Vulnerability and adaptation to climate change for milkfish farming in the Philippines: Science and technology adaptation solutions

Science and technology brief

Science and technology needs

- ENHANCEMENT OF POND PRODUCTIVITY: Undertake research on the enhancement of pond productivity by reviewing all previous studies. The research should be oriented towards plankton culture in deep water ponds. The use of ammonium sulphate and lime as an effective method of fertilization needs to be demonstrated.

- RESEARCH AND SELECTIVE BREEDING OF MILKFISH: i) Undertake research to investigate the reproductive performance of milkfish at higher water temperatures and their upper temperature tolerance for juvenile and grow out stages; ii) investigate the variability in growth performance and temperature tolerance between strains from Indonesia, the Philippines and Taiwan Province of China; and iii) conduct a genetic selection program focused on faster growth or better feed conversion to give the farmer better profitability and so be more resilient.

- LESSONS LEARNED FROM PREVIOUS EXTREME CLIMATE EVENTS: Research PAGASA records for coldest years and hottest years and check against production data, market data, fish catch data and look for any correlation between productivity and high rainfall or hot weather.

- RESEARCH MANGROVE PLANTING PROGRAM: i) Undertake research to identify the correct zone for planting to give coastal protection and the correct species to plant; ii) undertake GIS analysis of storm surge vulnerability along the coast to identify vulnerable coastlines and most suitable areas for mangrove planting; iii) research suitable mangroves species to be planted in different areas.

- STRENGTHENING FISH DISEASE SURVEILLANCE AND PEST CONTROL: SEAFDEC should arrange regular monitoring of pond pests and fish disease outbreaks and provide recommendations on treatment to farmers. BFAR should do the same for the rest of the country under the national bangus program. BFAR should expand and strengthen its initiative of developing a network for fish disease laboratories to cover the whole country.

- CLIMATE CHANGE TRAINING AND AWARENESS MATERIALS: i) BFAR and SEAFDEC should collect science based resource materials from KLIMA, PAGASA, NAMRIA and elsewhere and prepare training materials on present and future predicted climate change, potential adaptation and mitigation measures for aquaculture; ii) develop three different categories of training materials for fisheries school, farmer field school and regional fishers' training center and local, regional and central decision makers and implementers. SEAFDEC should then arrange a series of 'train the trainer' courses. The materials will need to be updated frequently to keep up to date with developments in climate change science.

Milkfish farmers stakeholders meeting, Iloilo, October, 2009.

Milkfish and climate change

This brief summarises the results from the interdisciplinary study conducted within the AQUACLIMATE project in Iloilo province in the Philippines, looking at the impacts of climate change on small scale milkfish farming. The brief provides guidelines for academics, researchers and technologists to support farmers for adaptation measures to address the climate change impacts on small scale milkfish farming.

Significance of milkfish farming

Milkfish farmers in the Philippines generally operate in brackish water ponds at the extreme coastal fringe and are reliant on natural resources including wild caught fry. The majority operate ecosystem-based aquaculture, relying on natural pond productivity to feed the fish, which is greatly influenced by the prevailing weather conditions.

The milkfish farming industry in the Philippines and specifically in Iloilo is a significant industry and a substantial source of livelihoods. In 2009 national production was around 220,000 tonnes of which 76,000 tonnes was produced in Region VI. The industry is however facing challenges such as a 4,982 hectare reduction in production area, rising cost of inputs, climatic changes such as sea level rise and natural disasters, which cause stock loss and destruction of farms.

The case study sites chosen were two municipalities located in Iloilo, namely the municipalities of Dumangas and Barotac Nuevo. These municipalities have the highest production of farmed milkfish from brackishwater ponds. Milkfish production in Iloilo province in 2008 was 18,956 tonnes from 11,579 hectares of culture area, of this about 4,500 ha were within Dumangas municipality and 1,799 ha within Barotac Nuevo municipality. In the recent years, typhoons, tidal surge, river flooding and seasonal changes have adversely affected the cropping season, production and wild fry collection.

Farmers from Fishpond Lease Agreement (FLA) farms were selected as the target segment for the study. FLA holders generally have extensive milkfish farms of less than 25 ha and can be considered as small-scale farmers. FLAs are lease agreements over coastal government land for the purpose of fish pond development. FLA entitles the holder certain rights but also comes with certain obligations. FLA entitlements include ability to develop fish ponds and undertake aquaculture activities. FLA obligations include establishing and or maintaining a mangrove buffer zone between the fish ponds and the ocean.

