



The Potential of Aquaculture Development in Brunei Darussalam

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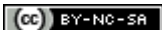
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Abstract: Brunei diversification of economic activities away from oil and gas will not be easy. The advent from Covid-19 saw the importance of agriculture, not on the notion of economics, but the need to be self-reliant in the face of a food security crisis. With access to long coastal areas and large water bodies, aquaculture has the potential to be developed further. Being a high-income country, Brunei Darussalam will require to develop its human capital and capabilities to push aquaculture as a food security agenda. The country's position in the heart of ASEAN, multiple water bodies, extensive coastal areas, with access to important aquaculture importing countries, Brunei Darussalam has the potential to diversify and develop its aquaculture activities and look beyond its small population.

INTRODUCTION

Even if we acknowledge that the resource curse has not been of significant importance to Brunei, like all other countries that are heavily reliant on the export of hydrocarbons, it is confronted by the iron law of resource depletion. Brunei's government has long been aware of this and has attempted to diversify the economy.

In this undertaking, however, it has not been particularly successful as is attested by the fact that over 90% of export revenues and over 76% of government revenues are coming from oil and gas (Ali et al, 2023; Slesman et al, 2023). The diversification of economic activities has been highlighted since the First National Development Plan (1954) and is still part of the national initiative till today (Radzuan et al, 2022). Due to the limited size of the local market and the significant influence of the government sector, which is supported by income from hydrocarbon exports, the emergence of a thriving private sector that is crucial for promoting diversification and the manufacturing of globally competitive products and services did not occur to the anticipated extent. The challenge of diversification is further complicated by the presence of the hydrocarbon sector which is "almost hermetically sealed" from the rest of the economy – little more than an enclave – and, for small countries, almost entirely dependent on foreign companies

and workers. Consequently, there exist limited connections and diffusion of impacts on local industries, albeit there are amplified ripple effects primarily in service-related arenas stemming from the derived demand of international enterprises and laborers.

Wawasan Brunei 2035

Wawasan Brunei 2035 is a long-term development plan for Brunei Darussalam that was launched in 2008 by the government of Brunei (Roslee and Yussof, 2022). The plan's primary goal is to diversify the country's economy away from its reliance on oil and gas resources and to create a sustainable, high-income nation. The strategy for diversification includes developing new industries such as tourism, information technology, agriculture and education. Additionally, the plan aims to improve the country's infrastructure and to promote the development of small and medium-sized enterprises. The plan also focuses on human capital development through investments in education and training to create a highly skilled workforce that can support the development of new industries. The Wawasan Brunei 2035 also emphasizes environmental and social sustainability, which aims to balance economic growth with environmental protection and social well-being. Aquaculture is a relevant industry to investigate due to Brunei Darussalam's unique geographic location, which encompasses a land area of 5,765 square kilometers and a coastline of 130 kilometers. The country is increasingly interested in developing its coastal and water resources as part of the economic diversification strategy, and is part of the national Wawasan 2035.

Brunei Darussalam waters

Brunei Darussalam is located on the northwestern coastline of Borneo and is adjacent to the Malaysian state of Sarawak. Historically separated into two regions, the district of Temburong is now connected to the remainder of Brunei Darussalam via the Temburong bridge. Temburong district has a land area of 1,288 square kilometers with mountainous terrain. The three additional districts situated to the east of Brunei consist largely of low-lying hills, measuring below 91 meters in elevation, with the exception of coastal areas that feature swampy plains and narrow alluvial valleys that extend into the primary rivers are Belait District (2,696 square kilometers), Tutong (1,152 square kilometers) and Brunei Muara (563 square kilometers). Offshore, the continental shelf is 9,400 square kilometers, and beyond this shelf is the Brunei Fishery limits (BFL) comprising 38,600 square kilometers.

Brunei possesses four primary river systems, namely the Sungai Belait, Sungai Tutong, Sungai Brunei, and Sungai Temburong. The Temburong basin which drains the whole of Temburong district has an area of 1,100 square kilometers. The fifth river serves as the international demarcation line between Temburong, Brunei Darussalam and Limbang, Malaysia, situated in the Sarawak province, thereby delineating their respective territories. Sungai Temburong has two tributaries flowing into its estuary which are Sungai Batu Apoi (mountainous catchment) and Sungai Labu (coastal swamp river), and draining into the Brunei Bay. The Temburong coastal zone is characterized by the presence of wetlands and is subject to the effects of tides.

