



**Nautilus Consultants Ltd**

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**Proceedings of the TROPECA planning  
workshops**

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IDB, Dhaka, Bangladesh 28<sup>th</sup>-29<sup>th</sup> May 2002

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## 1. Introduction

The following proceedings result from two workshops held as part of the TROPECA project, which commenced early 2002. Tropeca is a three year DFID-funded research project attempting to estimate environmental capacity and use this to assist the sustainable development of aquaculture in tropical developing countries.

The project is managed by Nautilus Consultants, Scotland and involves partners in Bangladesh and Vietnam as well as technical assistance from the University of Stirling. The two-day planning workshops held in Dhaka, Bangladesh and Nha Trang, Vietnam had the following objectives:

### Research objectives

- To identify and initiate case studies in each region
- To develop draft research plans for each case study to be conducted by research managers

### Capacity-building objectives

- To raise awareness of the potential use of environmental capacity (modelling, indicators, management) and raise awareness of local issues associated with aquaculture development
- To raise awareness of the project and its approach amongst relevant stakeholders in the regions

The workshops were attended by all project partners and a small number of invited participants (list of attendees in annex). The organisers would like to thank all participants as they greatly informed discussions and contributed to successfully achieving the objectives of the workshop.

### Workshop Format

**Day 1** focused on making information available to all involved or interested in the project. This increased the knowledge-base of partners and help potential collaborative links to be explored.

(open to all invited parties with an interest in the project)

**Day 2** aimed at using the information from the previous day to make decisions on case studies and research methodologies. Outputs required were a complete set of case studies and draft research plans associated with each. (project partners)

The following agenda was developed in order to achieve the objectives outlined above.

<i><b>time</b></i>	<i><b>description</b></i>	<i><b>speakers</b></i>
<b>Day 1</b>	<b>Information</b>	
9.00am	Welcome and introductions by participants, brief explanation of the project	John Hambrey, Project leader
9.15	Purpose of this workshop, outputs required, presentation and discussion format	Rod Cappell, Project manager
9.30	Use of models and indicators for establishing environmental capacity in relation to aquaculture	Trevor Telfer, Technical Advisor  (10 minute discussion after presentation)
10.00	National review  (15 minute discussion after presentation)	Author(s) of national review
10.45	break	

11.15	Integrating environmental capacity into the management and planning of aquaculture	Rod Cappell (with 10 minute discussion after presentation)
11.45	Appropriate use of environmental capacity in aquaculture development	John Hambrey (chair)
1.00	lunch	
2.00 – 5.00	Research managers present potential case studies. Each being followed by discussion.	Local research managers
<b>Day 2</b>	<b>Decision-making</b>	
9.00	Case study selection and discussion of issues associated with each	John Hambrey (chairing discussion)
	lunch	
2.00	Research methodologies for each case study (physio-chemical and biological analysis/monitoring required).	
	break	
3.00	Socio-economic & community collaboration, information and surveys required	
4.00	Draft research plan (outline) for each case study	
4.45	Other matters arising (administration, timescales, reporting procedures)	Rod Cappell & national co-ordinator
5.00	close	

## 2. An introduction to TROPECA, its aims and outputs.

**Presentation by John Hambrey, Research Director, Nautilus Consultants and Rod Cappell, Project Manager, Nautilus Consultants**

### **TROPECA: Practical guidance for the estimation and allocation of environmental capacity for aquaculture in tropical developing countries**

Tropeca is a 3 year research project funded under the DFID Aquaculture and Fish Genetics Research Programme. Feb 2002-Dec 2004, Bangladesh & Vietnam

#### **AFGRP goal:**

*To sustain and increase productive benefits of aquatic resources for poor people through improved knowledge of aquaculture processes and their management*

#### **AFGRP rationale:**

- The expansion of aquaculture in developing countries poses risks of exceeding environmental capacity
- The possible need to control the use of sites, in order to remain within environmental capacity, has implications for resource allocation and access

#### **The importance of environmental capacity:**

Conditions for achieving environmental sustainability include:

*“holding waste emissions within the assimilative capacity of the environment without impairing it”*

#### **Tropeca has 5 main outputs**

##### **Output 1**

- Enhanced understanding of the applicability of:
  - simple environmental capacity models and/or
  - adaptive management approaches

...in providing *effective* environmental management of key tropical aquaculture systems

##### **Output 2**

- Identification, and review of strengths and weaknesses, of *alternative biological and physical environmental indicators*
- Evaluation of their potential role in the development of *practical environmental quality standards*

for a range of tropical habitat types associated with aquaculture.

### Output 3

- Enhanced understanding of the applicability of
  - alternate planning instruments to allocate environmental capacity and control development

for aquaculture in tropical developing countries.

### Output 4

Collaborative, case-study based

*practical strategies*

for promoting aquaculture equitably within environmental capacity.

### Output 5

- *Enhanced capacity* to plan and manage tropical aquaculture
  - equitably, and
  - within environmental capacity

..on the part of key government departments and agencies regionally, nationally and internationally

### Interpretations of environmental capacity

There are important differences between the different interpretations of capacity:

- **Carrying capacity**: the number of organisms, or number of enterprises, or total production, which can be supported by a defined area, ecosystem or coastline;

–**implies a limit on production**

- **Environmental capacity**: “a property of the environment and its ability to accommodate a particular activity or rate of an activity...without unacceptable impact” – **implies a limit on waste**

The idea of environmental capacity directs attention to environmental effects, rather than the scale of activity or rate of production. Management based on environmental capacity should stimulate environment friendly technology since this will allow for increased production within a given environmental capacity.

### Environmental capacity and nutrient/organic matter loading

*What we need to understand:*

- production of organic matter and nutrients from aquaculture;
- dispersal; dilution; degradation; adsorption; assimilation
- effect on water quality; organisms; ecosystems;

*Then we:*

- compare effects with environmental quality standard

### **However, reality is less favourable**

- Estimates based on the above calculations will be optimistic since they assume perfect dispersal and mixing;
- In practice estimates should be adjusted downward to make allowance for imperfect mixing leading to “back up of waste; dead areas etc.
- Monitoring (of both production and nutrient concentrations) at key points should then be undertaken, dilution/assimilation calculated and environmental capacity estimates adjusted accordingly.

The influence of environmental capacity on risk of disease outbreaks in aquaculture is unclear as the following are all thought to impact on the likelihood of disease:

- biomass
- density
- spatial distribution
- technology
- management practices
- water quality & susceptibility
- concentration of disease organisms

It is therefore sensible to develop a precautionary approach to the estimation of limits to loading, density, etc in relation to disease supported by continued monitoring.

### **Environmental quality standards**

Examples of EQS are:

- no increase in suspended solids;
- light levels should not normally fall below 10% of surface levels at 2m;
- mean total N not to exceed 500 ug/l.

As guidance, typical ambient levels in a high water quality lagoon are around 25 ug /l total phosphorus and 50 ug /l total nitrogen in the lagoon water.



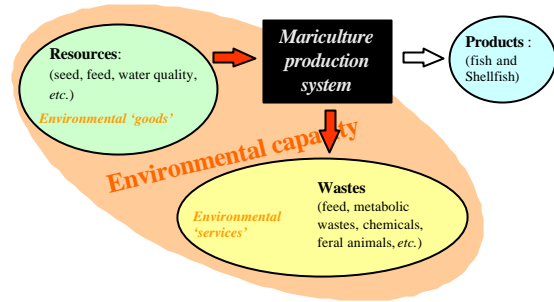
### 3. An introduction to environmental modelling and the use of indicators

Presentation by Dr. Trevor Telfer , University of Stirling, TROPECA  
Technical advisor

#### Definition

- Environmental capacity –  
"the ability of the environment to absorb and assimilate activity and effluent without unacceptable effects or exceeding pre-determined environmental quality standards"
- Carrying capacity -  
"the amount of a given activity that can operate within the environmental capacity"

#### Definition



#### Aims

- Present models enabling the effective estimation of environmental capacity or functions of EC
- Present indicators useful for confirming the predictions of these models

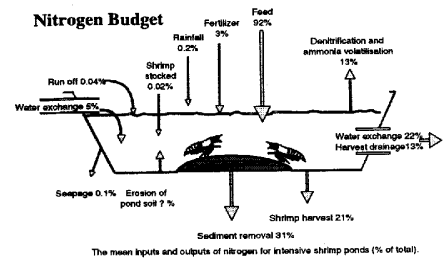
#### Types of models

- Time trend models –  
Black box models, single inputs and outs, e.g. growth against time
- Regression models –  
Complex systems with many variables, identify the most important for effect
- Bioenergetic models  
Theoretical descriptive models, e.g. fish growth from food ingested & metabolism
- Mass balance models –  
Mass flow and balance, based on input = output

## Models in aquaculture

- Models developed mainly for intensive aquaculture
- Complex environmental systems and production methods
- Simple and complex forms but tend to be data hungry
- Tend to be based around:
  - mass balance models
  - waste dispersal models

## Mass balance



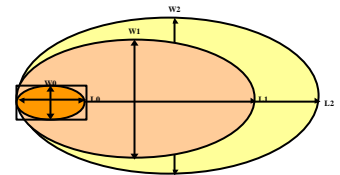
(see larger image at end of presentation)

## Waste dispersal models

- Dissolved
  - e.g. ammonia, dissolved oxygen, nitrate, BOD, chemical treatments
- Particulate
  - Waste food and faecal material as carbon, nitrogen or phosphorus, sedimentation, or chemicals from treatments

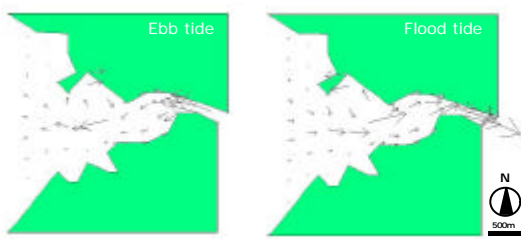
## Dissolved wastes – short term

Local dispersion and dilution

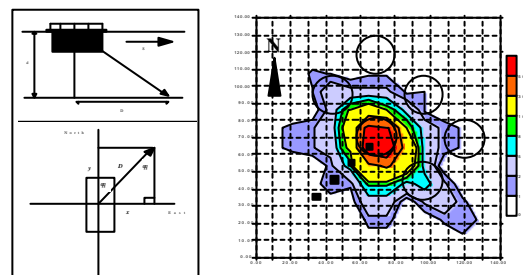


## Dissolved waste – longer term

Box models



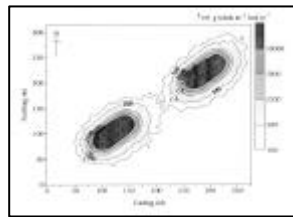
## Dispersal models – particulate wastes



## Dispersal – particulate wastes

### DEPOMOD

- Inputs of suspended solids
- Production data
- Relates to infaunal data (TI)
- Allows comparison to EQS

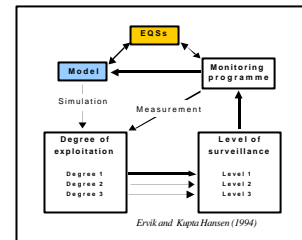


After Cromey et al. (2000)

## MOM

(Modelling On-growing fish farms Monitoring)

- Based on an agreement that fish farm sites should not deteriorate over time and that the impact must not lead to the extinction of the benthic infauna beneath the farm
- Three types of investigation:
  - A sedimentation measurement beneath cages
  - B characterization of sediment conditions (compare to EQS)
  - C sediment fauna study (compare to EQS)



- Recognises 3 zones of impact - local, intermediate, regional

## Constraints of EC

- Difficulty in pre-emptive determination before negative impact
- Environmental indicators can provide early information on changes in the ecosystem

## What are indicators?

- Physical  
Simple measure, clear indication – DO, sedimentation
- Chemical  
Measure of nutrient balance - P, NH<sub>3</sub>, C, N, Chl 'a'.
- Biological  
Complex interactions, e.g. diversity, change in trophic level– WHY USE?