The national partner for the Philippines case study was the Bureau of Fisheries and Aquatic Resources (BFAR), specifically BFAR central office and BFAR Region VI.

Impacts of climate change on milkfish farming

The analysis of the CSIRO climate model for Scenario A2 predict that the predicted mean monthly rainfall on the milkfish farm areas and in the watershed (river flow) are given in the figure below.

The potential consequences of this change in rainfall pattern are that there will be greater river flow in July leading to greater severity of flooding over a larger area than the present time.

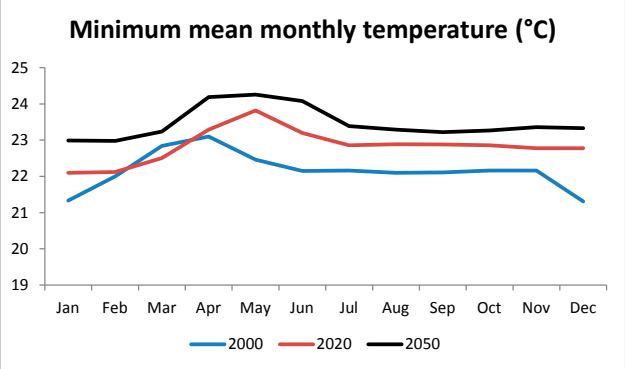
The model predicts that the minimum monthly mean temperature for Barotac Nuevo and Dumangas in 2020 will increase by 0.75°C in January and from July to November; and that there will be an increase in 1.2°C in May and December.

Predictions for 2050 are that there will be an increase in minimum mean monthly temperatures of 1 to 1.5°C in January and from July to November; and there will be an increase of 2°C in May and December.

The consequence for milkfish pond culture should be positive as higher minimum pond water temperatures will improve growth rate, food conversion ratio and pond productivity during the colder seasons. The difference in minimum average monthly water temperature will be relatively consistent, however the increase above 2000 temperatures will vary monthly, with higher than average temperatures in May, June and December and lower than average temperatures in February and March.

The AquaClimate Project is a three year initiative to strengthen the adaptive capacities of rural farming communities to the impacts of climate change. The project focuses on small-scale aquaculture in Vietnam, the Philippines, India and Sri Lanka. This brief provides a summary of the project's work with milkfish farmers in the Barotac Nuevo and Dumangas areas. It highlights the policy implications, research agenda and on farm adaptations that will be required to sustain the industry and its contribution to the livelihoods of poor farmers and food security. The project was coordinated by the Network of Aquaculture Centres in Asia-Pacific and funded by the Ministry of Foreign Affairs, Norway, through the Royal Norwegian Embassy, Bangkok, Thailand. The project was undertaken by international partners Bioforsk, Norway, Akvaplan-niva Norway, Kasetsart University, Thailand, in conjunction with the Bureau of Fisheries and Aquatic Resources, Philippines.

Figure 1. Predicted variations in minimum mean monthly temperature for 2020 and 2050.



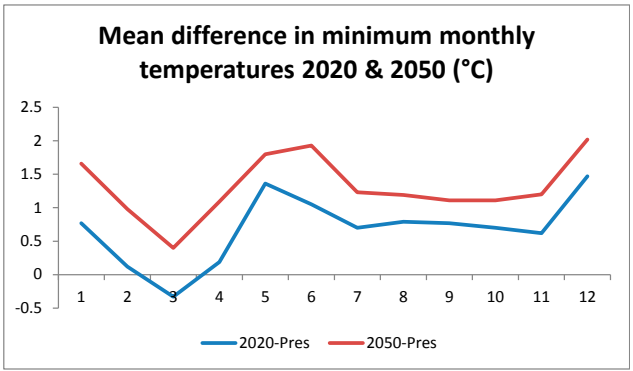
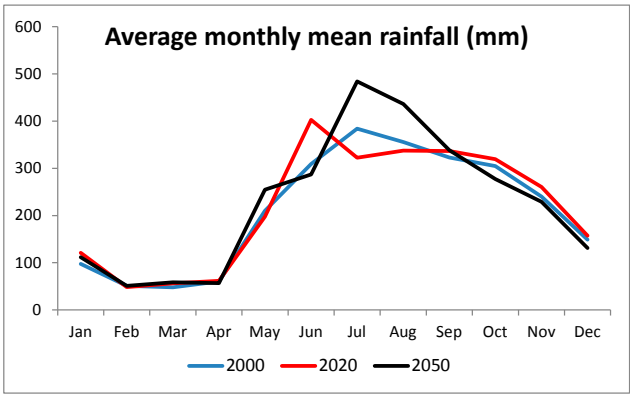
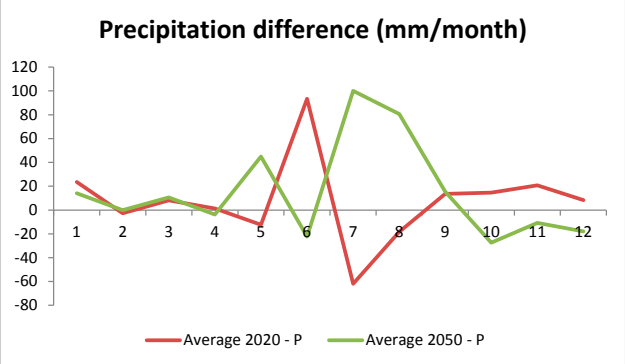