The Belait basin is the largest area comprising 2,700 square kilometers. The lower catchment region encompasses a vast expanse of peat swamp. A topographical feature, in the form of a ridge measuring 10 meters in height, acts as a physical barrier separating the coastal region of Belait. As the river approaches Kuala Belait, it tends to experience a reduction in width and the presence of a sandbar, thereby limiting the outflow of water into the South China Sea. The majority of the upper catchment area is dense forest, while only minor sections adjacent to the river and its tributaries have been cleared for agricultural use.

The Tutong basin encompasses an area of 1,300 square kilometers and the river is connected to that of Sungai Belait. The Sungai Tutong river flows into the ocean between two sandbanks, creating a complex estuarine system that runs parallel to the coastline for a span of 15 kilometers. The lower catchment area is characterized by a wide expanse of floodplain, while the upper catchment area is predominantly covered by dense jungle with intermittent agricultural activities along the river.

The Sungai Brunei watershed is situated at a low elevation and has a swampy terrain. It is defined by fragmented elevated areas and deeply carved valleys that comprise three significant subcatchments, namely Sungai Kedayan, Sungai Damuan, and Sungai Imang. The distinct sub catchments introduce

themselves to Sungai Brunei at varying locations. The river of Kedayan exhibits a considerable concentration of city infrastructure and merges with the Brunei River at Bandar Seri Begawan. The Sungai Damuan flows into the Sungai Kedayan approximately 3 kilometers upstream. The source of Sungai Brunei is derived from Sungai Imang and its associated tributaries. The primary area for water collection is contiguous with the Sungai Tutong basin on its western boundary, while its northern extent is demarcated by a non-uniform ridge that runs parallel to the shoreline. The boundary of the watershed shifts in a southeastern direction and subsequently traverses along the ridge that runs parallel to the Sungai Brunei, ultimately extending into the Brunei Bay.