## Visual indicator

Change in nature of sediments

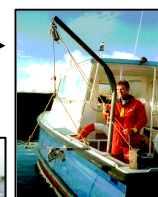
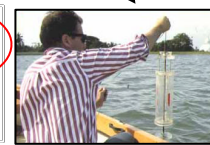


## Environmental indicators

Physico-chem.  
Biological

• Sediment  
• Water

• Organic C & N  
• Redox potential  
• Biodiversity  
• Therapeutants  
• Heavy metals  
• NH<sub>3</sub> & NO<sub>3</sub>  
• PO<sub>4</sub>  
• Chl 'a'  
• Turbidity



### Selection of indicators

- Must be sensitive enough to indicate the likely point of capacity "overload"
- Allows precautionary approach
- Action can be taken well in advance of "overload"

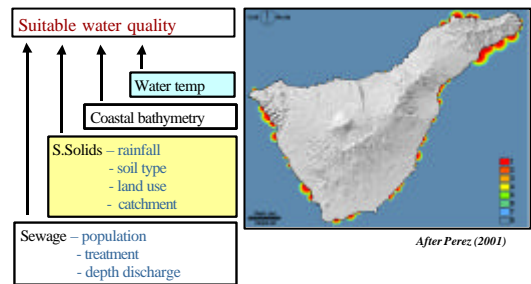
### Constraints in tropical systems

- Economic
  - Low input extensive systems – no revenue to pay for monitoring, e.g. chemical analysis, toxicity tests
- Practical
  - Resource, time and expertise. Tend to demand more detail
- Comparability?

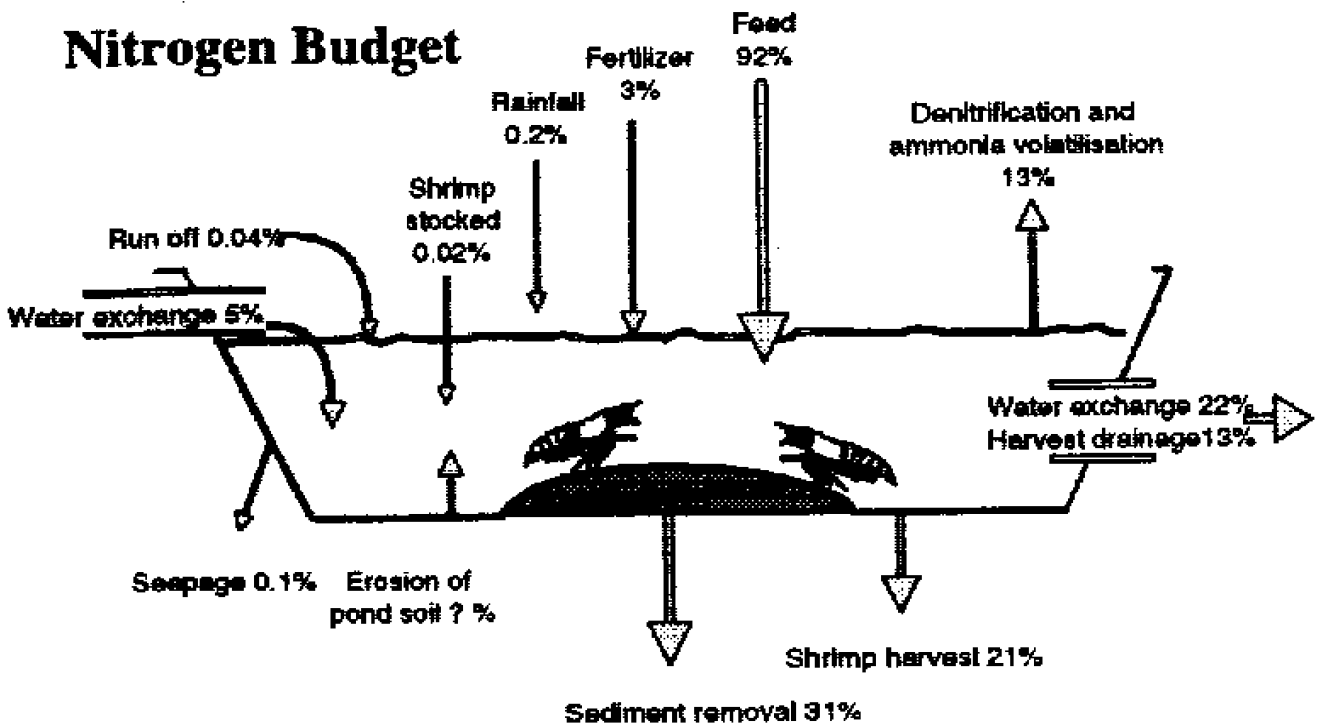
### Conclusions

- Models and indicators are developed largely for intensive aquaculture, thus it is only applicable to certain tropical aquacultures
- Need modification and relevant information
- Management and policy implications – talked about later

### Site selection/management for cages in Tenerife



## Nitrogen Budget



The mean inputs and outputs of nitrogen for intensive shrimp ponds (% of total).

## 4. Environmental capacity in the planning and management of aquaculture

**Presentation by Rod Cappell, TROPECA Project Manager**

*TROPECA will investigate the potential to estimate Environmental Capacity and how to use it in an Appropriate way.*

### **Where could environmental capacity be applied?**

1. Planning (encourage/discourage siting of farms)
2. Inputs (feed, seed, chemicals)
3. Process (farm management)
4. Outputs (products , by-products, waste)

### **1. PLANNING**

This phase is where the use of environmental capacity is most obvious and is therefore the most widespread.

Application of EC should be done at an appropriate scale:

International > national > regional > local > farm level

Examples of EC use in planning include:

**Modelling On-growing Fish Farm Monitoring (MOM)** system used in Norway.

(Regulatory)

Requires a high level of control and large amounts of data and resources as well as co-operation from the sector.

**Decision Support Tool for Aquaculture (DESTA)** developed by researchers in Australia

(Industry)

Operates at farm level: assists individual companies in responsible planning with potentially the dual benefits of better farm performance and reduced environmental impacts from optimal siting.

DESTA requires a lot of data for a single farm and currently the system is set to farm performance parameters rather than environmental impact, but possible.

**Zonation through Tax incentives or levies**

(Economic)

Designated priority development area for socio-economic and environmental reasons.

Potential revenue generation with environmental mitigation and can be linked to environmental capacity.

Requires substantial work on a national basis to objectively establish development areas and socio-economic needs may conflict with environmental needs.

## 2. INPUTS

Inputs into aquaculture systems include seed, feed, chemicals and medicines. All inputs have the potential to create negative environmental effects if misused.

The impact of inputs can be considered in two categories: the **quality** of inputs and the **quantity** of inputs.

Quality of input will influence what type of impact occurs.

Quantity of input will determine how severe or widespread that impacts is.

### Chemicals

From an environmental perspective there are 3 categories of chemical in use in aquaculture:

1. those that pose an inherently **high level of hazard**, whose use should be curtailed  
eg. chloramphenicol, organotin molluscicides, malachite green and some organophosphates.
2. those that can be used safely if **standard precautions** are followed but pose a threat to the environment and/or human health if misused.

Excessive dosage, failure to provide for adequate neutralisation or dilution prior to discharge, or lack of adequate personal protection equipment can make these unsafe.

3. those that may be **environmentally benign** under most situations but detrimental at specific sites because of the unique attributes of such sites.

Proper selection of farm sites can substantially reduce the environmental impacts of such aquacultural chemicals.

Use of chemicals widespread and often uncontrolled in developing countries : wrong type (banned etc.) or wrong dosage

#### Results of misuse:

- ⇒ crop itself damaged
- ⇒ adjacent crops damaged
- ⇒ farmer and/or surrounding community harmed
- ⇒ environment damaged
- ⇒ product and product from adjacent farms deemed unfit for human consumption due to chemical residue
- ⇒ loss of efficacy of prophylactic antibacterial agents.

Control of chemicals mainly by **licencing and monitoring** – both weak in developing countries.

Institutional limitations often prevent adequate enforcement to check for sale and use of banned chemicals and farmers' training may not extend to chemical use or may be out of date.

Chemical use is also controlled by **product standards** where detection of certain residues results in **import bans**, creating a strong incentive for developing countries to deal with the problem through stricter monitoring and control. This message should eventually permeate down the supply chain until farmers realise that incorrect chemical use will mean their harvest cannot be sold.

Dosage levels usually based on LD50 - a capacity-based environmental standard ?

The cumulative effect of chemicals in an aquaculture area is not considered, however, and chemical use is a farm-based decision. Controlling chemical use on a wider scale in relation to the environmental capacity of an area is only likely to result from local agreements or national codes of practice.

## Feed

Feed adversely impacts on the environment in a direct way when food contains harmful ingredients or is not fully digested (a **quality** issue) or if it is uneaten ( a **quantity** issue).

