Aqua Climate

The Network of Aquaculture Centres in Asia-Pacific

Aquaclimate Generic Case Study Methodology

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Kasetsart University

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Introduction

This is a brief description of the Aquaclimate generic methodology for analyzing the climate change effects on small-scale farmers in the respective case study areas. This is an iterative process and the methodology will be updated as the case studies progress. This generic methodology will allow the comparison of results between the different case studies and ensure that they follow similar methodology where relevant. A case study may not follow this methodology if another methodology is more appropriate.

Steps for Analysis for a case study

1. Literature Review (to get an overview of previous Climate Change studies undertaken in Case study country; Initiatives by Government to address Climate Change risks etc)
2. Assess data needs for the case study (***See Annexure I)***
3. Selection of Global Climate Change Model most suitable for Region Selection of most likely SRES scenario; Down scaling of GCM model and input to GIS
4. Institutional analysis of study area, To identify the key institutions or stakeholders and their policies related to climate change and aquaculture
   - Identification of key institutions or stakeholders, their mandates and policies (**See Annexure II**)
   - Conduct 1-2 Stakeholder workshops to analyse stakeholder Perceptions, Vulnerability, and Adaptability to climate change (**See Annexure III**)
   - Establish stakeholder panel for regular stakeholder contact and participation in the project (meeting with the panel every 6 months)
   - Meetings with key stakeholders (from Relevant Departments and agencies to map the current activities related to CC adaptation - **See Annexure IV**)
5. Study of the selected culture system, vulnerability (develop vulnerability indicators-ecological, social and economic, institutional), impacts, identify suitable adaptation and mitigation measures and the necessary costs.
   - Literature review of the selected culture system and study area
   - Conduct 3-4 Focus Group meetings (**See Annexure V**)
   - Preparation of seasonal and crop calendars **(See Annexure VI)**
   - Undertake Risk Analysis **(See Annexure VII)**
6. Selection of case study location for detailed quantitative survey (Assessment of technical, social and economic vulnerability, impacts and adaptability of farmers) through questionnaire surveys with at least 120 -150 small scale farmers
   - Adaptation of farm questionnaire to local case study
   - Translation into local language and test run of questionnaire by country partner and assessing culture methodology and technology
   - Revise questionnaire
   - Main farm survey of the revised questionnaire by local enumerators;
   - Data assimilation and standardization collected from questionnaire surveys
   - Feeding data into statistical models and data analysis
7. Generic Methodology impacts of future predicted climate change (**See Annexure VIII**)
8. Scenario development **(See Annexure IX)**
9. Development of policy guidelines and policy brief (**See Annexure X**)

Outputs from each case study

i) General Reports

- Notes on the field visit
- Notes on the Stakeholder workshop and focus group discussion

ii) Technical Reports
- Final case study report (three parts or reports to be compiled together)
- Analysis of farmers' perceptions of climate change

iii) GIS Analysis
- Assessment of vulnerability (socio-economic and productivity - See Annexure IX)

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iv) Technical Briefs
- Technical, social and economic vulnerability indicators
- Technical recommendations and guidelines
- Cost effectiveness of adaptation measures

v) Policy guidelines and policy brief (**see Annexure X**)
- Development of farmer BMPs
- Development of policy guidelines
- Development of policy brief

Annexure I

Data that may be useful for each case study area

Data collection or purchase

- Topography
- Land use maps
- Satellite images
- List of registered farms
- Farms to GIS plotting
- Flood maps
- River flow data
- River height data
- Salinity intrusion maps
- Storm surge maps
- Hazard maps
- Census data

Socio-economic data (Not a complete list)

Data analysis (Case study team supported by MSc students)

- Legal, policy and institutional analysis: Climate change and aquaculture
- GIS - climate change and vulnerable areas
- In depth economic analysis (10 farms)
- Nutrient flows
- Green house gas contribution
- Potential for carbon sequestration
- Analysis of adaptation measures- government and farmer level

Adaptation of other case study recommendations to own country

- Vietnam freshwater fish pond recommendations
- Vietnam brackish water shrimp pond
- Adaptation of India marine shrimp pond recommendations
- Adaptation of Philippine brackishwater fish pond recommendations

Production Function Estimation (including climate change linkage analysis)

- Perform a production function estimation based on all available data to select the best production function to represent each case study
- Perform a cost & benefit analysis for each case study to identify the net profit earning from each case study
- Identify the statistically significant variable(s) based on derived production function
- Perform further analysis on the linkage between the selected variable(s) and climate change variable(s)

Trade-off Analysis

- Perform the Trade-off Analysis to identify any feasible option (short and long terms) based on the climate change linkage analysis

Annexure II

Institutional analysis

In AquaClimate project, institutions can be defined as agencies or stakeholders or sets of policies or legislations that can be positively or negatively impacted by, or cause an impact on aquaculture practice, adaptation and mitigation measures of farmers when exposed to climate change.

Institutions can be found at all levels from the household to the international levels and from the private to public. Institutional analysis can be used to identify key stakeholders and relevant policies and legislations.

Key issues and questions to consider in the institutional analysis would include:

- Which organizations or stakeholders (governmental and non-governmental) are involved in addressing key aquaculture issues and problems related to climate change and specific culture systems?
- What do they do? Do they have a mandate to address climate change issues?
- What are their activities that are relevant to adaptation and mitigation?
- What are the policy or strategy documents that they have or used to guide their work?
- What are their longer term plans for working in the area?
- What is the institution's level of influence in addressing or over planning and implementation of adaptation and mitigation?
- What are their relationships with other organizations or stakeholders?
- Where are the overlaps with other organizations?
- How might some organizations impede the work of others?
- Where are the gaps in capacity?
- What are the strength (S), weakness (W), Opportunity (O) and Threat (T) of the institutions or stakeholders? (SWOT analysis)

Stakeholder analysis is one of important approaches that can be used for institutional analysis. A stakeholder is any person or organization, who can be positively or negatively impacted by, or cause an impact on the actions of a company. Types of stakeholders are:

- **Primary stakeholders** : are those ultimately affected, either positively or negatively by corporation's actions.
- **Secondary stakeholders** : are the 'intermediaries', that is, persons or organizations who are indirectly affected by corporation's actions.
- **Key stakeholders** : (who can also belong to the first two groups) have significant influence or importance in corporation.

