DRAFT 1 (13 July 2006)

MRC Environmental Risk Assessment Training Program

Chiang Rai/Bokeo Case Study
Workshop 1: Problem Formulation

Lao Consultants:

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Thailand Consultants:

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Mentor: **Professor Barry Hart**

30 June 2006

1. Overall risk assessment objective

- To determine the potential risks to three important environmental values[1] due to human activities[2] in the study region now and over the next10 years.

2. Study area

- The participants made a field visit on the second day of the Workshop from Chiang Rai to the Mekong River at Chiang Saen and Chiang Koch to view land use in the study region. Unfortunately we could not complete our proposed visit to Bokeo Province in Lao PDR.
- Activities seen included: Mekong, Kok, Ruak and Ing Rivers, Chiang Saen wetland RAMSAR site), rice fields, maize fields, major towns - Chiang Saen and Chiang Koch, human settlements along river, intake from drinking water treatment plant at Chiang Saen, Chiang Saen port, water transportation, raw sewage discharge to Mekong in Chiang Saen.
- Participants developed a system (big picture) conceptual model - see Figure 1

3. Scope of the project

Spatial

- See Figure 1 for scope - broadly the Mekong River from the confluence of the Ruak River (Border with Myanmar) to 10km south of Chiang Koch, the catchment of the Kok River in Thailand and Bokeo Province in Lao PDR.
- Subsequently, each team further considered the region of study to take account of the area of highest risk for their issue (see Team reports below).

Temporal

Two time periods will be investigated:

- present
- medium term – 10 years.

Future scenarios

The future scenarios still need to be decided. These will probably include all or some of the following:

- *Flow changes* due to upstream development of hydro dams,
- *Increased urbanisation and industrialisation* particularly of Chiang Rai and Chiang Saen,
- *Increase in tourists* visiting the region with subsequent increase in wastewater production,
- *Increased irrigation* during the dry season particularly in ??check with Hans??
- *Land use changes* (particularly further deforestation in Bokeo Province),
- Increases in *water transportation* (particularly due to increased trade with China),

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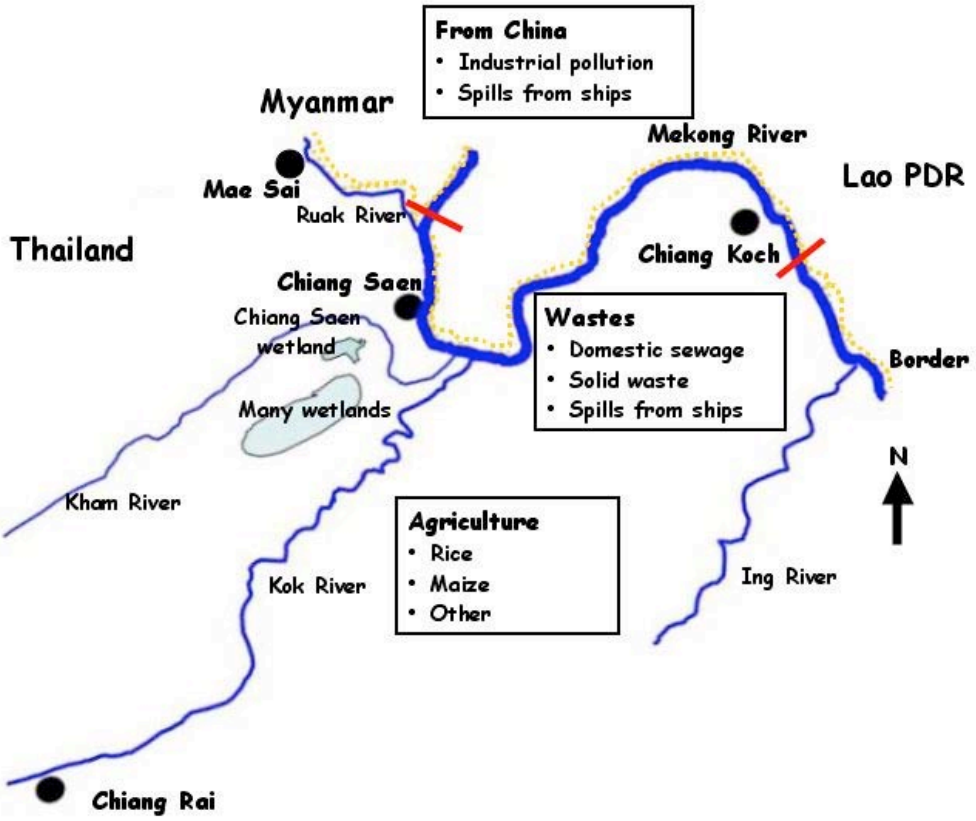
[1] The health of the Mekong River in sustaining Giant Catfish and other fish populations: the health of the human population related to (a) domestic water for drinking and cooking, and (b) contaminated aquatic food resources.

