Exploring Indonesian aquaculture futures

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WorldFish

EXPLORING INDONESIAN AQUACULTURE FUTURES

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Citation

This publication should be cited as: Phillips M, Henriksson PJG, Tran N, Chan CY, Mohan CV, Rodriguez U-P, Suri S, Hall S and Koeshendrajana S. 2015. Exploring Indonesian aquaculture futures. Penang, Malaysia: WorldFish. Program Report: 2015-39.

Acknowledgments

The authors thank the Gordon and Betty Moore Foundation and the CGIAR Research Programs on Policies, Institutions and Markets (PIM) and Livestock and Fish (L&F) for funding of the research. WorldFish also recognizes the strong partnership with the Ministry of Marine Affairs and Fisheries (MMAF) in Indonesia, as well as the contributions of a wide range of public, private, community and civil society members and organizations to the consultations and research. The participants in the 30–31 July 2015 Jakarta workshop are particularly thanked for their feedback on the research and contribution to the priority setting.

CONTENTS

OVERVIEW

Aquaculture is the fastest-growing food production sector globally, with production projected to double within the next 15–20 years. Future growth of aquaculture is essential to providing sustainable supplies of fish in national, regional and global fish food systems; creating jobs; and maintaining fish at affordable levels for resource-poor consumers. To ensure that the anticipated growth of aquaculture remains both economically and ecologically sustainable, we need to better understand the likely patterns of growth, as well as the opportunities and challenges, that these trends present. This knowledge will enable us to better prioritize investments that will help ensure the sustainable development of the sector.

In Indonesia, WorldFish and partners have applied a unique methodology to evaluate growth trajectories for aquaculture under various scenarios, as well as the opportunities and challenges these represent. Indonesia is currently the fourth largest aquaculture producer globally, and the sector needs to grow to meet future fish demand.

The analysis indicates that aquaculture will overtake capture fisheries as the major source of fish in Indonesia before 2030 and that investment in aquaculture will be essential in order to increase domestic fish supplies and consumption, maintain affordable fish prices for domestic consumers, and sustain the contribution fish makes to Indonesian food and nutritional security. Business-as-usual projections indicate that aquaculture will grow to more than 10.1 million metric tons per year, create 8.9 million full-time-equivalent jobs in production, and be an industry with production values of USD 39.5 billion by 2030. Increased investment in aquaculture for either export or domestic markets will generate more social and economic benefits, greater production volumes and values, additional employment, and higher consumption among domestic consumers.

Aquaculture's growth is necessary to meet future food and nutrition security requirements, but creates challenges for managing environmental impacts. All aquaculture growth projections modeled in Indonesia increase environmental impacts. Three particular environmental challenges emerge around land and habitats, sustainable aquaculture feeds, and reducing fresh water use, all of which require significant investment and change from business-as-usual approaches.

WorldFish's unique methodology can also be used in other national and regional contexts to help analyze future aquaculture growth pathways, as well as to prioritize the investments needed to ensure economically and environmentally sustainable growth of aquaculture at the speed and scale needed.

INDONESIAN FISHERIES AND AQUACULTURE

Indonesia provides a good model for developing and applying a common methodology for analyzing the future of aquaculture. Historically, most fish supply has come from capture fisheries, but landings have slowed over the last decade. There are also fears of additional stock collapses for several important species, including tuna and sardines. Aquaculture has in turn become the main driver for production increases, with farming in marine, brackish and fresh water.

Capture fisheries and aquaculture directly employed an estimated 6.4 million people in Indonesia in 2012. By volume, Indonesian aquatic production is dominated by seaweeds, but by value, domestically consumed species such as tilapia and milkfish, together with export-oriented commodities such as shrimp and tuna, are of greater importance. Tilapia, catfish and milkfish are increasingly important to domestic fish supplies. At present, almost 38% of aquatic production is intended for export, rendering seafood trade an important income source for Indonesia. Aquatic food products therefore contribute to food and nutrition security, employment, and national economic growth.

Aquaculture is given a high priority by the Indonesian government for further development, yet its future sustainable growth is not secure. This evaluation draws upon multiple analytical tools and a collaboration between Indonesian and WorldFish researchers. Its purpose was to increase understanding of future trends that would enable decision-makers, land managers and communities to assess environmental tradeoffs among different growth options and develop public policies and investments to create economic opportunity for sustainable aquaculture growth that mitigates impacts to ecosystems.

Shrimp farming in Aceh, Indonesia.

METHODOLOGY

The following challenges drove method development:

- Indonesian aquaculture production needs to grow in the future, but it needs to grow sustainably, contributing positively to fish supply while minimizing environmental impacts.
- Current projections for future aquaculture growth rarely consider the environmental limits and management strategies needed to offset potential environmental impacts.

