reported by local people. While many have survived their ailments, many others have also died, mostly within one and five day of becoming ill. The problem seems to be particularly acute in villages where drinking water is not regularly boiled or shallow wells are not being used. However, even in villages where the water is boiled and shallow wells are sometimes used, the problem persists, although to a lesser extent. While most villagers continue to drink water from the Se San River, some ethnic minority villages, especially in Andong Meas, have mostly stopped drinking water from the Se San River, and now rely primarily on shallow wells situated either next to the river, or farther inland. This may have reduced the rate of illness in those villages, and could explain why locals in some villages reported relatively few deaths due to the consumption of river water.

After completing the fieldwork, two medical doctors working for international non-government organizations in Ratanakiri Province were consulted regarding village health problems. They provided useful advise about the possible causes of symptoms being described by villagers. However, it is impossible to confirm causes of death, since highly trained medical doctors are not working in villages along the Se San River in Ratanakiri. It is possible that some of the people reported to have died due to drinking Se San River water may actually have died due to other diseases unassociated with the Se San River water quality problem. It is also possible that many were weakened by poor quality water, resulting in them dying from other diseases (*pers. comm.,* Dr. Christelda Pais, May, 2000). Nevertheless, Dr. Christelda Pais helped us rule out a number of major illnesses commonly reported in Ratanakiri. These included cholera, measles, chicken pox, respiratory problems, malaria and diphtheria. The symptoms described by villagers generally did not fit any of the above diseases, and seem likely to have been largely caused by some type of poisoning related to water quality (*pers. comm.,* Dr. Christelda Pais, May, 2000).

Dr. Lena Vought, a stream limnologist associated with Lund University in Sweden, has suggested that the problem may be associated to the presence of toxic blue green algae in the Yali reservoir, which has contaminated the Se San River (*pers. comm.*, Dr. Lena Vought, May, 2000). However, since there has never been any detailed water quality surveys conducted in the Se San River in Ratanakiri, it is difficult to confirm this hypothesis. However, if blue green algae is causing the problem, it has probably developed in the Yali reservoir, where euthrophication has likely occurred due to the decomposition of vegetation in the inundation area, which was largely left uncleared when the 64.5 km2 reservoir was first flooded. In Sweden, water contaminated with toxic blue green algae has caused cattle that have drunk the water to die (*pers. comm.,* Dr. Lena Vought, May, 2000). McCully (1996) has pointed out that during warm weather,

algae are likely to proliferate near the surface of highly enriched, or euthrophic reservoirs, like the Yali reservoir. In the former USSR, algae blooms in shallow stagnant reservoirs have rendered the water unfit for either household or industrial use (McCully, 1996).

Apart from blue green algae, these are also a number of other possible water quality problems affecting areas downstream from the Yali Falls dam. Although methane gases (mash gases) created in the dam's reservoir have probably dissipated by the time the Se San River enters Cambodia, nitrates created in the reservoir may still remain, and could be causing serious health problems, although that depends on their concentration in the water (*pers. comm.*, Dr. Abdur Rashid, May, 2000). Robertson (1992) reported that nitrate poisoning causes disorder in haemoglobin, cyanosis (bluish coloration of mucous membrane and skin), anoxia, stomach and intestinal disturbance, vomiting, headaches, dizziness, hypertension, respiratory failure and coma.

Increased stress levels can also lead to various health problems, and that villagers along the Se San River have widely reported increased anxiety due to the unpredictability of water levels, and the heavy losses they have suffered. Ethnic Lao women in Voen Say District reported that domestic conflicts have increased since the crisis began, caused by the stress of having much more insecure lives. This has lead to more domestic violence and even divorce, which has had a serious impact on family structures, and has increased the number of female lead households in Lao villages.

There are other possible reasons why the quality of the water in the Se San River has declined, although no evidence exists in relation to them. One possible health problem could be methylmercury contamination, which has recently been found to occur in a number of large reservoirs around the world, including one in Thailand. Methylmercury contamination can lead to dangerous concentrations of mercury in fish consumed by humans, and can lead to serious long-term health problems (McCully, 1996). Another possible problem is hydrogen sulphate, iron, or manganese water contamination, which often occurs in dam reservoirs (Bergkam *et al.*, 2000). Oxygen-poor, nutrient-rich and acidic water with damagingly high mineral concentrations can be released from dams when weather is warm (McCully, 1996). With anaerobic conditions, which generally occur in reservoirs 12 or more metres deep (Schouten, 1998), hydrogen sulfide is created that accounts for bad smelling water releases downstream. This has been a problem downstream from the Nam Ngum reservoir in Laos, which like the Yali reservoir, was not subjected to adequate vegetation removal before inundation (Schouten, 1998).

It is also possible that toxic substances used for constructing the Yali Falls dam have contaminated the water. In Phi Village, in O Yadao District, villagers have found large quantities of fuses buried in sand banks after water levels drop. Children were able to make them flare after setting them on fire. While there is no indication that the fuses have lead to any health problems, their presence indicates that at least some construction materials have been carried downstream from the dam site.

Two other factors that may be making local people more susceptible to illness relate to rainy season flooding and food security problems, both of which can be indirectly linked to the Yali Falls dam. It is commonly recognised that human and animal illness increases after periods of serious flooding, since it is difficult to maintain hygienic conditions during high flood periods. Moreover, floodwaters can spread various waterborne diseases. When animals and people die during floods, dangerous bacteria can also be introduced to the drinking water supply.

The second problem relates to food security and malnutrition. As will be elaborated in more detail later in this report, villagers have lost access to many of their traditional foods due to impacts caused by the Yali Falls dam. These include losing lowland and swidden rice crops through flooding, not being able to do vegetable gardening in the riverbed due to dry season surges, and reduced fish catches linked to dam impacts. Since villagers have much less food to eat, and lower quality food as well, they are almost certainly experiencing increased rates of malnutrition and under nutrition. This is certainly making them weaker, and more susceptible to disease. It is also true that the deteriorating economic situation of the people living along the Se San River means that they generally have less money available to pay for medical treatment. In Voen Say, many Lao families have become indebted to Chinese traders because of the their need to have money to buy medicines and rice. However, ethnic minority communities are farther from the markets, and have no access to credit. Therefore, when they do not have money, they are simply not able to access medical treatment.

Although it may never be possible to confirm exactly how many people have already died due to illnesses or toxic poisoning directly or indirectly associated with the Yali Falls dam, it is clear that water quality changes downstream from the dam have and are causing serious impacts to local people living along the river. Moreover, villagers are fully convinced that a large number have died due to water quality problems. They insist that the health problems they are experiencing now are different from those they experienced before the Yali Falls dam was built. 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 (see Table II). This represents a human tragedy of mammoth proportions.

3.3.2) Domestic Animal Health and Water Quality Problems

Domestic animal health has deteriorated significantly since the water quality problems in the Se San River first began over four years ago, and local people suspect that many of their domestic livestock have perished as a result of bathing in or drinking low quality water in the Se San River. They claim that their domestic animals did not die as frequently in the past, and that the causes of death observed recently are different from those experienced before the Yali Falls dam began to be constructed. Villagers claim that over 4909 buffaloes have died of unusual diseases since the water quality problems began in 1996, as well as over 2228 cows, over 7854 pigs, over 1670 ducks, over 147749 chickens, and well over 2388 dogs and 214 cats (only a small number of villages were

asked about dog and cat deaths). The only horse found along the Se San River also died of disease (see Table II).

