

## DRAFT 1 (13 July 2006)

# MRC Environmental Risk Assessment Training Program

## Chau Doc/Takeo Case Study Workshop 1: Problem Formulation



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**Vietnam Consultants:** Mai Thai An, Dr Tran Mai Kien, Tran Minh Khoi, Doan Van Tien, Pnam Ngoc Xuan

**Mentor:** Professor Barry Hart

23 June 2006

## 1. Overall risk assessment objective

To determine the potential risks to four important environmental values<sup>1</sup> due to human activities<sup>2</sup> in the study region now and over the next 10 years.

## 2. Study area

- The participants made a field visit around the Chau Doc part of the study region on the second day of the Workshop.
- Activities seen included: Bassac and Mekong rivers, canal system, rice fields, aquaculture fish cages (many), rice mills, human settlements along river, drinking water treatment plant (Tan Chau), livestock production (ducks, pigs), flood protection structures between Cambodia and Vietnam, water transportation, water supply input pipes, gas stations along the river, individual household wastewater discharge, solid waste everywhere, sand mining and fishing
- Participants developed a system conceptual model - see Figure 1

## 3. Scope of the project

### *Spatial*

- See Figure 1 for scope - broadly from 20km north of Takeo to 50km south of Chau Doc and about 20km west of the Bassac to 10 km east of the Mekong.
- 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*

Three time periods will be investigated:

- present
- short term – 5 years
- medium term – 10 years.

### *Future scenarios*

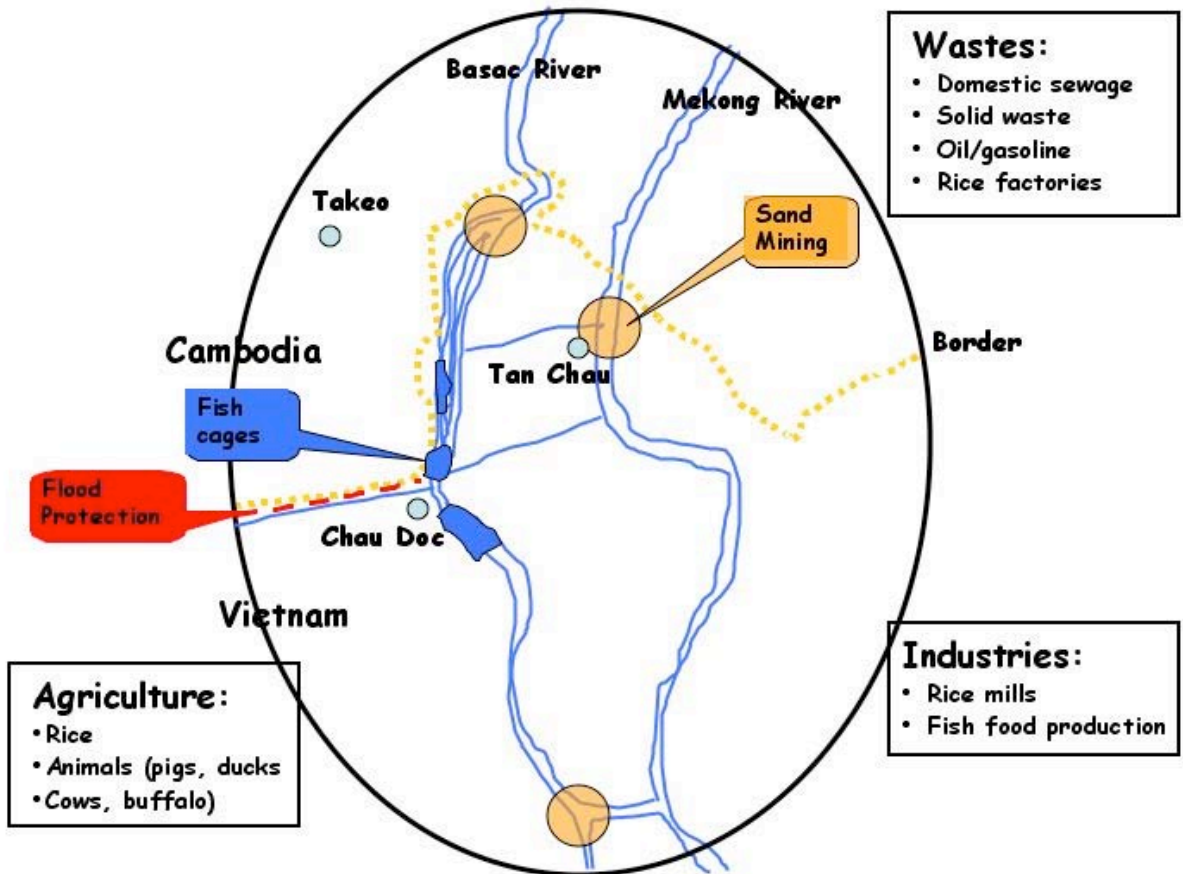
The future scenarios still need to be decided. These will probably include:

- *Flow changes* due to upstream development of hydrodams,
- Increased *urbanisation* particularly of Chau Doc and Takeo,
- *Increase in tourists* visiting the region with subsequent increase in wastewater production,
- *Land use changes* (further clearing for rice production particularly in Cambodia),
- Increases in *water transportation* (particularly around Takeo),
- *Climate change*.