Stakeholder analysis has the goal of developing cooperation between the stakeholder and the project team and, ultimately, assuring successful outcomes for the project. A stakeholder analysis is performed when there is a need to clarify the consequences of envisaged changes or at the start of new projects and in connection with organizational changes generally. It is important to identify all stakeholders for the purpose of identifying their success criteria and turning these into quality goals.

Undertake institution and stakeholder mappings

In order to better understand which institutions or stakeholders are most important to people in the target communities, institution and stakeholder mapping exercises are useful. The mapping exercise assists in identifying the institutions that should be engaged in the process, as well as potential allies and opponents in addressing vulnerability at the community level

Institution mapping

In some cases, institution mapping can be done alone without considering the stakeholder context. However, when look at the importance of relationship among the stakeholders, stakeholder mapping is useful. The main components when mapping institution are institution name/department, institution characteristics and capacity.

Stakeholder mapping

The first step in building any stakeholder map is to develop a categorised list of the members of the stakeholder community. Once the list is reasonably complete it is then possible to assign priorities in some way, and then to translate the 'highest priority' stakeholders into a table or a picture. Interaction with the potential list of stakeholders for any project will always exceed both the time available for analysis and the capability of the mapping tool to sensibly display the results. The challenge is to focus on the 'key stakeholders' who are currently important and to use the tool to visualise this critical sub-set of the total community.

The most common presentation styles use a matrix to represent two dimensions of interest with frequently a third dimension shown by the colour or size of the symbol representing the individual stakeholders.

Some of the commonly used 'dimensions' include:

- Power (high, medium, low)
- Support (positive, neutral, negative)
- Influence (high or low)

Examples of tables for mapping institution and stakeholder are presented in tables below.

Policy Analysis is another approach that can be used for institutional analysis. Decisions made by central governments can have a profound effect on the ability of communities to adapt to climate change. Policies in sectors such as water, agriculture, health, infrastructure, and economic development can facilitate or constrain adaptation. Integration of climate change considerations into these policies can ensure that they contribute to adaptive capacity from national to local levels. In some cases, existing policies provide opportunities to address climate change – as long as the capacities, resources and political will are in place to ensure they are implemented.

It is important to understand these dynamics and how they may affect adaptive capacity at the local government/ community, and household/individual levels. Therefore, the Climate Vulnerability and Capacity Analysis (CVCA) process should analyze relevant policies, focusing on the integration of climate change issues into policies, and on openings and barriers to facilitating adaptation in target communities.

Depending on the degree of decentralization of decision-making in a particular country,

local-level plans or policies may be important in shaping adaptive capacity of vulnerable households and individuals. Regional or district plans and/or sector strategies can give helpful information on priorities of local governments. Further, the process for developing these policies and strategies can provide insights into the level of participation of vulnerable people in establishing these priorities. The status of implementation can yield useful information on resource and capacity constraints faced by local actors.

Institutional Context Related to Climate Change

- Describe government structures to address climate change.
- Describe and assess capacity of relevant institutions to integrate climate change considerations into their work.
- Provide analysis of linkages between national policies and local implementation.
- Provide analysis of resource allocation for adaptation-related activities at national and local levels.

Underlying Causes of Vulnerability

- Provide analysis of impact of policies and programs on access to and control over critical livelihoods resources.
- Provide analysis of impacts of policies and programs on women and other marginalized groups.
- Describe and evaluate participation (particularly of vulnerable groups) in policy decisions at national and local levels.
- Provide analysis of inequalities within communities or households which exacerbate vulnerability (such as access to services, control over resources, mobility, etc.).

INSTITUTIONAL CHARACTERISTICS AND CLASSIFICATION

Ranks: Very low, low, moderate, high, very high.

Institution		Institution characteristics				Capability assessment				
Institution name	**Department**	**Institutional type** • **Government** • **Business** • **Research** • **Education** • **NGO** **National/ State level/ local level**	**Mandate**	**Description of Institution**	**Climate change programs related to aquaculture**	**Human Capacity to plan and manage (Rank)**	**Financial resources to plan and manage (Rank)**	**Information or knowledge about aqua-farmer CC problems (Rank)**	**Effectiveness to implement (Rank)**	**Relationship (+, -, neutral)**

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STAKEHOLDER CHARACTERISTICS AND CLASSIFICATION

Ranks: Very low, low, moderate, high, very high.

Stakeholders		**Stakeholder characteristics**									
Stakeholder name	**Organisation**	**Stakeholder type (Beneficiaries/ Implementers / Financing agents / Decision makers) National/ State level/ local level**	**Level of stake held in adaptation of aqua-farming to CC**	**Description of stakeholder group** **Farmers organizations/ Government agencies/ NGOs/ Research and Education institutions**	• **Power (high, medium, low)** • **Support (positive, neutral, negative)** • **Influence (high or low)**	**Interests**	**Information or knowledge about aqua-farmer CC problems**	**CC problems for**	**Required actions to support aqua-farmer CC adaptation**	**Primary activity**	**Resources at disposal for assistance of aqua-farmers adaptation to CC**
e.g. Farmers	Associations, cooperatives or Societies	Beneficiaries	Primary stakeholders	Small scale farmers, rural	**Low** influence, Not much influence on policy	**High** as livelihood are impacted	High – observed directly	Production and profitability impacted by CC; more vulnerable to ECEs.	Govt. support	Shrimp farming	Low

Annexure III

Stakeholder workshops

After the stakeholder mapping done, proper stakeholders will be selected and invited to the stakeholder workshop.