Figure 2. Predicted variations in mean monthly rainfall on the ponds and watershed 2020 & 2050.





Science and Technology adaptation measures

Enhancement of pond productivity

It is predicted that pond productivity will be affected by high water temperatures, fluctuations in temperature and rapid changes in water quality due to increased incidence of heavy rainfall. This will have an effect on pond primary productivity and thus milkfish productivity. However, there is scope to improve pond productivity through polyculture, which at the same time would diversify production and lower risks.

While there has already been research on this topic, especially when it comes to lablab production, there is aneed to review all such studies. The research should be oriented towards plankton culture in deep water ponds. Snails are a big problem in shallow ponds that are lablab based but this issue may be resolved if deep water culture is employed. The use of ammonium sulphate and lime has been demonstrated to be an effective pesticide method (see study made by Norfolk et al. 1981) in SEAFDEC Aquaculture Department AQD Leganes fishponds.

To address this, there needs to be research on the following:

- Pond preparation (rains during dry season February to May) disrupts the normal pond drying to eliminate predators, snails and encourage pond soil oxidation, acidity reduction and productivity.
- Biological pond snail eradication through test polyculture of milkfish and mud crab to determine optimal mud crab stocking density and identify seed supply.
- Determine correct levels of fertilisation to encourage lab lab growth and plankton growth especially during the cold season. Investigate incubator ponds (kitchen ponds) to incubate lab lab, algae and plankton for inoculation/ release to the grow-out ponds; determine the proportion of inoculation pond to grow-out pond.
- Determine plankton succession and species dominance for ponds that will have predicted 0.75°C (2020) and 1.5°C (2050) increase in temperature.
- Identify potential species for polyculture with milkfish and the optimum stocking densities for each species.

Concept proposals concerning these issues should be submitted to SEAFDEC, UPV, BFAR and donors for funding. Results could take up to three years to obtain.

Selective breeding for tolerance and growth rate

It is predicted that pond water temperatures will increase and that water quality and environmental variables will fluctuate more widely. Milkfish is already a very highly tolerant fish capable of surviving and growing from freshwater to hyper saline waters, and so far it seems to be resistant to most of the diseases affecting either fresh or salt water fish. However, it is not known if milkfish will be able to tolerate the expected poorer pond environment. Any genetic research on milkfish will need to be highly focused on some desired trait. By selecting for growth rate, the culture period could be shortened and so the peak water temperature period could be avoided.

The following research issues should be investigated:

- The reproductive performance of mature milkfish at higher water temperatures (ΔT 0.75°C (2020) and 1.5°C (2050)
- The upper temperature tolerance level of milkfish for effective productivity (SEAFEDC is already studying egg hatching and larval survival at higher temperatures).
- Undertake similar temperature tolerance research programme for juvenile, nursery and grow out phase.
- Genetic variability, growth performance and temperature tolerance (upper and fluctuating) between the Indonesian, Philippines and Taiwan Province of China strains of milkfish (UPMSI have some background data on Philippine strain already).
- Genetic selection can also be focused on faster growth or better feed conversion to give the farmer better profitability and so be more resilient.

Lessons learned

In recent years increasing climatic variability has been observed with significantly hotter or colder seasons than normal and higher and lower rainfall. This will have affected pond and milkfish productivity, fish growth and survival. An investigation of milkfish productivity during these years will illustrate the potential risks and impacts and allow lessons to be learned on how to cope during similar climatic conditions.

It is recommended to research PAGASA records for coldest years and hottest years, years with heavy rainfall or droughts and check against milkfish production data, market data, fish catch data and look for any correlation between reduced productivity and high rainfall or hot weather.