Despite the large number of domestic animals that have died of disease in recent years, it is difficult to know how much animal health problems are associated with water quality problems. That is because water quality problems in the Se San River began occurring around the same time as increased outbreaks of domestic animal diseases throughout Ratanakiri Province, including areas far away from the Se San River (*pers. comm.*, Ashish John, CARERE, May, 2000). For example, *Haemorrhagic Septicaemia* (H.S.), a disease that affects buffaloes, cattle, pigs and chicken, in different forms, began to occur throughout Ratanakiri in epidemic proportions about four or five years ago. Swine fever is another disease that is common in Ratanakiri, and affects pigs. Newcastle disease is yet another ailment that commonly affects chickens in all parts of Ratanakiri, and last year there was an outbreak of distemper, which kills dogs. Moreover, the increased mobility of people in recent times, and the increased trade in domestic animals throughout the province, has probably contributed to increased outbreaks of epidemic diseases for domestic animals (*pers. comm.*, Ashish John, CARERE, May, 2000).

Still, villagers remain convinced that water quality in the Se San River has impacted their domestic animals, and locals often claim that animals kept far from the river have less health problems than those staying near the Se San River. However, it is true that domestic animals generally contract more diseases in areas close to communities compared to those staying in more remote areas. Nevertheless, if blue green algae is responsible for many of the serious human health problems affecting communities, it would not be unreasonable to suggest that at least some of the health problems affecting domestic animals are also being caused by toxic algae. As mentioned earlier, cattle in Sweden have died after consuming water contaminated with toxic blue green algae (*pers. comm.*, Dr. Lena Vought, May, 2000). Reports of wild animals dying near the Se San River also add to the suspicions that poor water quality has contributed to increased domestic animal disease and mortality.

Rainy season flooding can put domestic animals at increased risk of contracting diseases, even when water quality in a river is normal. For example, ponds used by domestic animals have a higher likelihood of being contaminated by parasites during flood periods, leading to a greater risk of gastro-intestinal parasite infections that can affect all types of domestic animals. Stress caused by flooding can also lead to increased mortality for domestic animals. Domestic animals also tend to herd in the remaining dry areas during flood periods, which can lead to the increased transfer of diseases, especially tick borne diseases, such as *Theileria, Babesia* and *Anaplasma*, which can increase mortality. Finally, animals may have to move to areas where they normally do not go during flood periods, and this sometimes leads to the loss of animals that are unable to find their way back (*pers. comm.*, Ashish John, CARERE, May, 2000). All of the above may have been the result of dam induced flooding, and could have lead to considerable amounts of domestic animal losses.

3.4) Agriculture Impacts Related to Changes in the Hydrological Regime in the Se San River in Ratanakiri Province

The changes in hydrological patterns have caused considerable damage to both rainy season and dry season agriculture systems along the Se San River in Ratanakiri Province since 1996.

3.4.1) Rainy Season Flooding

As has already been explained, the Yali Falls dam has apparently contributed to a considerable amount of downstream flooding over the last four years, especially in the lower parts of the Se San River Basin in Voen Say and Ta Veng Districts. Although it was not possible to collect detailed information regarding the amount of agriculture land flooded in recent years, over 629 ha of swiddens were reportedly completely inundated in Ratanakiri in 1999, as well as over 1830 ha of lowland rice paddy (see Table II). However, villagers rarely accurately measure the sizes of their fields, so the area reported may be somewhat inaccurate. It should also be recognised that when 50% of the crop of 50 ha of land was lost, the area recorded as being flooded was only 25 ha. Therefore, the total area inundated was certainly greater than the amount recorded, and the amounts recorded only represent the total amount of area in which the whole crop was lost.

One important issue that needs to be considered relates to increased turbidity in the Se San River, and increased deposition in lower parts of the basin, such as Voen Say District. Although it is unclear how much extra sediment is being deposited there, local people believe that the amount is considerable. If the amount deposited is significant, the ability of the riverbed to hold water could be reduced, resulting in increased risk of rainy season flooding in future years.

The food security situation in villages situated along the Se San River is particularly critical this year. While lowland areas were devastated through flooding, upland swiddens not affected by flooding were also badly impacted by early wet season rains in 1999, which prevented the burning of newly cut fields, and resulted in very low rice production in the uplands. Therefore, both upland and the lowland agricultural areas along the Se San River only produced very small amounts of rice in 1999. This has contributed to serious food security problems in villages along the Se San River in Ratanakiri, and many villages do not even have enough rice seed to plant this year's crop.

While it has not been possible to quantify the impacts of rainy season flooding in the villages in terms of impacts to gardens and fruit trees that have been inundated and lost during the flooding, the impacts has, nonetheless, been significant, and in some cases large number of trees and crops died.

3.4.2) Dry Season Flooding

In the past, the majority of families situated along the Se San River made gardens along the silt enriched banks of the Se San River once water levels started to drop at the end of the rainy season. This practice was particularly important for local people in Andong Meas and O Yadao Districts, who used to make large gardens in the riverbed for growing tobacco, corn and a wide variety of vegetables for local consumption and sometime for selling. While villagers in Ta Veng and Voen Say Districts used to make much smaller gardens, and mainly grew vegetables for subsistence purposes, their gardens still provided them a critical supply of food in the dry season.

However, over the last few years, since the water levels in the Se San River started unusually fluctuating as a result of reservoir water releases and the holding back of water, the gardens of local people have been badly impacted due to flooding caused by large water releases from the Yali reservoir. Table III includes information about the number of families whose dry season gardens have been destroyed by dry season flooding. However, it should be noted that the two groups visiting villages used somewhat different methodologies for collecting information about the flooding of dry season gardens. One group asked how many families used to make gardens before dry season flooding began, and the second group asked how many families had dry season gardens flooded in 1999/2000. The problem with the information collected by the second group is that it only considers impacts in 1999/2000, but many families did not make gardens in 1999/2000 because their gardens were flooded in previous years, and therefore they had already given up gardening before this year. Therefore, the second group's figures greatly underestimate the impact that dry season flooding has had on dry season river bank gardening in the villages they visited. The total number of families recorded to have lost gardens to dry season flooding was 1333, plus an additional six ha (see Table III). However, it seems likely that if the methodology of the first group had been used by the second, the actual number of families would have been much higher, possibly more than 1800 families, or about 50% of all the families living along the Se San River in the province.

3.5) Other Losses Due to Rainy Season Flooding

Apart from causing a large amount of damage to agriculture crops and domestic animals, rainy season flooding, and to a lesser extent dry season flooding, has also caused many other material losses for local people. Most families have lost large quantities of household items, such as pots, plates, bowls, cups, spoons, mats, gourd bottles, motar and pestles, trays, baskets, cassette players, buckets, clothing and even salt. Wood for building houses and for making roofs has been lost, and agriculture tools, such as plows, shovels and hoes have been washed away (see Table V). While the monetary value of these items may not seem to be great to foreigners accustomed to a high material standard of living (see MRC, 2000, and accompanying letter from Jorn Kristensen, Chief Executive Officer, MRC Secretariat, to Mike Ounsted, Oxfam), the loss of these bought and homemade items is very significant for people without the financial means or the energy to replace them.

Although not all villages provided detailed information regarding the damage floods did to rice barns and rice stocks, the few that did reported that significant amounts of stored rice were lost, particularly in 1996 and 1999, when floods were highest. At least 50 tonnes of rice has been lost due to flooding (see Table V), and it seems likely that the actual amount is much higher.

In addition, rainy season floods washed away at least 39 houses and a large number of field houses (see Table V). Most of these were lost during the biggest floods in 1996 and 1999. Houses were also damaged, and in Pong Village, Voen Say District, the cement structure of the village's Buddhist temple was seriously damaged because of flooding (see Table V).