In light of these considerations, we adopted an approach that combined econometric modeling of demand for fish supply with analysis of environmental impacts and participatory approaches. This required collection and integration of quantitative data across several subject domains.

The methodology involves a stepwise application of tools through a structured process of analysis and consultations (Figure 1).

Step 1: System characterization
The Indonesian aquaculture sector is diverse, catering to domestic and export consumers and demand. The study first selected and examined the key aquaculture commodities and farming systems (Figures 2 and 3) with data collected from secondary sources and through fieldwork and consultations with farmers, feed mills and other value chain actors on Java, Sumatra, Lombok and South Sulawesi during 2015.

The characterization process provided an understanding of the performance of current aquaculture systems, key data for modeling, and a benchmark for identifying opportunities for improvement across key economic, social and environmental dimensions.

Economic. The economic evaluation shows that Indonesian aquaculture creates significant benefits for the Indonesian economy through a mix of domestic production and exports. The economic viability and value of farming systems were evaluated by the monetary value they generate at country level, and also by the profits they provide for aquaculture businesses and households.

Social. Aquaculture creates significant employment in Indonesia. Tilapia farming in ponds was the largest employer overall. In addition to estimating job numbers, social goods in terms of equity, financial security and social responsibility were evaluated.

Environmental. Environmental interactions were quantified using life cycle assessments. Life cycle assessment is a standardized environmental accounting tool that quantifies environmental interactions throughout the production line and scales these to a functional unit (ISO 2006). The life cycle assessment results link certain farming practices with specific impacts, showing various differences across systems and practices.

Figure 1. Approach to developing toolset and recommendations.

Step 2: Future scenarios

Future scenarios for the fish food system in Indonesia were explored with stakeholders. Between July and December 2014, three workshops were held, one at national level (Jakarta) and two at provincial level (Lombok and Makassar). At each workshop, participants from the government, the private sector, research and nongovernmental organizations, and communities worked together through a structured process to arrive at a series of scenarios for the Indonesian fish food system in 2030.

Drawing on conclusions from the three workshops, an integrated scenario frame emerged based on two key uncertainties: the natural environment and the socioeconomic enabling environment.

Environmental uncertainties include the following:

- pollution levels
- water quality
- availability of environmental services
- increased frequency and scale of extreme weather events due to climate change.

Uncertainties in the socioeconomic enabling environment include the following:

- evolution of market conditions, policies and regulations
- extent to which the financial regulatory climate is supportive for growth
- availability of broad infrastructure investment.

Based on these uncertainties, four scenarios emerged for the Indonesian fisheries and aquaculture sectors in 2030 (Figure 4).

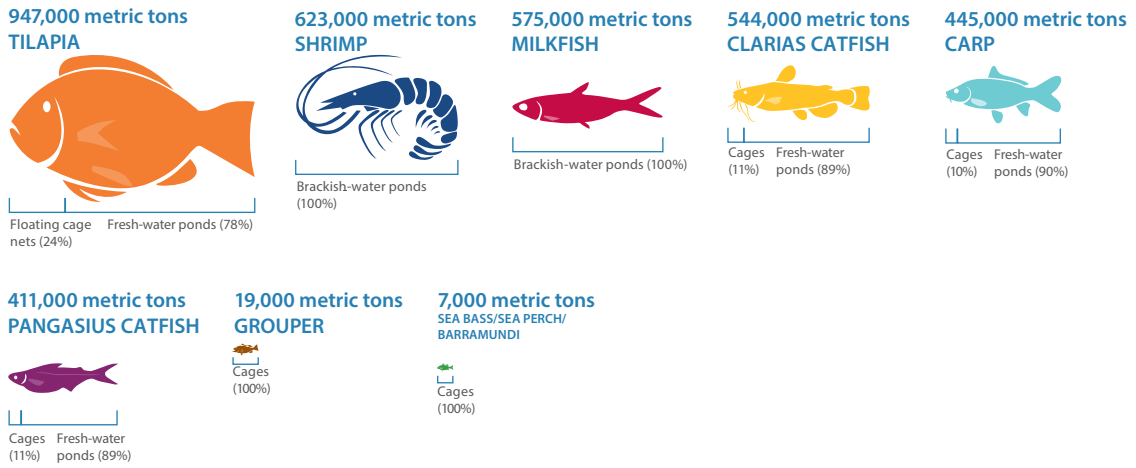

Figure 2. Indonesian aquaculture systems.