[2] Wastewater from humans, agriculture, water transportation; pollution from upstream Chinese industries; changed flow regimes (e.g. due to Chinese dams); climate change.

- *Climate change*.



Mekong at the Myanmar border	Mekong at Chiang Koch
	

Satellite view of the Chiang Rai region

Satellite view of the study region (yellow line is Cambodian/Vietnam border)

General information needed

General information required for this Case Study is listed below.

Information	**Where to find?**	**Who will find?**
General climate (rainfall, temperature, humidity)	MRC Lao Hydrology Dept	Arounna Chanthasack
Population profile: • Numbers in larger town, numbers in municipality, numbers of farmers • Itinerant workers (approximate numbers)	Chiang Rai Bokeo	Pornsak Doungchan
Flow regime • long term monthly flow (mean + sd, also median and confidence intervals) • flow rate at different times of year	MRC	Arounna
River morphology • cross sections • longitudinal profile	Thai Water Resources Department	Pornsak
General water quality (COD, DO, Nutrients (TP, TN, NO3), pH, Turbidity)	MRC/Burgeap report*	Arounna Bouakeo (Lao information)
Agriculture • Type and location of agriculture on both sides (Number of hectare of rice, maize, fruit trees, forests) • Crop seasons • Fertilizer use • Pesticide use • Any information on agricultural runoff	Thai and Lao Dept Agriculture	Who????
Domestic wastewater and stormwater (volume, where discharged, what treatment if any)	Municipalities	Pornsak Bouakeo
Pollution from China	Website for Yuanan University	Prof Hart
Water Transportation • Number large boats/day at Chiang Saen port • Approximately number crew members per boat • Type of goods transported	Chiang Saen Port Authority	Santiwat

* Burgeap & Cemagref (2004), Transboundary and Basin Wide Water Quality Issues in the Lower Mekong Basin, Report to Environment Program, Mekong River Commission, 2004.

4. Environmental values/issues considered

The group identified seven key environmental values (or issues). These are listed below.

The group then used two methods to rank the issues.

First (and before the field trip) individual team members were asked to rank their top three issues. The votes are shown in brackets.

Issue	Votes	Rank
River health - catfish/other fish	11	**1**
River health - general ecol health	5	**4**
Wetland health	2	**5**
Human health (domestic)	8	**2**
Human health (contaminated food)	6	**3**
Recreational health	0	**7**
Fish cage aquaculture	1	**6**

Second after the field trip the group were asked to qualitatively assess the risk of each issue on the basis of Risk = Consequences x Likelihood. The consequence ranking was 1 (good) to 5 (very bad effect) and the likelihood ranking from 1 (unlikely) to 5 (very likely). The ranking are provided in the table below.

Environmental value/issue	Group 1	Group 2	Group 3	Group 4	Group 5	Overall rank
River health - catfish/other fish	1	3	4	1	1	**1**
River health - general ecol health	2	3	1	3	4	**2**
Wetland health	5	6	6	7	4	**7**
Human health (domestic)	2	2	4	4	1	**2**
Human health (contaminated food)	2	7	1	4	1	**4**
Recreational health	7	1	6	2	4	**5**
Fish cage aquaculture	6	3	1	6	4	**5**

5. Issues for study

It was agreed that the environmental management goal for the study region was to maintain and protected the following environmental values:

- Improve the numbers of *Giant Catfish and other fish* in the Mekong River in the study region,
- Protect *human health* in the study region by maintaining *adequate quality water for drinking and cooking,*
- Protect *human health* in the study region by preventing *contamination of food* (particularly fish and other aquatic foods).

6. Study Teams

Study teams are:

Team 1 – River health - fisheries production • Dr Santiwat Pithakool (Coordinator) • Dr Narumon Sanpgradub • Ms Souvany Phommakone	
Team 2 - Human health – drinking water • Dr Voranach Wangsupachart • Mr Porsak Jevasuwan (Coordinator) • Mr Bouakeo Suvanthong	
Team 3 – Human health – contaminated aquatic food • Mr Chanthasack Bottaphanith • Mr Douangchan Lopaying • Dr Kannitha Krongthamchart (Coord)	
Modelling team • Ms Amphone Vongvixay • Dr Chavalit Ratanathamskul	

7. Hazard/threat analysis

The following major hazards (threats) were identified:

- *Domestic wastewater* discharged from Chiang Rai (population ????) to the Kok River, and from Chiang Saen (population ???) and Chiang Koch (population ????) to the Mekong River. These effluents include untreated sewage and stormwater. Possible adverse effects due to these wastewater discharges may occur in the vicinity of the city and further downstream. The risk assessment will determine the extent of possible downstream effects.
- *Agricultural* runoff to the Mekong River also occurs in the study region. This runoff may contain pesticides and herbicides, nutrients, suspended sediment and organic matter, and are a risk to the river and associated wetland ecosystems.

