Exploring Climate-Resilient Adaptations of Farmed Fish for Climate-Smart Aquaculture

Stephanie Ichien, Briana Goodwin, Jenna Borberg, and Hillary Egna
The Feed the Future Innovation Lab for Collaborative Research on Aquaculture & Fisheries
Oregon State University, USA
email: aquafish@oregonstate.edu
website: aquafish.oregonstate.edu

Introduction

Exploring climate-resilient adaptations in farmed fish for climate-smart aquaculture is one strategy for helping to improve food security for the world's growing population under changing environmental conditions. People worldwide rely on fish as a primary source of protein and income, supporting a rapidly growing aquaculture industry that provides roughly half of the global fish supply. In an era of global climate change and high demand for animal protein, increasing the production of fish through sustainable and environmentally sensitive practices is critical. The development of climate-smart aquaculture can provide responsible management strategies to the aquaculture industry. One aspect of this effort involves expanding the culture of climate resilient species with characteristics such as a tolerance for hyposaline conditions, wide temperature ranges, and the ability to breathe air. Incorporating the culture of air-breathing species like the Pangasius catfish into climate-smart aquaculture not only provides the potential to grow local economies, it can also address some of the concerns about environmental threats by taking advantage of the evolutionary ecology of these species in their natural environments. However, it is also necessary to fully understand the positive and negative tradeoffs associated with increasing fish production to ensure that practices remain environmentally and socially responsible.

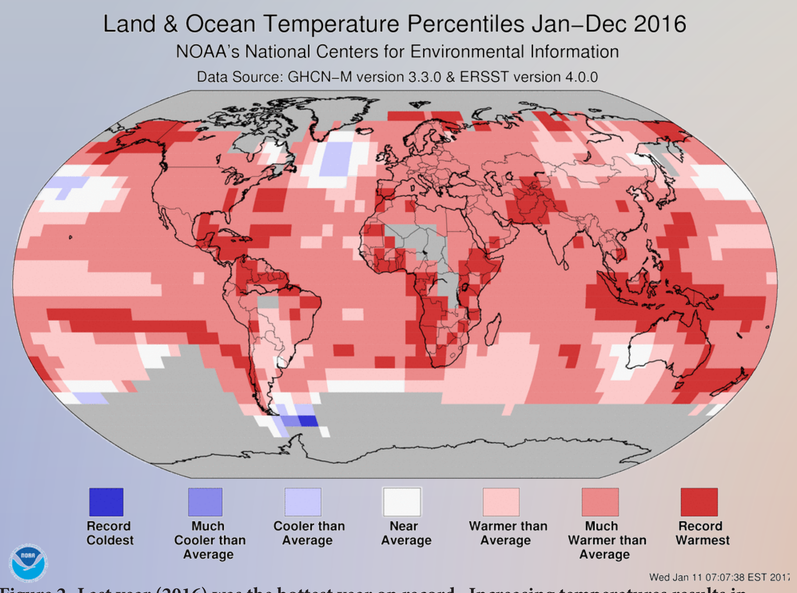

Figure 2- Last year (2016) was the hottest year on record. Increasing temperatures results in many compounding impacts on aquaculture world wide. (*Figure from www.ncdc.noaa.gov/temp-and-precip/global-maps/*)

Aquaculture in the face of Climate Change

Aquaculture, like agriculture and other human activities, will feel the effects of long-term climate change (Figure 1). Among the myriad challenges, global temperature increases (Figure 2), ocean acidification, and sea level rise will affect the world's coastal and inland aquaculture operations, much of which occur in poorer countries. Temperature changes will test the resiliency of domesticated varietals. The shifting distribution of global freshwater supplies and habitats will pose challenges as well as new opportunities for the aquaculture industry, small farmers, and the marketplace.

Research challenges and opportunities involve:

- Developing and refining cultivation techniques for new species, such as air-breathing fishes.
- Cultivation of indigenous species for contributing to the development of local communities and protecting ecosystems.
- Understanding the social, cultural, and economic impacts of climate change on the aquaculture industry and communities.

On the left, AquaFish partners visiting a snakehead farm in Vietnam (*Photo by Le Xuan Sinh*). On the right, a farmer uses a formulated snakehead feed, developed by AquaFish partners to reduce the dependence on fishmeal (*Photo by Peg Herring*).

Climate Resilience in Farmed Fish

One step towards implementing climate-smart aquaculture involves the diversification of the industry through climate resilient species and varietals that are also good candidates for aquaculture. Taking into consideration the dynamic tradeoffs, exploration of climate resilient fish for aquaculture can include the optimization of already cultured species, creating sustainable options for new species, and evaluating the socio-ecological impacts. Some of the climate resilient species under investigation by the AquaFish (listed below) include a range of air-breathing fish that are more able to withstand many of the expected impacts of climate change such as increased water temperatures and poorer water quality.

African Lungfish (*Protopterus aethiopicus*) in Uganda

- As an air-breather the African Lungfish is resilient to droughts and poor water quality, offering potential for future African aquaculture.
- A delicacy among certain groups in Uganda, markets are reliant on wild-caught fish for market size fish and juveniles in the limited culture that takes place. AquaFish partners from North Carolina State University, Auburn University, Oregon State University (OSU), and the National Fisheries Resources Research Institute of Uganda are developing sustainable, low-cost breeding techniques for the nascent industry.