Stakeholder meeting format

Divide the participants into groups (farmers, managers/planners, researcher/academic, mixed group, e.g. feed company, Drug Company, etc). Among the group create smaller sub-groups to encourage active participation.

Process:

Step 1 Scenario setting and CC Issue identification: Identify/define climate change (based on personal experience or observation)
Step 2 Prioritisation of issues, and rank the CC identified
Step 3 Identify the impacts
Step 4 Identify mitigating measures (existing or ways on how to address)
Step 5 Identify the responsible agency that can implement the adaptive and mitigating measures

Stakeholder panel

A major outcome of the project will be the ongoing dissemination of information and results to stakeholders and managers at all levels within the selected case study areas. These processes will be two-way and continue throughout the project period to ensure participation, deliberation, and dialogue based on local knowledge. In order to achieve this, the project will establish a "stakeholder panel" that will be comprised of 8 representatives from key stakeholders such as farmers, community groups, local fisheries departments and policy makers.

The stakeholder panel has a number of roles to play:

- Give inputs on the climate change effects already felt in the aquaculture industry
- Give comments on the implement ability of the recommendations
- Give feedback on the socioeconomic effects of the recommendations

There will also be a series of stakeholder consultations on scenario building during the case study areas analyses.

Purpose of a Stakeholder Panel (SP)

A stakeholder panel is a method that enables stakeholder integration in a project. It provides a platform for active consultation process, where stakeholders can express their problems and concerns about the given issue, provide feedback on the project results, help in developing scenarios and adaptation measures, and assist in networking with other stakeholders whenever needed. It is also a process where the experiential knowledge of stakeholders can be incorporated with the scientific knowledge.

SP identification process

The identification of a Stakeholder Panel (SP) normally follows through several stages. In the process, the technical, political, and ethical rationality needs to be considered. The process

has to address some important questions about legitimacy, representation, and credibility. This can be undertaken by stakeholder mapping. Stakeholders will be included based on how much they can influence the process. Clearly, the choices of whom to include, how, when, and why, are dependent on their effectiveness and value in the process (their interest and influence).

A larger stakeholder workshop could set the stage for a SP selection. The project team, with the help of some key stakeholders may come up with a probable panel as a starting point for SP selection. The list then needs to be circulated and discussed with key stakeholders, and based on their feedback it should be revised. After revision the members have to be approached for their consent to participate in the project panel. Whether a SP is possible has to be clear before actually involving the stakeholders. This must be discussed with some key stakeholders and also determine what the level of participation can be expected. Also a preliminary set of ground rules for the process have to be designed. Often this is a challenge in research projects, due to resource constraints. It is also difficult to motivate the stakeholders unless they see a direct benefit in the process for themselves.

Check the following:

1. To check if the list includes relevant stakeholders interested in the issue.
2. To ensure that due representation is given based on their role (Managers, Researchers, Farmers organizations, NGOs, Extension agencies from local and regional level etc.)
3. To rate, if possible, the stakeholders on a 1-4 scale based on their influence and interest (1 –Most influential and most interested and 4 –least influential and least interested), and select SP based on that.

Terms and conditions for SP members:

- To participate in meetings as agreed during the Aquaclimate project period (at least take part in two panel meetings in a year)
- To contribute positively and actively to the development of scenarios and adaptation measures or strategies in the Aquaclimate project
- To further take the results and communicate with policy makers
- To keep confidentiality and not to disseminate or use the results from the project without prior permission of the project co-ordinator.
- To assist in strengthening the networks between the project partners and other stakeholders

Specific terms to small scale milk fish aquaculture

- We would need stakeholders that represent
- the small-scale pond producers (owner operators)
- government and institutional support to the producers
- Upstream industries such as hatcheries and fry collectors
- Downstream industries such as deboning and processing
- We would need advice from the panel relating to the impact of climate change on
- small scale milkfish pond aquaculture in the Philippines
- Collection of wild fry for supplying seed to the producers.

Annexure IV

Key Stakeholder Interviews

Key stakeholders can provide useful insights into local governance structures and status of implementation of local policies and programs. Power issues within and between communities and other stakeholders can also be surfaced through interviews with key actors. Again preserving their anonymity may allow them to speak more freely.

Key informants at the local government/community level would include:

- Local leaders (chiefs, mayors, elected representatives, etc.)
- Representatives of community-based organizations (CBOs) such as farmer's groups, savings and credit groups, etc.
- Representatives of women's groups or other rights-based groups
- Representatives of NGOs working on programs or advocacy in the target area
- Academic/research institutions engaged in the target area

Annexure V

Focus group meetings

For the socio-economic vulnerability assessment, focus groups together with stakeholder workshops and individual farmers' surveys will be used to gather data necessary for the analysis. The size and selection of the focus groups is important, and the purpose of the study will guide the selection of the focus group members. The normal recommended size of a focus group is 8-10. The farmers' selected (through stratified random sampling) will represent famers in different locations of the study area, from different age groups (with varied experience in farming) and owning farms of different sizes. In some case studies, key stakeholders will be also invited for the focus group discussion.

Focus group objectives

1. To map farmers perceptions about climate change and likely impacts on small scale aquaculture systems in particular
2. To assess vulnerability of the production system to climatic changes and extreme climatic events
3. To estimate the economic losses for the farmers due to climate changes and extreme climate events
4. To map the adaptation measures that farmers/communities respond with, when exposed to climate change and extreme climate events
5. To identify agencies and their assistance to the farmers for dealing with impacts from climate changes

Focus group process

The focus groups can generate a lot of relevant information during the discussions. To begin with, adequate background information was provided to the focus groups about the project, purpose of the meeting and expectations from the meeting. The participants were given freedom to express themselves, disclose their practices and ideas, both positive and negative. Least interference by scientific personnel is recommended to allow free expression of opinion. The group responses are taken as collective opinion. Preferably the focus group meetings should take place close to the farmer's farms in a comfortable setting where farmers can express their opinions freely.