3.6) Impacts on Riverine Vegetation in the Se San River in Ratanakiri Province

Local people living along the Se San River in Ratanakiri Province have long collected various kinds of aquatic and riverine vegetables to supply themselves with nutritional food. However, all the local people interviewed during the survey reported a vast decline in these vegetables, due to unnatural flooding in the dry season, which has interrupted the lifecycles of riverine vegetation. One shrub species that grows in rocky parts of large rivers in northeastern Cambodia and southern Laos is *Telectadium edule* (Asclepiadaceae) (*"Pkar Ondaeng"* in Khmer). It generally flowers in the dry season, but over the past few years unnaturally high waters in the low water season have resulted in no flowering occurring, since the flowers have been flooded. These flowers used to be an important food for local people and fish (especially *Osphronemus exodon, Pangasius pleurotaenia* and *Hypsibarbus wetmorei*), but they are no longer available for eating. Many trees and bushes in the riverbed have also been uprooted and killed by the unnaturally high surges of water, and high levels of erosion has degraded stream bank habitat and caused a large number of trees and bushes to fall into the river, further destabilising the river banks, and leading to further erosion downstream.

Villagers report that at least 14 types of riverine plants that they used to collect to eat have been seriously impacted over the last few years. Their names, in Lao, are *"Kok Doke Khai"("Pkar Ondaeng"* in Khmer), *"Phak Khi Khouay", "Phak Kadang Khom" ("Pamut Dai"* in Khmer), *"Phak Hai Kai", "Phak Peo/Phak Pawng", "Phak Ket Hoi", "Phak Tang Som", "Phak Koum", "Phak Kout" ("Pamoi Damrey*" in Khmer), *"Phak Kam", "Phak Mai", "Phak Kout", "Phak Nyawt Seng",* and *"Phak Kadon Nam" ("Drouay Arieng"* in Khmer) (minorly impacted*).* It was not possible to determine the names for all of these plants in Khmer, since very few ethnic Khmer speakers live near the Se San River in Ratanakiri, and most of those who do have only lived in the area for a relatively short period, and are not familiar with the native plants of the area. In any case, these impacts were reported all along the Se San River in Ratanakiri, but were especially severe in upper parts of the river in Andong Meas and O Yadao.

In some areas, local people have also reported that even the wild tubers and cassava that they rely on for food during rice shortage periods in the rainy season have

been impacted by rainy season flooding, because long periods of flooding can also kill them. This problem has resulted in local people sometimes having to travel long distances to access these important plants.

3.7) Impacts on Wildlife in the Se San River Basin in Ratanakiri Province

Wildlife in Ratanakiri Province has been seriously impacted by changes in hydrological patterns in the Se San River, as well as possibly water quality changes as well. These impacts are especially significant in terms of the management of Virachey National Park, which is situated on the northern side of the Se San River in Ta Veng and Voen Say Districts (Ashwell, 1997; Samith *et al.,* 1995).

3.7.1) Impacts on Reptiles

The Yali Falls dam has apparently had an impact on a number of reptile species, both directly and indirectly. The soft-shelled turtle *Pelochelys cantorii ("Kanthi-ay*" in Khmer) has reportedly been heavily impacted by irregular Se San River water levels in the dry season, which have resulted in nests on sand bars being inundated, and the species' eggs becoming rotten. Since this animal is largely restricted to larger rivers, it is unlikely to be to adapt to laying its eggs in small streams, and may be the reptile most vulnerable to dam-induced downstream impacts over the long-term (*pers. comm.,* Bryan Stuart, May, 2000). It should, however, be noted that this species has also been seriously impacted by over harvesting and the wildlife trade, although the other soft-shelled turtle found along the Se San River *(Amyda cartilaginea)* (also *"Kahnthi-ay"* in Khmer) is in greater demand by wildlife traders. However, the second species is more common in smaller tributaries, and therefore may be more adaptable to flood conditions (*pers. comm.,* Bryan Stuart, May, 2000). Nonetheless, the nests of populations living along the Se San River are probably being impacted.

The iguana *Physignathus cocincinus ("Ka-trawng"* in Khmer*)* also lays its eggs on sand banks in the dry season, although it generally lays them higher up the bank compared to soft-shelled turtles, and therefore nests are sometimes out of the reach of dam caused dry season floods. Moreover, the species lays it eggs more commonly in small tributaries, which are generally not directly impacted by the dam during the dry season (*pers. comm.,* Bryan Stuart, May, 2000). Nevertheless, the reproductive success of populations along the Se San River may have been hindered by dry season water releases, as widely reported by villagers.

The water monitor lizard *(Varanus salvator)* (*"Awnsawng"* in Khmer) also sometimes lays its eggs on sand banks in the Se San River, and villagers report that its eggs have also been washed away during dry season flooding. However, this species also lays its eggs in other habitats that are less vulnerable to dry season flooding caused by the Yali Falls dam. Lizard eggs from an unidentified species (*"Pakouay"* in Khmer) have also reportedly been flooded on sand banks during the dry season.

3.7.2) Unexplained Wild Mammal Deaths

People from many communities along the Se San River have reported finding dead wildlife near their villages over the last few years. Many villagers believe that the wild animals had gone down to the Se San River to drink before dying, and sometimes their tracks going down to the river were observed by locals. The species most commonly reported were Wild Boar (*Sus* spp.) *("Jarouk Prey"* in Khmer), Barking Deer *(Muntiacus muntjak*)(*"Chalou"* in Khmer), and Sambar Deer *(Cervus unicolor)(*"*Preu"* in Khmer*)*. In addition, a small number of Civet Cats *("Sawmpoi-it"* in Khmer), Porcupines (*"Prama"* in Khmer) and Rodents *("Gandol Thom"* in Khmer) have also been found dead in the forest. People from one village in O Yadao District, near the Vietnamese border, reported finding 10 dead Gaur *(Bos gaurus) ("Kating"* in Khmer*)* near the Se San River over the last year (see Table II).

Dead wild animals were generally more commonly observed in villages where there were few dry season water sources apart from the Se San River, and where wild animals presumably had to go down to the Se San River to find water to drink. Villagers often reported that dead wild animals were rarely found far from the Se San River. Local people in some villages observed that while dead animals had been found in the past, but the cause of death of animals found recently appeared to be different than what they were used to. Previously, they sometimes found animals that had been killed by wild dogs. After the dogs had eaten some of the meat, villagers sometimes collected the rest and took it home to eat. However, the animals they have found recently are different than those animals in that they have no fat on them, indicating to villagers that they have not died from being attacked, but from some kind of disease. Some have speculated that they may have died from drinking water in the Se San River. However, it is difficult to confirm the reasons for why the wildlife have died, as it is possible that other disease have caused death, including ones transferred from domestic animals. Still, the possibility that toxic compounds in the water of the Se San River have poisoned wildlife cannot be ruled out.

It is a concern that in recent years a number of dead otters (*Lutrogale*/*Lutra* spp.) *("Phay"* in Khmer) have been found in the Se San River. Villagers are not sure why these animals died, but suspect that it has something to do with the quality of water in the river.