It is recommended that a research institute (such as SEAFDEC) is assigned to collect and analyse the data, write a report for BFAR so that it can develop the necessary policy and guidelines and give advice to the farmers. This would take around one year to undertake.

Research mangrove planting programme

In many areas there is no longer any mangrove fringe along the coast with perimeter pond dykes directly along the coast. Increasing sea level rise together with increasing frequency and intensity of storms will tend to increase coastal erosion and perimeter dyke damage. A wide mangrove fringe along the coast would help protect the coastline against erosion and effectively protect the perimeter dike against storm surges. There is a fisheries regulation (Section 13 of FAO 197 - Series of 2000) that prescribes that there should be a 50 meter buffer zone along the coastal zone and along riverbanks. BFAR should enforce this regulation. There have been instances of mangrove reforestation of river banks and coastal areas but with unsuitable mangrove species and planting in unsuitable areas leading to high mortality of trees.

It is recommended to undertake research to identify the correct zone for planting to give coastal protection and to identify the correct mangrove species to plant. This would include:

- GIS analysis of storm surge vulnerability.
- Bathymetry and topography slope analysis.
- Fetch and wind /wave analysis.
- Identification of the most suitable areas for mangrove planting (this is already known for some areas).

In addition there should be a survey to determine how many of the fishponds actually adhere to the existing regulation on the mangrove buffer zone.

BFAR Region 6 needs to request BFAR Central Office to instruct NIFTDC to undertake this research.

Strengthening fish disease surveillance and pest control

Rapid changes in water quality parameters and consistently high water temperatures leads to a higher risk of disease and pests. It is recommended that SEAFDEC should arrange regular monitoring of pests and fish disease outbreak and provide recommendations on treatment to the farmers. BFAR should do the same for the rest of the country under the national bangus program. BFAR should expand and strengthen its initiative of developing a network for fish disease laboratories to cover the whole country.

Climate change training and awareness materials

There is a lack of awareness and understanding on climate change by farmers particularly of predicted future climate change and potential adaptation measures. This means that farmers are not well prepared to cope with unexpected climate changes. It is recommended that BFAR and SEAFDEC should collect science based resource materials from KLIMA, PAGASA, NAMRIA and elsewhere and then should prepare training materials on present and future predicted climate change, potential adaptation and mitigation measures for aquaculture. There should be three different categories of training materials developed:

- Fisheries school level.
- Farmer field school and regional fishermen training center.
- Local, Regional and Central decision makers and implementers.

It is recommended that SEAFDEC should then arrange a series of 'train the trainer' courses for:

- Climate change field schools.
- DA Agricultural Training Institute.
- Regional Fishermen Training Centres.
- SEAFDEC.
- NIFTDC.
- NFRDI.

It is recommended that the training of trainers should be focussed towards climate change adaptation strategies as follows:

- Training of technicians/trainers on climate change adaptation strategies: Five day training modules can include climate scenarios development, management, impacts and similar issues. Funding support should be sought from the Department of Agriculture.
- Training of caretakers and operators on climate change adaptation strategies. The 16 week course content should also include the training contents given training of trainers.
- Capacity-building of the Climate Field School technicians. The school is becoming popular, not only in the Philippines but in other countries and gets visitors from Indonesia, Pakistan, Cambodia and China. The local government in Iloilo sees the need to strengthen the capacity of the Climate Field School and train more people to be able to replicate these initiatives.

As climate science research is developing rapidly and lessons are being learned from adaptation measures developed elsewhere, the resource materials and training materials should be updated regularly (at least yearly). This recommendation could be undertaken in a one to three year timeframe.

Reference

Norfolk JRW, Javellana DS, Paw JN, Subosa PF. (1981). The use of ammonium sulfate as a pesticide during pond preparation. Asian Aquaculture 4(3): 4, 7.

Summary of Recommendations for Key Stakeholders

Stakeholder group	Recommendations
Government research stations, eg. NIFTDC, and university research departments, eg. Institute of Aquaculture, College of Fisheries and Ocean Sciences, University of Philippines Visayas	Undertake specific research on milkfish to improve pond productivity and genetic selection More research through long term breeding programs and validation at farmer level
Research Institutes, eg. SEAFDEC	Development of training curriculums, training materials and facilitating training and capacity building for extension officers and local government unit staff.
Training Institutes such as the Climate Field School, LGU Dumangas, Regional Fisheries Training Colleges.	Undertake training courses on adaptation measures to climate change for farmers and training of trainers.