Aquaculture or the farming of aquatic plants and animals is an important fisheries industry in the Philippines. In 2015, aquaculture contributed 50% of the total fisheries production of the country with a value of 85 billion pesos (PSA, 2016). The main Philippine aquaculture products are seaweeds (67%), milkfish (16%), and tilapia (11%).

Global warming or climate change impacts on aquatic systems. From the assessment report of the Intergovernmental Panel on Climate Change, the ocean’s mean temperature of 0.11 °C per decade from 1971 to 2010, while the mean sea level rose by 1.7 mm/yr from 1901 to 2010 and the frequency of intense cyclones increased (Seggel and De Young, 2015).
The El Niño of 1997–1998 caused by high surface temperature and drought negatively affected Philippine fisheries. As a result of the event, total fisheries production decreased by 283.879 metric tons valued at 72.48 million pesos. The aquaculture sub-sector of Philippine fisheries was the most adversely affected with 85% of the total economic loss. The culture of species in brackishwater ponds and seaweed farms in coastal waters were the most seriously impacted.

Studies have been proposed to address climate change through mitigation and adaptation. Mitigation refers to actions that can lower greenhouse gas emission and sequester carbon. Adaptation, on the other hand, consists of measures or strategies for coping with climate change impacts.

This study was done to assess the impacts of climate change on Philippine aquaculture with focus on the farming of seaweeds, milkfish and tilapia, and to identify coping strategies for cushioning such impacts on the culture of the said species.

In assessing the impacts of climate change on Philippine aquaculture, information from the literature was gathered and field observations were made. In identifying coping strategies for seaweeds, milkfish and tilapia culture, interviews with reliable persons, field observations and an experiment were conducted.

A. Assessment of Climate Change Impacts on Philippine Aquaculture

(1) Seaweeds

The Philippines is one of the world’s biggest producers of the red seaweeds, Eucheuma denticulatum and Kappaphycus alvarezii (Fig. 1), which are cultured in more than 150,000 hectares of coastal waters in the country by over 100,000 fisherfolk families. The common methods of culture are monolines fixed to the bottom (Fig. 2) in shallow waters (0.5–1 m deep at low tide) and floating monolines (Fig. 3) in deeper waters (more than 1 m at low tide).

While seaweeds are capable of taking up carbon dioxide in the sea for photosynthesis, their growth and survival are reduced by high surface sea temperature and intense exposure to sunlight particularly in shallow waters during the hot weather months (March to April) and drought periods (i.e., El Niño). The occurrence of the so-called “ice-ice disease” caused by unfavorable environmental conditions as high salinity, high temperature, lack of nutrients and other factors (Largo, 2002) is also prevalent.

Typhoons have also been destructive to seaweed farms in the country. Super Typhoon Yolanda in November 2013 destroyed more than 2,000 hectares of the farms in MIMAROPA (Region 4B), the Central and Eastern Visayas (Regions 7 and 8) and diminished the livelihoods of an estimated 16,500 coastal families (FAO, 2014; Galvez, 2014).

(2) Milkfish

The milkfish (Chanos chanos) is the most important cultured fish (Fig. 4) in the Philippines that is extensively grown in brackishwater ponds (Fig. 5), fishpens (Fig. 6) in lakes and tidal rivers, and floating cages (Fig. 7) in coastal waters. There are about 200,000 hectares of brackishwater ponds, more than 10,000 hectares of fishpens and around 5,000 hectares of floating cages used for milkfish culture throughout the country.

Fishpens and floating cages made of suspended net enclosures with bamboo poles for support and floatation are destroyed by the strong winds and waves brought about by typhoons. Even the floating Norwegian-type cages (Fig. 8) with sturdy polyvinylchloride (PVC) and steel pipes for frames and floatation were not spared in 2010 by Typhoons “Mina” and “Pedring” which hit Lingayen Gulf causing losses amounting to millions of pesos (Cardinoza, 2011).

Fixed cages are used in shallow lakes while floating cages, also made of bamboo poles for framing and floatation with suspended net enclosures, are used in deep lakes and reservoirs.

Freshwater ponds are vulnerable to floods caused by heavy rainfalls especially in floodplain areas such as that of Central Luzon. Prolonged dry spells and droughts can also limit fish production with the lack of water from the irradiation source and high water temperature of the shallow ponds. In the Cagayan Valley (Region 2), fish farmers have experienced “fish kills” or heavy fish mortalities in their ponds particularly in the months of May to August when the air temperature can be as high as 40°C and the rainy season sets in which subjects the cultured fish to abrupt changes in water temperature (Guerrero, 2014).

(3) Tilapia

The Nile tilapia (Oreochromis niloticus) is the second most important cultured fish (Fig. 9) in the country with more than 14,000 hectares of freshwater ponds (Fig. 10) particularly in Central Luzon and around 10,000 hectares of fixed (Fig. 11) and floating cages (Fig. 12) in lakes (e.g., Laguna de Bay and Taal Lake) and reservoirs (e.g., Magat Reservoir).

The freshwater ponds are generally shallow (1 meter deep) and supplied with water from an irrigation source and/or pumped underground water.