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<sup>1</sup> Cage aquaculture fish production, the health of the Bassac River ecosystem, the health of the human population and rice production.

<sup>2</sup> Wastes from humans, agriculture, aquaculture, water transportation; major land use changes; changed flow regimes (e.g. due to Chinese dams); climate change.



Satellite view of the lower Mekong 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 landscape characteristics of study region	MRC Web	Prof Hart
Population in large towns (Chau Doc, Takeo) and small villages	Where??	Xuan Sokha
General information on rainfall, temperature and seasons in the study region	MRC – WUP modelling team	Arounna
General information on flow characteristics of Bassac and Mekong Rivers in study region	MRC	Arounna
General information on flooding in study region	MRC – FMMP An Giang Province	Arounna Xuan/Khoi
Water quality for Bassac and Mekong Rivers (physico-chemical, microbiological, biological)	MRC MoE (Cambodia) Vietnam region	Arounna Sokha/Sophea Xuan/Khoi
Water quality (physico-chemical, microbiological, biological) in canals in study region	MoE (Cambodia) Vietnam region	Sokha/Sophea Xuan/Khoi
Future scenarios – flow changes over next 10 years	MRC	Arounna
Future scenarios – any major land use changes in study region	Vietnam Cambodia	Xuan/Khoi Sokha
Future scenarios – any industrial developments in study region	Vietnam Cambodia	Xuan/Khoi Sokha

**4. Environmental values considered**

Eleven key environmental values were identified by the group, including (votes for in brackets):

1. Fisheries production – natural (5)
2. Fisheries production – aquaculture (9)
3. Human health – riverside villages (houses) (7)
4. Human health – large towns (e.g. Chau Doc, Takeo) (5)
5. Ecological health – river (Bassac) (6)
6. Ecological health – floodplain, wetlands (4)
7. Recreation (e.g. swimming) (0)
8. Ecosystem services (natural processes) (1)
9. Agriculture (e.g. rice production) (7)
10. Tourism (2)
11. Flood protection (2)

**5. Issues for study**

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

- Maintain *adequate cage aquaculture fisheries production* in the Bassac River in region of Chau Doc,

- Protect *human health* in the study region by maintaining adequate drinking water quality & preventing contamination of food (particularly fish and other aquatic foods),
- Maintain a *healthy ecosystem in the Bassac River* (including fish migration) in the study region and also maintain *healthy wetland ecosystems* around Takeo,
- Maintain *adequate rice production* in the study region.

## 6. Study Teams

Study teams are:

### ***Team 1 - Fisheries production – cage aquaculture***

- Mr Nom Sophearith
- Mr Doan Van Tien (Coordinator)
- Ms Pnam Ngoc Xuan

### ***Team 2 - Human health – riverside villages***

- Dr Tran Mai Kien (Coordinator)
- Mr Lak Leng

### ***Team 3 - Ecological health – Bassac river & Cambodian wetlands***

- Mr Chrin Sokha (Coordinator)
- Dr Chea Tharith
- Mr Mai Thai An

### ***Team 4 - Agriculture - rice production***

- Mr Tran Minh Khoi
- Ms Nhim Sophea (Coordinator)

## 7. Hazard/threat analysis

The following major hazards (threats) were identified:

- *Domestic wastewater* discharged from Chau Doc (population ca. 114,000) to the Bassac River. These effluents include: untreated sewage, septic tank effluent 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 Bassac 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 wetland ecosystems.
- There are a very large number of *aquaculture cages* in the Bassac River and also in some canals for producing large quantities of fish. It is known that these contribute organic pollution to the Bassac River.
- *Water transport* – a large number of small and large boats use the Bassac River in the study region. We will assess the risk to the river ecosystem, aquaculture and human health from possible spills of chemicals and oil from these ships, and spills of gasoline from the many gas stations located on the river.

- *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.
- *Need to also make some comments about domestic wastewater from Takeo and also agricultural runoff from Cambodian side. Will do this after field trip to this area as part of Workshop 2.*

## 7. Details of each risk assessment

### **Team 1 - Fisheries production – cage aquaculture**

#### *Statement of the issue*

This part of the case study will assess the risk to cage fish aquaculture activities in Chau Doc and Takeo.