Farmers were divided into groups of 3. Each group of three had to discuss among them selves and present their findings to the others at each step of the process.

Step 1 Identify the climate change and extreme climate events that affect the farms
Step 2 Identify the impacts of those climate change and extreme climate events
Step 3 Action taken by the farmer to deal with or rectify the problem
Step 4 Estimate of costs to deal with or rectify the problem
Step 5 Which agency could help the farmers in dealing with the impacts of climate change and extreme climate events

Annexure VI

SEASONAL AND CROP CALENDARS

Objectives

- To identify periods of stress, hazards, diseases, hunger, debt, vulnerability, etc.
- To understand farm activities, livelihoods and coping strategies
- To analyze changes in seasonal activities
- To evaluate use of climate information for planning

How to Facilitate

This activity should take approximately 1 hour and 15 minutes including discussion: 30 minutes for the calendars, and 45 minutes for the discussion.

1. Use the ground or large sheets of paper. Mark off the months of the year on the horizontal axis.
2. Explain to the participants that you would like to develop a calendar to show key events and activities that occur during the year.
3. Ask people to list seasons, events, conditions, etc., and arrange these along the vertical axis. The list should include:
   a. Seasonal climate
   b. Timing of farming practice
   c. Harvest seasons
   d. Harvesting and price of production
   e. Timing of hazards/disasters such as cyclones, droughts and floods
   f. When common seasonal fish/shrimp disease occurs
   g. Holidays and festivals
   h. Etc.
4. When the key events have been listed, plot the timing of them in the table based on agreement among the participants. The note taker should note any events for which the group has difficulty deciding on timing.

Seasons calendar	J	F	M	A	M	J	J	A	S	O	N	D
Dry season												
Risk of droughts												
Risk of saline intrusion												
Rainy season												
Risk of floods												
Hot spells												
Storm weather												
Holidays (Tet etc)												
etc												
Crop Calendar												
Pond preparation												
Pond stocking												
Grow out												
harvesting												

etc												
Price of Production												
Disease risks												
Water quality risks												
Mortality risks												

Learning and Discussion

When the calendar is complete, ask the group members the following questions:

- What are the most important fish/shrimp production strategies employed at different points of the year?
- What are current strategies to cope during the difficult times? Are they working?
- Have fish production strategies changed based on the changing seasons or events?
- How are decisions made on timing of fish production strategies?

Communicating Climate Change

When discussing coping strategies and changes, there may be opportunities to examine whether existing coping strategies are working in the context of the changing environment and/or to identify innovative strategies that have emerged as a result of the changes. It can provide an opening to discuss the need for new strategies in the context of climate change, and to introduce the concept of adaptation.

The note taker should take a photograph of the crop calendar produced and carefully transcribe the key points of the discussion.

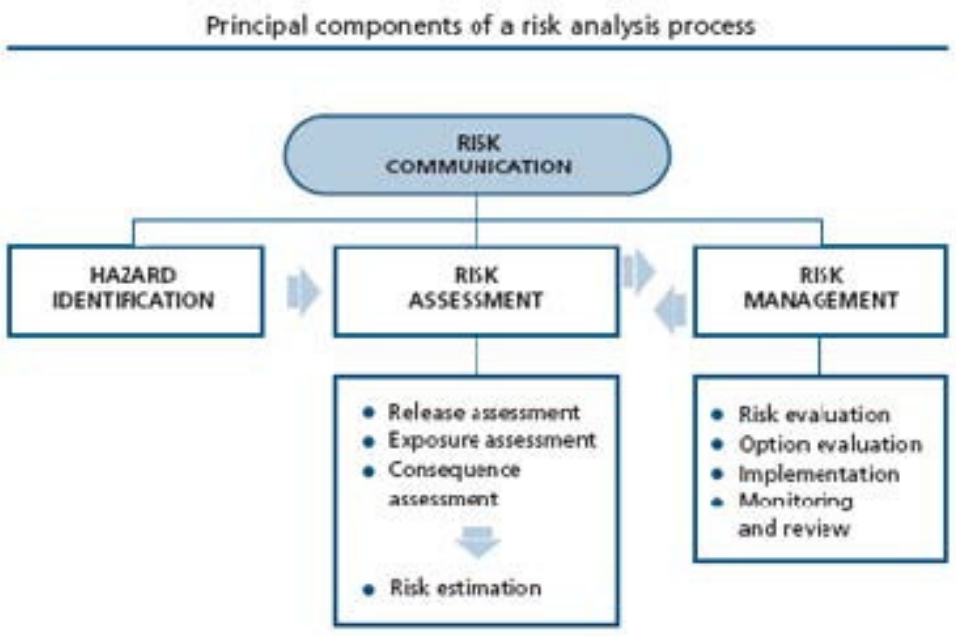
Annexure VII

Generic Risk Assessment Methodology

Identification of climate change element, related impacts and benefits/risks to aquaculture

Climatic change element	Impacts on aquaculture or related function	Benefits or Risks
Warming - Long term gradual warming - Short term exceptional warm periods	Decreased productivity	Raise above optimal range of tolerance of farmed species. Higher stress
	Increased productivity	Increase in growth; improved FCR. Longer growing season
	Changes in wild fisheries	Changes in availability of wild broodstock, wild fry collection
	Increase in disease incidence	Increase virulence of dormant pathogens and expansion of new diseases. Possible invasion with non-native species
Sea level rise	Intrusion of salt water	Local conditions in traditional rearing areas may become unsuitable for many traditional species. Reduction in freshwater culture area. Relocation of freshwater culture upstream. Increased area for brackishwater culture
	Loss of agricultural land	Provide alternative livelihoods through aquaculture.
	Loss of natural habitats	potential to flood coastal land areas, mangrove and sea grass regions which may supply seed stock for aquaculture species
	Coastal erosion	Coastal pond damage,
Ocean circulation changes	Changes in coastal upwelling	Reduced catches from coastal Fisheries; Uncertain supplies of fish meal and fish oil supplies/ price. Possible increase in harmful algal blooms
	Changes in ocean circulation	seedstock disruptions, less availability of trash fish
Acidification – Ocean and freshwater	Impact on calcareous shell formation/deposition in marine waters	Problems with mollusc production. Changes in plankton populations
	Increased incidence and level of acid rain	
Changes in precipitation pattern	Increased rainfall - Flooding	Increased incidence of flooding. Loss of stock, damage to farm facilities. Changes in water quality