3.7.3) Impacts on Birds

A number of bird species have apparently been seriously impacted along the Se San River in Ratanakiri due to irregular dry season water releases from the Yali Falls reservoir. Timmins and Men Soriyun (1998) reported that the Se San River in Ratanakiri contained possibly the most important populations of River Lapwing *(Vanellus duvacelii),* River Tern *(Sterna aurantia),* Small Pratincole *(Glareola lacteal),* and Great Thick-knee *(Esacus recurvirostris)* in Indochina and Thailand. In addition, a small but important population of the globally threatened Black-bellied Tern *(Sterna acuticauda)* was also found along the Se San River. All five species lay their eggs on dry season sand

banks in the Se San River, but villagers have widely reported that the first four species have been unable to reproduce in recent years because after they have laid their eggs, water levels have suddenly risen and all the eggs have either been washed away or have been smothered. Villagers believe that populations of these species, and probably the black-bellied tern as well, have declined dramatically since water levels became irregular. We saw some River Lapwings, Small Pratincoles and River Terns when traveling up and down the Se San River, but villagers believe that they have not been able to successfully reproduce, and that only old birds remain. Villagers have observed very few juveniles, and we did not observe any either. It should be noted that while locals sometimes hunt the Great Thick-knee for food, the other species are hardly ever hunted, although their eggs are sometimes collected for food. In any case, impacts to their populations are likely to be mainly the result of the dam.

It is likely that other bird species are also being impacted by the irregular water levels, but to a lesser extent. For example, Bee-eaters *(Merops spp.),* the Pied Kingfisher *(Ceryle rudis),* the Common Kingfisher *(Alcedo sp.)* and White-throated and Stork-billed Kingfishers *(Halcyon spp.)* nest in the banks of the river, and some of their holes have reportedly been inundated during dry season flood periods, although others are located high enough up the banks to escape from being flooded. Fish declines associated with dam impacts may also be making it harder for birds of prey, such as Brahminy Kites *(Haliastur Indus) ("Khleng Phleung"* in Khmer) and Grey-headed Fish-eagles *(Ichthyophaga ichthyaetus)* to find food. Other fish eating birds like Grey Herons *(Ardea cinerea)* and Egrets may also be subject to impacts due to declines in their food supply, as well as possibly habitat loss. The three species of vultures *("Thamat"* in Khmer) found along the Se San, as well as populations of Woolly-necked Storks *(Ciconia episcopus)* and Lesser Adjutants *(Leptoptilos javanicus)("Draw-daw Douic"* in Khmer) could be impacted through declines in fish populations as well (*pers. comm.*, Colin Poole, May, 2000). It is unclear how much oriental darters *(Anhinga melanogaster)("Saman"* in Khmer) have been impacted by the changes in hydrology, and it has not been determined whether any species of birds have been impacted by changes in water quality.

Local people in a number of villages along the Se San River reported finding large numbers of dead Spotted Doves *(Strptopelia tranquebarica)("Lo Lok"* in Khmer) and Red Jungle Fowl *(Gallus gallus)("Moa-an Prey"* in Khmer*)* in the forest near the Se San River in recent years. They believe that their deaths may be associated with the consumption of water from the Se San River. However, this hypothesis could not be verified during the study.

3.8) Impacts on Aquatic Resources in the Se San River Basin in Ratanakiri Province

It is clear that changes in hydrological patterns in the Se San River, as well as changes in water quality, have seriously impacted aquatic resources in the province.

3.8.1) Impacts on Fish, Fish Habitat, and Fisheries

Local people living along the Se San River believe that almost all fish species in the river have been negatively impacted by unusual hydrological and water quality conditions. However, it appears that some species have faired worse than others.

One important problem relates to important deep-water pools in the Se San River, which have become critically shallow over the last few years due to increased silt deposition and possibly river scouring caused by downstream erosion resulting from the Yali Falls dam. For example, one deep-water pool in Voen Say District near Tiam Kroam Village was reportedly 7-8 metres deep just 3 years ago. Now, when water levels drop to their extreme dry season levels, the area is only about one half metre deep. Therefore, the area is no longer able to support many of the deep-water fish species that used to be found there. Some of the main fish species that have reportedly decreased in numbers, or have almost completely disappeared, are species that previously relied on this deep-water habitat, especially in the dry season. They include the catfishes *Pangasius krempfi ("Trey Pra"* in Khmer), *Pangasius conchophilus ("Trey Ke"* in Khmer),, *Pangasius polyuranodon, Pangasius larnaudiei ("Trey Po"* in Khmer) *Belodontichthys dinema,* and *Micronema micronema ("Trey Ke"* in Khmer). Other large catfishes, like *Hemibagrus hypopthalmus ("Trey Khya*" in Khmer), *Wallago attu* and *Wallago leeri* are still found in the river, but populations have reportedly dropped dramatically. The catfish *Bagarius yarrelli* was also reported to have seriously declined since the dam impacts began. The large snakehead, *Channa micropeltes* has also reportedly been impacted heavily, although it is unclear why this species has disappeared from many parts of the Se San River over the last few years, since it is not a deepwater species. Generally, the largest fish species seem to have been the most impacted.

As explained earlier, one serious impact of the Yali Falls dam has been downstream riverbank erosion along the Se San River in Ratanakiri. Apart from badly affecting riverbank habitat and filling up deepwater pools, the increased turbidity in the water has probably also badly affecting various species of fish in other ways. For example, one species of fish that local people say has disappeared over the last few years is *Macrochirichthys macrochirus*. This species is known to be very sensitive to changes in water quality, including increased levels of nitrates (Baird *et al.*, 1999; Rainboth, 1996). It is also important to recognise that increased turbidity in the river is probably seriously impacting primary productivity, since light cannot penetrate highly turbid waters, and therefore algae production based on photosynthesis is likely to be greatly reduced. This is bad news for algae grazers, such as the famous fish species *Mekongina erythrospila ("Trey Pa Sa-Ee"* in Khmer*)* and *Labeo erythropterus ("Trey Pa Va"* in Khmer*)*, as well as many other species. However, there is little known regarding the tolerance of most fish species to changes in water quality and water temperature, and therefore it is difficult to know exactly how various fish species are being affected by the turbid water of the Se San River. Nevertheless, it seems likely that many species are probably being impacted, and that the entire aquatic community is undergoing vast shifts due to changes in water quality. This is likely to disrupt the lifecycles of many species of

fish, reduce reproductive success and juvenile survival rates for various species, and ultimately result in decreased biodiversity and fisheries productivity in the Se San River.

Migratory fish species have also faired poorly in general, although some of the small cyprinids that move up the Mekong River from the Great Lake and other parts of Southern Cambodia in the early dry season (Baird, 1995) are still migrating up the Se San River each dry season, although in smaller quantities compared to before. Unnatural fluctuations in water levels in the Se San River can be expected to confuse and seriously affect migratory species, since many rely on hydrological triggers to start them off on their migrations (Baird *et al.,* 1999; Rainboth, 1996; Baird, 1995).

One of the reasons why fish populations have declined steeply in the Se San Rivers is that dry season water levels have been reduced to their lowest levels ever, due to periodic closures of the dam. When water levels are so low, the amount of water and fish habitat left in the river is reduced to very low levels, and fish can generally survive in just a few relatively deep areas over large stretches of river. Moreover, as mentioned earlier, most deepwater pools have become increasingly shallow, which further reduces the habitat available. This situation makes fish very vulnerable to fishing activities, including both legal and illegal methods, as areas that could previously not be fished can now be easily accessed. Many villagers have reported catching a relatively large amount of fish the first time water levels dropped to their lowest levels, but once those fish had been caught, they soon found that the next time water levels rose and dropped again, they were not able to catch nearly as many in the same location. Since local people have never been in a position in which they could fish the river at such a low level, they have not developed traditions to ensure that they do not cause damage when water levels are so low. If the dam had not been built, fishers would not be in a position to over-harvest fisheries resources as much, and these synergistic impacts would not be occurring.