- *Industrial pollution* from China has also being identified as a possible risk the upper Mekong River in the vicinity of Chiang Saen. Currently, we have very little information on the types of industries that exist along the Chinese section of the Mekong River and of the composition of any waste discharges.
- *Water transport* – a large number of large boats transport goods from China to Thailand and Lao PDR through the Chiang Saen port. We will assess the risk to the river ecosystem and human health from possible spills of chemicals and oil from these ships.
- *Reservoirs* are being built upstream in the Chinese section of the Mekong River, and these have the potential to significantly alter the river flows in the study region, and to increase the risks to the ecological health of the river and to the fisheries production.

Domestic sewage directly discharged to the Mekong River at Chiang Saen	
	
Chiang Saen port	Ships at Chiang Saen port
	
Maize crop growing on the riparian floodplain of the Mekong River	Rice is the most abundant agricultural crop grown in the study region

7. Details of each risk assessment

Team 1 - The protection of fish populations with a focus on the Mekong giant catfish

Statement of the issue

This part of the case study will assess the risk to the fish populations in the study region, with a particular focus on the Mekong giant catfish (*Pangasianodon gigas*).

The Mekong giant catfish is the largest catfish in the world. It is found specifically in the Mekong River and its tributaries, for example, Songkram river and Mae Mun River. Fishing of the giant catfish by local fishermen, particularly in Chiang Khong and Huai Sai area, has occurred for many years, and is still allowed despite the fact that this species is critically endangered. Figure 2 shows the estimated numbers caught each year since 1986 by Thai fishermen. It is a reasonable assumption that Lao fishermen also catch similar numbers. Obviously, the numbers caught per year has been steadily decreasing.

Team 1 will investigate the factors causing this rapid decrease in giant catfish numbers (and also on the population of other major fish species), and assess the risk that population levels will decrease even further.

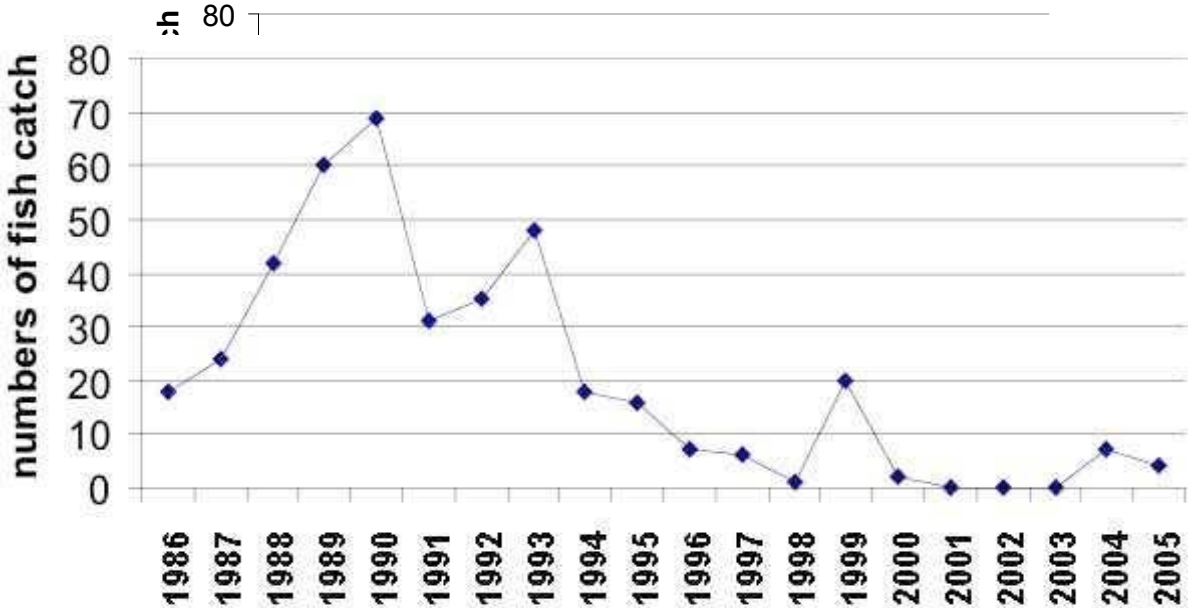


Figure 2: Numbers of Mekong giant catfish captured in Chiang Khong during the period 1986 – 2005

Assessment endpoints

Will be the change in giant catfish numbers, and the change in abundance and diversity of the general fish population

Threats & Hazards

The major threats to fish populations were identified as:

- Loss of habitat and spawning grounds (the Khon Pi Long rapids in dry season are thought to be a particularly important habitat),
- Changes in flow regime (particularly in the dry season),
- Increased fishing pressure, particularly through the introduction of more efficient fishing gear (Chiang Khong area),
- Bank erosion (particularly in Chiang Saen to Chiang Khong during the wet season)
- Poor water quality (from the discharge of domestic wastewater from Chiang Saen and Chiang Khong municipalities, from Huai Sai area in dry season, and from agricultural run off in rainy season).