	Decreased rainfall - Drought	Limitations for freshwater abstraction
	Changes in rainfall timing Early or late rains	Un predictable production seasons
	Changes in precipitation pattern	Change in water-retention period (inland systems reduced, coastal lagoons increased)
	Change in monsoon patterns	
Extreme weather events	Increased typhoon strength and change in location	Destruction of facilities; loss of stock; loss of business; mass scale escape with the potential to impact on biodiversity
	Increased storm events	Damage to cages, pens and longlines. Damage to coastal ponds. Disruption of production.
	Increased storm surge	Coastal pond damage, increased saline intrusion



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Relevant Steps		Methodology	Actions/Response
Step 1	**Identify risks to Aquaculture from Climate Change**	Each participant is asked to write on separate cards the main risks in 5 words that have been identified in the focus group discussion.	Check that groupings are correct and include all identified risks.
Step 2	**Undertake an assessment of the likelihood that it will occur**	Each participant is asked to categorise the likelihood of occurrence (1 to 5) for each of the climate change impacts as 5. Almost Certain 4. Likely 3. Possible 2. Unlikely 1. Rare	
Step 3	**Undertake an assessment of the consequence to aquaculture (Economic, and social) if it occurs**	Each participant is asked to categorise the consequence (1 to 5) for each of the climate change impacts 5. Catastrophic 4. Major 3. Moderate 2. Minor 1. Insignificant	
Step 4	**Based in the above, assign a risk factor to identify the highest risks**	Add up the total scores for each risk to identify the highest risks. Confirm with the participants that these are indeed the greatest risks.	Identify greatest risks in each case study from Climate Change and a significance of impact for the major impacts
Step 5	**Determine relevant adaptation measures to minimise climate change impacts/risks**	Starting with the highest risk, ask each participant to write down in 10 words what can be done to adapt or minimise the risks. Ask any participant if they have written anything different that is not already on the wall.	Identify the most appropriate adaptation measures to minimise climate change.
Step 6	**Identify who can undertake the adaptation measures – farmer, Institute, Government Agency**	Group discussion - who can do something about or is responsible for implementing the adaptation measures	Identify responsibility.

Risk Assessment terminology is given below:

- **Risk** – The chance of something happening that will have an impact upon successful commercial production. It is measured in terms of consequence and likelihood;
- **Consequence** – The outcome or impact of an event expressed qualitatively or quantitatively, ranging from 5. Catastrophic to 1. insignificant or positive;
- **Likelihood** – Used as a general description of probability or frequency. Can be expressed qualitatively or quantitatively from 5. Almost certain to 1. Rare;
- **Risk Management** – The culture, process and structures that are directed towards effective management of potential opportunities and adverse effects.

Risk Likelihood Ratings

Rating	Recurrent Risks	Single Events
Almost Certain	Could occur several times per year	More likely than not - Probability greater than 50%
Likely	May arise about once per year	As likely as not - 50/50 chance
Possible	May arise once in ten years	Less likely than not but still appreciable - Probability less than 50% but still quite high
Unlikely	May arise once in 10 years to 25 years	Unlikely but not negligible - Probability low but noticeably greater than zero
Rare	Unlikely to occur during the next 25 years	Negligible - Probability very small, close to zero

Risk Consequence Scales

Rating	Economic	Social and Community	Environment & Sustainability
Catastrophic	Business failure	Loss of employment, livelihood and hardship	Major widespread environmental impact and irrecoverable environmental damage
Major	Business are unable to thrive	Reduced quality of life	Severe environmental impact and danger of continuing environmental damage
Moderate	Significant general reduction in economic performance relative to others	General appreciable decline in services	Isolated but significant instances of environmental damage that might be reversed with intensive efforts
Minor	Individually significant but isolated areas of reduction in economic performance relative to others	Isolated noticeable examples of decline in Quality of life	Minor instances of environmental impact that could be reversed
Insignificant or positive	Minor shortfall in profitability relative to others or positive	There would be minor areas in which the region was unable to maintain its current services	No environmental impact or benefits to the environment

Risk Priority Matrix

Consequence Likelihood	1. Insignificant	2. Minor	3. Moderate	4. Major	5. Catastrophic
5. Almost Certain	5 = Medium	10 = Medium	15 = High	20 = Extreme	25 = Extreme
4. Likely	4 = Low	8 = Medium	12 = High	16 = High	20 = Extreme
3. Possible	3 = Low	6 = Medium	9 = Medium	12 = High	15 = High
2. Unlikely	2 = Low	4 = Low	6 = Medium	8 = Medium	10 = Medium
1. Rare	1 = Low	2 = Low	3 = Low	4 = Low	5 = Medium

Risk Level Descriptors	
Extreme	Risks demand urgent attention and adaptation solutions need to be found as soon as possible at all levels.
High	Risks are the most severe that can be accepted as part of routine operations but adaptation solutions need to addressed quickly.
Medium	Risks can be expected to form part of routine operations but adaptation solutions need to be developed in the medium term and the risk monitored regularly.
Low	Risks will be maintained under review but it is expected that existing farm management will be sufficient and no further action will be required to find adaptation solutions unless they become more severe.

