CGIAR
INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

What do we know about THE FUTURE OF AQUATIC FOODS IN GLOBAL AGRIFOOD SYSTEMS?

Chin Yee Chan (WorldFish), Nhuong Tran (HSB-VNU and ANU), Yan Hoong (S&P Global), Timothy B. Sulser (IFPRI), and Yee Mon Aung (Yezin Agricultural University)

Key messages

- Demand for aquatic foods has increased rapidly due to population growth, rising incomes, and enhanced appreciation for the health benefits of fish. The rapid growth of aquaculture in the past two decades has been the key contributor to meeting the increasing demand for aquatic foods.
- Aquatic foods are nutrient-rich, generate low emissions and impacts on land and water, and contribute to the human health, well-being, and livelihoods of rural communities.
- The latest fish foresight studies provide multifaceted insights into future scenarios of technological progress, climate change, population growth, diet transformation, urbanization, investments, and policy shifts in the fish sector and the potential for fish to provide nutrition-sensitive interventions to combat food insecurity and malnutrition at the global, regional, and national level.
- Further foresight studies are needed to inform policymaking and develop a deeper understanding of the role aquatic foods can play in addressing the nutritional, social, and environmental food systems challenges while navigating the trade-offs of pursuing these different goals.

RECENT TRENDS AND CHALLENGES

Food, land, and water systems are facing unprecedented change. Nourishing 9.8 billion people with a healthy and sustainable diet by 2050 and within planetary boundaries is recognized as one of the biggest challenges facing humanity (Springmann et al. 2018; United Nations 2022). Aquatic foods offer significant potential in the transformation of food systems toward healthy and sustainable diets, sustaining livelihoods, and generating income for women and youth (Chan et al. 2021; FAO 2022; Simmance et al. 2021; Tigchelaar et al. 2022), and are accessible to these vulnerable populations even in the face of political shocks and market failures, such as those brought about by COVID-19 (Béné 2020). Yet the role of aquatic foods has been largely overlooked and remains remarkably absent from many contemporary food system discussions and policies (Chan et al. 2021; Crona et al. 2023).

Demand for aquatic foods has increased rapidly due to population growth, rising incomes, and enhanced appreciation for the health benefits of fish consumption (Aung et al. 2022; Naylor et al. 2021b; Wang et al. 2022). The rapid growth of aquaculture in the past two decades has been the key contributor to meeting the increasing demand for aquatic foods. Some aquaculture systems are associated with environmental drawbacks, highlighting the need for new approaches to sustainability (Le Gouvello, Brugere, and Simard 2022; Naylor et al. 2021a). Also, expanding production of food from the sea will bring co-benefits and trade-offs and will require national and interregional governance, as well as local capacity, to ensure equity and sustainability (Costello et al. 2020). The productivity, biodiversity, and carbon-sequestering functions of aquatic ecosystems are threatened by multiple factors, including pollution, the proliferation of disease outbreaks, climate change, competing water demands, lack of effective fisheries management to combat illegal, unreported, and unregulated fishing, habitat degradation, and infrastructure development and land use change (Long et al. 2020; Tran et al. 2022; Tweddle et al. 2015). Carefully managed aquatic food systems that include "nature-based solutions" can deliver better impacts on "ecological, economic, and social needs, as well as increased employment and food security" (Theuerkauf et al. 2019).