There are many fish aquaculture cages located along the Bassac River near Chau Doc (Photos) and a lesser number around Takeo<sup>3</sup>. The production of fish in these cages is very important to both the local economy and to the health of the local people (important source of protein). There are a number of potential threats to these activities including: adverse effects caused by waste from towns and villages, factory wastes, aquaculture wastes, agricultural runoff, sedimentation and acidic runoff<sup>4</sup>.

Team 1 will investigate the toxic and stress effects and increased incidence of fish diseases on aquaculture fish production (yield) that may be caused by these threats.

#### *Assessment endpoints*

Will be the maintenance of both fish production (measure by yield) and fish health (measured by the incidence of disease).

#### *Scope of the assessment*

This assessment will focus on:

- the area about 20 -25 km around the Bassac River on Vietnam site (An Phu and Chau doc District) and Cambodia (Takeo province), and will
- the dry and wet season, and the transition period between the dry season and the rainy season.

The assumption is that this is the area and the times when the risk is likely to be greatest.

#### *Threats & Hazards*

The major threats to cage aquaculture were identified as:

- *Hazards causing fish toxicity* – mainly ammonia from sewage discharges, heavy metals (Hg, Cd, Pb, Cu, Zn) in waste discharge from agriculture, domestic sewage, oil leaching from boats and gas stations, and pesticides from agricultural runoff.
- *Hazards causing stress to fish* – reduction in dissolved oxygen (DO) concentration due to organic matter (BOD) from domestic and agricultural runoff, elevated TSS concentrations and reduced pH from acid runoff.

<sup>3</sup> Estimates of these numbers will be obtained.

<sup>4</sup> From both acid sulfate soils and acid rain.

- *Hazards causing fish disease* - bacteria, parasites and viruses from water waste and aquaculture discharges.