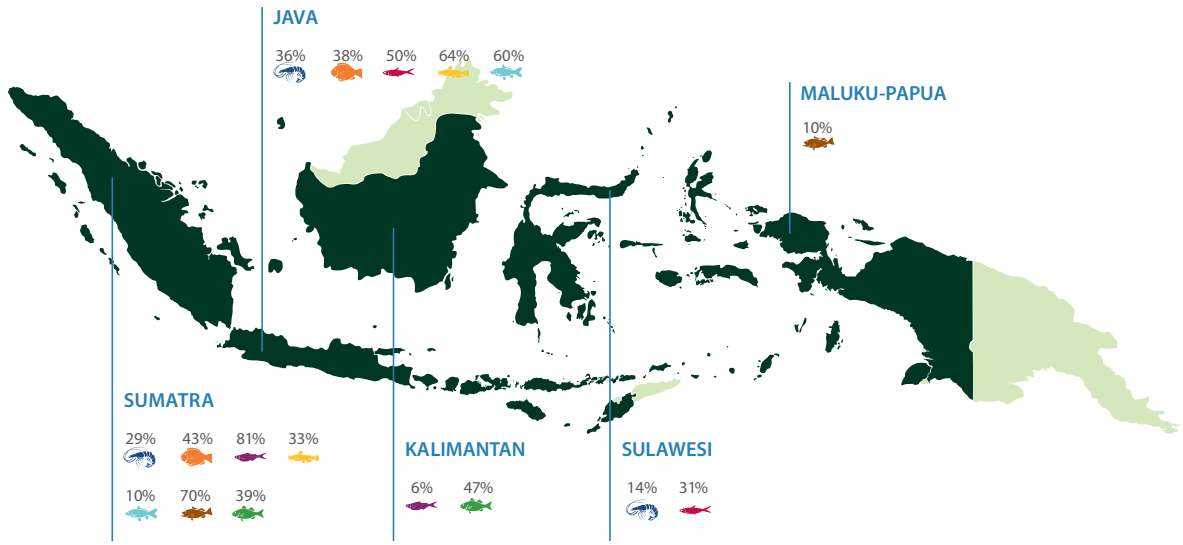

Figure 3. Indonesia aquaculture regions (with percentages of national production).