LATEST FORESIGHT RESEARCH

In recent years, aquatic foods have become more integrated into foresight models of the agriculture and land use sectors. To date, fish commodities have been included in several partial equilibrium economic models, including the International Model for Policy Analysis of Agriculture Commodities and Trade (IMPACT) (Chan et al. 2021; Chan et al. 2019; Kobayashi et al. 2015; World Bank 2013), the AgLINK-COSIMO model (Lem, Bjorndal, and Lappo 2014; OECD/FAO 2021), the Global Biosphere Management Model (GLOBIOM), and the Common Agricultural Policy Regionalised Impact (CAPRI) model (Chang, Witzke, and Latka 2018; Deppermann et al. 2019; Heckelei et al. 2018; Latka et al. 2018). These economic models focus on analyzing the future supply and demand of fish by simulating the impacts of external drivers such as technological progress, population and income growth, and climate change on fish production, consumption, and trade at the national, regional, and global level. Some studies using the CAPRI model focus on simulating the economic impact of fisheries policies on aquafeed production and different fish commodities. Overall, these comprehensive models focus on medium- or long-term projections at the global and regional level. Other partial equilibrium modeling approaches developed by WorldFish, such as the AsiaFish model (Dey et al. 2016; Tran et al. 2023; Tran et al. 2017) and the multispecies–multisector equilibrium model (Tran et al. 2019, 2022), provide more disaggregated projections of the fish sector at the country level. Historical data, in conjunction with stakeholder consultation inputs, are used to generate projections that mirror past trends while giving direction to future projections.

Foresight analyses using the IMPACT, AgLINK-COSIMO, GLOBIOM, and CAPRI fish models have projected the future of fish supply and demand across different fish types around the world under various scenarios (Cardon 2020; Chan et al. 2019, 2021; Delgado et al. 2003; Latka et al. 2018; Lem, Bjorndal, and Lappo 2014; OECD/FAO 2021; World Bank 2013). Globally, nominal fish prices are projected to increase at a rate of between 0.8 percent and 1.6 percent per year over the 2021–2030 period, with a stronger increase in 2022, when the negative effects of COVID-19 on markets are expected to end (OECD/FAO 2021). The ASEAN (Association of Southeast Asian Nations) region is projected to account for nearly one-quarter of global fish production in the coming decades (Chan et al.

2017). Despite the relatively fast expansion of the aquaculture sector, capture fisheries will remain a dominant fish source in the region. Compared to the rest of Asia, the ASEAN region exhibits remarkably high per capita fish consumption, more than doubling over the past four decades and double the world average (Chan et al. 2017). Africa has the lowest per capita fish consumption compared to other global regions, with an extraordinary potential for growth (Chan et al. 2019). In Africa, aquaculture development has significant potential to contribute to the goal of reducing food and nutrition insecurity. However, Africa will continue to be a net fish-importing continent to fulfill the required demand, representing important opportunities for fish sector entrepreneurs (Chan et al. 2019). Sustained investment is important to support sustainable fish sector growth for food system transformation toward healthy diets (Chan et al. 2021). In Europe, the GLOBIOM model estimates that the total fish production will increase to 6.3 million metric tons by 2030, of which 82 percent will come from capture fisheries (Latka et al. 2018). Both the GLOBIOM and CAPRI models project that Europeans will consume approximately 10 million tons of fish by 2030, with the balance coming from imports.

Alternative scenarios of future potential risks have been explored through country-level foresight analysis. For example, disease outbreaks could considerably reduce future aquaculture production in Bangladesh, Egypt, and Indonesia (Tran et al. 2017, 2022, 2023). In addition, the share of fishery stocks within biologically sustainable levels declined to 65 percent in 2019 due to overfishing, pollution, poor management, and other factors (FAO 2022), resulting in stagnant or slightly declining capture fisheries. Consequently, per capita fish consumption fell as consumer prices rose due to the reduction in fish availability. Another major challenge, climate change, is likely to constrain a rise in aquaculture production, due to impacts on water quality, pH level, and salinity (Tran et al. 2022).

KEY GAPS AND OPPORTUNITIES FOR FORESIGHT RESEARCH

The role of aquatic foods in food system transformation has remained relatively overlooked due to the limited scientific data and evidence to inform aquatic foods investment planning and priority setting. Compared to other food commodities, substantial uncertainties persist regarding the quantification of greenhouse gas emissions associated with aquatic foods. As these foods are a relatively underdeveloped realm for foresight modeling, it is imperative to enhance the quality of modeling projections and incorporate these improvements for a more complete and accurate view of food systems. Aquatic food systems are highly heterogenous and complex, thus disaggregated foresight modeling studies should be conducted to capture the diversity of trends within specific subsectors at the global, regional, and national level. Such analyses are important for developing intervention options for sustainable fishery sector development. Additional analyses are needed to explore future potential for outcomes in additional areas of interest, such as poverty alleviation, nutrition, gender equity, and environmental sustainability, while effectively navigating trade-offs (Chan et al. 2021).