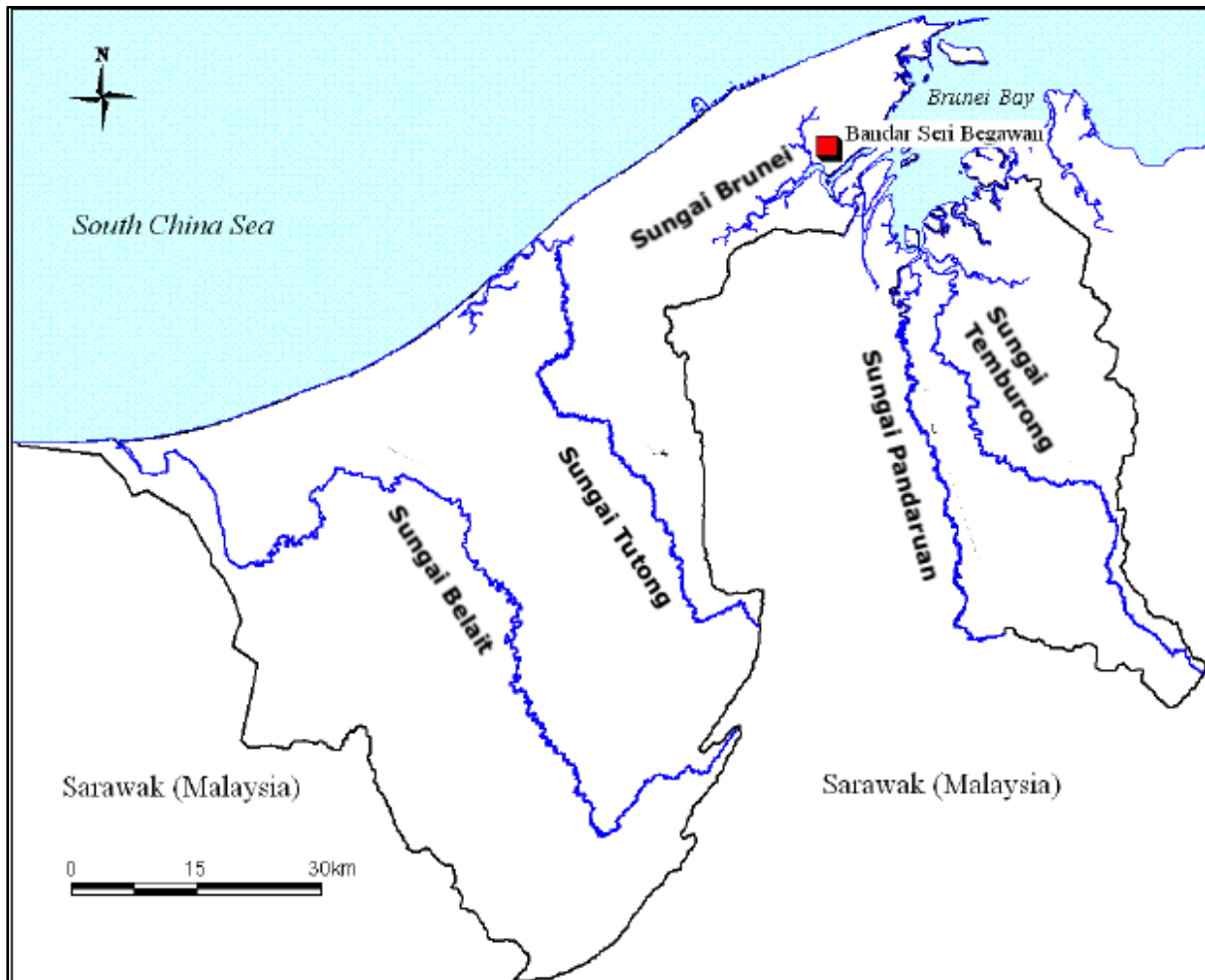


Figure 1. The major rivers of Brunei Darussalam

Aquaculture Development in Brunei Darussalam

One of the main environmental factors that affects aquaculture in Brunei Darussalam is water quality. High levels of water turbidity can make it difficult for fish and other aquatic species to see and feed, which can lead to slower growth rates and increased stress (Campbell and Hall, 2019; Tigan et al, 2020; Eze et al, 2021; Tumwesigye et al, 2022) Additionally, sedimentation and pollution can lead to the buildup of harmful substances in the water, which can be toxic to fish and other aquatic species (Schumaan and Brinker, 2020). Brunei acid sulphite soils may give uneven pH levels especially from the effect of rainfall, or water movement (Gödeke et al., 2020), and can be detrimental to the health of surrounding water bodies and soil (Sulaiman et al, 2019; Zak et al, 2021). Abandoned freshwater ponds are evident within the Brunei-Muara District which were associated with water acidification (Ndah et al, 2017).

One of the main types of fish aquaculture in Brunei is cage aquaculture. This method involves keeping fish in cages or pens in the ocean. This is a popular method for raising species like grouper, sea bass, and snapper. The government of Brunei has invested in the development of fish cage farming, including providing funding and training for local farmers. This has led to the development of several fish

cage farms around the country, mainly concentrated in the coastal waters of the Belait and Tutong districts.

Another type of fish aquaculture in Brunei is pond culture. This method involves raising fish in man-made ponds. This is a popular method for raising species like tilapia and catfish. The government of Brunei has also supported the development of pond culture, including providing funding and training for local farmers. This has led to the development of several fish pond farms around the country, mainly concentrated in the Temburong district. In addition, Brunei has also started to explore the possibilities of recirculating aquaculture systems (RAS), which is a closed-loop system that filters and recirculates water, allowing for the efficient use of resources and minimal environmental impact. This method is increasingly used for raising species like tilapia and salmon.

Brunei government has also been actively promoting the development of fish processing and packaging plants to increase the value of fish products and to create more jobs for the local community. This will help the country to be more self-sufficient in terms of fish supply and to export more fish products to other countries.