Giant catfish	Giant catfish
	
View of Khon Pi Long rapids in late June 2006	View of Khon Pi Long rapids in late June 2006
	

Cause-effect conceptual model

Figure: Cause-effect conceptual model for the reduction of *adult Mekong giant catfish numbers*

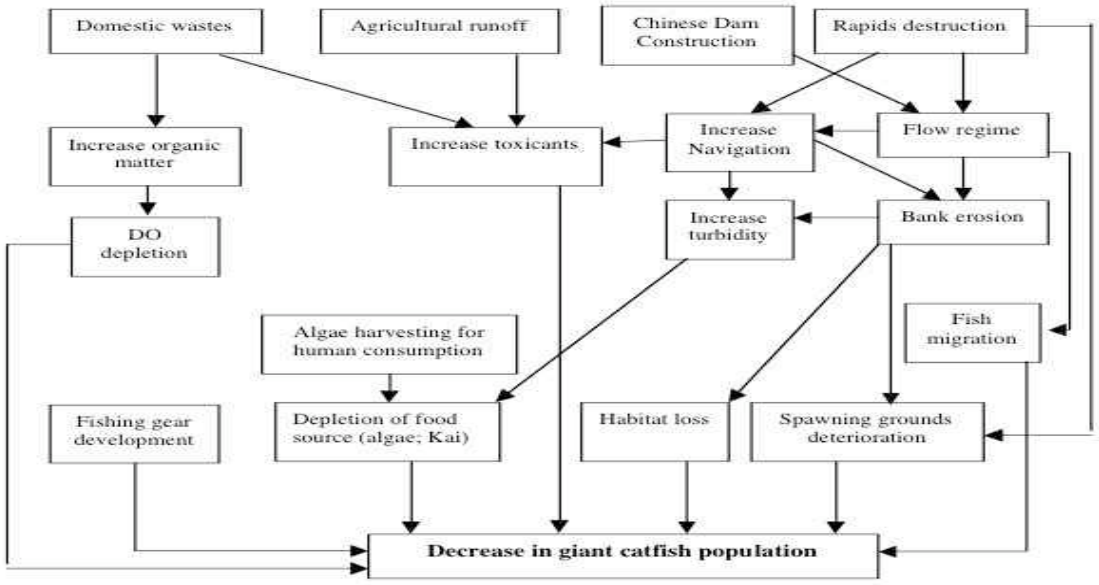
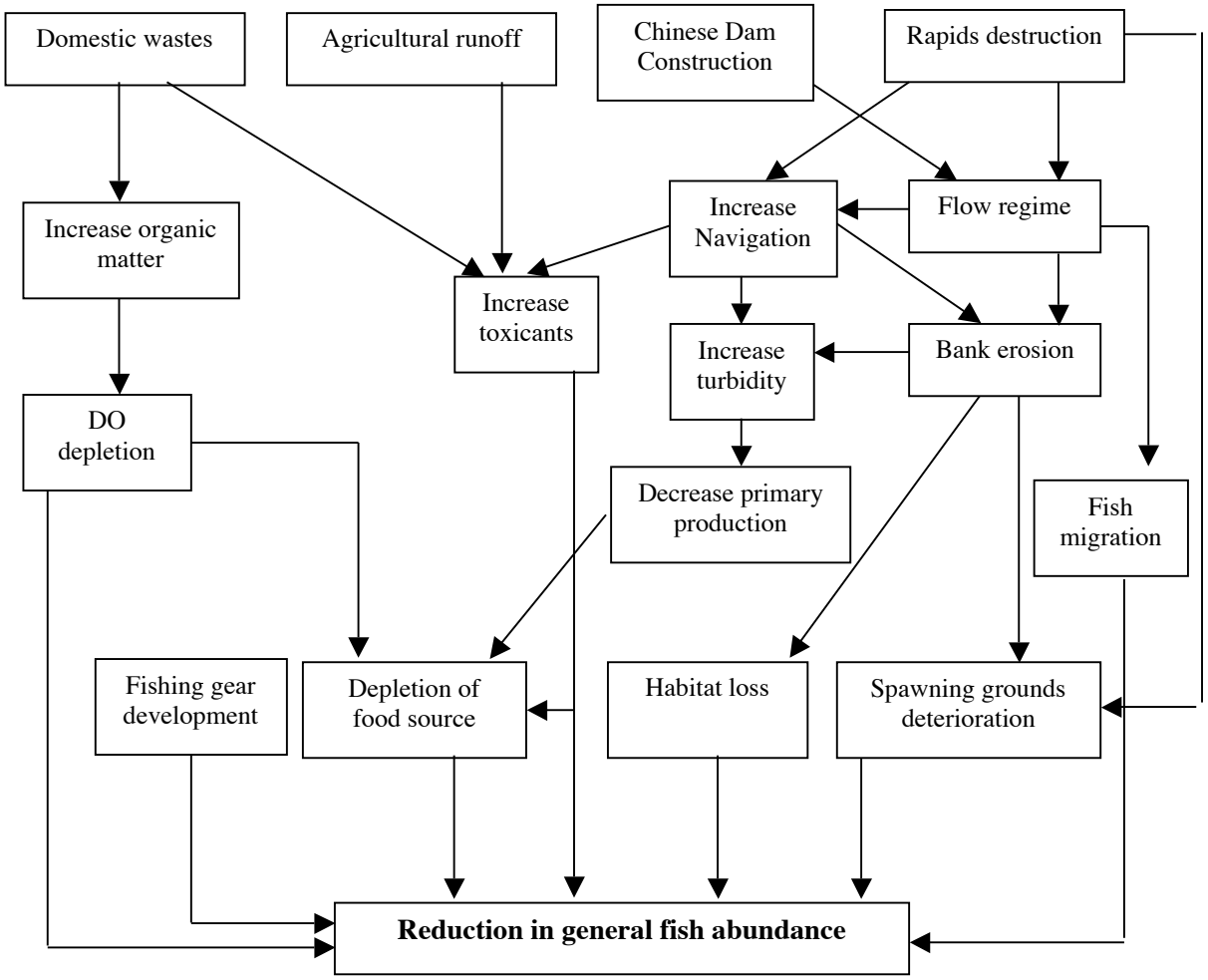