Annexure VIII

Generic Methodology impacts of future predicted climate change

The focus group discussion and stakeholder workshop methodology described above focuses on stakeholder perceptions of recent climate change. It is predicted that the climate will further change into the future based on the impact from current levels of greenhouse gas emissions and future levels of greenhouse gas emissions. The impact on climate of greenhouse gas emissions has been the subject of a number of climate change models and these climate change models have been reviewed. The outputs from these models is characterised in terms of minimum, maximum temperature or precipitation levels etc… these can then be utilised in conjunction with bio-socio-economic data to understand and map what impact these climate changes will have on the aquaculture reliant communities.

Analytical Hierarchy Process can be used framework to weight and rank the relative importance to each other of groups of parameters. This methodology can combine data from a range of sources including spatially explicit data to produce an index value, in this case for predicted impact of climate change on the case study aquaculture communities.

Some examples of parameters that may be used include:

Minimum monthly temperatures
Maximum monthly temperatures
Monthly precipitation/ flood predictions
Sea Level Rise/ saline water intrusion / Tidal paterns
Topography
Monsoon Pattern
Socio-economics
Other parameters from secondary data depending on data availability and impact

From these parameters an index or vulnerability rating can be obtained. The higher the value for the index, the greater the vulnerability of that location to climate change.

Climatic change element	Impacts on aquaculture or related function	Benefits or Risks
Cooling - Short term exceptional cool periods	Decreased productivity	Higher stress, lower growth rate, worse Food Conversion rate
	Increase in disease incidence	Increase incidence of disease
Warming - Long term	Decreased productivity	Raise above optimal range of tolerance of farmed species. Higher stress
gradual warming	Increased productivity	Increase in growth; improved FCR. Longer growing season
- Short term exceptional warm periods	Changes in wild fisheries	Changes in availability of wild broodstock, wild fry collection
	Increase in disease incidence	Increase virulence of dormant pathogens and expansion of new diseases. Possible invasion with non-native species

Changes in precipitation pattern	Increased rainfall – Flooding	Increased incidence of flooding. Loss of stock, damage to farm facilities. Changes in water quality
	Decreased rainfall – Drought	Limitations for freshwater abstraction
	Changes in rainfall timing – Early or late rains	Un predictable production seasons
	Changes in precipitation pattern	Change in water-retention period (inland systems reduced, coastal lagoons increased)
	Change in monsoon patterns	
Sea level rise	Intrusion of salt water	Local conditions in traditional rearing areas may become unsuitable for many traditional species. Reduction in freshwater culture area. Relocation of freshwater culture upstream. Increased area for brackishwater culture
	Loss of agricultural land	Provide alternative livelihoods through aquaculture.
	Loss of natural habitats	potential to flood coastal land areas, mangrove and sea grass regions which may supply seed stock for aquaculture species
	Coastal erosion	Coastal pond damage,
Topography	Prone to flooding	Damage to Perimeter Dikes, escape of fish,
	Coastal erosion	Coastal pond damage,
	Increasing tidal fluctuation	Damage to Perimeter Dikes, escape of fish,
Changes in monsoon pattern	Increased rainfall – Flooding	Increased incidence of flooding. Loss of stock, damage to farm facilities. Changes in water quality
	Decreased rainfall – Drought	Limitations for freshwater abstraction
	Changes in rainfall timing – Early or late rains	Un predictable production seasons
	Changes in precipitation pattern	Change in water-retention period (inland systems reduced, coastal lagoons increased)
Extreme weather events and other factors	Increased typhoon strength and change in location	Destruction of facilities; loss of stock; loss of business; mass scale escape with the potential to impact on biodiversity
	Increased storm events	Damage to cages, pens and longlines. Damage
Other		to coastal ponds. Disruption of production.
	Increased storm surge	Coastal pond damage, increased saline intrusion
	River flow Saltwater intrusion Etc	

Using GIS, each of the parameters could be graphically represented. By converting all of the files to grid documents, the RASTER calculator could then be used to produce a vulnerability map. Essentially, GIS takes data from different formats and sources to make comprehensive information available about a location, so that informed decisions could be made. GIS can help make the results of a more clear through visual representation, thus providing an

applicable tool for decision makers.

Annexure IX

Scenarios

The challenge now is to develop methodologies to include stakeholders and the public in policy making. According to Gooch and Huitema (2007) a number of methods are available to enable stakeholders to participate in environmental management, including, citizen juries, stakeholder panels etc. However these methods may not be able to include all sections of the society who are affected by climate change. One way of engaging stakeholders and the farmers in the formulation of possible futures is through the use of scenarios. Scenarios are projections of possible futures (Alcamo 2001; Shell 2003), not necessarily the most likely futures.

In Aquaclimate (www.enaca.org/aquaclimate), a major focus is on the involvement of stakeholders and the public in the development of scenarios and adaptation models for sustainable aquaculture in the respective case study areas. Scenarios provide a means to map possible future situation and the measures necessary for sustaining aquaculture production. Scenarios can also be used as a tool for improving stakeholder participation. Involvement of stakeholders in the development and validation of scenarios, can provide insights not readily available for policy-makers.

Scenario as a policy tool

Scenarios essentially describe possible future situations and the path that may make it possible to arrive at such a future situation.[1] They are a useful tool to look at possible paths of development, to illustrate how alternative policy pathways can raise awareness about the future environmental problems, pinpoint priority issues, identify the main actors in relation to the key variables and their strategies, and provide education and operational strategies.2 Scenarios are verbal picture of a situation or a phenomenon based on certain assumptions and factors (variables). Scenarios are used in estimating the probable effects of one or more variables, and are an integral part of situation analysis and long-range planning.

Scenarios can be made up of

1. a base year -usually the current year, which provides a starting point for assessing scenarios;
2. time horizon -the most distant future year or end year covered by a scenario;
3. pathways -description of the changes that may take place from the base year to the end year;
4. drivers – the main factors or determinants that influence the pathways described in a scenario; and
5. storyline – a narrative description of a scenario which highlights its main features and their relationship to the driving forces.