Overall, fish aquaculture is a growing industry in Brunei, supported by the government's investment and efforts in promoting sustainable practices. The development of fish cage farming and pond culture, along with exploration of RAS, are helping to meet the growing demand for fish as a source of protein while also addressing concerns about overfishing and the environmental impact of traditional wild-catch fishing methods. There is a lack of research and development in aquaculture in Brunei, which can lead to a lack of knowledge and understanding of the best practices for farming different species and the most effective ways to manage and mitigate the challenges, in particular towards better economic growth (Broughel and Thierer, 2019). The hesitance of local aquaculture players to embrace technology transfer further hinders the progression of applying technology in aquaculture practices (Muhamad, 2019).

Agencies associated with the Aquaculture industry

In Brunei, various government agencies are responsible for regulating and promoting the development of the fish aquaculture industry. The Ministry of Primary Resources and Tourism is responsible for the management, conservation, and development of the country's natural resources, including fish aquaculture. The ministry works closely with the Department of Fisheries to promote the sustainable development of the fish aquaculture industry. The Department of Fisheries is responsible for the management, conservation, and development of the country's fisheries resources, including fish aquaculture. The department is responsible for issuing licenses and permits for fish farming operations, as well as for monitoring and enforcing compliance with regulations and standards. The Ministry of Energy, Manpower and Industry is responsible for promoting the development of the country's industries, including fish aquaculture. The ministry can provide funding, incentives, and support for the development of the fish aquaculture industry. The Ministry of Education is responsible for providing education and training for fish farmers, processors and packaging plants workers. This can help to improve the knowledge and skills of the workforce in the fish aquaculture industry. The Ministry of Health is responsible for ensuring that the fish aquaculture industry complies with regulations and standards related to food safety and public health. This can help to ensure that the fish products produced by the industry are safe for consumption. The Ministry of Environment is responsible for monitoring and enforcing regulations and standards related to the environmental impact of the fish aquaculture industry. This can help to ensure that the industry is sustainable and that the environment is protected.

Overall, the government of Brunei has a variety of agencies involved in the regulation and promotion of the fish aquaculture industry. These agencies work together to ensure that the industry is sustainable, efficient, and compliant with regulations and standards, and to provide education, training and funding for the industry, and to ensure the safety of the fish products for consumption.

Current Aquaculture Produce of Brunei Darussalam

Although the aquaculture volume produced in Brunei is considered small, due to its small population, production value per population is considered high compared to other ASEAN countries

(Figure 2). This is largely due to shrimp farming that was developed within the last decade. It was reported that the largest prawn producer in Brunei exports over 80% of its produce. The volume of aquaculture per capita is also considered average for Brunei compared with other ASEAN countries (Figure 3) with brackish water aquaculture being dominantly produced over marine and freshwater culture. In terms of value, the aquaculture industry for Brunei Darussalam is small and can be considered as having insignificant impact on the wider ASEAN aquaculture industry (Figure 4).

Brackish water aquaculture is the most significant industry compared to marine and freshwater aquaculture, and the diversity of aquaculture produce is still small.