Figure: Cause-effect conceptual model for the reduction of *juvenile giant catfish and other fish numbers*



Information needs and who will obtain

Information need	**Where is the information?**	**Who will find it?**
General information on wild fishery catch and aquaculture in the study area • Fishery statistics including Giant catfish catch statistic • Numbers of fishing boat, and fisherman • Numbers and type of fishing gears, including C.P.U.E. • Algae harvested for human consumption	Dept Fishery Local people	Thai - Santiwat Laos - Souvany
General biology of the giant catfish		Santiwat
Fish species diversity and abundance	Dept Fishery MRC	Thai - Narumon Laos - Souvany
Fish migration (species and seasons, locations)	MRC Thai NGO SEARIN website	Thai - Santiwat Laos - Souvany
Macroinvertebrate species diversity	Academic institutes MRC	Thai - Narumon
Aquatic plants species diversity	Dept Fishery MRC Academic institute	Thai- Narumon Laos- Souvany
Specific location of the aquatic habitats, e.g. rapids, riffles, run, pool	Field survey NGO groups Lao Dept Navigation	Thai - Santiwat Laos - Amphone
Quantity and type of pesticides used on riparian vegetable crops	Dept Agriculture	Thai - Santiwat Laos - Souvany

Timetable

Activities	**July**				**August**				**September**	
	W1	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**	**W10**
General information on Agriculture	←							→		
Domestic waste water and storm water	←							→		
Water transport / navigation	←							→		
Specific information on wild fishery catch and aquaculture	←					→				
Fish species diversity and abundance	←							→		
Fish migration (species and seasons, locations)	←							→		
Macroinvertebrate species diversity		←					→			
Aquatic plants species diversity	←						→			
Specific location of the aquatic habitats	←				→					
Quantity & type of pesticides		←					→			

used on riparian vegetables										
Report preparation								◄	►	

Team 2 - Human health

Statement of the issue

This part of the case study will assess the risk to human health from contaminated domestic water used in the study region for drinking and cooking.

Most of the residence in Chiang Saen and Chiang Koch are supplied with treated domestic water (alum flocculation, sand filtration and chlorination). However, there still a considerable proportion of local people residing along the Mekong River in the study region who need to use raw water from the Mekong for drinking and cooking. Direct use of such raw water might pose a potential health hazards to those people.

This study will assess whether any health risk exists.

Raw water intake at Chiang Rai	????
	

Assessment endpoints

Will be (a) whether the water used for drinking and cooking is acceptable when compared with international drinking water standards, and (b) the number of communicable diseases reported (with a focus on water-born and water related diseases, e.g. dysenteri, diarhea, typhoid fever, parasites).

Scope of the assessment

This assessment will focus on the populations taking their domestic water directly from the Mekong River within the study area. High-risk areas (hot spots) and high-risk population will be selected after we collect more information.