Certainly the decline in fish catches in the Se San River cannot be entirely blamed on the Yali Falls dam, as there was already an apparent modest decline in fisheries along the Se San River prior to the building of the dam (Baird, 1995). Nevertheless, as has already been outlined above, it is only reasonable, based on what is known about riverine ecology, to expect that the Yali Falls dam is causing serious impacts to fisheries in downstream parts of the Se San River in Ratanakiri. Moreover, the declines in fish catches that have consistently been reported by villagers living along the Se San River during the survey are much greater, and have occurred much more rapidly, than declines previously observed (see Baird, 1995). It is now typical for villagers to claim that their fish catches have declined to just 10-30% of what they were four years ago, before the impacts of the dam were first observed. While some of the decline in catches can be attributed to the loss of fishing gears due to water surges, and the inability of fishers to put gears in certain places that are particularly vulnerable to rapidly rising waters, local people are adamant that real declines in fish stocks and species diversity are a major problem. They claim that the problem has become much more serious since the dam began causing impacts downstream. In that most villagers used to consume fish as their main source of protein, as well as sell fish to generate an important source of income

(Baird, 1995), these declines in fisheries have greatly affected local people living along the river.

3.8.2) The Spread of Epizootic Ulcerative Syndrome (EUS)

Epizootic Ulcerative Syndrome (EUS) is a mysterious disease or bacterial infection that leads to ulcer-like wounds on fish (usually their heads and fins), which eventually causes them to die. EUS was first encountered in Thailand over 25 years ago, and has since spread throughout Indochina, including southern Laos and northeastern Cambodia. Although it is still not entirely clear what EUS actually is, or how it is contracted, recent research has suggested that it may be a fungal infection, and that it might have been originally introduced to the region through the transfer of fish used for aquaculture purposes. Research in Bangladesh has linked some of the most serious outbreaks of EUS with environmental degradation, although there is still much that is not known about its proliferation (Baird *et al.*, 1999).

EUS has occurred in the Se San River Basin for at least over a decade, and it is well known to local people living along the Se San River in Ratanakiri. However, in the past EUS was largely isolated to seasonal streams and wetland ponds, and fish with ulcers caused by EUS were rarely, if ever, encountered in the mainstream Se San River. The fish species mostly affected were *Channa striata ("Trey Rok"* in Khmer) and *Clarias batrachus ("Trey Ondaeng"* in Khmer), as well as other wetland species. Environmental conditions, including regularly flowing water in the Se San, apparently prevented its occurrence in the main river. However, villagers now report that over the last few years EUS has spread to the mainstream Se San River, where it has apparently seriously impacted fish species in the river that were previously unaffected by EUS. While the carps have reportedly been affected the most, including *Cyclocheilichthys* spp., *Hypsibarbus* spp. *("Trey Speun"* in Khmer), and *Henicorhynchus* spp. *("Trey Riel"* in Khmer), just to name a few, other species like the catfishes *Hemibagus hyphophthalmus ("Trey Khya"* in Khmer) and *Hemibagrus nemurus ("Trey Shlung"* in Khmer) have also reportedly been infected.

It seems possible that the spread of EUS is related to changes in the hydrological condition of the Se San River. The Se San River now sometimes becomes very shallow at the height of the dry season when the Yali Falls dam is closed – much shallower than it ever was in the past. Since the river hardly flows during the extreme low water periods, conditions similar to those found in natural wetlands and seasonal streams are partially replicated. These conditions may have provided EUS with the opportunity to establish itself in the mainstream Se San River. Whatever the case may be, local people report that EUS is killing large numbers of fish in the Se San River, although they have not been able to quantify these impacts.

3.8.3) Impact on Shellfish, Crustaceans, Insects and Earthworms

Widely fluctuating water levels in the dry season have apparently caused serious impacts to various species of shellfish in the Se San River. These include at least three

species of edible bivalves *("Ki", ("Kroum"* in Khmer) *"Ki Noi"* and *"Kouang"* in Lao) and another four species of edible gastropods *("Hoi Sai"("Khayawng Dong" in Khmer), "Hoi Kon Lem"("Khajao"* in Khmer), *"Hoi Choup"* and *"Hoi Hin"*). The major impact to shellfish relates to their tendancy to move up the banks of the river as water levels rise. However, when water levels drop dramatically, as is presently often the case, the shellfish are often unable to retreat rapidly enough, and so many die due to desiccation. Villagers report that large numbers of shellfish have died over the last few dry seasons, since water levels in the Se San River went down to levels previously unknown. The result has been a major reduction in shellfish populations.

Earthworm populations along the edge of the Se San River have also been devastated due to widely fluctuating river levels. They have either been drowned by rapidly rising water, or have died due to desiccation after water levels have dropped rapidly.

Shrimp species and small fishes have ended up trapped in small pools, and have died in large numbers as well. Even edible species of insects that burrow in sandy areas, such as two species of mole cricket (family *Gryllotalpidae) ("Meng Khi Nai"("Sat Jawng Ret"* in Khmer*)* and *"Meng Khi Lo"* in Lao) and two other varieties of edible *("Meng Khi Noun"* and *"Meng Juk Jun"* in Lao) *("Sat Kha Noun"* in Khmer) have been badly affected by the widely fluctuating water levels. It appears that the lifecycles of most of the biota dependent on the Se San River in the dry season have been terribly impacted by irregular hydrological conditions.

3.8.4) Fishing Gear and Boat Losses

Apart from being faced with steep declines in fisheries and other aquatic life, local people have been seriously impacted materially by irregularly fluctuating water levels in the Se San River. One important impact has been the washing away of fishing gears and boats when water levels quickly rise due to water releases from the Yali reservoir. Gillnets and many other fishing gears are often set at night and retrieved the next morning, but when water levels rise rapidly at night, the gears end up floating downstream, where they are generally irretrievable. Although the price of gillnets, castnets, longlines and hooks varies greatly depending on the size and type of gear purchased, large-meshed gillnets often cost about US$ 20 each, which is a large amount of money for a poor villager. Therefore, it is not surprising that fishers often complain bitterly about losing gillnets and other fishing gears, such as large and small basket traps, funnel traps and falling-door traps, which are made by their owners using bamboo and rattan. Villagers reported losing 9563 gillnets, 129 castnets, 300594 hooks (including longlines), 24192 small basket traps, 5606 large basket traps, 2187 funnel traps and 5247 falling-door traps since the water fluctuations began (see Table III). Most losses have occurred during the dry season, when villagers are not wary about rapidly increasing water levels. Moreover, most losses have occurred over the last two dry seasons, when water levels have fluctuated the most. Stolen fishing gears were not included in the statistics. It is unclear whether the massive numbers of gillnets lost have been acting as

"ghost nets", which are nets which are still capable of catching fish, but are not checked by people and therefore waste fisheries resources.

Dugout canoes are often lost when water levels rise rapidly, and there is no opportunity for their owners to tie them safely higher up the riverbank. At least 1191 boats have been lost since the Se San River problems began. In addition, 18 engine boats were lost (mostly 5.5 and 8 hp engines), and one electric generator was damaged beyond repair (see Table III).

Apart from the boats listed above, which were irretrievable or damaged beyond repair, a smaller number have been retrieved, although their owners were only able to get them back after agreeing to pay the people who caught them as they floated downstream. Some poor villagers were able to find their boats after searching for them downstream, but since they could not afford to pay to get them back, many ended up abandoning them for those who caught them as they floated downstream. This situation has sometimes resulted in bad feelings and arguments between individuals and communities, and has had a negative impact on village relationships and village solidarity.

Because most boats used along the Se San River are dugout canoes made of single large trees, the loss of boats requires villagers to cut down large trees to replace them. Therefore, this is likely to have some impact on forestry resources. Nevertheless, boats are critical for local people, and it would be unreasonable to expect that villagers would not need to make new boats replace lost ones.