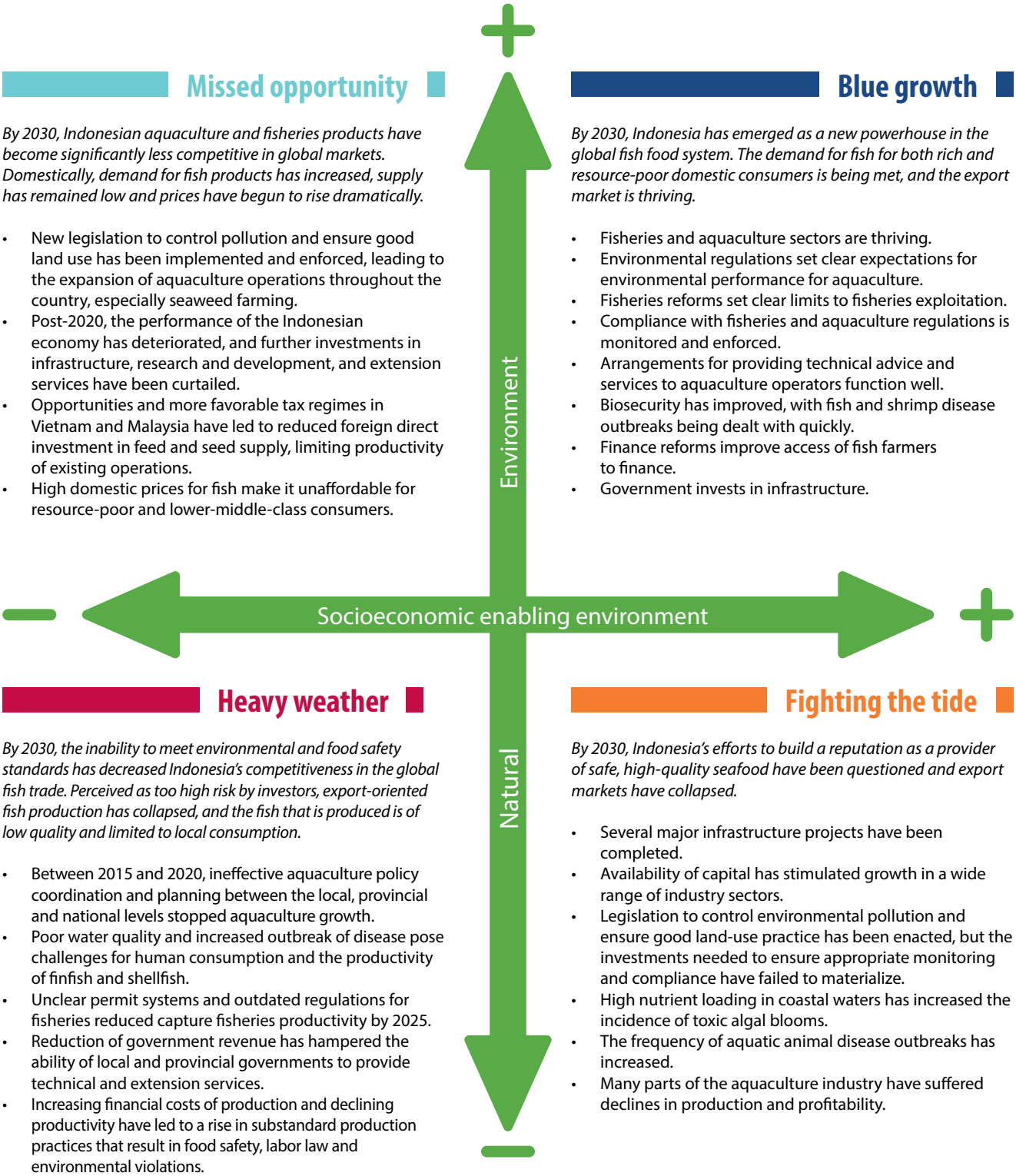

Figure 4. Scenarios for the future of Indonesian fish food systems.

Step 3: Fish supply and demand modeling
The future supply and demand for fish was analyzed using a partial economic equilibrium model called AsiaFish (Dey et al. 2008). The model was used to explore future fish supply-demand dynamics and the role of aquaculture in meeting food and nutrition goals for Indonesia. A business-as-usual projection assumes that exogenous variables of the model (income, population, input and output prices, food and non-food price indexes, capture fisheries and aquaculture productivity growth) follow historical trends.

Five alternative future projections were modeled using the following assumptions:

- Capture fisheries landings remain stagnant (FP1).
- An export-oriented aquaculture industry shows stronger growth, driving increases in production of shrimp, grouper and tilapia (FP2).
- A domestic-oriented aquaculture industry shows higher growth, driving increases in production of milkfish, carp, catfish and tilapia (FP3).
- Aquaculture growth slows down (FP4).
- Disease outbreaks occur in shrimp and carp aquaculture in the year 2018, with a gradual recovery after a 5-year period (FP5).

Under business-as-usual projections, capture fisheries and aquaculture grow at 2% and 5.6% annually (Table 1). Aquaculture becomes increasingly dominant, overtaking capture fisheries as the main supplier of fish by 2030. Fish consumption and prices (for both consumers and producers) show an upward trend. Net trade (exports less imports) is also expected to increase (Figure 5).

Modeling using other assumptions provides insight into Indonesian fish food systems and the influence of aquaculture growth (Table 1):

- Stagnating capture fisheries lead to increasing fish prices and decreasing fish consumption.
- An emphasis on export aquaculture results in higher fish supply and exports, but also helps lower domestic prices and thus increase consumption.
- An emphasis on domestic aquaculture commodities increases fish supply, providing best consumption outcomes and lower consumer prices.
- Constrained aquaculture growth reduces fish supply and leads to undesirable increases in domestic prices and decreasing domestic consumption.
- Disease outbreaks in shrimp and carp aquaculture result in a short-term reduction in aquaculture outputs and increasing fish prices, lowering fish consumption.

Aquaculture growth is significant under all realistic assumptions, with highest production levels projected when investment in aquaculture for domestic consumption is prioritized. Strong growth is seen across all commodities, with different emphases depending on the focus on export or domestic supply (Figure 6).

	Business as usual	FP1	FP2	FP3	FP4	FP5
Capture fisheries	2.0% growth annually	↘	→	→	→	→
Aquaculture	5.6% growth annually	→	↗	↗	↘	↘
Fish consumption	2.9% growth annually	↘	↗	↗	↘	↘
Fish consumer and producer prices	6.3% growth annually	↗	↘	↘	↗	↗
Fish export	2.3% growth annually	↘	↗	↗	↘	↘
Fish import	7.8% growth annually	→	→	→	→	→

Table 1. Fish food system trends according to business as usual and five future projections.