Protopterus aethiopicus
(Image from aquarium-passion.com)

Giant Snakehead (*Channa striata*) in Vietnam and Cambodia

- One of the two dominant aquaculture species and popular food fish in the Mekong Delta, the air-breathing snakehead is a climate resilient species for its ability to survive dry seasons.
- AquaFish partners from the University of Rhode Island, University of Connecticut, OSU, Can Tho University in Vietnam, and the Inland Fisheries Research and Development Institute in Cambodia have been developing sustainable culture practices for the highly carnivorous fish in order to lessen its impacts.

Channa striata
(Photo by Hap Navy)

Pangasius Catfish (*Pangasius hypopthalamus*) in Vietnam, Cambodia, and Bangladesh

- An economically important air-breathing fish, *Pangasius* offers the potential for increased culture in a region that is already suffering from seawater encroachment—one of the many effects of climate change.

Pangasius hypopthalmus
(Image from tepbac.com)

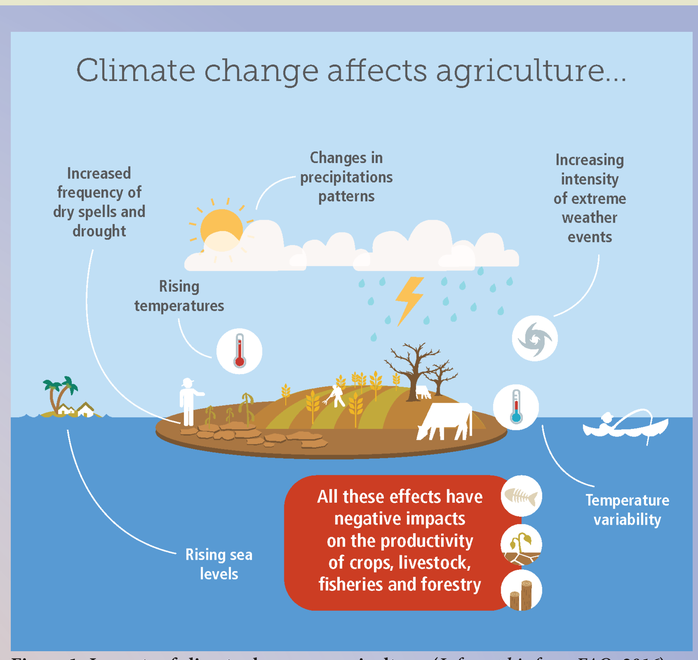

Figure 1- Impacts of climate change on agriculture. (*Infographic from FAO, 2016*)

Climate-Smart Agriculture

Climatic variability and its associated impacts can impose production risks and challenge the coping capacity of farmers at all scales. A climate-smart approach to agriculture can easily be adapted for aquaculture, by which increased production is managed for sustainability, climate adaptation, and climate mitigation. This provides an approach to build resilient food production systems to more effectively support development and ensure sustainable food security in the face of climate change (Figure 3).

The climate-smart approach pursues three primary objectives towards reconciling tradeoffs for building resilient systems on local and global scales through time:

1. Sustainably increase production and incomes
2. Climate change adaptation
3. Climate change mitigation

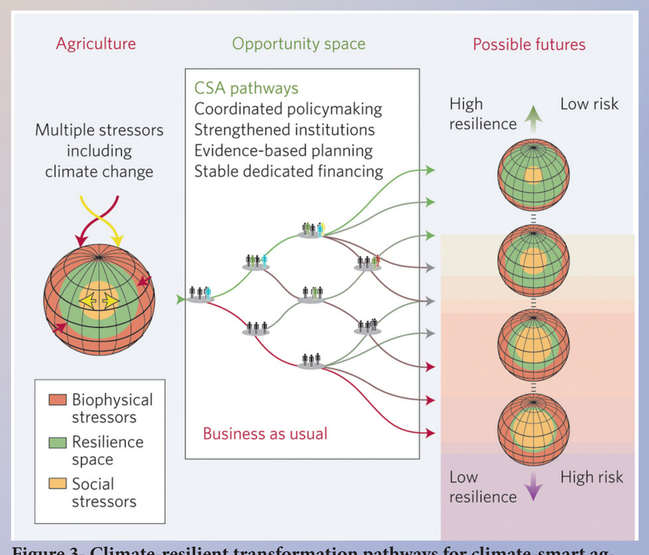

Figure 3- Climate-resilient transformation pathways for climate-smart agriculture. Actions taken at various decision points along a climate-smart pathway results in higher resilience. Alternatively, business as usual leads to higher risk and low resilience. (*Figure from Lipper et al., 2014*).

References

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The Feed the Future Innovation Lab for Collaborative Research on Aquaculture & Fisheries (AquaFish Innovation Lab) is funded under USAIDLeader with Associates Cooperative Agreement No. EPP-A-00-06-00012-00 and by the participating US and Host Country partners. This work was made possible by the generous support of the American people through USAID. The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.

Aquaculture America, San Antonio, Texas, February 2017