This chapter was supported by the CGIAR Research Initiative on Foresight and the CGIAR Science Program on Policy Innovations. We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund.

The authors of this chapter are **Chin Yee Chan**, a Scientist at WorldFish; **Nhuong Tran**, a Senior Researcher and Lecturer at Hanoi School of Business and Management, Vietnam National University (HSB-VNU), and Honorary Associate Professor in the Crawford School of Public Policy at The Australian National University (ANU), and formerly an Applied Economic Senior Scientist at WorldFish; **Yan Hoong**, an Economist at S&P Global, and formerly a Research Analyst at WorldFish; **Timothy B. Sulser**, a Senior Scientist in the Foresight and Policy Modeling Unit at the International Food Policy Research Institute (IFPRI); and **Yee Mon Aung**, a Lecturer at Yezin Agricultural University, Myanmar.

Related chapters on the future of food system drivers and impacts, regional and national perspectives, food commodities, and foresight tools are available in our Table of Contents.

Citation: Chan, C.Y., N. Tran, Y. Hoong, T.S. Sulser, and Y.M. Aung. 2025, "What Do We Know About the Future of Aquatic Foods in Global Agrifood Systems?" In *What Do We Know About the Future of Food Systems?*, eds. K. Wiebe and E. Gotor, Chapter 29. Washington, DC: IFPRI. https://hdl.handle.net/10568/175019

Photo credit: Chosa Mweemba/WorldFish

References

Aung, Y.M., L.Y. Khor, N. Tran, M. Akester, and M. Zeller. 2022. "A Disaggregated Analysis of Fish Demand in Myanmar." *Marine Resource Economics* 37 (4): 369–514. https://doi.org/10.1086/721054

Béné, C. 2020. "Resilience of Local Food Systems and Links to Food Security—A Review of Some Important Concepts in the Context of COVID-19 and Other Shocks." *Food Security* 12: 805–822. https://doi.org/10.1007/s12571-020-01076-1

Cardon, V. 2020. "Bounded Futures: Growing a Boundary Foreknowledge Infrastructure in Food Security Research." *Science, Technology & Society* 25 (1): 38–66. https://doi.org/10.1177/0971721819889918

Chan, C.Y., N. Tran, K.C. Cheong, T.B. Sulser, P.J. Cohen, K. Wiebe, and A.M. Nasr-Allah. 2021. "The Future of Fish in Africa: Employment and Investment Opportunities." *PLoS ONE* 16 (12): e021615. https://doi.org/10.1371/journal.pone.0261615

Chan, C.Y., N. Tran, C.D. Dao, et al. 2017. *Fish to 2050 in the ASEAN Region*. Working Paper: 2017–01. WorldFish, Penang; IFPRI, Washington, DC. https://hdl.handle.net/20.500.12348/111

Chan, C.Y., N. Tran, S. Pethiyagoda, C.C. Crissman, T.B. Sulser, and M.J. Phillips. 2019. "Prospects and Challenges of Fish on Food Security in Africa." *Global Food Security* 20: 17–25. https://doi.org/10.1016/j.gfs.2018.12.002

Chang, C.Y., H.P. Witzke, and C. Latka. 2018. *A Model for Data Consolidation of the Fish Market in CAPRI*. 58th Annual Conference, Kiel, Germany, September 12–14. German Association of Agricultural Economists (GEWISOLA). https://ideas.repec.org/p/ags/gewi18/275842.html

Costello, C., L. Cao, S. Gelcich, et al. 2020. "The Future of Food From the Sea." *Nature* 588: 95–100. https://doi.org/10.1038/s41586-020-2616-y

Crona, B.I., E. Wassenius, M. Jonell et al. 2023. "Four Ways Blue Foods Can Help Achieve Food System Ambitions Across Nations." *Nature* 616: 104–112. https://doi.org/10.1038/s41586-023-05737-x