View of aquaculture cages along the Bassac River



Closer view of aquaculture cages along the Bassac River



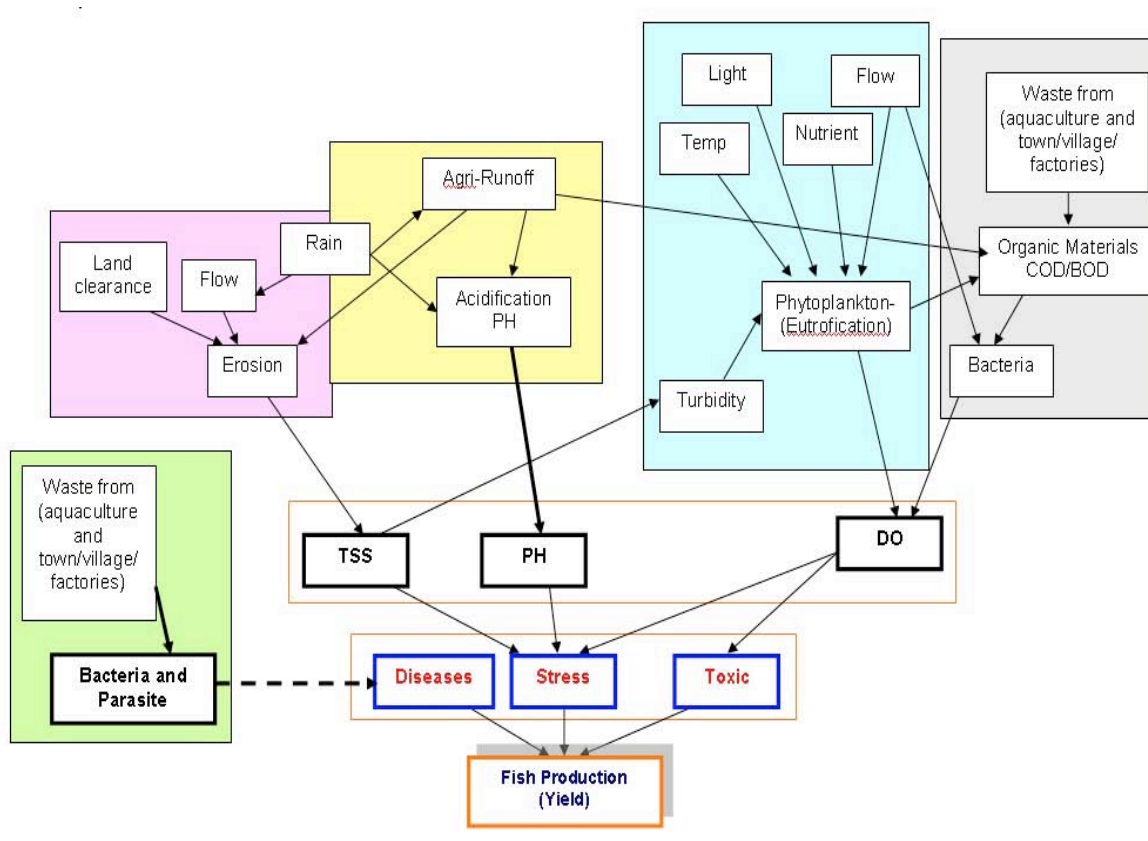
Man feeding fish in aquaculture cage



Propellor used to aerate bottom water when DO gets too low



*Cause-effect conceptual model*



*Information needs and who will obtain*

Information need	Where is the information?	Who will find it?
<b>Production information</b> <ul style="list-style-type: none"> <li>• Yield</li> <li>• Main species farmed</li> <li>• Number &amp; size of cages</li> <li>• Density of fish input</li> <li>• Food type &amp; application rate</li> <li>• Fish diseases reported</li> <li>• Chemicals used</li> </ul>	<b>Takeo</b> <ul style="list-style-type: none"> <li>• Provincial Fisheries Office, Department of Fisheries</li> <li>• NGOs working in the Koh Andet and Boricholesa districts</li> </ul> <b>Chau Doc</b> <ul style="list-style-type: none"> <li>• Research Institute for Aquaculture No. 2, Ho Chi Minh City</li> <li>• Department for Statistics of An Giang</li> <li>• Statistical Office of Districts in An Giang</li> <li>• People Committee of Chau Doc town</li> <li>• Dept Planning &amp; Investment of An Giang</li> <li>• Dept Fisheries of An Giang</li> </ul>	Sophearith  Tien/Xuan
<b>Factors effecting fish</b> <ul style="list-style-type: none"> <li>• DO concentrations</li> <li>• TSS concentrations</li> <li>• Turbidity or transparency data</li> <li>• pH data</li> <li>• Flow data</li> <li>• Temperature data</li> <li>• Organic matter (COD, BOD) data</li> </ul>	Takeo Chau Doc	Sophea (Team 4) Tien/Xuan
<b>Thresholds</b>		



DO toxic to fish	MRC Literature	Aounna Tien/Xuan
pH stress or toxicity to fish	WQ guidelines	Tien/Xuan Hart
TSS/turbidity effects on fish	WQ guidelines	Tien/Xuan Hart
Bacteria for catfish		Xuan

### **Team 2 - Human health**

#### *Statement of the issue*

This part of the case study will assess the risk to human health from water-related factors in the Chau Doc and Takeo regions.

In the study region, it is generally only those people in the larger townships (Chau Doc, Tan Chau, Takeo) that have treated drinking water available to them. Most of the villagers living along the Bassac River and canals use water from the river/canal without treatment.

Additionally, sanitation is poor with domestic sewage generally delivered directly to the waterways from which drinking water is sourced. It is only in the larger townships that any sewage treatment occurs, and then only in septic tanks many (most) of which are poorly maintained.

Thus the part of the case study will focus on water-borne diseases and potential human toxicity due to contaminated food.



### *Assessment endpoints*

Will be the number of communicable diseases (with a focus on water-borne and water related diseases) related to:

- The digestive system (e.g. dysentery, diarrhea, typhoid fever, parasites),
- Other systems (e.g. malaria, sistosomia, tuberculoses, dermatitis, STD (including HIV/AIDS), gyneacological diseases).

We will also investigate the development and use of a general health index (see conceptual model).

### *Scope of the assessment*

This assessment will focus on the Chau Doc district in the context of the An Giang province in Vietnam and the TaKeo province in Cambodia.

### *Threats & Hazards*

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

(a) By mechanism

- Drinking,
- Eating (Food quality with cumulative effects of toxicology through food-chain mechanism),

- Contact with contaminated water\_(e.g. domestic water use, air-dissemination),
- Poor behaviour (related to health culture & education),
- Water-related accidents (e.g. accidents associated with water transportation, extreme floods or erosion may cause death or injuries).

(b) By agent

- Biological (e.g. pathogenic bacteria and viruses),
- Chemicals (e.g. toxic heavy metals),
- Organics (e.g. pesticides).