Average effluent load (nutrient load / product yield) has reduced in intensive aquaculture due mainly to improvements in formulated feed. (Improved understanding of nutritional requirements and high-energy diets lead to less wastage).

Authorities have attempted to regulate feed inputs in the past, but the introduction of feed quotas per farm can cause a stagnation of production and may prevent innovation in new techniques. Depending on the precise regulatory terms, the control of feed input can encourage the development of more efficient (and therefore more environmentally-friendly) diets.

Development usually sees:

no input systems > low input > formulated feeds.

This is often linked to:

⇒ intensification

⇒ more capital available

⇒ reduced availability/increased cost of locally-available feeds

Such developments can be environmentally beneficial as less pressure on local natural resources (eg. trashfish) and nutrient inputs can be more accurately controlled with formulated feed.

**BUT** - Risk of excessive nutrient input can increase with formulated feed as overfeeding is far easier to do. Farmers may lack the knowledge to optimise feeding regimes, assuming more food will result in faster growth.

Optimising the feeding regime is both beneficial to the farmer and the environment:

⇒ Feed is generally the largest operational cost so any waste is money lost

⇒ Too much feed hampers growth or even cause mortality of the crop as localised nutrient increases can reduce oxygen levels in the culture area and in the receiving environment.

Eg., Aquasmart: A computerised feedback system used by the salmon industry.

In developing countries, such a system is not suitable as it is associated with a particular feed regime, is costly and impractical to install.

Reduce environmental impacts of feed inputs mainly by **training** and **local management agreements**.

## Seed

Quality: dictates likelihood of mortality directly from disease or from environmental stress.

Remains a farm-level (management) issue unless it contributes to a disease outbreak.

It is in the interest of all farmers to agree to buy from reputable sources - can be written into codes of conduct or local management agreements.

Quantity: Stocking density is determined by the carrying capacity of the culture area (oxygen levels) as well as making the incidence of disease more likely and its spread more rapid.

Risk of disease is the most pressing concern for developing country farmers.

Rapid expansion of aquaculture in South East Asia has exceeded institutional capacity for training in good practice and regulation of supply channels.

Measures to avoid disease outbreaks are usually only brought in following major disease outbreaks.

Eg. shrimp culture in India and Bangladesh in 1994. In these countries, the importation of seed has stopped or is strictly quarantined, while hatcheries are providing technical assistance to farmers on how to avoid and deal with disease.

### **Disease and EC**

Link difficult to clearly establish.

Poor environmental conditions cause stress, increasing disease susceptibility.

widely accepted, but quantification and modelling relationship not possible so far

Establishing environmental quality standards in relation to disease is therefore not currently feasible.

## **3. PROCESS**

### **Best Management Practice (BMP).**

- ⇒ industry-based voluntary participation,
- ⇒ can be furthered through market initiatives eg. labelling schemes.
- ⇒ may also be included as a licence condition.
- ⇒ BMP can incorporate EC, but most is implemented at farm level

Overall goal of Codes of Conduct could be to ensure cumulative activities do not exceed EC. Most state an overall goal to avoid or reduce environmental effects, but these are not tied in to EC at present.

*eg. National Codes of Practice in Thailand*

*complex so not enforced, farmers have developed a simplified agreement*

### **Strengths of Codes of Conduct** (from Boyd et al 2002)

- valuable discussion among stakeholders
- BMPs with codes can make aquaculture more environmentally and socially responsible
- Can make aquaculture more efficient, sustainable and profitable
- Provide an excellent means of technology transfer to producers
- Positive interactions with environmental agencies and other government agencies resulting from process of code development
- BMPs could provide the basis for future environmental regulations
- Codes can provide marketing advantages

### **Weaknesses of codes of conduct** (from Boyd et al 2002)

- Adoption is voluntary
- Producers may only adopt easiest or cheapest elements of the code and avoid difficult parts
- Many obstacles to effective self-evaluation or third party verification
- Producers may lack technical knowledge for using BMPs
- Implementation could be slow and result in substantial costs to farmers
- Effectiveness of BMPs assumed but not proven
- Unless all stakeholders involved in preparation, BMPs may not address all significant issues (especially social issues)

**Biomass limits** – *farm-level tool used to limit process and so pollution from that process.*

*Could be extended to a regional basis and be based on environmental capacity – particularly for **marine mollusc culture** where capacity may be -dependent on natural feed (plankton) with its removal being the limit to environmental capacity as well as carrying capacity.*



*In other situations, biomass limits have been found to **dissuade innovation in production** as maximum production for a site is set.*

## 4. OUTPUTS

Most environmental policy focused on outputs – limiting the waste output from aquaculture.

**Discharge consents** – *widely used, but are arbitrary (not linked to EC).*

*eg. Total Maximum Daily Limits (TMDL) in the US*

*Do incorporate EC as a basis for allocation of individual EQS for specific sites.*

*These create the potential to be tradeable*

**Tradeable permits** – *controversial as seen as licence to pollute, but does create an incentive for cleaner production.*

For such strict control of emissions, however, accurate measurement is essential as well as good enforcement. This is not feasible in most situations, particularly in developing countries.

### How should environmental capacity be applied?

The examples of environmental management tools mentioned show a variety of approaches which can be defined as:

- Regulatory (dictated by authorities)
- Participatory (dictated by the industry)
- Economic (dictated by the market)

**Regulatory** tools generally result in some form of licensing

planning: \_\_\_\_\_ site licenses

inputs: \_\_\_\_\_ product licenses

process: \_\_\_\_\_ food safety, animal welfare regulation

outputs: \_\_\_\_\_ discharge consents

**Participatory** tools such as an agreement by the sector aiming towards better practice. An over-arching example of this is **Best Management Practice** which should incorporate all aspects of aquaculture.

planning: \_\_\_\_\_ site selection

inputs: \_\_\_\_\_ feed / chemical control

process: \_\_\_\_\_ process efficiencies, HACCP

outputs: \_\_\_\_\_ local user agreements

**Economic** tools relating to aquaculture can take a variety of forms:

planning: \_\_\_\_\_ tax incentives/subsidy

inputs: \_\_\_\_\_ accreditation

process: \_\_\_\_\_ product quality standards

outputs: \_\_\_\_\_ tradable permits

### **But what will work in developing countries?**

Environmental capacity has only recently been recognized as a more objective basis on which to manage aquaculture and its development.

The majority of examples of its application are associated with intensive cage culture in industrialised nations.

For a variety of reasons, such solutions may not be applicable in developing country situations.

Some factors to be consider are listed below:

- data availability
- cost
- policies and governance
- institutional capacity/ community willingness to act
- land use and ownership (“stewardship”)
- complexity (eg. user interactions)
- implementation timescale

While mainly seen as limiting factors, some of those listed above may also make alternative approaches more feasible than in industrialised nations.

A recent review of environmental policy relating to aquaculture found:

*“Environmental policies which set only the framework for aquaculture are more efficient in protecting the environment than those which regulate every aspect of fish farm operation.”*

***EIFAC working group, 2001***

## 5. Bangladesh Proceedings



*The Bangladesh Tropeca Team*

### **5.1 Bangladesh National Review**

#### ***Presentation by Michael Roy, local consultant***

##### **Objectives of the review**

To understand:

- Existing aquaculture practices
- Present trend of production of aquaculture
- Environmental consequences of aquaculture
- Present management system of aquaculture
- Research into environmental implication of aquaculture

#### **Aquaculture Resource base**

Perennial

- Pond
- *Baor*
- Irrigation canals had been released due to FCD & FCDI projects (Flood Control & Drainage/Irrigation project)
- Inland open water capture fisheries which can be converted into aquaculture through stocking programs (conversion of open water into aquaculture-based capture fisheries)

Seasonal

- Seasonal pond which retain water for 4-8 months
- Low lying paddy fields enclosed within flood control dykes
- Road side ditches/canal
- Low lying areas in and around the cities and towns and numerous low lying areas which retain water for 4-6 months.

## **Aquaculture in Practice**

- Small backyard ditch/ponds/homestead aquaculture, which holds great promise for increasing family nutrition and fish production
- Pond Fish culture through intensive, semi-intensive methods
- Traditional and community based aquaculture in *baors*, *beels* and other low-lying areas
- Brackish water aquaculture (shrimp cultivation)
- Integrated *gher* farming (Golda approach)
- Integrated fish/rice/poultry/duck farming (FSR system)
- Cage culture
- Pen culture
- Mud crab culture

## **Aquaculture in Different regions**

**North region:** Dinajpur, Rangpur, Rajshahi, Bogra

**South-west region:** Khulna, Jessore, Khustia, Faridpur

**South region:** Barisal, Noakhali,

**South-east region:** Chittagong

**North-east region:** Sylhet

**Central region:** Dhaka, Mymensingh, Comilla

### **North Region**

- Pond culture
  - Monoculture (pangas, tilapia)
  - Polyculture (carps, pangas)
- Paddy cum fish culture (puti, common carp, tilapia)
- Fish stocking in *Beel*
- Cage culture

### **Southwest Region**

- Pond culture
  - Monoculture (shrimp, prawn, tilapia, pangas)
  - Poly culture (fish with prawn, carps)
  - Integrated culture (poultry cum fish)
- *Gher* culture:
  - Monoculture (shrimp, prawn, pangas)
  - Poly culture (fish with shrimp, fish with prawn)
  - Integrated culture (paddy cum fish and/or prawn)
  - Fish stocking in *Beel/Baor*
  - Mud crab culture

### **South Region**

- Pond culture
  - Monoculture (shrimp, prawn, pangas etc.)
  - Poly culture (fish with shrimp and/or fish with prawn)
  - Integrated culture (poultry cum fish)
- *Gher* culture
  - Monoculture (shrimp, prawn, pangas )
  - Poly culture (fish with shrimp and/or fish with prawn)
  - Integrated culture (paddy cum fish)
- Cage culture

### **Southeast Region**

- Pond culture
  - Monoculture (shrimp, fish)
  - Poly culture (carps and pangas)
- *Gher* culture
  - Monoculture (shrimp, pangas etc.)
  - Poly culture (fish with shrimp)
  - Cage culture
  - Pen culture
- Stocking in Kaptai lake and creeks

## Northeast Region

- Pond culture
  - Monoculture (pangas)
  - Poly culture (carps)
  - Integrated culture (duck cum fish, paddy cum fish)
- Fish stocking in *Haor*

## Central Region

- Pond culture
  - Monoculture (prawn, pangas etc.)
  - Poly culture (carp with prawn, pangas, tilapia etc.)
  - Integrated culture (duck cum fish, paddy cum fish culture)
- Cage culture
- Pen culture