Advantages of developing scenarios together with stakeholders

[1] 'Scenarios' has been defined as "a sequence of emerging events, an account of a projected course of action or events" (Webster's Ninth Collegiate Dictionary, 1989); the IPPC define "scenarios" as "images of the future, or alternative futures that are neither predictions nor forecasts, but an alternative image of how the future might unfold" (Alcamo, J., "Scenarios as tools for international environmental assessments", Experts' corner report, Prospects and Scenarios No. 5, European Environment Agency, Copenhagen 2001, at 7).

1. The experiential knowledge of stakeholders together with the scientific knowledge will be useful to develop most realistic scenarios.
2. Scenarios are useful tools to integrate knowledge from various disciplines and sectors.
3. Stakeholder inputs would be useful to develop more meaningful adaptation strategies, as they would be aware of the resources and limitations and the immediate needs.
4. The scenarios thus developed would be of direct use to managers and decision makers and easy to implement.
5. Scenarios developed through active participation can increase awareness of the issue amongst stakeholders and at the same time build trust between the scientific and civil society.

Constraints in the development and use of scenarios

1. Stakeholder involvement can be time consuming, as it requires several meetings, workshops, and interactive sessions, before trust is developed.
2. Identification of relevant stakeholders is one of the key constraint and often a cumbersome process. Selection can be biased and in the process potential stakeholders can be left out
3. In some situations it is difficult to communicate with local agencies and farmers due to language barriers.
4. Stakeholders might build some expectations when asked to participate and projects like Aquaclimate may not be able to meet the expectations. It is better to inform about the purpose of their involvement and the project limitations.

Annexure X

Development of policy guidelines and policy brief

Policy guidelines

This part aims to collate and synthesize the results of project results into policy guidelines and action recommendations, adaptation and mitigation strategies. The project will determine farmers and other stakeholders' preferences towards the adaptation and mitigation strategies. As aquaculture has a multiple set of stakeholders that have direct and varying interests in (as well as influence on) the sector, and who might be benefited or harmed by an action or policy, it will be important to determine the attitudes and preferences of various interest groups towards the identified/proposed actions and policies. This would provide a basis for deciding on trade-offs among the various policy options that would give an optimally efficient outcome for society in general and the poor small aquaculture sector in particular.

A very important practical application for government would be the balancing of allocation of resources for specific purposes and to specific sectors of the rural economy for the purpose of increasing their overall adaptive capacities to manage a broader set of risks (rather than to specific risks) to their livelihoods and security.

Steps for developing the policy guideline:

1. Development of practical adaptation and mitigation framework based on the integration of project results. The framework should be compatible with the strategies being developed from the project. ***For example***, the ***Production Function***, analyzed results from economic part in the questionnaire can be used to generate the adaptation and mitigation framework (***see "The Production Function Estimation" part below***)
2. Development of practical guide to policy and action programs based on the adaptation and mitigation framework (above) and people's perceptions of the strategies being developed by project.
    i. Undertake consultative workshops in the case study areas
    ii. Use workshop facilitating methodology for clarifying attitudes and preferences of farmers and other stakeholders
    iii. Identify and describe prioritized adaptation solutions and options
3. Development of policy guidelines and recommendations based on the analysis of the workshop outputs using decision support tools
    i. Synthesize the results of the project results into potential strategy/policy options
    ii. Determine weighting of different factors in a cluster using Analytical Hierarchy Process* (Saaty, 1977) and develop a hierarchy (Ranking) of decision elements will be built enabling cluster comparisons (as a matrix).

iii. Conduct a cost-benefit analysis (CBA) of key strategies/options ***(see the explanation of CBA below***)
iv. Carry out a trade-off analysis of key policy options (***see the explanation of Trade-off analysis below***)

The Production Function Estimation
Based on the general aquaculture production economic concept, the production function can generally be set as:

Aquacultural output (monetary / weight unit) = f(group of socioeconomic variables, group of aquaculture production variables, and group of climate change perception indicators) ……..(1)

The group of socioeconomic variables is composed of the variables that can represent the socioeconomic aspects of each operator (e.g. gender, age, educational background, skills and experience in aquaculture activity). The group of aquaculture production variables can be divided further into 2 subgroups; aquaculture technique and management data (e.g. total farm size, pond size and number of fry stocking) and incurred aquaculture costs (e.g. total seed cost, total commercial feed cost and total chemical cost). The group of climate change perception indicators can represent each operator's perception on any incident that being related with the climate change impact.

Group of Socioeconomic Variables (Example)

1. Owner's age (year)
2. Number of year in aquaculture (year)
3. Farm age (year)

Group of Aquaculture Production Variables

- **Aquaculture Technique and Management Data (Example)**
  4. Crop stocking density 1 , 2 (1,000 fry/ha)
  5. Fry size crop 1 , 2 (cm)
  6. Crop duration 1 , 2 (month)
  7. Crop survival rate 1 , 2 (%)
  8. Pond area (ha)
  9. Pond depth (ha)
  10. Water depth (m)
  11. Pond age (year)
  12. Number of Crop in 1 , 2 year(s) (crop)
  13. Number of seed per pond (1,000 fingerlings)
- **Incurred Aquaculture Costs (Example)**
  1 Total seed cost (million VND)
  2 Total commercial feed cost (million VND)
  3 Total homemade feed cost (million VND)
  4 Total vitamin cost (million VND)
  5 Total chemical cost (million VND)
  6 Total drug cost (million VND)

7 Total fuel cost (million VND)
8 Total electricity cost (million VND)
9 Total temporary labor cost (million VND)
10 Total permanent labor cost (million VND)
11 Total sediment removal cost (million VND)
14. Total maintenance and repairing cost (million VND)

Group of Climate Change Perception Indicators (Example)

1 Flood experience (yes/no)
2 Irregular weather (yes/no)
3 Typhoon/heavy rain/storm (yes/no)
4 Temperature fluctuation (yes/no)
5 Salinity (yes/no)
6 Others (yes/no)
7 Change in temperature (gradual impact) (yes/no)
8 Change in precipitation (gradual impact) (yes/no)
9 Change in season (gradual impact) (yes/no)
10 Water pollution (gradual impact) (yes/no)
11 River/canal level rise (gradual impact) (yes/no)
12 Wind change (gradual impact) (yes/no)
13 Others (gradual impact) (yes/no)
14 Personal experience on extreme weather events in last 7 years (gradual impact) (yes/no)

The 1st multiple regression technique can be performed in order to select the best production function from the best statistical performance of each case study. The derived aquaculture production function can demonstrate the statistically significant relationship, if any, between aquaculture input(s) and output.