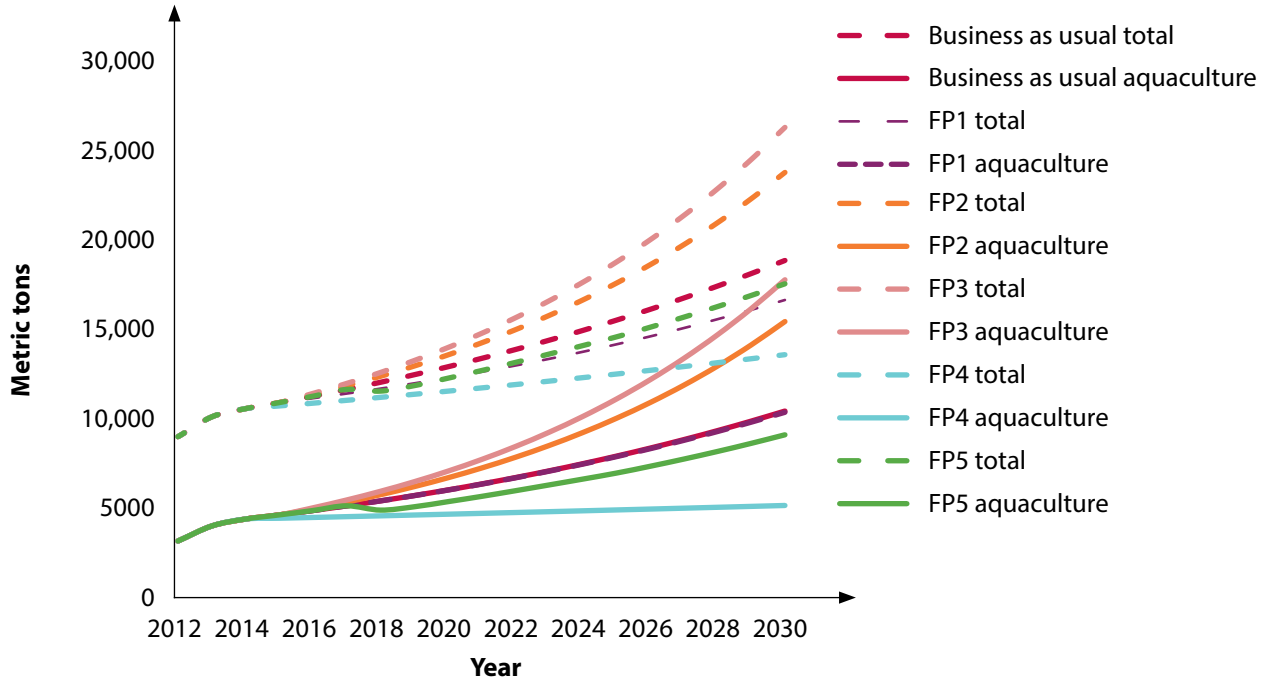

Figure 5. Projected future fisheries and aquaculture production volumes.

Step 4: Analyzing implications
Combining the modeling results with the aquaculture characterization provides new insights into the future opportunities and challenges for aquaculture. The analysis focused on three dimensions: employment, economic and environmental implications.

Employment. Aquaculture's growth will generate significant new employment opportunities in Indonesia by 2030. Business as usual creates 8.9 million jobs, up from current levels of 2.7 million. Approximately 15 million people will be employed on aquaculture farms by 2030 if export and/or domestic-oriented growth policies for aquaculture are implemented. Tilapia farming is expected to be a major employer in the future, but higher-value species, such as shrimp and grouper, will provide proportionally more jobs in supporting industries, such as processing and retailing.

Economic. Aquaculture's growth will create an industry with substantially increased economic value. Production values for the seven major aquaculture commodities are projected to rise from USD 5.9 billion in 2012 to USD 39.5 billion in 2030 under business as usual, with export and domestic-oriented aquaculture policies generating higher production values of USD 50.4 billion and USD 43.9 billion respectively. Achieving this will, however, require substantial new investment in farm infrastructure and operations, as well as supply industries such as feed, seed and services. Grouper and shrimp production will grow and provide larger revenues per unit of volume. However, a constraint in the availability of low-value fish for feed is expected to limit the growth of these two sectors, shifting emphasis towards species such as *Pangasius*, *Clarias* and tilapia. Value additions for domestic markets can help boost profits while limiting environmental impacts. Our toolset showed that an export-oriented aquaculture industry has potential to generate the largest monetary value. The future projection driven by domestic demand, however, almost matched this value by having larger quantities compensating for the lower values per tonnage. Small aquaculture enterprises, currently comprising more than 80% of aquaculture farms in Indonesia, lack easy access to finance, and investment policies for this part of the sector need special attention.

Environmental. While much of Indonesia is well suited to aquaculture, the life cycle assessments for future aquaculture highlight some stark outcomes for the country. Environmental impacts from aquaculture production increase significantly over 2012 levels under all growth projections and across all major impact categories, in some cases by up to 800% (Figure 7). Environmental impacts increase most drastically under future projections for export and domestic-oriented aquaculture, with increase in use of fresh water for brackish-water shrimp aquaculture being most stark.