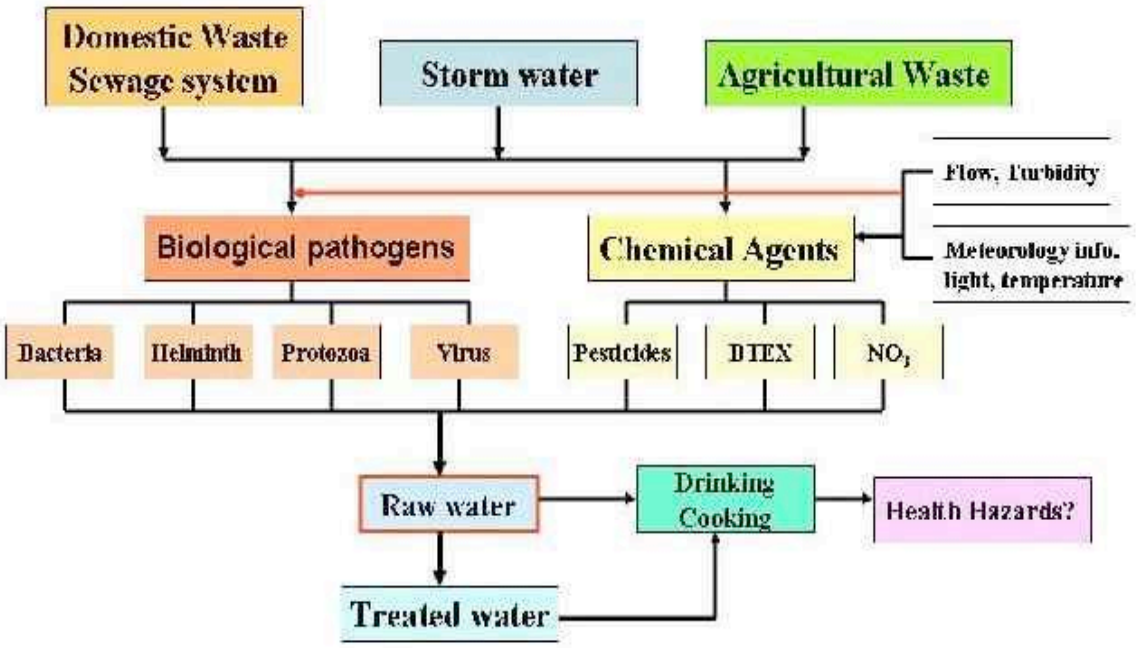
Threats & Hazards

Two types of water-related threats to human health have been identified for study:

- Biological pathogens (e.g. bacteria, Helminths, protozoa, enteric viruses),
- Chemical agents and toxicants

- Organic chemicals such as organophosphate pesticides (OPs), other major group of pesticides used in the study sites (such as organochlorine, carbamate, paraquat) and key aromatic hydrocarbons from vessel fuel,
- Inorganic chemicals such as arsenic, nitrate and other key elements found in the study sites as waste activities.

Cause-effect conceptual model



Information needs and who will obtain

Information needs	**Where to find?**	**Who will find?**
Population profile by age and sex • Towns, Municipality, Farming • Illegal worker (approx) • No.of Chinese crew/boat	Chiang Rai Bokeo:	Thai-Pornsak Laos-Bouakeo
Biological water quality of the Mekong River (e.g. bacteria, virus, helminths, protozoa**)**	US & Australian guidelines for raw drinking water MRC/WUP	Thai - Voranuch Laos - Bouakeo Prof Hart
Population health status by age and sex of the study sites	Local health offices	Thai - Voranuch Laos - Bouakeo
Disease pattern of the study population by age and sex (prevalence and incidence, tabulation form	Local health offices	Thai - Voranuch Laos - Bouakeo
Drinking water guidelines (treated water)	Chiang Saen, Chiang Kong, Huay Sai US & Australian Guidelines	Thai - Voranuch Laos - Bouakeo Prof Hart

Raw water quality guidelines for pesticides, BTEX contamination and inorganic chemicals (e.g. As)	US & Australian Guidelines	Thai-Voranuch Laos-Bouakeo Prof Hart
Arsenic contamination from rodenticide use in Lao PDR	Bokeo, Huay Sai	Bouakeo

Team 3 - Risk to human health from eating contaminated aquatic food from the Mekong River

Statement of the issue

This part of the case study will assess the risk to human health from eating contaminated aquatic food obtained from the Mekong River in the study area.

There is some concern that industrial pollution from upstream China will result in the contamination of aquatic food resources in the Mekong River in the study region. Additionally, there is also the possibility that more local pollution from domestic wastewater and agricultural runoff may also contribute to the contamination of these food resources.

This study will assess the potential that aquatic foods (fish, algae Kai) in the Mekong River will become contaminated because of both transboundary and local pollution sources and then a risk to human health.

Large quantites of fish are consumed in the regiion	People also harvest algae (kia) for their consulption
Need photo of fish being caught or in a market	Need photo of kia

Assessment endpoints

Will be the levels of toxicants in two main types of aquatic food (fish and algae (kai)) when compared with international food standards.