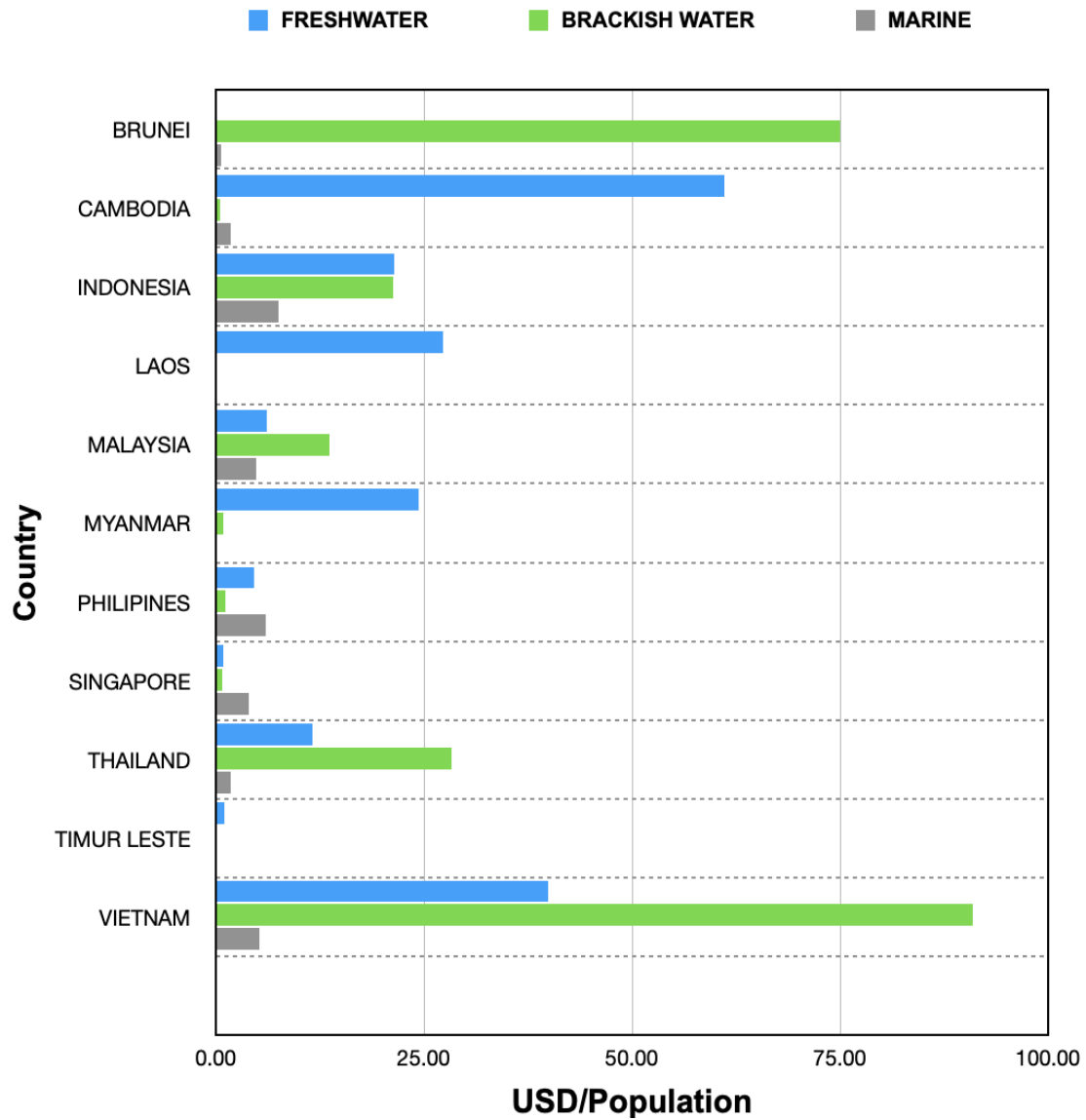


Figure 2. The value (USD) of Aquaculture industry per population for freshwater, brackish water and Marine aquaculture in ASEAN member countries. (FAO, 2023)