*Cause-effect conceptual model*

**Add this in here**

*Information needs and who will obtain*

<b>Information needs</b>	<b>Where to find?</b>	<b>Who will find?</b>
<p><b>General socio-demographic information</b></p> <ul style="list-style-type: none"> <li>• Population of An Giang (Chau Doc if possible) &amp; Takeo provinces (general and by age &amp; sex)</li> <li>• GDP, socio-economic development plan for the next 5–10 years, Income per capita</li> <li>• Education indexes (e.g. % of each education levels: from non-educated (not reading or writing) to degree.</li> </ul>	<p>Local authorities Other Teams</p>	<p>Team 1 (Xuan) &amp; Team 3 (Sokha)</p>
<p><b>General natural and socio-economic data</b></p> <ul style="list-style-type: none"> <li>• General natural characteristics, weather conditions (seasons) in the study region</li> </ul>	<p>From general information</p>	
<p><b>General public health infrastructure data:</b></p> <ul style="list-style-type: none"> <li>• Number of hospitals (government/private) &amp; medical personal</li> <li>• Health budget</li> <li>• No of curative care and consultation</li> <li>• Number of medical facilities &amp; beds</li> <li>• IMR, CDR, MMR, 5-years MR etc.</li> <li>• Reproductive health data and child health care</li> <li>• Levels of malnutrition</li> </ul>	<p>Public health dept Survey (?) From MoH: Institute of Health Policy and Strategy</p>	<p>Kien &amp; Leng</p>
<p><b>Specific public health data</b></p> <ul style="list-style-type: none"> <li>• Number of cases on communicable diseases (e.g. water-born diseases (dysentery, diarrhea, typhoid fever, parasites), malaria, systosomia, tuberculoses <i>(for estimated epidemiological situation)</i>, STD (including HIV/AIDS), dermatitis, bird flu)</li> <li>• Number of cases on non-communicable diseases (e.g. gynecological diseases)</li> </ul>	<p>Public health dept Survey (?) From MoH: nstitute of Health Policy and Strategy</p>	<p>Kien &amp; Leng</p>
<p><b>General information on sanitation &amp; hygine</b></p> <ul style="list-style-type: none"> <li>• Number of septic tanks</li> <li>• Number of vaccinated children and adults</li> </ul>	<p>Public health dept Survey (?)</p>	<p>Kien &amp; Leng</p>

<p><b>Drinking and domestic water quality parameters</b></p> <ul style="list-style-type: none"> <li>• Number of household using home-treated water</li> <li>• Number of household using centrally treated water</li> <li>• Physicochemical &amp; bacterial characteristics (e.g. E coli)</li> <li>• Chemical characteristics: Organic toxicants: pesticides, heavy metals (Hg, As, Cu, Pb)</li> </ul>	<p>From other teams (1,3,4) Aquaculture</p>	<p>Sokha/Sopheha Xuan/Khoi</p>
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**Team 3 - Ecological health – Bassac river & Cambodian wetlands**

*Statement of the issue*

This part of the case study will assess the risk to the ecological health of (a) the Bassac River around Chau Doc and (b) the wetlands around Takeo.

The ecological health of these waterbodies is extremely important because of the fish they produce and the ecosystem service they provide – particularly the capacity to ‘treat’ much of the wastewater that enters them from domestic sources, aquaculture and agriculture.

In addition to degradation in quality due to many sources of pollution, the riverine ecosystems are also under threat because of upstream flow changes. Equally, the wetlands in Cambodia are being destroyed due to clearing of inundated forest regions to make way for more rice fields.

<p>Man fishing in Bassac River near Chau Doc</p>	<p>Bassac River (background) with Mekong River water (brown) flowing into it via a canal – note difference in colour</p>
	

*Assessment endpoints*

Will be:

- (a) the maintenance of fish (and macroinvertebrate) species composition in the Bassac River,
- (b) the maintenance of fish (and phytoplankton & zooplankton) species composition in the study wetlands.

*Scope of the study*

The specific study area for the Bassac River will be from the border to 20 km downstream of Chau Doc, while the wetlands study area will be in Cambodia from Takeo township to the Vietnam border.