Scope of the study

The assumption is that the areas and the times of year when the risk is likely to be greatest are:

- The region around the Chiang Saen port, particularly during the dry season,
- Regions close to domestic wastewater discharge points (throughout the year),
- The region around the Khon Pi Long rapids during the dry season.

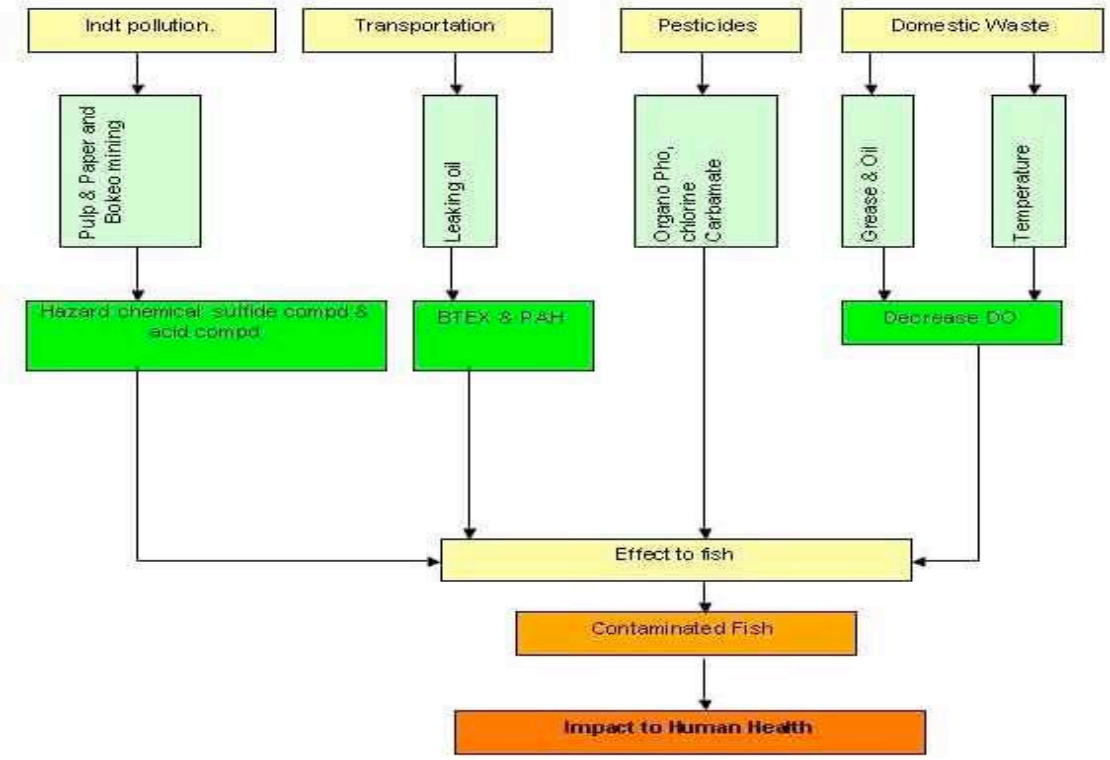
Threats & Hazards

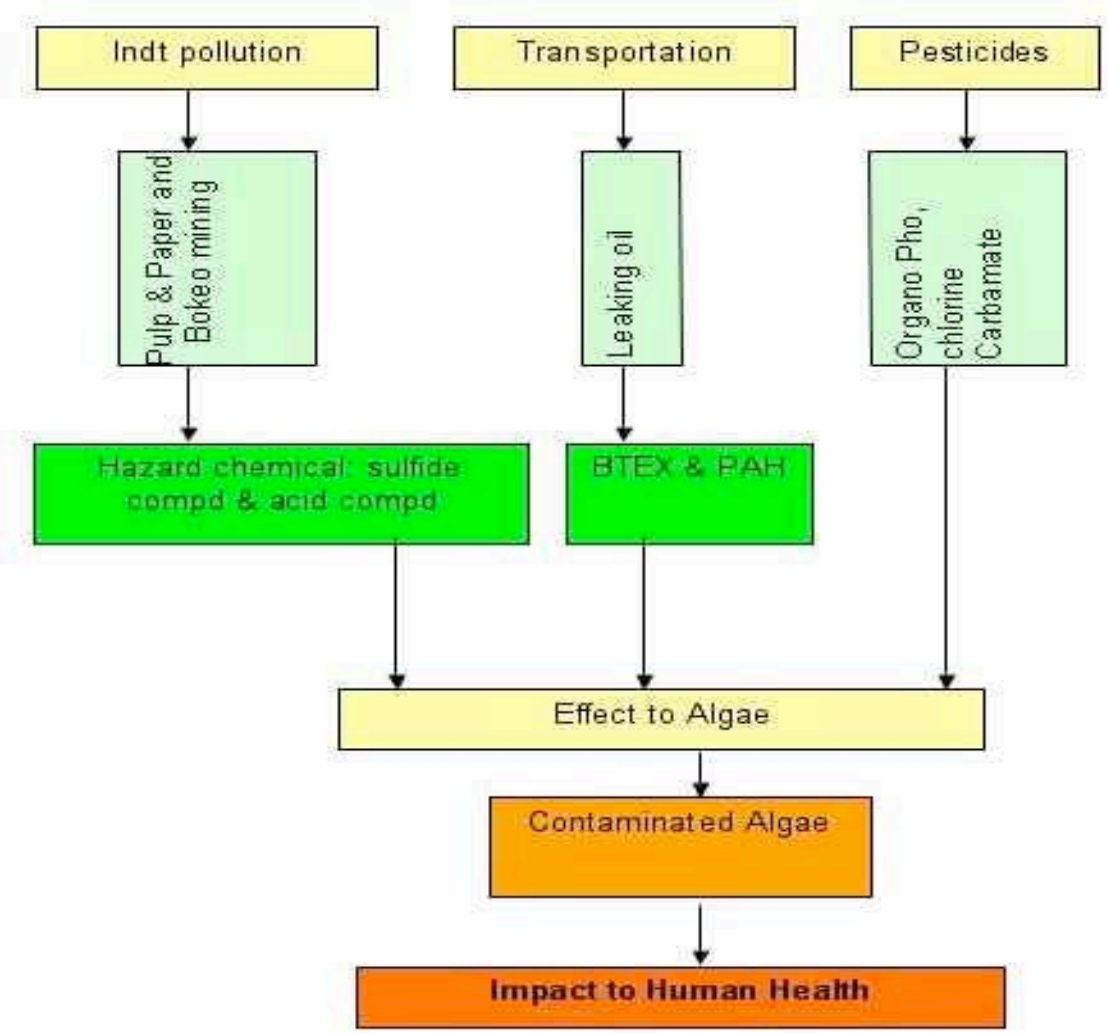
The main threats and hazards to be assessed will be:

- Chinese industrial operations (paper mills),
- Leaking oils from ships (BTEX, PAH),

- Domestic waste (wastewater and solid waste),
- Pesticides (from agricultural runoff),
- Contamination from mining activities (this is to be assessed).

Cause-effect conceptual model





Information needs and who will obtain

Information Need	**Where to find?**	**Who to find?**
Pesticides (additional to general info) • Pesticide uptake mechanisms (fish & algae) for organophosphate, organochlorins, carbamates	Website, Journals	Dr. Kannitha
Domestic wastewater and stormwater (additional to general info) • Temp, pH, grease and oil, BOD (or COD)	MRC	Dr. Kannitha
Water Transportation • Navigation regulations • Possible discharges of PAH, Benzene, Toluene, Ethyl benzene, Xylene	Chiang Saen port authority	Douangchan
Uptake mechanisms of fish & algae for PAH, Benzene, Toluene, Ethyl benzene, Xylene	Web, Journals, MCTPC	Dr. Kannitha
Pollution from Industry • From China (General information) • From mining in Bokeo Province (e.g. heavy metals, other pollutants)	Yuanan Univ, MRC Industrial department	Prof. Hart Chanthasack Dr. Kannitha

8. Reporting