B. Coping Strategies for Philippine Aquaculture

(1) Seaweeds

A coping strategy practiced by farmers for minimizing the occurrence of the “ice-ice disease” in seaweeds is growing the plants with floating monolines in deep coastal waters instead of with fixed monolines in shallow waters to avoid high sea surface temperature and intense exposure to sunlight particularly during the...
hot weather months of April and May. The floating monolines (Fig. 13) to which the plants are attached can also be lowered underwater with weights to further lessen the effects of high surface temperature and intense light. Field tests to verify the effectiveness of such measures against the “ice-ice disease,” however, need to be done.

Another possible coping strategy is the application of fertilizers such as the “Ocean Green” (20% ferrous sulfate) at 40 g/m²/wk which was found in a study to be cost-effective with increase in the yield of floating raft-cultured K. alvarensi by 30% more than that of the control and apparent resistance to “ice-ice disease” during the hot weather months of March-April (Guerrero et al., 2003).

A powder extract of the brown seaweed Ascophythium nodosum found in the North Atlantic and commercially produced as AMPPEP (Acadian Marine Plant Extract Powder) is also said to be effective for enhancing growth and disease resistance of K. alvarensi when applied as a dip at low concentrations for planting materials (Hurtado et al., 2015).

(2) Milkfish

The coping strategies that may be applied to minimize loss of the cultured species in brackishwater ponds during flood events are to increase the height of pond dikes (Fig. 14) at least a meter above the highest recorded flood level to forestall water overtopping from the outside and/or the installation of net enclosures (Fig. 15) along the perimeters of the ponds to prevent the stock from escaping.

To reduce fish loss during dry spells or droughts, the ponds can be further deepened to hold more water (Fig. 16) and a supplemental supply of underground water can be tapped using pumps (Fig. 17) to augment the low water supply of tidal rivers.

The coping strategy applied to prevent the escape of fish cultured in coastal water floating cages during typhoons is the use of submersible cages. One such innovation is the “rope-framed floating fish cage” (RFFC) in Region 1 developed by researchers of the Bureau of Fisheries and Aquatic Resources led by Regional Director Nestor Domenden. Instead of using PVC or steel pipes for framing and flotation, the RFFC has a rope frame that is kept afloat by plastic buoys (Fig. 18).

The RFFC is more flexible, easier to build and cheaper than the rigid, difficult to build and more expensive Norwegian-type of floating cages commonly used by the industry. Only the 20 RFFCs of the company which adopted the innovation remained intact after the series of typhoons that struck Lingayen Gulf in 2010 and 2011 (Cardinola, 2011). A patent for the RFFC is being applied for.

Another submersible floating cage design for milkfish culture has been introduced by the Japanese International Cooperation Agency (JICA) in the country particularly to replace the conventional cages with bamboo frames which were destroyed by Super Typhoon Yolanda in Samar and Leyte (JICA, 2016). The new cage design uses high density polyethylene (HDPE) pipes for frames and floatation which is said to be resistant to strong waves. With a system of weights, the Japanese-designed cage can be lowered underwater to avoid the surface wind and wave forces (Fig. 19).

The use of fine-mesh nets (Fig. 20) for shading similar to that for protecting plants sensitive to sunlight in agriculture has been done by some fishpond operators in the country to lessen pond water temperature. The cost of such practice, however, can be prohibitive for large ponds and needs to be evaluated.

In a field study conducted by the author in a fishfarm in Bay, Laguna in March–April 2016, the use of water lettuce (Pistia stratiotes), a floating aquatic weed, was tested to determine its effectiveness as shade plant to reduce water temperature of fertilized freshwater ponds and its effect on the growth of the black-chin tilapia (Sarotherodon melanotheron). The results showed that the use of the plant (Fig. 21) which was contained at the pond surface with floating PVC pipes lowered pond water temperature by 3.2 °C with 24% shading of the pond compared to 33.8 °C of the control pond (without shading). The fish in the pond with 24% shading grew at the rate of 0.59 g/day while those in the pond with only 12% shading and with pond water temperature only 1.5 °C lesser than that of the control pond had a 0.12 g/day growth rate. The cost of shading 24% of the surface of a 200 m³ pond using 5 cm diameter PVC pipes to contain the floating plant was Php 4,500.

In shallow lakes like Laguna de Bay, submersible fixed cages (Fig. 22) have been used for the culture of the Nile tilapia by farmers for many years to minimize the loss of the fish during typhoon events. The cages are simply held down below the water surface with weights when winds and waves are strong and brought up again to the surface when the weather improves.

Recommendations

There is a need to evaluate the efficiency and cost-effectiveness of using underwater monolines and fertilizers for seaweed culture and net shading for pond culture of Nile tilapia as coping strategies to minimize the impact of high water temperature. Further studies on the use of floating aquatic plants for shading freshwater pond for fish culture are also recommended.
References


Food and Agriculture Organization. 2014. Helping seaweed farming flourish after typhoon hits Philippines (www.fao.org/in-action/helpingseaweedfarming...)


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