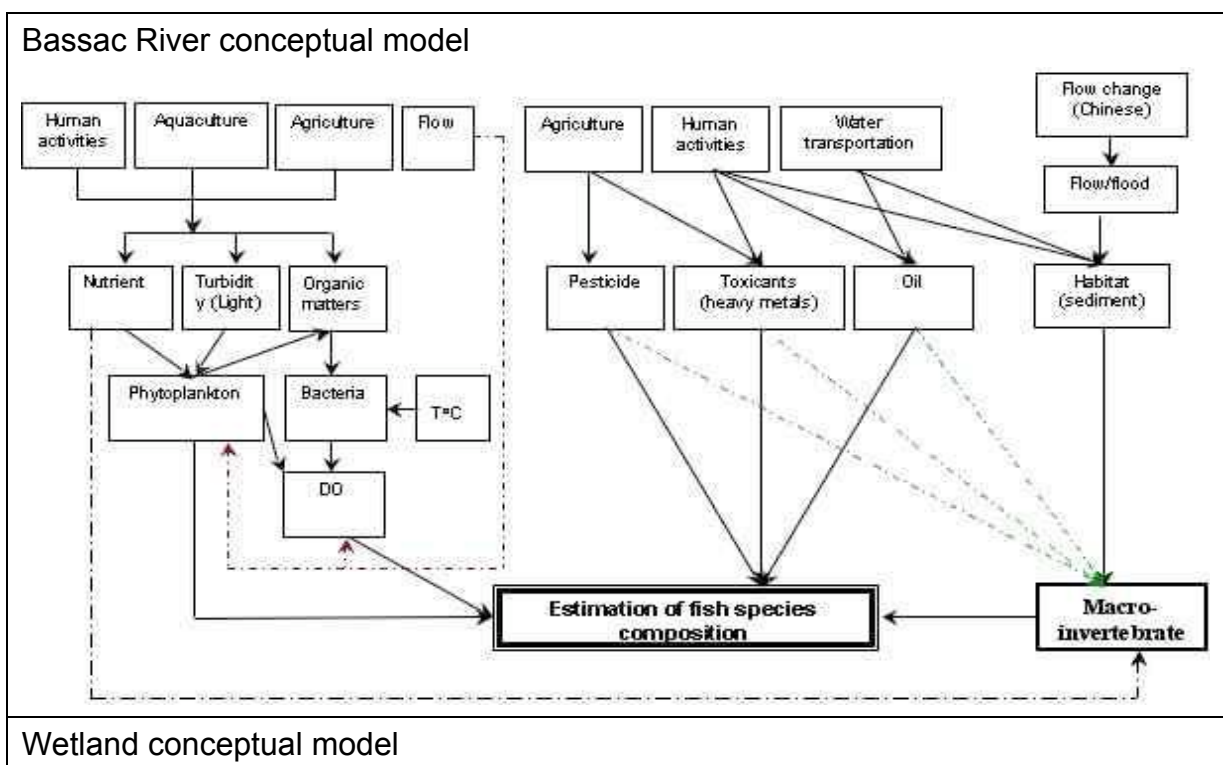
**Any specific time of the year that will be the focus??**

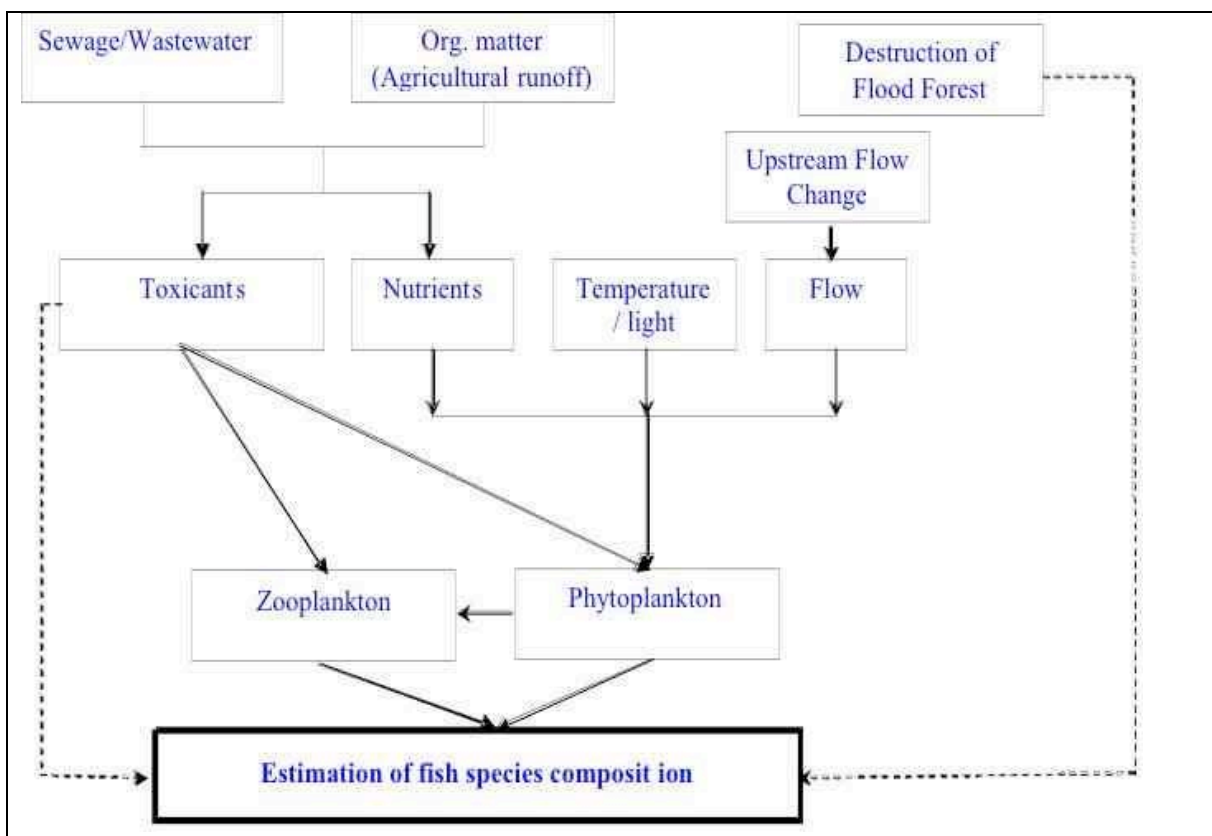
The assumption is that this is the area and the times when the risk is likely to be greatest.