3.9) Impacts on Gold Panning in the Se San River in Ratanakiri Province

One of the most important dry season occupations for local people living along the Se San River used to be gold panning. It was especially important in Andong Meas and O Yadao Districts, where gold is very plentiful in the riverbed. Local people used to rely on gold panning to supply them with funds to buy rice in years of shortages, and when they wanted to buy a buffalo or a cow, gold panning was the main means for getting the income needed to do so. Of the 59 villages surveyed, 47 reported that they used to do gold panning up until the time that dam induced irregular water fluctuations started occurring. Since then, virtually everybody has stopped looking for gold (see Table V). In the upper parts of the basin, it is the shear fear of surges of water tumbling down on top of them that has caused people to stop gold panning. However, in lower parts of the river, locals have stopped because if they dig a deep hole in the riverbed to reach gold deposits, it becomes filled with silt when water levels rise. Then when water levels drop again, they have to dig the hole again. This has discouraged people from continuing to look for gold.

3.10) Indirect Impacts on Terrestrial Natural Resources and Livelihood Systems

It is important to recognise that the Yali Falls dam has caused indirect downstream impacts that are not easily recognisable at first glance. Because agriculture has been severely impacted by flooding, and local people are no longer able to harvest as

many resources from the Se San River, they have had no choice but to turn to the forests and upland areas to supply them with the resources they need to survive. In the past locals also relied on these forest and upland resources, but they were able to balance their harvesting patterns between the river and the forest, and they generally did not have to sell as many non-timber forest products (NTFPs) to get money to buy rice. Villagers are the first to admit that increasing their resource harvesting activities in the forests has resulted in an imbalance that has lead to resource overexploitation. They lament the result, which has been a depletion of certain forest resources. Increased wildlife trade has been one way in which locals have managed to make ends meet, but now most villages claim that the main species that they used to trade, monitor lizards, turtles and snakes, have become scarce. In other cases, the collection of forest fruits, wild mushrooms and dipterocarp resin has not had such a negative impact on sustainable forest use, but generally speaking, locals recognise that impacts caused by the dam has forced them to overexploit terrestrial resources. "We are starving", said one villager, "What else can we do? If the dam was not impacting us we would not be causing nearly as much damage." However, villagers are also worried about the future, because now that some NTFPs have been overexploited, they wonder what will be available for them to fall back on in the future, if they continue to be impacted by the dam.

Villagers living along the Se San River have also been adopting other strategies to try to alleviate their problems. For example, 20 Lao families from Hat Pok Village have started doing swidden agriculture in upland areas far from their village. In Pong and Fang Villages, two other Lao communities in Voen Say District, most of the people in the village have started doing swidden agriculture behind their communities, although they have very little experience doing swidden. According to villagers in Pong Village, the forest behind their village has all been flattened as a result, and they admit that do not have as good a system for doing swidden compared to indigenous peoples living along the Se San River. Other ethnic groups conducting swidden agriculture have also generally increased the size of their swiddens, in order to try to get out of their difficult situation. They have also begun cutting new fields along the roads far from the river, in order to try to escape the impacts of the dam.

It is clear that the impacts of the Yali Falls dam in Ratanakiri extend far beyond the river itself. It is also clear that "development" will be almost impossible to achieve in impacted communities as long as they continue to suffer from the dam. Villagers in many communities reported that in recent years they have sold off what valuable items they used to have in order to buy rice to eat and other necessities. For example, some women in Lam Pat used to have a limited amount of gold jewelry, but since the impacts began it has all been sold off. They do not have anything more to sell, they said, and are more vulnerable to impacts than in the past.

Over the course of the survey, a large number of village leaders representing a broad cross-section of ethnic groups reported that if the impacts along the Se San River continue, their communities could be forced to move to higher ground and away from the Se San River (see Table V). While this is not surprising in terms of highlander villages, since many are more familiar with upland areas than lowland areas anyway, it is

surprising to hear the same story coming from ethnic Lao communities that have inhabited their villages for up to 200 years. The Lao stated that they would not be able to stay in their communities for much longer, if the impacts continue. However, they also emphasized that they do not want to abandon their villages, unless it becomes necessary. They admitted that they are generally not familiar with life in upland areas, and emphasised that they were only considering the option of moving because the situation is so critical.

The implications of both the direct and indirect impacts being caused by the Yali Falls dam in Ratanakiri Province are very significant in terms of the management of Virachey National Park, and the present situation is likely to make it much more difficult to protect natural resources within and outside of the protected area. However, it would be insensitive and unproductive to blame local people for the problems they may cause in terms of natural resource management in the protected area, because local people are faced with desperate conditions, and have few options for survival. Instead, the impacts facing the National Park must largely be attributed to the dam, which has forced the crisis on the people.

3.11) Impacts and Gender

The downstream impacts of the Yali Falls dam in Ratanakiri Province have been serious for both men and women. However, local people living along the Se San River largely believe that women have been affected more by the changes that have taken place compared to men. Of the 59 villages surveyed, 56% of the men's groups interviewed reported that women had been affected more than men, while 30% believed women and men had been impacted equally, and just 14% thought that men had been impacted more than women. However, 64% of the women's groups thought women had suffered more than men, while 25% thought the impact had been equal according to gender, and only 2%, or one village, thought men had been impacted more than women. 9% of the women's groups did not provide an answer to the question (see Tables VI and VII for a detailed breakdown by village).

Considering the above question in terms of the different ethnic groups inhabiting the villages visited, it becomes clear that indigenous peoples more stronger belief that women have been impacted more than men, compared to ethnic Lao villages. In fact, the only women's group that thought men had been impacted more than women was ethnic Lao. Of the eight men's groups that reported that men had been impacted more than women, only two were ethnic minority villages, and both of those were situated in close proximity to ethnic Lao villages in Voen Say District. Both the men and the women in the one Chinese village thought that both men and women had been impacted equally (see Tables VI and VII).

It is not entirely clear whether the differences in perceptions between ethnic Lao groups and indigenous groups are based more on the lifestyles and social structure or fundamental differences in values and perceptions. It may be a little of both. It may also have a lot to do with the fact that the indigenous people are generally less familiar with

living near large water bodies than the ethnic Lao. Moreover, most ethnic minority women are unable to swim, while most Lao women can. It is also true that ethnic minorities are mainly living in the upper part of Se San River Basin in Ratanakiri, while the Lao dominate the lower part of the basin. Therefore, the ethnic minorities have generally had to face stronger water surges, which terribly frightens most the women. However, the Lao have been faced with more problems related to rainy season flooding, which is also causes extreme anxiety.

Livelihood issues are probably a critical factor. In Lao villages most of the fishing activities are conducted by men, and women spend much less time on the river. Moreover, Lao men are generally responsible for providing food for the family. This may be why the Lao tend to believe that men are more heavily impacted, since it has become much more difficult to catch fish in the river, which is by far the most important source of protein consumed in Lao villages. In contrast, it appears that in ethnic minority villages women used to play a somewhat more active role in harvesting resources from the river, although men are still the main users of larger fishing gears like gillnets and castnets in their communities. Women reportedly used to spend a lot of time using scoop baskets to catch small fish and shrimps along the edge of the river, and regularly collected wild vegetables and reptile and bird eggs from the banks of the river during the dry season. Furthermore, the dry season gardens done in the riverbed by the indigenous peoples are generally larger than those done by the Lao, and have traditionally been planted, cared for, and watered mainly by women. Ethnic minority women also used to do more gold panning than Lao women. Many indigenous women are afraid to cross the river without the assistance of a man, whereas in the past they were not afraid to do so on their own. Now that the dam has disrupted all these activities, ethnic minority women feel that they have lost much of their independence, and they must rely on men to supply them with fish and hunt more than before.