## Relative share by types of fisheries

%	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Inland culture	18	20	21	22	23	24	24	23	24	27	30	33	33
Inshore capture	55	53	51	50	50	49	50	52	53	50	48	46	46
Marine	26	27	28	28	28	27	26	25	23	23	21	21	21

20 years ago Hilsha contributed 55% to capture fisheries, now this is below 15%

## Resource based increased

- Pond are increased by 1 percent per year  
*-Islam and Collis(1998)*
- Number of pond increased up to 8 percent per year in Patuakhai-Barguna area.  
*-PBAEP(1998)*
- 13000 ha of land come under *gher* fish culture in Khulna area within last 10 years
- 8000ha land increased for shrimp cultivation per year  
*Daily Sangbad 1998*

## Resource increased by aquaculture practice

- Pond under culture increased from 27 percent to 52 percent in the last 12 years
- Derelict ponds declined from 43 percent to only 17 percent
- Locally 90 percent pond brought under fish culture
- Number of cages increased from 520 to 15000 from 1997 to 2002
- Govt. increasingly brought *beel- baor* under stock enhancement programme

## Environmental stress associated with culture techniques

Issues	Extensive polyculture	Semi-intensive shrimp monoculture	Polyculture prawn-fish-paddy	Monoculture shrimp	Integrated culture (poultry/fish)	Integrated culture (paddy/fish)	Pen culture	Cage culture	Mud crab culture	Beel/baor stocking
Water quality (nutrient loading)	+	++	++	+++	+++	+	++	++	++	+
Disease	+	+++	+++	+++	+++	++	++	+	-	++
Water management	++	++	+++	+++	++	++	+	-	++	+
Soil quality	++	++	+++	+++	+	+	+	+	++	-
Soil salination	-	-	++	+++	-	-	-	-	++	-
Ownership/access rights	-	-	++	++	-	-	++	++	+	+++
Habitat destruction	-	-	++	+++	-	-	-	-	++	++
Stocking density	+++	+++	++	++	+++	++	++	+++	-	+
Handling	+	+++	+++	+++	+++	++	++	++	+++	+
Aquatic plant management	-	+++	++	+++	++	-	+	+	+	+
Snail stock depletion	+	+++	+++	-	-	-	-	+	+++	-

+++ = high stress

- = no stress

## Concern

Growth of culture-based fisheries may affect:

- ⇒ Resource accessibility
- ⇒ Biodiversity
- ⇒ Ecological balance

## National fisheries policy focus

- Growth (open water 50%, prawn/shrimp 20%, marine 10% by five years)
- Income
- Equity/Poverty alleviation
- Sustainability

## Sectors prioritized

- Inland closed water bodies
- Inland open water bodies
- Coastal shrimp Culture
- Marine fisheries

Priority option : *semi-intensive or intensive practice*

Is there a mis-match between priority option and policy focus?

There needs to be a rational balance between culture and capture

## Extension and Management

- NFMP should be in place with full implementation
- Community involvement should be encouraged with collaboration of NGOs
- Extension policy should consider environmental issues adequately

## Research Status

- Shrimp sector has some research/studies on environmental impact,
- CARE -GOLDA has some studies on environmental impact of *Gher* culture
- Otherwise, no such in-depth research so far carried out to study the environment consequences of aquaculture



### **Aquaculture Development in Bangladesh (mt)**

	1990-91	1991-92	19921-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999- 2000 (Provisional)
<i>A Inland fisheries</i>	654397	706605	770162	837566	908218	988238	1085764	1190761	1242620	1321151
<i>(a) Inland open water (capture)</i>	443404	479742	532419	573376	591145	609151	599900	615949	649418	672059
1) <i>River &amp; Estuaries</i>	135355	124843	138746	143425	152782	165367	159660	156894	151309	167478
2) <i>Sundarban</i>	6651	6297	6939	7127	6951	7265	9225	7031	11134	12235
3) <i>Beel (Depression)</i>	47923	49201	53019	55592	58298	60768	62798	67812	69850	81866
4) <i>Kaptai Lake</i>	4392	4216	4142	6635	5556	6148	5764	5932	6689	8135
5) <i>Flood Lands</i>	249083	295185	329573	360597	367558	369333	362453	378280	410436	402345
<i>(b) Inland Close water (Culture)</i>	210993	226836	237743	264190	317073	379087	485864	574812	593202	649092
1) <i>Ponds</i>	181018	195034	202167	222542	267282	307974	403830	483416	499590	547677
2) <i>Baors (Ox- bow Lake)</i>	1544	1682	1803	2201	2460	2764	3014	3378	3536	4940
3) <i>Shrimp Farms</i>	28431	30147	33773	39447	47331	68349	79020	88018	90073	96075
<i>B. Marine Fisheries</i>	241538	245474	250492	253044	264650	269702	274704	272818	309797	340000
1) <i>Industrial</i>	8760	9623	12227	12454	11715	11959	13564	15273	15818	16450
2) <i>Artisanal</i>	232778	235851	238265	240590	252935	257743	216140	257545	293979	323550
<i>Country Total</i>	895935	952079	1020654	1090610	1172868	1257940	1360468	1436579	1552417	1661151
<i>Annual Growth rate</i>	4.72	6.27	7.20	6.85	7.54	7.25	8.15	7.58	6.07	7.00

## **5.2 Group Discussion:**

### ***Aquaculture and environment issues in Bangladesh***

- **Habitat destruction**

Primary concern from shrimp monoculture in brackish water areas with clearing of mangrove areas and soil and aquifer salination due to retention of saltwater in ponds.

- **Reduction in biodiversity**

From overfishing for aquaculture inputs (seed and feed) and as a consequence of habitat destruction.

- **Disease transmission**

Farmers see this as a constant threat causing farmers to avoid much investment as it was seen to cause the failure of intensive practice in the mid 90's.

- **Intensification – horizontal development**

There were differences of opinion as to how the aquaculture sector would develop in Bangladesh. There is a general switch to monoculture from polyculture other than some areas where the efforts of NGOs have been in diversified farming systems (ie. GOLDA). Additionally some suggested intensification is the most likely trend, evidenced by experienced in other countries and some cage farmers looking at use of bigger cages. Local feeds have been superseded by pelleted feed in many instances. Others suggested, however, that intensification was attempted in mid 90's and failed due to disease. This has scared off others operating intensively as they feel it is too high a risk – too much capital tied up in one crop could be disastrous. It appears that if the risk is bigger, the likelihood of intensification is less. For example with seasonal water bodies, smaller cages are preferred to larger ones.

- **Conflicts between aquaculture and capture fisheries**

These conflicts relate to resource use, seed capture and supply, demand for trashfish from aquaculture and human consumption.

- **Shrimp market price**

Although demand remains strong, it was suggested that market price has recently decreased. This implies a lack of transparency in the marketing of product and there is certainly a lack of information in this area.

- **Property rights, land ownership and access**

The development of small-scale cage culture was supported to assist the land-less poor. Access to waterbodies used by many of these small-scale cage farmers is controlled by the owner of those water bodies. Where water bodies are communally or state-owned, conflicts between users can occur.

- **Water quality**

Within ponds as a result of bad practice: over-feeding, low quality (inefficient) feed, over-stocking, lack of aeration. In some instances this leads to algal blooms in ponds which pose a risk to the crop and also to public health if certain fish is harvested and prepared incorrectly. In the wider environment as a result of increased nutrient outputs from aquaculture and also (in macrobrachium culture areas) as a result of excessive snail collection for aquaculture feed (the snail acts as a biofilter).

- **Use of pesticides and other chemicals**

Pesticides and chemicals have in some cases, such as beel culture, accumulated in the environment. Use is currently unmanaged and dosages vary considerably between farmers. This points to a lack of education regarding these chemicals linked with no control of the availability of chemicals and inadequate infrastructure to enforce licensing of products.

### **5.3 Selection of Bangladesh Case Study (B1):**

#### **Presentation by Dr. Niamul Naser, University of Dhaka, Research Manager**

##### **Environmental and Public Health Issues from Cage Culture in Bangladesh**

The CARE CAGES project, implemented between 1996 and 2002, offers a fascinating insight into the problems and opportunities for technology transfer and adaptation for poor households. The project began with a technology and development focus, and evolved to become more “people” and poverty focused as the policy environment evolved.

*Water is unlikely to be a significant constraint to the further development of small scale cage aquaculture. Bangladesh is not short of suitable waterbodies. Taken together, the canals, rivers, household ponds, oxbow lakes, roadside pits and other water bodies offer a huge resource which can be further developed.*

*The short cropping cycle (3 months and less for some systems) and small size of cages allows for the use of seasonal water bodies of all sizes, although the CARE extension materials emphasise year round water to maximise profits. However, in some areas the use of groundwater for irrigation in the dry season may shorten the production season.*

*There is no reason why cages should not be sited in ponds stocked for carp polyculture. Indeed, the cages may contribute to pond fertility and enhance overall production.*

- The key to the evolution of a suitable technology was the learning network and learning support system established by CAGES, coupled with a steadily less prescriptive and more adaptive approach to technical recommendations.
- Research should support rather than drive this process, and assess strengths and weaknesses of evolving technologies against broader social and economic issues and trends.

##### **Water issues**

- Drought
- Flood
- Inundation creating flood plain
- Drinking water
- Sanitation
- Water borne diseases

##### **ENVIRONMENTAL concerns from cage outputs**

- fish,
- feed,
- chemicals & medicine,
- excretory products,

–nutrients

### **PUBLIC HEALTH concerns**

- Bacteria also utilize nutrients like iron for multiplication
- The relationships between nutrient and bacterial load in water can also address any public health issue from cage culture

–

Cholera is an endemic disease in Bangladesh. During the endemics toxigenic *Vibrio cholerae* 01 can be isolated from water bodies. *Vibrio cholerae* was isolated from various aquatic flora and fauna. Plankton also acts as a reservoir of the bacteria.