Delgado, C.L., N. Wada, M.W. Rosegrant, S. Meijer, and M. Ahmed. 2003. *Fish to 2020: Supply and Demand in Changing Global Markets*. WorldFish Center Technical Report 62. Washington, DC: IFPRI. https://hdl.handle.net/20.500.12348/2203

Deppermann, A., H. Valin, M. Gusti et al. 2019. *Towards Sustainable Food and Land-Use Systems: Insights From Integrated Scenarios of the Global Biosphere Management Model (GLOBIOM)*. Laxenburg, Austria: International Institute for Applied Systems Analysis (IIASA). https://pure.iiasa.ac.at/id/eprint/16091/

Dey, M.M., M.W. Rosegrant, K. Gosh, O.L. Chen, and R. Valmonte-Santos. 2016. "Analysis of the Economic Impact of Climate Change and Climate Change Adaptation Strategies for Fisheries Sector in Pacific Coral Triangle Countries: Model, Estimation Strategy, and Baseline Results." *Marine Policy* 67: 156–163. https://doi.org/10.1016/j.marpol.2015.12.011

FAO (Food and Agricultural Organization of the United Nations). 2022. *The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation*. Rome. https://doi.org/10.4060/cc0461en

Heckelei, T., M. Batka, C.Y. Chang, et al. 2018. *Enhanced Modelling of Sustainable Food and Nutrition Security: Food Supply and Use of Scarce Resources*. Deliverable 9.3. The Hague: SUSFAN.

Kobayashi, M., S. Msangi, M. Batka, S. Vannuccini, M.M. Dey, and J.L. Anderson. 2015. "Fish to 2030: The Role and Opportunity for Aquaculture." *Aquaculture Economics & Management* 19: 282–300. https://doi.org/10.1080/13657305.2015.994240

Latka, C., T. Heckelei, M. Batka et al. 2018. *The Potential Role of Producer and Consumer Food Policies in the EU to Sustainable Food and Nutrition Security*. Deliverable No. 10.3: SUSFANS Project H2020/SFS-19 - 2014: Sustainable Food And Nutrition Security Through Evidence Based EU Agro-Food Policy GA No. 633692. Wageningen, Netherlands: SUSFAN. https://edepot.wur.nl/464089

Le Gouvello, R., C. Brugere, and F. Simard. 2022. *Aquaculture and Nature-based Solutions: Identifying Synergies Between Sustainable Development of Coastal Communities, Aquaculture, and Marine and Coastal Conservation*. Gland, Switzerland: IUCN. https://doi.org/10.2305/IUCN.CH.2022.02.en

Lem, A., T. Bjorndal, and A. Lappo. 2014. *Economic Analysis of Supply and Demand for Food up to 2030—Special Focus on Fish and Fishery Products*. FAO Fisheries and Aquaculture Circular No. 1089. Rome: FAO. https://openknowledge.fao.org/server/api/core/bitstreams/aa6175f4-2359-4daf-b634-b183dc39ca72/content

Long, T., S. Widjaja, H. Wirajuda, and S. Juwana. 2020. "Approaches to Combatting Illegal, Unreported and Unregulated Fishing." *Nature Food* 1: 389–391. https://doi.org/10.1038/s43016-020-0121-y

Naylor, R.L., R.W. Hardy, A.H. Buschmann et al. 2021a. "A 20-year Retrospective Review of Global Aquaculture." *Nature* 591: 551–563. https://doi.org/10.1038/s41586-021-03308-6

Naylor, R.L., A. Kishore, U.R. Sumaila et al. 2021b. "Blue Food Demand Across Geographic and Temporal Scales." *Nature Communications* 12: 5413. https://doi.org/10.1038/s41467-021-25516-4

OECD/FAO (Organisation for Economic Co-operation and Development/Food and Agriculture Organization). 2021. OECD-FAO Agricultural Outlook 2021–2030. Paris: OECD Publishing. https://doi.org/10.1787/19428846-en.