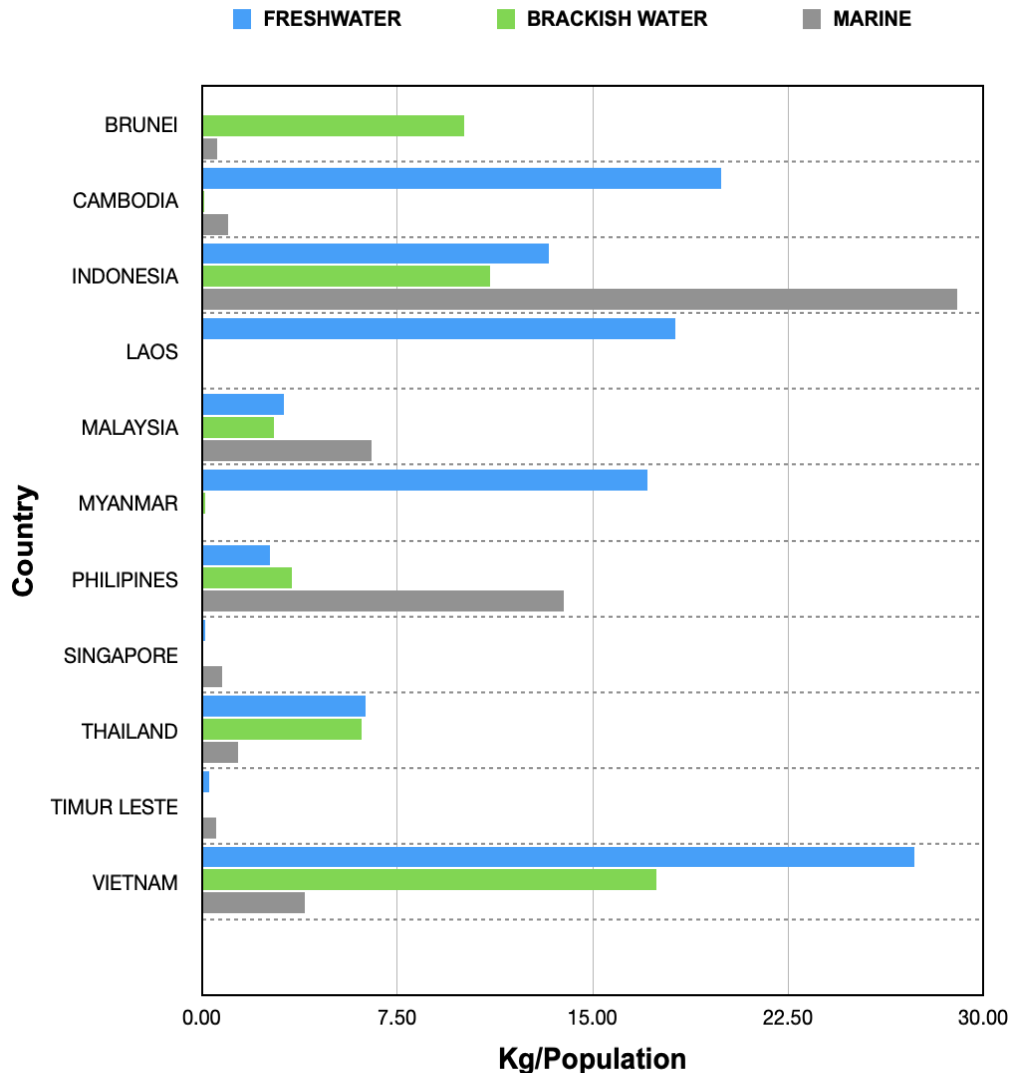


Figure 3. The quantity (Kg) of aquaculture industry produced per population for freshwater, brackish water and Marine aquaculture in ASEAN member countries.