Ethnic minority women often report being fearful about going down to the edge of the river, even to collect water, and they also worry a great deal about their children staying next to the river, as they never know when a surge of water might come tumbling downstream. They often tell their children not to play next to the river. The women have become very anxious, and many now expend much more energy to collect water from shallow wells that are generally much farther from the village than the Se San River, where they used to collect water. Women must also expend a lot more labour to dig for wild potatoes and cassava due to rice shortages, since this is mainly the job of women.

Women expressed a great deal of bitterness about the impacts occurring due to the Yali Falls dam. For example, many household items important to women have been lost in floods. One Brao woman from Ta Naich Village said,

> "The things we have lost may appear not to be valuable to the people in the city, but they are valuable for us. The gourds that we use to make water bottles are not easy to make. First, we have to plant them and care for them in our fields. Then after we harvest them, we have to cut their tops off and soak them in mud for a week. After the rotten inside of the

> gourd comes out, we then fill them up with water and leave them to soak for another week. Then we can begin to use them, but it takes a month for the rotten smell to go away. We also make our own mats, motars and pestles, baskets and trays, along with many other things. It takes us a long time to replace those items once they are lost, and a lot of labour."

Another Kachok woman from Nay Village, in Andong Meas District said,

> "I am very angry. I want to see the ones who made the dam. I will tell them we are suffering. I want to break the dam. I will encourage the ethnic minorities living along the Se San River to go to break the dam. If we cannot break it, we will stand right in front of it and tell the dam builders that we suffering."

Although both men and women, especially from ethnic minorities villages, both expressed reservations about receiving compensation for their losses, preferring instead to see the old Se San River returned to them, women articulated these reservations more clearly than men. Women often said that they feared for the next generation. Some said, "What will be left for them?" They also often said that they thought that compensation would not last them a long time. One woman asked,

> "If they want to give us compensation, will they be able to feed us all our lives? It seems impossible, and what about our children and grandchildren? How are they going to survive? We want the old Se San River back so we can fish and do other activities the same as before."

During the course of the survey, it became clear that it was very important that we separated the men and the women into separate groups when conducting interviews. To begin with, women have been less able to participate in village meetings since the UNTAC period, because Women's Union activities have essentially ceased at the village level since then, and a venue no longer exists that allows women to discuss development issues with government. Therefore, the women were glad to have their own meeting, in which men would not dominate them. Women were also glad to hear about the Yali Falls dam from other women, as in past most of the information they have received about the dam has come from men. Therefore, they generally understood less about the dam than men, and their concerns are different from those of men, so they wanted to ask specific questions about the dam.

Another problem is that women living along the Se San River in Ratanakiri, whether ethnic Lao or indigenous peoples, are largely unable to speak Khmer, and so when ethnic Khmer officials hold meetings in their villages, they are largely unable to participate. It is fortunate that the women who conducted the women's workshops during the survey were able to speak the local languages of the communities they visited, and local women expressed their thanks many times.

During the survey we found that while the women were not able to provide as many details regarding the timing of floods, the amount of agriculture land flooded, and the number of boats and fishing gears lost, they generally provided more accurate information regarding the number of people who had died from floods and disease, compared to men. Our experiences represent an important lesson in terms of assessing dam related impacts, because if we had only interviewed men, or mixed groups of men and women, it is likely that we would have under reported the number of people who had perished because of the dam. This may also partially explain why deaths were under reported before we conducted the survey. After village meetings were completed, and we found that women had reported more deaths, we often asked the village headman to clarify the discrepancy. A heated discussion usually followed between the men and women of the village, followed by a meek explanation by the village headman in which he admitted that the women were correct, and that the men had "forgotten" to count some of the people who had died. This problem was especially evident in ethnic minority villages, although it was also true for some Lao villages as well.

This study indicates that, as Ms. Bina Srinivasan recently reported at a World Commission on Dams conference in Bratislava, Europe, specific issues related to the impacts of dams on women are important, and have largely been disregarded and under studied and documented in the past (Srinivasan, 2000).

3.12) Cultural Considerations

The people living along the Se San River in Ratanakiri belong to a diverse array of ethnic groups, and have significant cultural-based differences. However, except for the Lao and the Chinese, who are largely Buddhist, the vast majority of the indigenous peoples living along the Se San River in Ratanakiri are Animists, with deep spiritual connections to nature and the spirit world (Baird, 1995).

In that most of the people did not even know about the Yali Falls dam until long after impacts were first observed, many people have associated problems with flooding and irregularly fluctuating water levels with spirits, who many believe are angry with them and punishing them. For example, an old Brao man from Ke Kouang Thom Village, Ta Veng District, told us that he had been convinced that irregularly rising waters had been caused by spirits until he heard about the dam. He had sacrificed a chicken and had conducted an *"Arak Paba"* ceremony every time the water rose unexpectantly, before hearing about the dam.

One old Tampuan woman from Kachon Kroam Village, in Voen Say District, recently provided a cosmology-based explanation for why the people along the Se San River are suffering so much from the dam. She provided the explanation shortly after learning that the construction of the dam had begun seven years ago. She said,

> "That is why the weather has changed for so many years but the flooding has only occurred for three or four years. I think the spirit of the water and the spirit of the trees are angry with the humans. Now the Vietnamese

> have blocked the path of the spirits of the water, and the dam has caused many big trees in the reservoir area to be flooded. Therefore, both the spirits of the water and the spirits of the big trees are angry. Then when the Vietnamese releases the water from the reservoir downstream, it is like releasing the angry spirits upon us, and the spirits makes us sick and causes us to die a lot."

3.13) Other Cambodian Villages Impacted by the Yali Falls Dam

Apart from the villages visited during the survey, there are others communities that have been impacted, but were not visited. For example, in Andong Meas District all 34 families from Tang Chi Village (Jarai) moved away from the Se San River due to problems with the Se San River in 1998. All 48 families in Nyang Village (Jarai) moved for the same reasons in early 2000. Many of the families from Nay, Dal and Tang Se Villages have also moved away from the Se San River over the last few years.

In Ta Veng District, the only community that was not included in the study was Ta Bok Village (Brao), since it is now situated far up O Ta Bok Stream, far from the Se San River. Although the village has probably not experienced serious impacts from the Yali Falls dam in recent years, it should be noted that about ten families from the village were situated along the Se San River in 1996 when the first big dam related floods took place. Therefore, in that year those families were probably impacted.

There are a number of villages situated along the Se San River in Se San District, Stung Treng Province, just downstream from Voen Say District, and upstream from the Se San/Sre Pok confluence. While they were not visited, villagers living on the Ratanakiri side of the provincial border reported that they have also been seriously impacted. The villages are called Phan (Kreung), Svay Lieng (Khmer Kho), Talat (Khmer Kho), Saysami Thom (Khmer Kho), Saysami Douic (Khmer Kho), Kalaphou (Khmer Kho) and Sre Ko (Lao). There are also a large number of villages situated along the Se San River below its confluence with the Sre Pok River, and it is presently unknown how much they have been impacted, and how much the water flow from the Sre Pok River has been able to mitigate the downstream impacts of the Yali Falls dam.

It should also be recognised that local people from many other villages situated far from the Se San River have traditionally traveled to the Se San to fish or conduct other economic activities. For example, people from the district centre of O Yadao used to travel to the Se San River for fishing on a irregular basis. Others have gone to the river to pan for gold. However, since fisheries have declined in the river over recent years, and gold panning has become dangerous, people do not make the trip as much as they used to. The same is true for local people from Malik and other villages in Andong Meas that are situated away from the Se San River, but sometimes go to the Se San River for fishing trips, etc. The dam has affected these people, even though they are not situated adjacent to the river.