The presence of *Vibrio* in water is dependent upon:

- Carrying capacity of water: Whether nutrient inputs lead to improve the carrying capacity of water system.
- Nutrient dynamics in water: Whether nutrient inputs of cages enhance a closed water system

### **Type of analysis possible:**

- Water quality analysis
- Fish feed analysis
- Biological parameters analysis
- Presence of *Vibrio* in water
- Presence of planktonic reservoir for *Vibrio* in water

### **The case study should therefore consider:**

Cage culture in Closed and Open water system

- Physico chemical parameters: pH, DO, CO<sub>2</sub>, Nitrite, BOD, P
- Biological parameters: Phyto and Zooplanktons
- Benthos
- Bacterial count
- *Microcysts* bloom?
- Environmental impact of cage in aquatic system
- Nutrient dynamics in cage culture
- public health concerns

### **Options**

- A private fish farm at ARICHA
- 6-12 Cages in Carp culture pond
- 6-12 Cages in Flood Plain within the boundary
- Short term study: 3 mo, Tilapia
- Long term study: 9 mo, Thai Pangus

## 5.4 Selection of Bangladesh Case Study (B2)

### Presentation by MA Rouf, University of Khulna, Research Manager

#### Environmental Issues

- "Mangrove forest and wetland losses
- "Eutrophication and sedimentation of receiving waters
- "Salination of soils and aquifers
- "Disease transfer to wild stocks
- "Exotic species introductions
- "Discharge of toxic and /or bioreactive substances
- "Reduced biodiversity in shrimp culture areas

#### Management Issues

Mortality trend due to Viral (Monodon Baculo Virus -MBV) disease –

A case of Satkhira district:

There is widespread destruction of agricultural land due to Shrimp culture:

	Agriculture land (%) during 1975	Agriculture land(%) during 1999
Mongla	84.24	19.24
Rampal	81.30	17.80
Dacope	86.79	42.25
Shyamnagar	87.09	50.32

Environmental Impact Values (EIV) due to the increase of shrimp cultivation:

	Study area During 1975-85	During 1985-99
Mongla	(-) 26	(-) 77
Rampal	(-) 18	(-) 78
Dacope	(-) 30	(-) 51

Source : Shah and Karim, 2001

#### Management Issues

- ◆ Reducing soil quality
- ◆ Feed problems: High cost, No artificial feed, Natural feed.
- ◆ Seed supply: No hatchery, Seed from Cox's bazar
- ◆ Water supply
- ◆ Poaching
- ◆ Less accessibility of poor land owners

#### Policy issues

Policy for 1990-2000 has stated goals of

**Shrimp farm area:** 01 lakh hector

**Extensive culture:** Area: 70,000 ha,

Production: 400-500kg/ha/yr shrimp

200 kg fin fish (mullet, bhetki and other )

**Semi-intensive culture:**

Area: 20,000 ha (Khulna-15,000; Cox's bazar-5000 ha)

Production: 3000 - 4000 kg/ha

**Intensive culture:** Area: 7000 - 8000ha.

Production: 7-8 tons/ha/yr

Source: **Nuruzzaman, 1993.** Cluster of ideas and actions for fisheries development in Bangladesh

**Available data:**

Fish Production at 2001 from different water body (Number and area) and target production for 2002.

**Recent projects:**

Poverty elevation project through community based fisheries

Extension of shrimp culture technique project

Fourth fisheries project

**Potential case studies**

Possible study areas: Athuria, Mouza, Kulbaria, Thana, Dumuria, Khulna

**1. Estimation of Carrying capacity of the Bhadra River or a canal of Dumuria, Bangladesh : Taking shrimp farming into consideration.**

- Evaluation of water quality trends in the river or canal
- Assessment of the impact of shrimp aquaculture on water quality in the canal or river
- Preliminary analysis of carrying capacity of canal
- Identified management options for sustainable development of aquaculture in the canal or river.

Natural Brackish water (20-25 ppt)

Extensive culture of:

- Rainy season (February-July)-Poly culture. *P.monodon* with *Catla catla*, *Labeo rohita*, *Liza parsia*.
- Wet season (August-December) - Paddy

Total culture area - 80-180 ha.(individual shrimp farm)

Number of ponds or ghers-500

Production- 120-150 kg/ha

NGOs and other associated links: Collaborative works (ATTP), Uttaran BRAC, ASHA NGOs

**2. Estimation of the Carrying capacity of shrimp farm areas in Dumuria, Bangladesh**

Prawn Fish Polyculture

Aquaculture Training Transfer Project (ATTP), BARC.

Carp Polyculture

ICLARM

Indigenous Species Conservation Project

Recent Research:

SHRIMP CULTURE AND CHANGES OF LAND USE PATTERN IN COASTAL BELT OF BANGLADESH: A SPATIO-TEMPORAL ANALYSIS

M. S. Shah and M. R. Karim

**Sponsored by** BANGLADESH AGRICULTURE RESEARCH COUNCIL, DHAKA. January, 2001

**Report available**

Recent research

**PORESSFA: Policy Research for Sustainable Shrimp Farming in Asia:**

A comparative analysis of Bangladesh, India, Thailand, and Vietnam with particular reference to institutional and socio-economic aspects.

**Sponsor:** European Commission Programme INCO-DEV

**Duration:** 3 years: **April 2002 - April 2005**

**Dr. Atiq Rahman** (Responsible Scientific)

Bangladesh Center for Advance Studies

**Objective:** To address the sustainable development issues of shrimp farming activities in Asia.

Available data and format:

**Topographic map (1:10,000):**1999-2000

Land use- elevation, slope, vegetation

Price (Tk) - 200-300 per paper; Available- Survey of Bangladesh, Tezgaon (Sat rasta more)

**Satellite Image:**

Land Sat TM (30m.)

Price (Tk) - 200-300 per MB; Available-SPARSO

Available data and the format

**Hydrology:**

Tide table (near by station) - Daily, monthly, Yearly

Price ( Tk) - 25 per page; Available-BIWTA

**Climate:**

Rainfall, Sunshine, humidity, Temperature

Available - Meteorology department

Non-Available data and the format

**Water quality data:**

**Laboratory analyzed parameters:** Total phosphorus (TP),

Total nitrogen(TN), Ammonia nitrogen (NH<sub>3</sub>-N),

Nitrate Nitrogen (NO<sub>3</sub>-N), Nitrite Nitrogen (NO<sub>2</sub>-N),

Dissolved reactive phosphorus (PO<sub>4</sub>- P), total solids(TS),

Total volatile solids(TVS)

**Insitu parameters:** Temperature, Dissolved Oxygen, salinity, pH, Secchi Disc (cm) and Total Depth (m).

## 6. Vietnam Proceedings



The Vietnam Tropeca Team

### 6.1 VIETNAM NATIONAL REVIEW

#### **Presentation by Le Anh Tuan, University of Fisheries, Nha Trang**

##### **Introduction**

*Aquaculture has developed since 1960*

*Aquaculture has great potential to develop in Vietnam*

- *120,000 ha are small ponds, lakes, canals, gardens;*
- *340,000 ha are large water surface reservoirs;*
- *580,000 ha are paddy fields*
- *660,000 ha are tidal zones.*

##### **Current Aquaculture Activities**

Figure 1. Production by aquaculture and capture fisheries by year

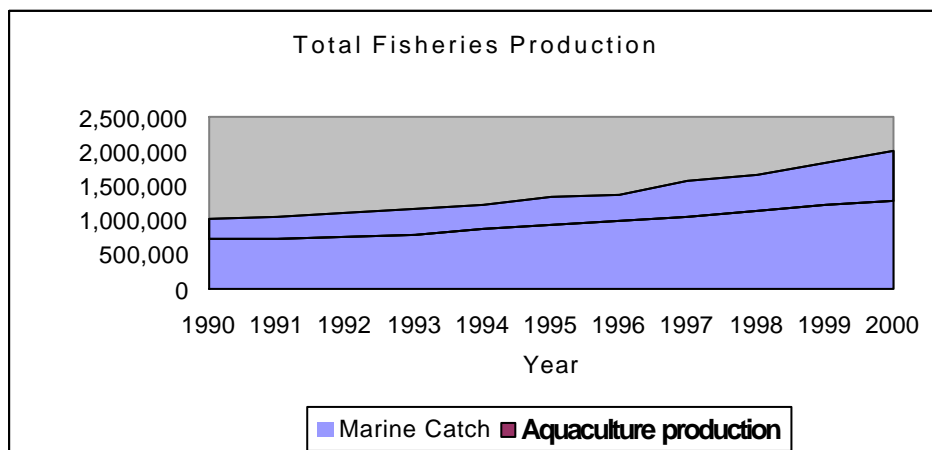
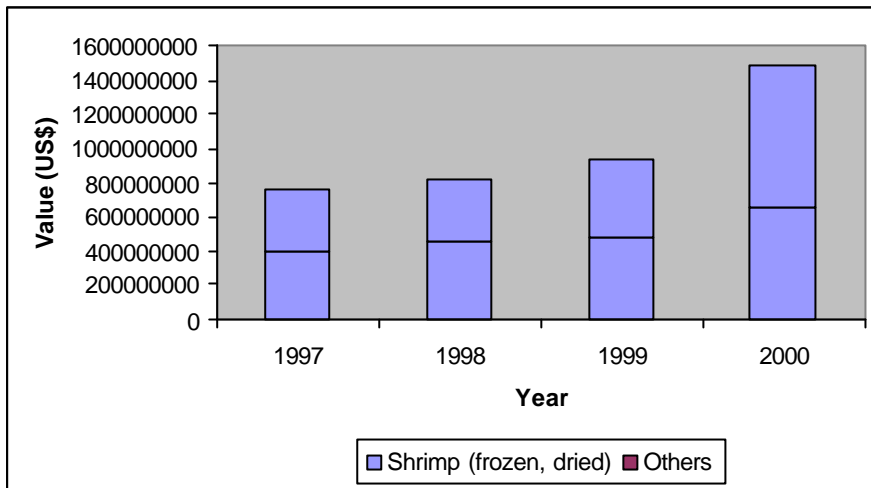




Figure 2. Export value of shrimp and other seafood by year



### Production systems

- ⇒ *The two main aquaculture systems in Vietnam are ponds and cages.*
- ⇒ *Ponds are used commonly to raise shrimp along the coastal area and freshwater fish species in the inland area.*
- ⇒ *Cages are designed in various ways depending on cultured species and characteristics of culture areas*

### Feed supply

- ⇒ *Formulated feed such as CP.Group, Betagro Kiladum, Classic, Grobest... (Thailand), Woosung (Korea), Seahorse (Taiwan), KP 90, Thanh Toan, Nam O (Da Nang, Vietnam), etc.*
- ⇒ *Self-made feeds, and*
- ⇒ *Trash fish*

### Seed supply

- ⇒ Shrimp
  - seed: hatcheries; ca 10 billions/yr
  - brood-stocks imported
- ⇒ Grouper
  - Seed: wild, hatcheries, imported; ca 1-2 million pcs/yr
- ⇒ Lobster
  - Seed: wild; ca 1-2 million pcs/yr

### Ownership

- ⇒ *Ownership of aquaculture farms changed over time and by region.*
- ⇒ *Five major types of existing enterprises:*
  1. Private;
  2. Improved co-operative;
  3. State-owned;
  4. Joint-venture between Vietnam partner(s) and overseas partner(s); and
  5. 100% foreigner-owned

### Environmental issues

#### *Shrimp farming*

- *Mekong delta, Can Gio, etc in the South;*
- *Nha Phu lagoon, etc in the Middle;*
- *Hai Phong, etc in the North.*

#### *Grouper culture*

- *Cage culture in Quang Ninh*

- Pond culture in Cam Ranh

### Lobster cage culture

- Xuan Tu

## Environmental policy and implementation

- Vietnam Assembly issued the Law of Environmental Management in 1994.