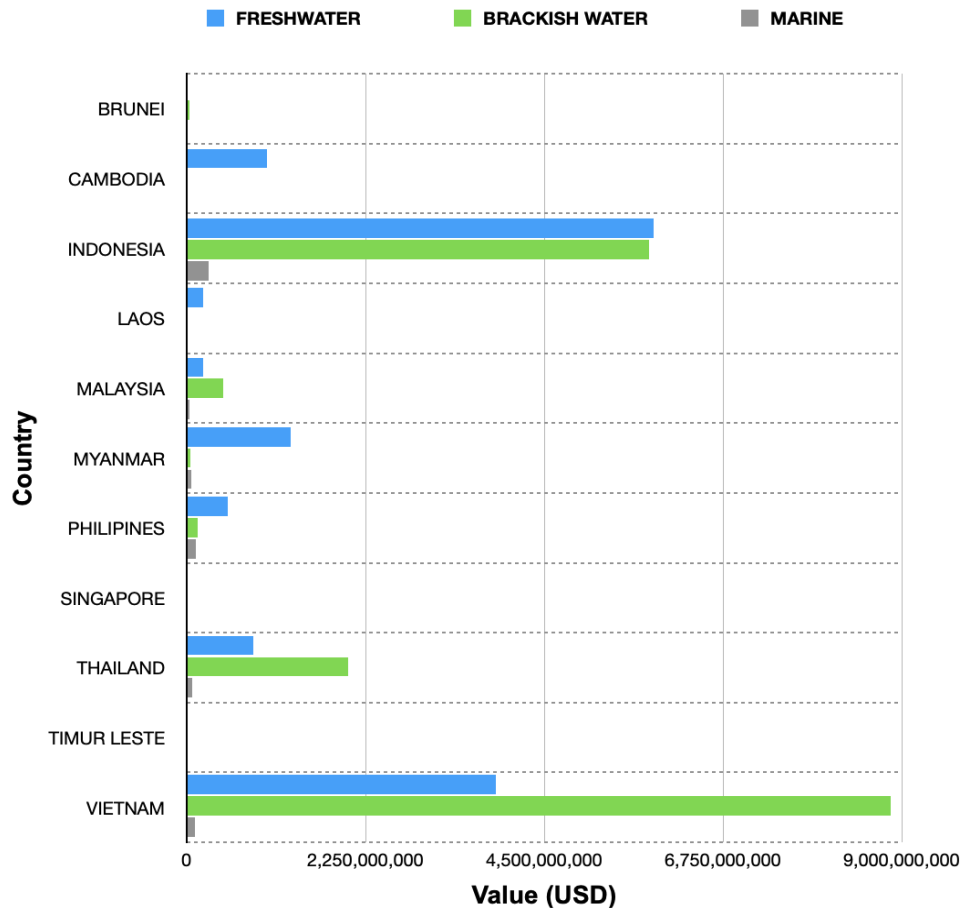


Figure 4. The overall value of the Aquaculture industry for freshwater, brackish water and Marine aquaculture according to ASEAN member countries. (FAO, 2023)

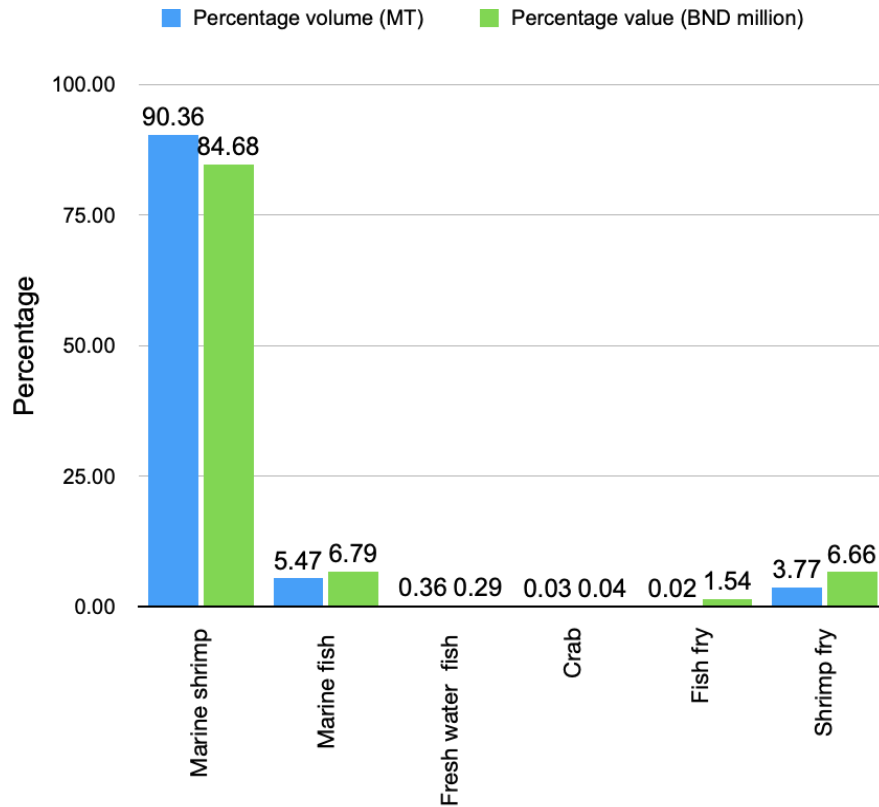


Figure 5. Percentage volume MT (Metric Tonne) and percentage value (BND Million) of the aquaculture produced in Brunei Darussalam in 2021 (Jabatan Perikanan, 2021).