4) Discussion

Although this study has provided important information regarding the downstream impacts of the Yali Falls dam in Cambodia, one of its major weaknesses of it has been that we have not been able to compare many of the findings to baseline data regarding the environmental and socio-economic conditions along the Se San River before 1996. For example, the only research done on fisheries along the Se San River in Ratanakiri before 1996 was a preliminary study conducted by Baird (1995). Baseline data regarding hydrological patterns and water quality is simply absent. This has made it difficult for us to make definite conclusions related to many of the findings of the study. Nevertheless, strong anecdotal evidence regarding impacts exists, and our inability to provide definitive answers regarding some of the impacts must largely be blamed on the dam builders and their supporters, and the lack of attention they have paid to the issue in the past.

Some proponents of the Yali Falls dam may argue that many of the impacts discussed in this report cannot be proven. This may be partially true, but, again, it should be clearly recognised that the blame for there not being adequate baseline data available must certainly lie with those who were responsible for studying the impacts and facilitating the construction of the Yali Falls dam. They have been the ones who have been negligent in collecting data regarding the social and environmental conditions downstream from the dam in Cambodia before constructing the Yali Falls dam. It would therefore be completely unfair for these same organizations and governments to deny that the impacts are taking place, or to try to play them down. However, this is apparently already happening. For example, the MRC (2000) vastly underestimated the impacts of the Yali Falls dam in Ratanakiri after a short visit to the province in March 2000, and even gave the dam credit for preventing downstream flooding in 1997 and 1998, even though Voen Say was severely flooded in both years! Moreover, they were apparently unaware that part of O Yadao District is adjacent to the Se San River, and so failed to consider the district at all. The fact that the team only visited Voen Say District for about 20 minutes, and failed to visit any community leaders, apart from the District Chief, also illustrates how serious the MRC has taken the issue so far, and partially explains why they failed to recognise the severity of the impacts. They also made the critical mistake of asking the districts to ask the villages to collect data about dam-related losses right around the Khmer New Year, which resulted in a number of villages vastly under reporting impacts, since they did not see the purpose of reporting all the impacts, and were busy with the biggest festivals of the year.

It is also important to recognise that the Environmental Impact Assessment (EIA) for the Yali Falls dam, which was funded by the Swiss Government, coordinated by the Interim Mekong Committee, and conducted by the Swiss company Electrowatt Co. Ltd., only considered the downstream impact area of the project to be eight km long and one km wide (Electrowatt, 1993a & b). Furthermore, no provisions were recommended for monitoring downstream impacts in Cambodia. These critical errors on behalf of the dam builders and their supporters, including the Interim Mekong River Committee (presently called the Mekong River Commission) has made it difficult for us to determine

the exact extent of the impacts of the Yali Falls dam. They have neglected the downstream impacts of the Yali Falls dam almost entirely since the project was conceived, and only began to consider the downstream impacts of the dam after press coverage regarding the plight of impacted villagers in Ratanakiri Province was released in March 2000. Letters from non-government organisations concerned with the situation were also partially responsible for prompting the Mekong River Commission (MRC) to belatedly begin to look into the impacts of the Yali Falls dam in Cambodia in March 2000 (Permpongsachareon, 2000; Ounsted, 2000; MRC, 2000).

5) Recommendations

5.1) Community-based Recommendations

Tables VI and VII include individual community appeals of both men and women, in relation to the downstream impacts of the Yali Falls dam. Readers should consider the appeals of local people carefully. The following is a brief summary of the main points that most villages brought up during the survey.

1) It is important that the serious ecological and socio-economic problems of local people be addressed as soon as possible, as local people have already suffered for over four years and their patience and constitutions are running short.

2) The Vietnamese Government, and those international organizations, foreign countries and companies who have supported them in building the Yali Falls dam should take responsibility for the losses that local people have already experienced, including the loss of life and the loss of livelihoods. Compensation will need to be provided on a continual basis if the impacts from the dam are not alleviated.

3) The villagers living along the Se San River would like to see the Yali Falls dam decommissioned, and the Se San River returned to its natural state. However, if this is not immediately possible, strong measures need to be adopted to mitigate the downstream impacts in Cambodia, including releasing water from the dam in a way that replicates natural flows.

4) Local people living along the Se San River in Ratanakiri Province are not in favour of regulating the Se San River so that dry season river flows are higher than natural flows, and rainy season flows are reduced from natural levels. River regulation will seriously impact a number of important livelihood activities and cause serious ecological problems. They want the old Se San River back!

5) Villagers living along the Se San River in Ratanakiri Province are adamant that they do not want the Se San 3 dam built 20 km downstream from the Yali Falls dam in Viet Nam. They are adamant that the Asian Development Bank (ADB) and other foreign bodies should withdraw all support for the Se San 3 dam and other dams planned in the Se San River Basin in Viet Nam. It should be noted

that the Vietnamese news media recently reported that the ADB has agreed to provide US$ 80 million to help finance the Se San 3 dam (Vietnam News Agency, 17 March, 2000).

5.2) Research-based Recommendations

1) It is critical that a detailed water quality survey be conducted in the Se San River in Ratanakiri Province. However, it should be recognised that the water quality may have changed significantly over the last four years since impacts were first reported. In any case, the basic chemistry of the water needs to be analysed (mainly nitrogen and phosphorous). Algae samples also need to be collected in both a qualitative and quantitative manner, so that toxic compounds from blue green algae can be analysed. There should be 4-5 sampling stations, as sampling in just one location is not likely to be enough.

2) The human and animal health situation in the villages along the Se San River need be carefully monitored, and detailed studies need to be conducted.

3) Downstream impacts on communities situated adjacent to the Se San River in Stung Treng Province need to be surveyed. Investigations should be conducted both above the confluence of the Sre Pok River in Se San Commune, and downstream from the confluence of the Sre Pok River to at least the Mekong River. This baseline survey needs to be done as soon as possible, as villagers in Ratanakiri have reported that at least the villages in Stung Treng province situated upstream from the confluence of the Sre Pok River have been seriously impacted by the Yali Falls dam.

4) Research regarding the impacts of the Yali Falls dam on downstream parts of the Se San River in Vietnam, as well as the project's inundation area, need to be conducted as soon as possible.

5) Erosion and sediment deposition rates along the Se San River in Ratanakiri Province need to be studied so that the risk of rainy season flooding in the lower part of the basin in Ratanakiri can be assessed, as well as other critical ecological and socio-economic issues related to erosion and deposition.

6) The impacts of the Yali Falls dam on fish and fisheries of the Se San River need be studied in greater depth.

7) The impacts of the Yali Falls dam on birds, reptiles and other riverine wildlife need to be monitored and documented in more detail.

6) Conclusions

It is clear that the Yali Falls dam has and is continuing to cause serious downstream environmental and socio-economic impacts in the Se San River Basin in

Ratanakiri Province, and probably in Stung Treng Province as well. These impacts have been recognised by local people since the rainy season of 1996, but have only recently been acknowledged outside of the province. While impacts related to the construction of the Yali Falls dam have already severely affected downstream parts of the Se San River, it is likely that the nature of some of the impacts will change once the Yali Falls dam is fully operating. Nevertheless, it would be naï ve to expect that operational impacts will be any less serious, although they may be different.

The situation along the Se San River is critical, and more attention needs to be paid to solving the problems affecting the ecological processes and the local people who depend on the Se San River in Cambodia. It is also important that other dams planned on the Se San River in Viet Nam, including the Se San 3 dam, planned for 20 km downstream from the Yali Falls dam, not be built, and that international financers, including the Asian Development Bank, not support dams that have such a potential to impact on indigenous peoples and the environment.

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