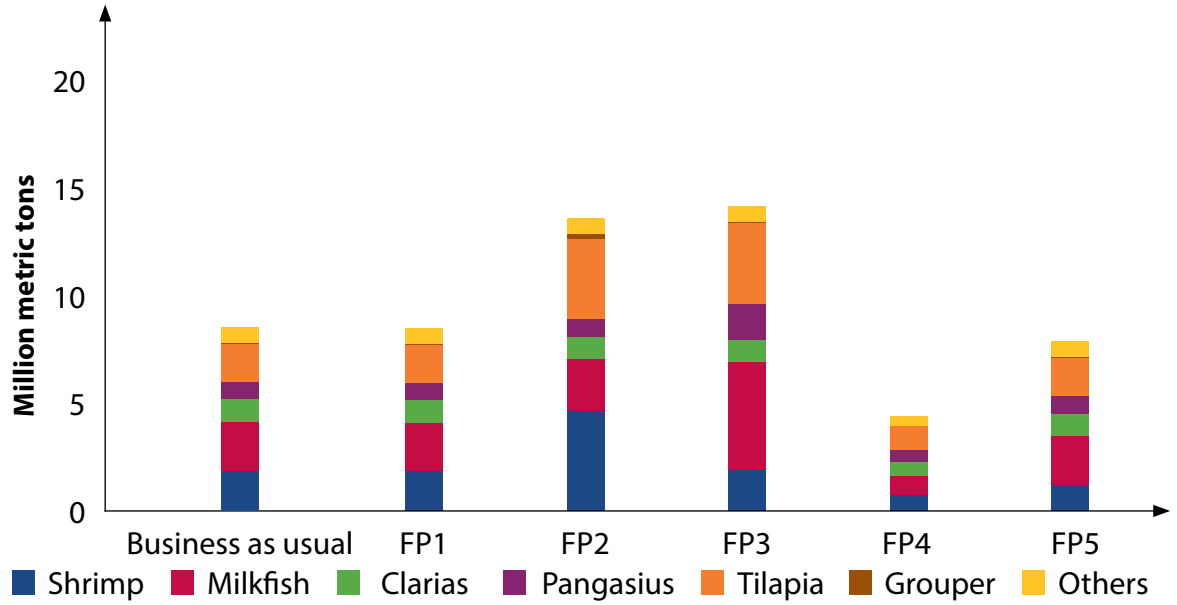

Figure 6. Projected aquaculture output by 2030.

Three major environmental challenges emerge:

- Land area is insufficient to support aquaculture growth under business as usual and high domestic or export-oriented growth projections. Business as usual will require nearly 95,000 square kilometers of land for production and inputs by 2030, greater than the land area of Java—clearly unlikely. Intensification in use of land resources, combined with effective land-use policies, will be essential. Expansion needs to be carefully managed, given the high social and ecological value of Indonesia's remaining coastal forests and wetlands.
- Freshwater use needs to be reduced substantially. Brackish-water aquaculture expansion in particular could put severe pressure on fresh water, and strong controls on usage and efficiencies are needed.
- Aquaculture feeds currently rely on ingredients sourced from agriculture and marine ecosystems, particularly marine fish and oils. Continuation of current practices will require over 7.8 million metric tons of marine fish as feed ingredients by 2030 under business-as-usual projections, and 16.4 and 11.9 million metric tons under export and domestic-oriented growth pathways, respectively. This demand would require all Indonesian fisheries catches to be transformed into ingredients for aquaculture feed by 2030, clearly an impossible and undesirable outcome. Therefore, investments in increasing efficiencies of feed should be a priority; alternative protein sources must be found.

The only solution that will allow for socioeconomic prosperity while limiting environmental impacts is therefore a significant transformation to sustainable farming practices in Indonesia, along with stimulating innovations in feed, land and water use in particular.