The Cost & Benefit Analysis (CBA)

The CBA in this project can be performed along with both production function estimation and trade-off analysis. The essence of CBA is to calculate the difference between the cost being spent for aquaculture production and the revenue earned from selling their production to the market. The general formulation for CBA calculation is;

Net Revenue or Profit (π) = Total Revenue (TR) – Total Cost (TC) ……..……(2)

The TR can be calculated by multiplying a price of aquaculture product with an amount of aquaculture product. A unit of TR can be 'per crop and per area' to make it easy for comparing across different regions.

The TC can be divided further into 2 groups; Total Fixed Cost (TFC) and Total Variable Cost (TVC), respectively. A unit of TC can be 'per crop and per area' to match with the TR calculation.

The calculated NR or profit can be used as the baseline profit before any climate change adaptation being proposed (Work package II)

The Trade-off Analysis (TA) incorporated with Cost & Benefit Analysis

The derived aquaculture production function can be used to identify the statistically significant inputs for aquaculture production for each case study. The 2nd multiple regression can be performed by setting the function as;

Selected statistically significant input = f(group of climate change perception indicators)…(3)

As before, the group of climate change perception indicators can represent each operator's perception on any incident that being related with the climate change impact. The linkage between the selected significant input and climate change perception can be determined. The most common climate change linkage can be selected and further investigated on any feasible adaptive measures or mitigation technique via TA (Sharing input with Work package III – IV)

The TA can be performed by using the CBA to compare the feasibility, efficiency and net return among different adaptive measures or mitigation techniques. The CBA can be used to calculate and compare the net return of each adaptive measures and mitigation techniques along with other considerations about the feasibility and efficiency in the short and long run (inputs for Work package IV).

The flow diagram of aquaculture Production Function Estimation and derivatives is presented in figure below.

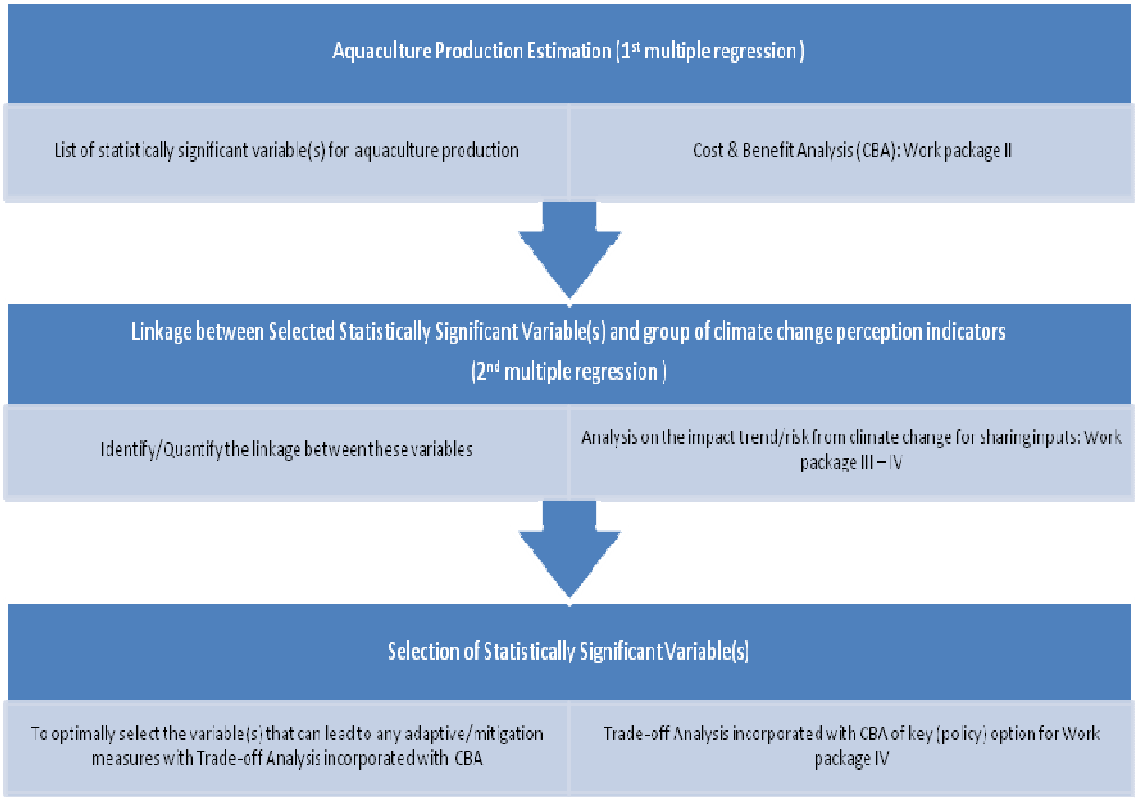

Figure 1 The Flow Diagram of Aquaculture Production Estimation and derivatives

Policy briefs

Policy makers seldom have the time to read through all the literature related to a specific policy question. To make well-informed decisions, they rely on short, tightly written briefs that quickly and cogently relay the important policy facts, questions, and arguments about an issue. The policy brief should advance a persuasive argument in a concise, clearly organized fashion. A policy brief does not include a lengthy analysis or review of the literature. The Policy brief will conclude with policy recommendations.

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