*Threats & Hazards*

<b>For Bassac River</b>	<b>For wetlands</b>
<ul style="list-style-type: none"> <li>• water pollution</li> </ul>	<ul style="list-style-type: none"> <li>• water pollution</li> </ul>
<ul style="list-style-type: none"> <li>• reduction of water flow</li> </ul>	<ul style="list-style-type: none"> <li>• reduction of water flow and change of flow regimes</li> </ul>
<ul style="list-style-type: none"> <li>• water transportation</li> </ul>	<ul style="list-style-type: none"> <li>• destruction of inundated forests for farming and fuel wood</li> </ul>
<ul style="list-style-type: none"> <li>• bank erosion and sedimentation</li> </ul>	

*Cause-effect conceptual model*





*Information needs and who will obtain*

Information Need	Where	Who
<b>For wetlands</b>		
Population and related information	MoEF, MoP	Sokha
Sewage/wastewater	MoE, DoEnv/DoPWT Takeo, Provincial Authorities	
Agricultural runoff	MAFF, DoALI (central and provincial offices, Agr. Group (Sophea)	
Water flow and related conditions	MoWRAM, MRC	
Land-use change	MAFF, DoALI in Takeo Province, Agr. Group (Sophea)	Tharith
Zooplankton/Phytoplankton	DoF (MAFF), MRC	
Fish species composition	DoF (MAFF) and provincial Dept., MRC	
<b>For Bassac River and Chau Doc</b>		
Population	Provincial and Chau Doc Town authority	An
Human wastes & sewage/wastewater	Dept. of Env. & Resources, Chau Doc Town authority	
Water transportation	Dept. of Env. & Resources; Dept. of River Road;	



Agricultural practice (rice, duck)	Dept. of Agriculture & Rural Development; Chau Doc Town authority; Agr. Group (Sophea)	
Aquaculture	Dept. of Agriculture & Rural Development; Chau Doc Town authority; Aquaculture Team (Sophearith)	
Oil spill	Dept. of River Road	
Phytoplankton/zooplankton	Dept. of Env. & Resources; MRC ??	
Macro-vertebrate	Dept. of Env. & Resources; MRC ??	
Water flow and related conditions	Dept. of Hydrology and Meteorology; Dept. of River Road;	
Additional relevant information <i>(along Bassac River on Cambodia side)</i> <ul style="list-style-type: none"> <li>• Oil station</li> <li>• Water transportation</li> <li>• Water quality parameters</li> <li>• Water flow and related conditions</li> </ul>	MRC; MoPWT; MoWRAM;	

**Team 4 – Agriculture – rice production**

*Statement of the issue*

This part of the case study will assess the risk to rice agriculture in the region close to the Cambodian/Vietnam border.

Rice production is by far the most dominant agricultural activity in this region, and has been for many years. In Vietnam, many areas now have three rice crops per year, with two being normal. In Cambodia, there has been a major expansion in the area devoted to rice production in Takeo Province over recent years.

Rice fields near Chau Doc	Rice fields near Chau Doc
	
Duck farm near Chau Doc (Sun mountain in background)	



### *Assessment endpoint*

Will be a decrease in rice productivity.

### *Scope of the study*

This study will focus on the area spanning about 20 km on both sides of the border between Takeo and Chau Doc, and the time period January to September (with focus on the early flood season).