- to protect the salubrious environment for people's health and living,
- to ensure the sustainable development in harmony with the whole environment.

- At lower levels, there were plans, regulations, and criteria for the environmental management

•

**Table 1. National environmental quality standards of coastal waters**

Factor	Unit	For swimming	For Aquaculture	Other places
Temperature	°C	30	-	-
Smell		no	no	no
pH		6.5 – 8.5	6.5 – 8.5	6.5 – 8.5
DO	mg/L	≥4	≥5	≥4
BOD (5 day period)	mg/L	< 20	< 10	< 20
Suspended solids	mg/L	25	50	200
Asenic	mg/L	0.05	0.01	0.05
NH <sub>3</sub> (based on N)	mg/L	0.1	0.5	0.5
Cd	mg/L	0.005	0.005	0.01
Pb	mg/L	0.1	0.05	0.1
Cr (VI)	mg/L	0.05	0.05	0.05
Cr (III)	mg/L	0.1	0.1	0.2
Chloride	mg/L	-	0.01	-
Copper	mg/L	0.02	0.01	0.02
Floride	mg/L	1.5	1.5	1.5
Zinc	mg/L	0.1	0.01	0.1
Mn	mg/L	0.1	0.1	0.1
Ferric	mg/L	0.1	0.1	0.3
Hg	mg/L	0.005	0.005	0.01
Sulfide	mg/L	0.01	0.005	0.01
Cyanide	mg/L	0.01	0.01	0.02
Total phenol	mg/L	0.001	0.001	0.002
Oil foam/skin	mg/L	no	no	0.3
Oil suspension	mg/L	2	1	5
Chemicals used as pesticides	mg/L	0.05	0.01	0.05
Coliform	MPN/100mL	1000	1000	1000

## Current research and opportunities for collaboration

- There have been more than 120 fisheries sector projects in Vietnam since 1982.
- About one-tenth of the projects are occurring of relevance to the TROPECA project.
- Danida-SUMA and Hon Mun MPA projects are among potential collaborators

## 6.2 Proposed case studies in Southern Vietnam

### Presentation by Nguyen Van Tu, University of Agriculture and Forestry, HCM city

	1	2
Name of potential case study	Can Gio District of Ho Chi Minh City	Thanh Phu District of Ben Tre Province
Type of case study (1)	Coastal area - Shrimp culture	Coastal area - Shrimp culture
Size of case study area	Total district area: 71,642 ha Total shrimp culture area: 1,123 ha	Total district area: 39,099 ha Total shrimp culture area: being developed
Distance from your base	60 km from UAF	200 km from UAF
Do you have easy access to whole area?	Easily access by vehicle and boat	Easily access by vehicle and boat
Type of water body (2)	Tidal zone with salinity ranging from 2 to 22 ppt	Tidal zone with salinity ranging from 8 to 21 ppt
Type of culture systems (3)	Shrimp culture system Rice-shrimp rotating system	Shrimp culture system
Species cultured (4)	Black tiger shrimp Some finfish and crab	Black tiger shrimp Some crab
Level of activity (5)	- intensive shrimp culture: 191 ha - semi-intensive shrimp culture: 203 ha - rice-shrimp rotating system: 729 ha Until 2001, total shrimp production was 1360 T/crop of 1,123 ha	Shrimp culture projects - Giao Thanh commune (1995): 1000 ha - Thanh Phong commune (1996): 700 ha - Thanh Hai commune (1998): 700 ha - An Nhon commune (1999): 700 ha
Number of aquaculturists involved (6)	1,391 households involved in shrimp culture	Provided jobs - Giao Thanh project: unknown - Thanh Phong project: 700 labors - Thanh Hai project: 318 labors - An Nhon project: 435 labors
Aquaculture ownership (7)	State-run and private enterprise, and small-scale farmers	State-run and private enterprise, and small-scale farmers
Productivity of aquaculture (8)	In 2001 - intensive shrimp culture: 4 T/ha/crop - semi-intensive shrimp culture: 1.5 T/ha/crop - rice-shrimp rotating system: 0.4 T/ha/crop	Projected yields - Giao Thanh project: unknown - Thanh Phong project: 1.4 T/ha.yr - Thanh Hai project: 1.3 T/ha.yr - An Nhon project: 1.4 T/ha.yr
Environmental issues (9)	Untreated discharged water from shrimp pond is believed to have negative impact on the environment and shrimp farms themselves	Untreated discharged water from shrimp pond is believed to have negative impact on the environment and shrimp farms themselves

Management issues (10)	High mortality may be resulted from poor management of pond environment	High mortality may be resulted from poor management of pond environment
Current related research (11)	Lack of information	The Legal and Institutional Framework, and Economic Valuation of Resources and Environment in the Mekong River Region: A Wetland Approach
Data being recorded or available (12)	We can access the findings or data	We can access the findings or data
NGOs or other associated links (13)	Unknown	SUMA?
Policy in place (14)	- to treat pond water before discharging into outside environment - to support farmers to treat pond water of disease-disease ponds	- planning of shrimp culture
Policy being implemented? (15)	Protecting mangrove forest - buying sefl-planted forest of farmers	Improvement of extension service - contracted service
Political and social context (16)	Top-down Participatory to some extent	Top-down Participatory to some extent

#### Explanatory Footnotes

1. Type of case study: Geographical region, water body type or culture type
2. Natural, man-made, freshwater, saltwater, brackish, tidal, seasonal temporary
3. Pond culture, cage culture, semi-intensive, extensive
4. Allocate species to all cultures being employed
5. Total Ha, number of ponds/cages, production
6. How many individuals either known or approximated from extent of culture and typical ownership structure
7. Individuals, company, number of aquaculture units per farmer or group
8. Quantitative or qualitative assessment
9. What current environmental problems or issues are there? Such as water quality, impacts on wild species or water bodies
10. What current management issues are there? Low yields, high mortalities, reducing soil quality, feed problems, seed supply. Is there evidence that these are related in any way to environmental limits?
11. Is there any related research ongoing or recent either associated with aquaculture or the environment or both?
12. If yes, can we access the findings or data?
13. What researchers or NGOs are currently working in the region?
14. What relevant policies are there relating to this case study (environmental, land use, planning, water use)
15. Are any of those policies being implemented and to what extent?
16. What are the decision-making and local power structures associated with the region or community?

### 6.3 Proposed case studies in Central Vietnam

#### Presentation by Le Anh Tuan, University of Fisheries, Nha Trang

	1	2	3
Name of potential case study	Xuan Tu	Nha Phu Lagoon	Cam Rahn Bay
Type of case study (1)	Lobster village	Mixed use lagoon	Mixed use bay
Size of case study area	Culture area 118 ha (41ha old area, 77ha new area); Van Phong bay (472ha);close to MPA (IMA);	3000 - 5000 ha; (Littoral & supralittoral zone = 2000 ha)	18,000ha Thuy Trieu lagoon (~19.6Km <sup>2</sup> )
Distance from your base	60 km north of NT;	20-45 km north of NT	60km south of NT
Do you have easy access to whole area?	yes	yes	yes
Type of water body (2)	Semi-enclosed bay	Rectangular bay with 1km wide mouth	
Type of culture systems (3)	Cage culture	Pond and cage	Pond and cage
Species cultured (4)	Lobster, sweet snail, seabass	Shrimp, lobster (nursery)	Shrimp, lobster, grouper
Level of activity (5)	2,000 lobster cages 100 sweet snail	1,800 ha shrimp 100 lobster nursery cages	1,500 ha shrimp 71 ha grouper 5,000 cages lobster
Number of aquaculturists involved (6)	Approx. 700	> 2,000	>2,500
Aquaculture ownership (7)	Individuals	Individuals	Individuals, companies
Productivity of aquaculture (8)	100 t/yr	2,330 t/yr	3,800 t/yr
Environmental issues (9)	Pollution & disease	Pollution,disease, wild fisheries	Pollution, disease
Management issues (10)	Low yield. High morts (30%)	Low yield, high morts (50% shrimp), soil quality	Low yield, high morts (30% grouper)
Current related research (11)	IMA	HM MPA	
Data being recorded or available (12)	Little	Old	Old
NGOs or other associated links (13)	Local plan, IMA	Local plan, HM MPA	
Policy in place (14)	Planning	Planning	planning
Policy being implemented? (15)	IMA	HM MPA	-
Political and social context (16)	Van Ninh DPC, DoFI	Ninh Hoa DPC, DoFI	Cam Ranh DPC, DoFI

#### Explanatory Footnotes

1. Type of case study: Geographical region, water body type or culture type
2. Natural, man-made, freshwater, saltwater, brackish, tidal, seasonal temporary
3. Pond culture, cage culture, semi-intensive, extensive
4. Allocate species to all cultures being employed
5. Total Ha, number of ponds/cages, production

6. How many individuals either known or approximated from extent of culture and typical ownership structure
7. Individuals, company, number of aquaculture units per farmer or group
8. Quantitative or qualitative assessment
9. What current environmental problems or issues are there? Such as water quality, impacts on wild species or water bodies
10. What current management issues are there? Low yields, high mortalities, reducing soil quality, feed problems, seed supply. Is there evidence that these are related in any way to environmental limits?
11. Is there any related research ongoing or recent either associated with aquaculture or the environment or both?
12. If yes, can we access the findings or data?
13. What researchers or NGOs are currently working in the region?
14. What relevant policies are there relating to this case study (environmental, land use, planning, water use)
15. Are any of those policies being implemented and to what extent?
16. What are the decision-making and local power structures associated with the region or community?