Agreed that all reporting (reports, email contacts) between team members, coordinators and Prof Hart should go through the MRC (Arounna), with a copy to the relevant EP coordinator.

9. Role of coordinator

A coordinator has been selected for each Team. The coordinator's tasks are:

- To ensure all work is completed on time.
- To report to Prof Hart and Arounna any problems being experienced (e.g. can't find data, can't access data). Important to report problems EARLY and not wait until the final report is needed.
- To prepare regular short progress report (suggest FORTNIGHTLY by email).
- To coordinate the preparation of the team report for presentation and discussion at the September 2006 Workshop.
- To be the main contact point for Arounna and Prof Hart.

10. Risk assessment – future scenarios

Will decide on the future scenarios at the September workshop.

11. Final report

Two reports will be prepared in February 2007:

- Report 1 will be full technical report.
- Report 2 will be small (2 page) summary report card setting out the main conclusions in simple terms.

12. Team workshops & Mentor visits

The project has planned three additional workshops to coincide with important milestones, namely Completion of Phase 1 (and training of modeller in Bayesian modelling), completion of the risk assessment for the present and future scenarios, and preparation and presentation of final report.

- Workshop 1 & site visit (Planning, Problem formulation) Jun 2006
- Workshop 2 & site visit (Completion Phase 1) Sep 2006
- Special Workshop (Bayesian network modelling) Sep 2006
- Workshop 3 (Quantitative risk assessment, develop models) Nov 2006
- Workshop 4 (Completion risk assessment, final report) Feb 2006

Prof Barry Hart

30 June 2006