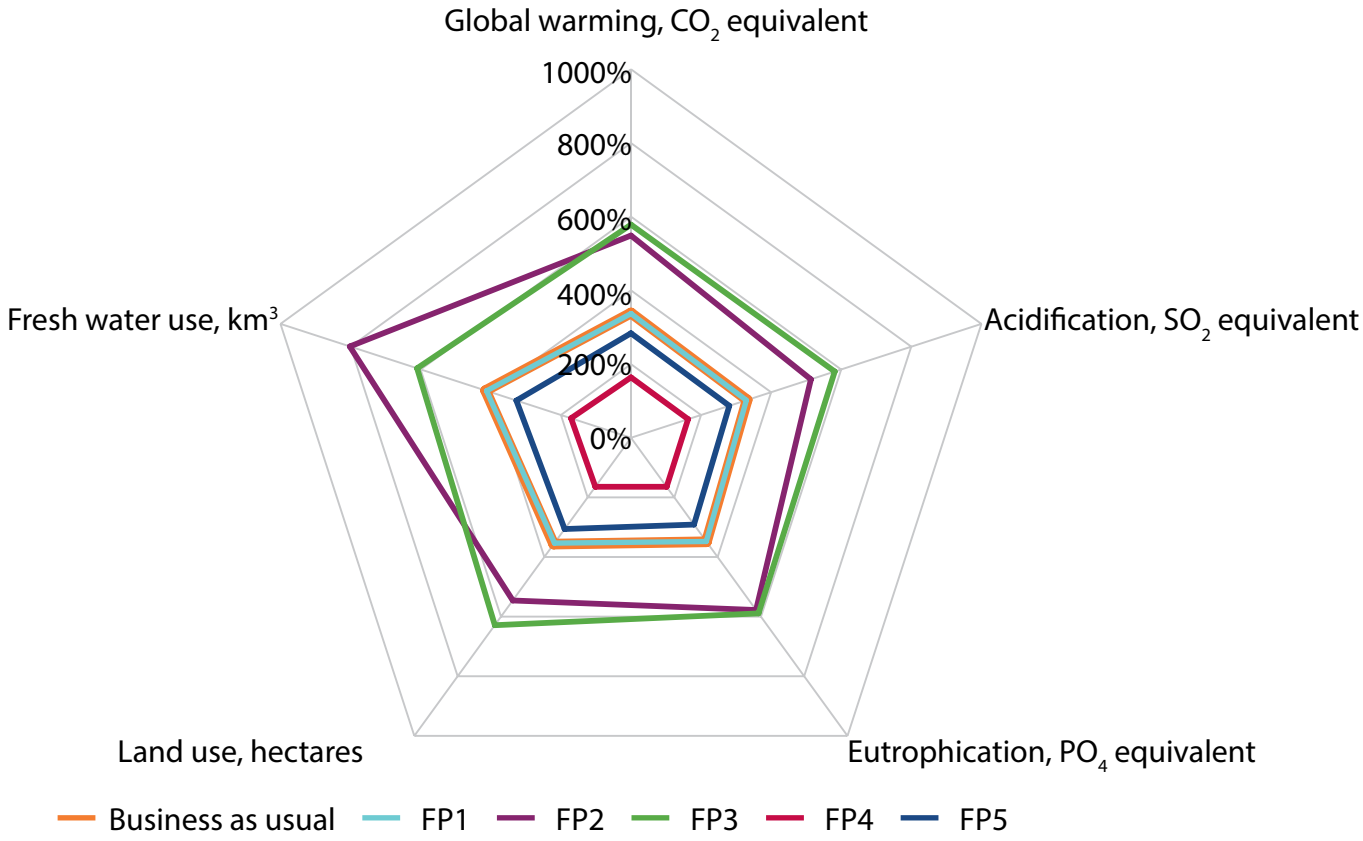

Figure 7. The increase in five key environmental impacts over 2012 levels associated with business as usual and different future projections.

Step 5: Setting priorities

The analyses described above show that successful growth of aquaculture can make a significant contribution to the future food and nutritional security and economic development needs of Indonesia. These analyses also provide insights into the future environmental challenges implied by such growth. Deciding how best to meet the aquaculture growth imperative while addressing the sustainability challenges requires a clear set of priorities for action and investment.

To arrive at these priorities, a generic impact pathway for aquaculture development (Figure 8) was employed to help guide the thinking at a final stakeholder consultation meeting.

The following top five priorities emerged:

Accelerate innovation. The changes needed to grow the aquaculture sector along sustainable pathways, including mitigating environmental impacts associated with feeds and land and water use, require innovations in technology and investment across multiple domains. A new private and public sector partnership mechanism was proposed to accelerate aquaculture research and connect innovations to investment and scaling.

Reform spatial planning and regulations. Spatial planning requires reform to site aquaculture in suitable areas, encourage intensification of existing areas, and ensure critical and sensitive habitats such as mangroves are protected from aquaculture. Regulations across feed, fish health, water use and waste management need review and reform in ways that mitigate environmental impacts and incentivize efficiencies and improvement.

Attract private sector investment. Aquaculture needs substantial new investment to grow to the scale required. Indonesian aquaculture is made up of complex value chains, in many areas dominated by small and medium enterprises, which poses both opportunities and challenges for investors. The structure of these value chains, many with limited transparency, displays strong regional diversification, where investment options need to be tailored to local conditions. Logistics also display shortcomings, making transportation expensive and increasing waste. New business models, investment reforms, improved data availability, and partnerships among the public and private sectors are necessary to stimulate private sector investment into low-impact technologies, sustainable aquaculture production and efficient value chains.

Improve existing aquaculture operations. Environmental performance in Indonesian aquaculture can be substantially improved using current knowledge and technology. Feed, water, land and wastes can all be managed better, leading to increased efficiencies, profitability and reduction of environmental impacts. Intensified investment in training and outreach, as well as partnerships involving private, public and production sectors, is necessary in the short term, particularly to reach the large numbers of small and medium aquaculture enterprises in the country.

Improve compliance and enforcement. Government at all levels requires an increased emphasis on enforcement of laws and regulations, combined with more effective and responsible self-regulation within the private sector, including major Indonesian aquaculture industry associations.