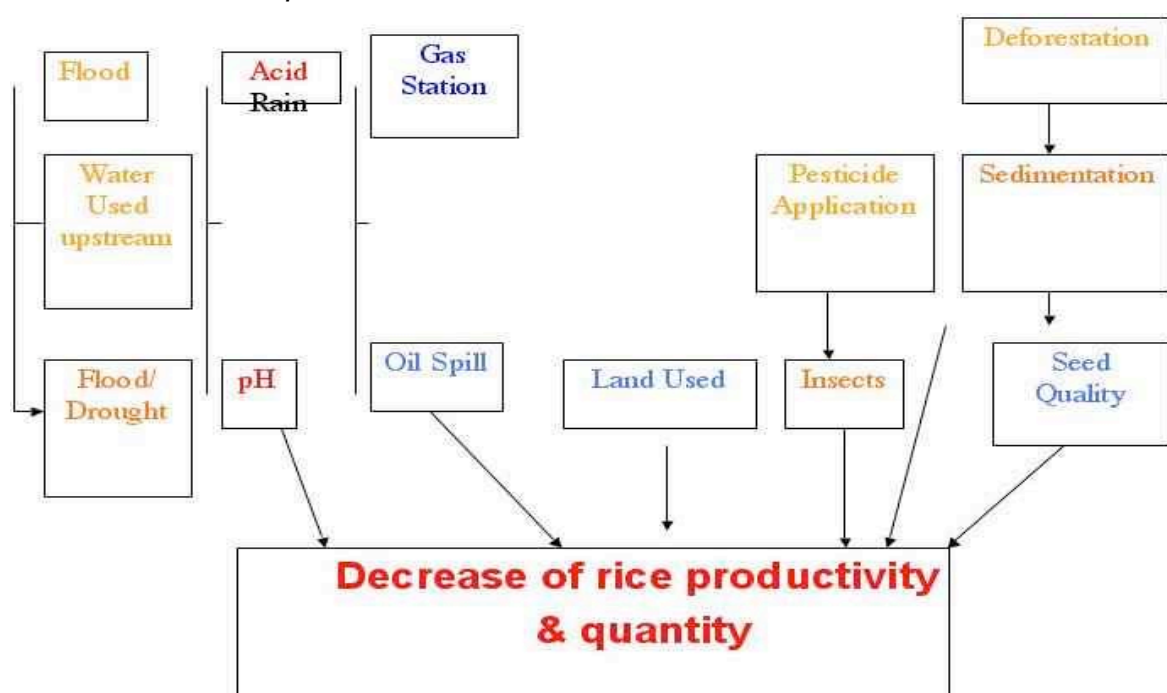
The assumption is that this is the area and the times when the risk is likely to be greatest.

### *Threats & Hazards*

These will include:

- Flood conditions,
- Pollution particularly pH, oil spills and sedimentation,
- Insects,
- Seed quality.

### *Cause-effect conceptual model*





*Information needs and who will obtain*

Information needs	Where to find?	Who to find?	Time
<b>Water Quantity:</b> <ul style="list-style-type: none"> <li>Water Level</li> <li>Discharge</li> <li>Flow</li> <li>Inundation area and duration</li> <li>Water use in the upstream</li> </ul>	MRCS Hydrology Department (Cam.) Southern Institute for water resources planning (VN)	Arounna Sophea Khoi	July
<b>Water Quality</b> <ul style="list-style-type: none"> <li>pH</li> <li>other</li> </ul>	Hydrology Dept (Cam) Southern Institute for water resources planning (VN)	Sophea Khoi	
<b>Pesticide use</b> <ul style="list-style-type: none"> <li>Type and amount used</li> <li>Management of pesticides</li> <li>Disease and insects</li> </ul>	DARD - An Giang Dept Agric & CARDI	Khoi Sophea	
<b>Fertilizer use</b> <ul style="list-style-type: none"> <li>Type and amount used</li> <li>Management of fertilizers</li> </ul>	DARD - An Giang Dept Agric & CARDI	Khoi Sophea	
<b>Sedimentation</b> Sediment load/ distribution Sediment quality	Hydrology Dept (Cam) Southern Inst for water resources planning (VN)	Sophea Khoi	July
<b>Seed Quality</b> <ul style="list-style-type: none"> <li>Type and amount</li> <li>Management</li> </ul>	DARD - An Giang Dept Agric & CARDI	Khoi Sophea	
<b>Rice Production</b> <ul style="list-style-type: none"> <li>Yield</li> <li>Type</li> <li>Price</li> </ul>	DARD - An Giang Dept Agric & CARDI	Khoi Sophea	
<b>Land Use</b> <ul style="list-style-type: none"> <li>Areas</li> <li>Cropping patterns</li> </ul>	DARD - An Giang Dept Agric & CARDI	Khoi Sophea	
<b>Oil Spill</b> <ul style="list-style-type: none"> <li>No gasoline station along/on the river</li> <li>Water transportation information</li> </ul>	????	Khoi Sophea	
<b>Flooding history</b> <ul style="list-style-type: none"> <li>Flooding history Cambodia to Vietnam</li> <li>Border dam construction</li> </ul>	??	Khoi	

## **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
- Workshop 3 (Quantitative risk assessment, develop models) Nov 2006
- Workshop 4 (Completion risk assessment, final report) Feb 2006

Prof Barry Hart  
23 June 2006