Simmance, F.A., P.J. Cohen, C. Huchery, et al. 2021. "Nudging Fisheries and Aquaculture Research Towards Food Systems." *Fish and Fisheries* 23 (1): 34–53. https://doi.org/10.1111/faf.12597

Springmann, M., M. Clark, D. Mason-D'Croz, et al. 2018. "Options for Keeping the Food System Within Environmental Limits." *Nature* 562: 519–525. https://doi.org/10.1038/s41586-018-0594-0

Theuerkauf, S.J., J.A. Morris Jr., T.J. Waters, L.C. Wickliffe, H.K. Alleway, and R.C. Jones. 2019. "A Global Spatial Analysis Reveals Where Marine Aquaculture Can Benefit Nature and People." *PLoS One* 14 (10): e0222282. https://doi.org/10.1371/journal.pone.0222282

Tigchelaar, M., J. Leape, F. Micheli, et al. 2022. "The Vital Roles of Blue Foods in the Global Food System." *Global Food Security* 33: 100637. https://doi.org/10.1016/j.gfs.2022.100637

Tran, N., C.Y. Chan, Y.M. Aung, et al. 2022. "Foresighting Future Climate Change Impacts on Fisheries and Aquaculture in Vietnam." *Frontiers in Sustainable Food Systems* 6: 829157. https://doi.org/10.3389/fsufs.2022.829157

Tran, N., L. Chu, C.Y. Chan, S. Genschick, M.J. Phillips, and A.S. Kefi. 2019. "Fish Supply and Demand for Food Security in Sub-Saharan Africa: An Analysis of the Zambian Fish Sector." *Marine Policy* 99: 343–350. https://doi.org/10.1016/j.marpol.2018.11.009

Tran, N., L. Chu, C.Y. Chan, J. Peart, A.M. Nasr-Allah, and H. Charo-Karisa. 2022. "Prospects of Fish Supply-Demand and Its Implications for Food and Nutrition Security in Egypt." *Marine Policy* 146: 105333. https://doi.org/10.1016/j.marpol.2022.105333

Tran, N., U.P. Rodriguez, C.Y. Chan, et al. 2023. "Future Scenarios of Fish Supply and Demand for Food and Nutrition Security in Bangladesh: An Analysis With the AsiaFish Model." *Aquaculture* 568: 739288. https://doi.org/10.1016/j.aquaculture.2023.739288

Tran, N., U.P. Rodriguez, C.Y. Chan, et al. 2017. "Indonesian Aquaculture Futures: An Analysis of Fish Supply and Demand in Indonesia to 2030 and Role of Aquaculture Using the Asiafish Model." *Marine Policy* 79: 25–32. https://doi.org/10.1016/j.marpol.2017.02.002

Tweddle, D., I. Cowx, R. Peel, and E. Weyl. 2015. "Challenges in Fisheries Management in the Zambezi, One of the Great Rivers of Africa." *Fisheries Management and Ecology* 22 (1): 99–111. https://doi.org/10.1111/fme.12107

United Nations. 2022. *World Population Prospects 2022: Data Sources*. UN DESA/POP/2022/DC/NO. 9. New York: UN-DESA. https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_2022_wpp-data_sources.pdf

Wang, P., N. Tran, D. Enahoro, et al. 2022. "Spatial and Temporal Patterns of Consumption of Animal-Source Foods in Tanzania." *Agribusiness* 38 (2): 328–348. https://doi.org/10.1002/agr.21729

World Bank. 2013. *Fish to 2030: Prospect for Fisheries and Aquaculture*. World Bank Report Number 83177-GLB. Washington, DC. http://documents1.worldbank.org/curated/en/458631468152376668/pdf/831770WP0P11260ES003000Fish0to02030.pdf

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

A world free of hunger and malnutrition

IFPRI is a CGIAR Research Center

1201 Eye St, NW, Washington, DC 20005 USA | T. +1-202-862-5600 | F. +1-202-862-5606 | Email: ifpri@cgiar.org | www.ifpri.org | www.ifpri.info

Handle: https://hdl.handle.net/10568/175019