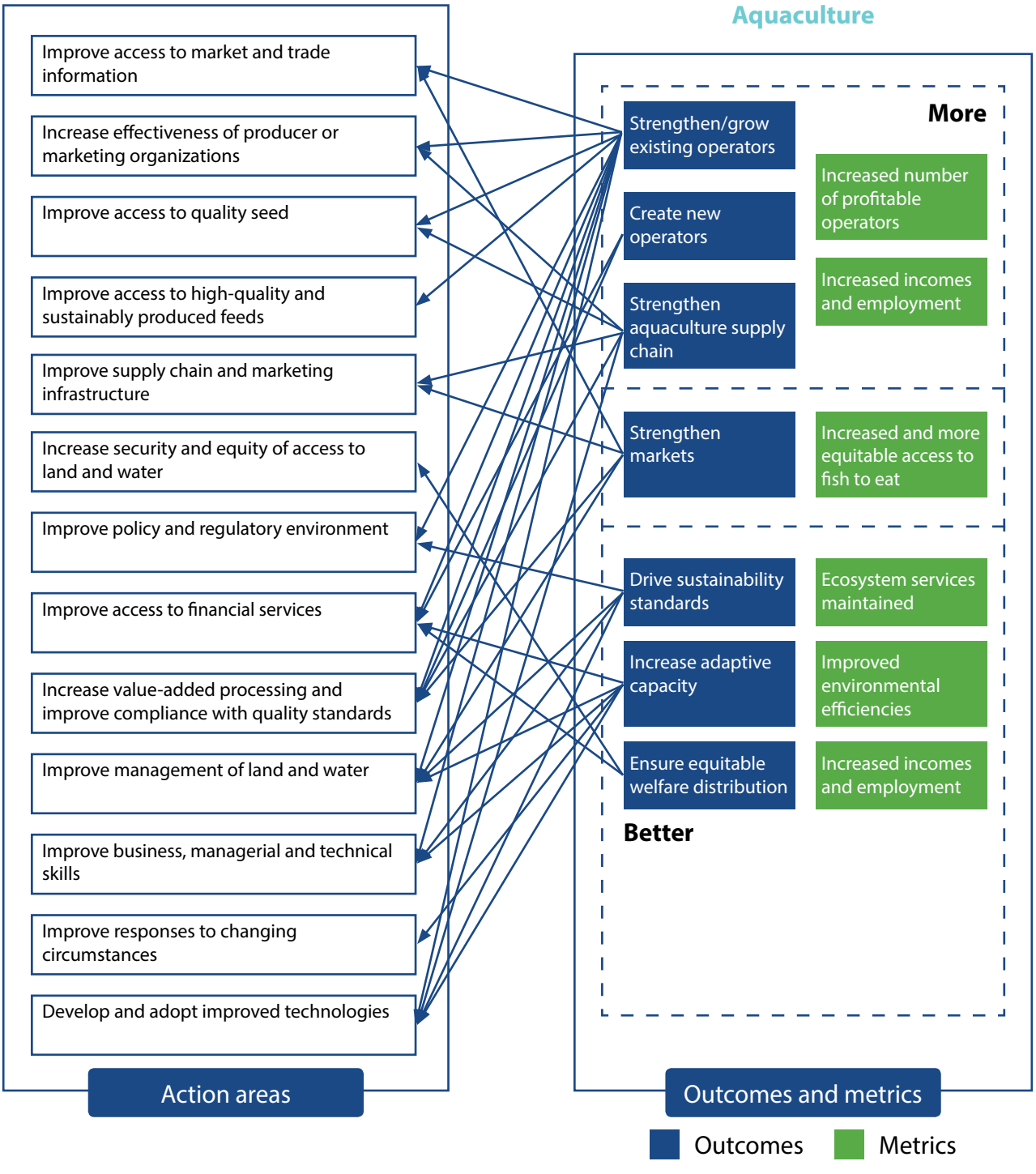

Figure 8. Generic theory of change for sustainable growth of aquaculture.

CONCLUSION

This study overlapped economic and environmental models with quantitative and participatory approaches to understand the future of aquaculture in Indonesia. Such analyses, while not definitive, have provided new understanding of the future supply and demand for seafood in Indonesia stretching to 2030, and these results have been shared and used to engage key Indonesian stakeholders. These new analyses highlight stark challenges for the Indonesian aquaculture sector as it grows to overtake fisheries within the next 10–15 years. Aquaculture is essential for domestic fish supplies, but it is clear that whatever pathway is chosen, transformational change in aquaculture systems, investments and policies will be needed to secure growth and to mitigate the potential impacts on the natural environment. The learning from this research provides a foundation for future interventions in Indonesian fish food systems, as well as a suite of methodologies that can be applied more widely for insightful analyses of aquaculture growth trajectories in other countries or regions.

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This publication should be cited as:
Phillips M, Henriksson PJG, Tran N, Chan CY, Mohan CV, Rodriguez U-P, Suri S, Hall S and Koeshendrajana S. 2015. Exploring Indonesian aquaculture futures. Penang, Malaysia: WorldFish. Program Report: 2015-39.

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