## 6.4 Proposed case studies in Northern Vietnam

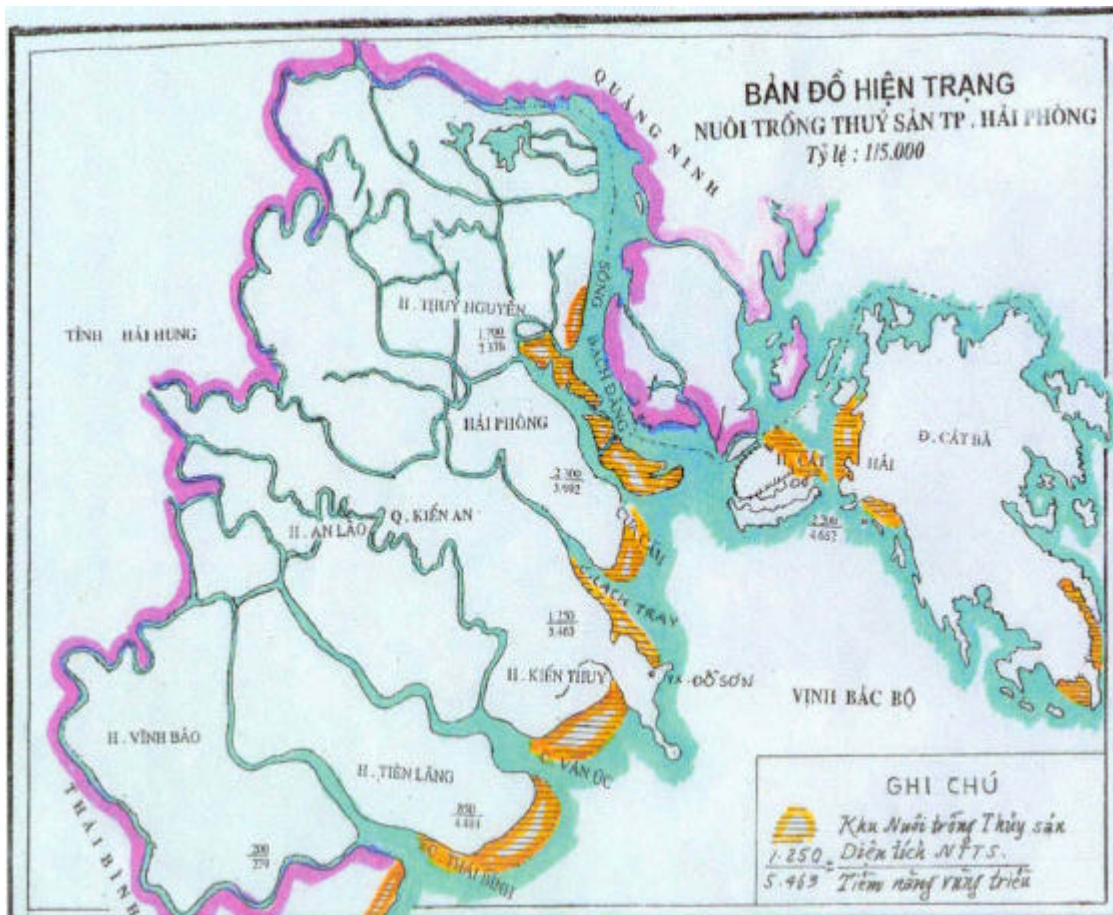
### Presentation by Vu Van In and Nguyen Nguc Hung

	1	2
Name of potential case study	Doson – Kien Thuy (see map)	Thuy Nguyen (see map)
Type of case study (1)	Tidal shrimp area	Tidal shrimp area
Size of case study area	743.5 ha	750 ha
Distance from your base	25km	30km
Do you have easy access to whole area?	Yes	yes
Type of water body (2)	Brackish water, tidal	Brackish water, tidal
Type of culture systems (3)	Extensive, Semi-intensive and intensive pond culture	Extensive, Semi-intensive and intensive pond culture
Species cultured (4)	Penaeus monodon ( <b>black tiger shrimp</b> ) Metapenaeus ensis ( <b>brackishwater shrimp</b> )	Penaeus monodon ( <b>black tiger shrimp</b> ) Metapenaeus ensis ( <b>brackishwater shrimp</b> )
Level of activity (5)	Extensive 47.1% Semi-intensive 50.5% Intensive 2.4%	Extensive 69.3% Semi-intensive 30.7% Intensive 0.3%
Number of aquaculturists involved (6)	850 households 4,250 individuals several aquaculture agencies	285 households 1,425 individuals
Aquaculture ownership (7)	Normally one to two households share a farm. Agencies are intensifying culture (18 ha)	Normally one to two households share a farm. Not much move to intensification yet.
Productivity of aquaculture (8)	240 tonnes (0.32 t/ha)	80 tonnes (0.32 t/ha)
Environmental issues (9)	Deterioration in water and soil quality	Deterioration in water and soil quality
Management issues (10)	<ul style="list-style-type: none"> <li>Lack of culture plan for region</li> <li>farm techniques poor due to lack of education/information (overfeed, overstock)</li> <li>disease problems</li> </ul>	<ul style="list-style-type: none"> <li>Lack of culture plan for region</li> <li>farm techniques poor due to lack of education/information (overfeed, overstock)</li> <li>disease problems</li> </ul>
Current related research (11)	Completion of technologies and equipment for aquaculture (2001-2004) Project for converting 325ha to intensive culture	
Data being recorded or available (12)		
NGOs or other associated links (13)	<ul style="list-style-type: none"> <li>Haiphong fisheries department</li> <li>BWRC, Haiphong</li> <li>Research institute for marine products</li> <li>Fisheries training schools</li> <li>Doson aquaculture service co.</li> <li>Aquaculture enterprise - Kienthuy</li> </ul>	

Policy in place (14)	<ul style="list-style-type: none"> <li>• Resolution no.16 on development of fisheries</li> <li>• Development strategy for aquaculture 1999-2010</li> <li>• Other gov. policies on low interest loan, investment, to develop farms</li> </ul>	
Policy being implemented? (15)		
Political and social context (16)		

#### Explanatory Footnotes

1. Type of case study: Geographical region, water body type or culture type
2. Natural, man-made, freshwater, saltwater, brackish, tidal, seasonal temporary
3. Pond culture, cage culture, semi-intensive, extensive
4. Allocate species to all cultures being employed
5. Total Ha, number of ponds/cages, production
6. How many individuals either known or approximated from extent of culture and typical ownership structure
7. Individuals, company, number of aquaculture units per farmer or group
8. Quantitative or qualitative assessment
9. What current environmental problems or issues are there? Such as water quality, impacts on wild species or water bodies
10. What current management issues are there? Low yields, high mortalities, reducing soil quality, feed problems, seed supply. Is there evidence that these are related in any way to environmental limits?
11. Is there any related research ongoing or recent either associated with aquaculture or the environment or both?
12. If yes, can we access the findings or data?
13. What researchers or NGOs are currently working in the region?
14. What relevant policies are there relating to this case study (environmental, land use, planning, water use)
15. Are any of those policies being implemented and to what extent?
16. What are the decision-making and local power structures associated with the region or community?





## 7. Selection of case studies and development of research plans (Day 2)

Day two of the workshop focused on the local project partners and how they should proceed. The day began with a reminder of the objectives and required outputs of the project, as laid out in the log frame. After the scientific nature of the presentations in day one, the following points were highlighted from the logical framework for the project:

- The overall objective of the DFID research programme and therefore of this project is **poverty reduction**
- The work is **needs driven** but drawing on scientific and regional/international knowledge and experience.
- The starting point should be **local workshops** in the case study areas to discuss with local resource users what the key environmental or resource management issues are.
- To produce a draft research plan we must **agree what is possible/feasible/useful from a scientific perspective**, to be informed by regional knowledge provided at the local workshops and the plan adapted accordingly.

Based on the information provided by the research managers the previous day, the team discussed the most suitable case studies to undertake, in terms of their geographical, culture-type and species focus.

The appropriate scale of projects in relation to the operations involved (culture area, number of operators) and resources available were also decided with specific locations selected based on agreed criteria.

### Summary of Case Studies

Ref	Description	Focus Area	Researchers
B1	Freshwater finfish culture in enclosed water bodies (pond and cage)	60km NW of Dhaka (tbc)	University of Dhaka
B2	Extensive polyculture/rice culture in Gher (pond) system	Dumuria, within 20km of Khulna	Khulna University
V1	Semi-intensive brackishwater shrimp culture	Can Gio, 50km SW of HCM	UAF, HCM city
V2	Marine cage culture of lobster, sweet snail and sea bass	Xuan Tu, 60km North of Nha Trang	UoF, Nha Trang
V3	Intensive brackishwater culture of shrimp	Doson, 5km outside Haiphong	RIA1, Haiphong

### Bangladesh Case Studies

**Case Study B1**, to be undertaken by University of Dhaka in association with suitable local NGOs, will consider **freshwater culture in enclosed water bodies**, including cage culture. Three pond scenarios will be investigated within this case study:

1. Private-owned, single use pond
2. Private-owned, multiple use pond
3. Community owned multiple user pond

The study is likely to include the pond (and cage culture within ponds) of a variety of finfish species. It is anticipated that consideration of various pond-ownership and access structures will help to develop appropriate implementation strategies for dealing with environmental capacity and management issues in each pond use scenario. It is intended that the estimation of the

environmental capacity of these enclosed water bodies will inform their management and encourage pond user agreements based on optimal use.

**Case study B2**, to be undertaken by Khulna University in association with suitable NGOs, will consider **extensive pond culture of shrimp/fish and rice**. Kulbaria (Athuria village) within Dumuria district, close to Khulna city, will be the geographical focus of the case study. As outlined in the research manager's presentation, farmers in the region operate shrimp pond systems (Ghers) with water exchange to and from a shared canal, linked to the tidal section of a river via a sluice gate. Management of water exchange (sluice operation and timing of pond water change) is expected to be a major issue. This is closely associated with concerns over water quality, which is in turn linked to environmental capacity issues for these water bodies.

## **Vietnam Case Studies**

**Case study V1**, to be undertaken by the University of Agriculture and Forestry, HCM city, will investigate environmental capacity issues associated with **semi-intensive shrimp culture**. The region to be investigated will be a small group of farms within Can Gio district. Criteria for selecting a suitable area for study within the district were developed (see draft research plan). The expansion of shrimp culture in this region and elsewhere has resulted in the destruction of areas of mangrove. This particular culture area is within a region that has been replanting large areas of mangrove in recent decades. The case study will therefore look at the potential of the area to accommodate a need to increase the income of local people with a desire to continue conservation efforts.

**Case study V2**, to be undertaken by the University of Fisheries, Nha Trang, will investigate **marine cage culture** associated with Xuan Tu village which is dominated by the culture of spiny lobster, but also includes the culture of sweet snail and sea bass in the nearby area. The lobster farmers from Xuan Tu are already finding mortality rates are increasing during the warmest months of the year and are relating this to reduced water quality. As a result the farmers are having to move to the outer edges of the culture area for improved water quality. This does, however, impact on the economics of the operation (greater water movement requires stronger structures) and on the farmers sited on the landward side. The other resource users in the bay are also concerned that continued expansion of the lobster sector could also adversely impact their operations.

**Case study V3**, to be undertaken by RIA1 Centre for Brackishwater Aquaculture in Haiphong, will investigate the capacity issues associated with the expansion of **intensive brackishwater shrimp culture** in Doson. The region has farmed shrimp semi-intensively for some time, rotated with seaweed harvest (of substantially lower value) in the colder winter months. There are plans to increase the current 18 ha of intensive farming operations up to 325 ha through large investment. There is, however, no scientific basis for this increase and the case study aims to introduce environmental capacity considerations to help inform decision-making as to extent and siting of intensive operations.

## **8. Draft Research Plans**

### ***Bangladesh Case study (B1):***

#### **Environmental capacity of multiple use closed water bodies**

##### **Objectives:**

1. To appraise perceptions and develop awareness amongst communities of environmental limits of closed water bodies
2. Address access and rights issues
3. Estimate the environmental capacity of selected closed water bodies
4. To estimate maximum levels activity of alternative pond uses, including cage culture
5. To develop a locally agreed pond management / access / allocation agreement

##### **Outputs:**

1. An agreed EQS for the selected closed water bodies
2. A simple model to estimate environmental capacity
3. A carrying capacity estimate for different pond uses
4. Enhanced understanding of the environmental limits and associated trade-offs by stakeholders
5. Local agreement on pond management

##### **Methodology:**

1. Local workshop on pond management and environmental limits – and research objectives (August/September)
2. Survey of phosphorous levels and environmental partitions in three ponds (Niamul, Naseem and Anis to finalise pond & NGO selection by end of June; Niamul and Trevor to finalise sampling regime by end of August, start sampling December)  
December - January: winter sampling  
April – May: summer sampling  
July - August: monsoon sampling
3. Survey of access and rights conducted by NGO field staff for selected ponds
4. Experimental and management system development work as required
5. Develop strategy

##### **Reporting and dissemination**

Report selection and sampling regime to Rod by end of June (NN/TT)  
Report output from workshop by end of September (NGO partner/AR)  
Progress article for wider dissemination in Bangladesh – Bangla/English – by end of September (RC/AR)  
Email distribution list including partners, NGOs, aid agencies (AR)  
Regional fora informed (AR).

## ***Bangladesh Case study (B2):***

### **Environmental management of extensive polyculture/rice system**

#### **Objectives:**

1. To appraise perceptions and develop awareness amongst a community of environmental issues (current and future) associated with a group of shrimp ponds
2. Understand the hydrodynamics of water bodies associated with selected shrimp ponds
3. To define critical environmental constraints to sustainable production in shrimp Ghers
4. To develop a locally agreed environmental management strategy

#### **Outputs:**

1. An agreed environmental management and development objective for the selected area
2. Describe the hydrodynamics of water bodies associated with selected shrimp ponds in Kulbaria (Athuria village)
3. An appraisal of environmental constraints for shrimp Ghers
4. Enhanced understanding of the environmental limits and associated trade-offs by stakeholders
5. Agreed environmental strategy

#### **Methodology:**

1. Review of previous studies and available documents / information
2. Local workshop on aquatic system management, environmental issues and research objectives (July)
3. Survey of hydrodynamics and confirm pond management practices for the Kulbaria aquatic system (Rod, Rouf and Anis to finalise NGO selection by end of June; Rouf and Trevor to finalise sampling regime by end of June)
4. Build on hydrodynamic analysis to develop water use/environmental protocols and derive implications for different management strategies
5. Experimental and management system development work as required
6. Develop strategy

#### **Reporting and dissemination**

- Report selection and sampling regime to Rod by end of June (MAR/TT)  
Report output from workshop by end of July (NGO partner/AR)  
Progress article for wider dissemination in Bangladesh – Bangla/English – by end of September (RC/AR)  
Email distribution list including partners, NGOs, aid agencies (AR)  
Regional fora informed (AR).

## **Vietnam Case Study (V1):**

### **Can Gio semi-intensive shrimp culture in ponds**

#### **Objectives:**

1. To appraise perceptions and develop awareness amongst communities of environmental limits of selected area\*
2. Estimate the environmental capacity of selected area\*
3. To estimate maximum levels activity for current and future uses
4. To develop a locally agreed management agreement

#### **Outputs:**

1. A simple agreed EQS for the selected area\*
2. A simple model to estimate environmental capacity
3. A carrying capacity estimate for current uses
4. Enhanced understanding of the environmental limits and associated trade-offs by stakeholders
5. Local management agreement (with same EQS refined or more informed EQS)

#### **Methodology:**

1. Review existing data to assess most likely limiting nutrient (N, P) or toxic substance
2. Local workshop on good practice and environmental limits – and research objectives
3. Scientific survey based on workshop and existing data / monitoring
  - Sample for total N & P, possible nitrites, ammonia etc. if budget permits
  - Frequency of survey should be twice a month (based on tidal cycle) or five times per crop minimum.
  - 4 ponds to be sampled each time along with sampling of water outside the system. 2 samples per pond – 1 near sluice gate and one in deepest part of pond. 2 samples for receiving waters (outside the ponds).
  - Sampling should be for water (pond and inflow) and sediment (just ponds)
  - At time of sampling record locally appropriate gauge of water quality (eg. colour or turbidity or the shrimp themselves) as well as basic physio-chemical conditions (temp, pH, DO, salinity)
  - Also record feed inputs and production from sampled ponds and compare with other ponds in area based on discussion with farmers.
  - Conduct analysis for each type of feed used to assess nutrient content.
4. Experimental and management system development work as required
5. Develop strategy

#### **Reporting and dissemination**

Quarterly progress report (Rod to provide format) including financial and research status.

Selection of specific case study area by end of June (NVT)

Convene local workshop with farmers and local authority by (NVT to check growing calendar)

#### **\*Criteria for Can Gio case study**

- Avoiding area with potential for large impacts from HCM city-based pollution
- Based on water-quality data showing reasonable oxygen demand (BOD, COD) and low chemical/metal levels upstream of selected area
- Area less than 20 ha, separated by major channels, with no more than 20 farmers
- Area with support of local authority and community.

## **Vietnam Case Study (V2):**

### **Xuan Tu Lobster Village**

#### **Objectives:**

1. To appraise perceptions and develop awareness amongst community of environmental limits of selected area
2. Estimate the environmental capacity of selected area
3. To estimate maximum levels activity for current and future uses
4. To develop a locally agreed management agreement

#### **Outputs:**

1. A simple agreed EQS for the selected area
2. A simple model to estimate environmental capacity
3. A carrying capacity estimate for current uses
4. Enhanced understanding of the environmental limits and associated trade-offs by stakeholders
5. Local management agreement (with same EQS refined or more informed EQS)

#### **Methodology:**

1. Review existing data to assess most likely limiting nutrient (N, P) and hydrographic data
2. Local workshop (include IMA or link with their regular meetings) on good practice and environmental limits – and research objectives
3. Scientific survey based on workshop and existing data / monitoring  
Compare hydrographic records with positions of all aquaculture activities by mapping position of cages and comparing with water movement.  
[Production cycle is at least 12 months starting from November (small seed takes 18 months) or April (bigger seed takes 12)]  
Farmers to record feeding regime (specific inputs, frequency and type) and lobster behaviour (rising off bottom, mating etc.)  
Base environmental quality on benthic environment (sea grass presence, colour of sediment also redox and carbon). Confirm at workshop.  
Record DO and temp in and around cages.  
Frequency of survey should be twice a month (based on tidal cycle)  
Record production from cages and compare with other cages in area based on discussion with farmers.  
Record feed inputs and use existing data (cage project, MSc thesis) from trashfish on carbon content etc.
4. Experimental and management system development work as required
5. Develop strategy

#### **Reporting and dissemination**

Quarterly progress report (RC to provide format) including financial and research status.  
Selection of specific cages based on mapping case study area by end of June (LAT)  
Convene local workshop with farmers, IMA and local authority by August (LAT).

## **Vietnam Case Study (V3):**

### **Doson intensive shrimp culture**

#### **Objectives:**

1. To appraise perceptions and develop awareness amongst communities of environmental limits of area where intensification proposed
2. Estimate the environmental capacity of selected area
3. To estimate maximum levels activity for current and future uses
4. To develop a locally agreed management agreement

#### **Outputs:**

1. A simple agreed EQS for the selected area
2. A simple model to estimate environmental capacity
3. A carrying capacity estimate for current uses
4. Enhanced understanding of the environmental limits and associated trade-offs by stakeholders
5. Local management agreement (with same EQS refined or more informed EQS)

#### **Methodology:**

1. Review existing data to assess most likely limiting nutrient (N, P) or toxic substance
2. Local workshop (involving stakeholders from area of proposed intensive culture) on good practice and environmental limits – and research objectives
3. Scientific survey based on workshop and existing data / monitoring  
Sample for total N & P, possible nitrites, ammonia etc. if budget permits  
Frequency of survey should be once a week or ten times per crop minimum.  
4 ponds to be sampled each time along with sampling of water outside the system.  
2 samples per pond – 1 near sluice gate and one in deepest part of pond.  
2 samples for outside water  
Sampling should be for water (pond and inflow) and sediment (just ponds)  
Also collect farmer records of water quality from the 18 ha area (eg. colour, turbidity, temp, pH, DO, salinity) and/or checks on the shrimp themselves.  
Record production from sampled ponds.  
Record feed inputs and conduct analysis for each type of feed used to assess nutrient content.
4. Experimental and management system development work as required
5. Develop strategy

#### **Reporting and dissemination**

Quarterly progress report (RC to provide format) including financial and research status.  
Convene local workshop with farmers, enterprise and local authority by (NNH and VVI) by end of June.

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