Aquaculture contributes the most GDP for agriculture, with the majority coming from the export of cultured shrimps compared to marine fish, freshwater fish, crab, fish fry and shrimp fry (Figure 5). As highlighted earlier, the aquaculture Industry in Brunei Darussalam does not bring much impact to the country's GDP nor is it superior to other ASEAN countries. Yet with agriculture being an important national strategy for being resilient in food production, encouragement and involvement within this sector will need to be supported for the future needs of the country.

Why developing Aquaculture important for Brunei Darussalam

With agriculture contributing to roughly just 1% of the country's GDP, it seems irrelevant that aquaculture will have any imminent impact. Being a small country, diversification of economy was previously small prior to its involvement in the petrochemical industry, with study suggesting that country's are negatively affected in its ability to develop other economic activities (Djimeu and Omgba, 2019). At a country level, agriculture has been associated with poverty eradication and is widely adopted by underdeveloped and developing countries (Zwane, 2020). The advent of Covid-19 pandemic was a wakeup call that even developed countries' food security can be affected (Saboori et al, 2022). While the country encourages Foreign Direct Investment (FDI) in agriculture, particularly for aquaculture, the country will need to look at the long term requirement of building a sustainable food supply system that is capable of sustaining through a potential food crisis (Jamaludin, 2022). With access to ample space and water bodies, aquaculture can be developed into a much bigger and vibrant industry that can bring better food security status to Brunei Darussalam.

Being a high-income country, Brunei will have the ability to outsource the expertise and materials to jumpstart aquaculture projects. Export oriented companies have come and developed their production such as Golden Corporation Sendirian Berhad and Barramundi Group. This has also allowed smaller companies to also increase their production capacity. Yet this growth has been particularly slow due to the lack of local expertise throughout the whole value chain particularly seed production, feed technology, postharvest, and species diversification.

The establishment of the Faculty of Agriculture at the Sultan Sharif Ali Islamic University in 2021 was developed to fill in the gap to develop competent human capital is an example of a proactive approach in developing the growth of agriculture. Developing local talent in Brunei Darussalam is essential for the growth and success of various industries, including the fish aquaculture industry and increasing the efficiency of technology transfer (Muhamad, 2019). There are several ways in which local talent can be developed in Brunei. Providing educational opportunities and training programs for local individuals can help to develop the skills and knowledge necessary for success in the fish aquaculture industry. This can include programs in fish farming, fish processing, and packaging, as well as in business management and marketing. Offering apprenticeships and internships to local individuals can provide hands-on experience in the fish aquaculture industry. This can help to develop practical skills and knowledge, as well as to provide a pathway to employment. Encouraging and supporting local research and development in the fish aquaculture industry can help to develop new technologies and methods that can improve the efficiency and sustainability of the industry. The government and industry can work together to promote entrepreneurship and small business development in the fish aquaculture industry. This can help to create opportunities for local individuals to start their own fish farming operations and contribute to the growth of the industry. Encouraging collaboration between local fish farmers, researchers, and government and industry can help to share knowledge and expertise and to promote the development of sustainable practices in the fish aquaculture industry.

There exists local anecdotal evidence that agriculture, in particular aquaculture, is not feasible due to the small country population, and the reluctance of the local Bruneians to palette new fish species, in particular freshwater aquaculture produce. Introducing new fish species in their diet can be a challenge. One of the main challenges is consumer acceptance. Many consumers in Brunei are used to eating traditional fish species, mostly marine, and may be hesitant to try new species, especially if they are unfamiliar with their taste or preparation methods. For example, there are very limited choices of freshwater fish found or sold in wet markets, or supermarkets. It is still not known if local consumers are aware that frozen *pangasius sp* filet is sourced from freshwater fish. Another challenge is the lack of knowledge about new fish species and how to prepare them. Many consumers may not know how to properly cook or prepare new fish species, which can discourage them from trying them. This can be overcome through education and awareness campaigns that provide information about new fish species and how to prepare them. These are not marked by proper research to evaluate the economic potential, in particular local demand, particularly among the strong expatriate community.

CONCLUSION

Brunei Darussalam has a long history of fishing and seafood consumption, and fish aquaculture is seen as a way to meet the growing demand for fish as a source of protein while also addressing concerns about overfishing and the environmental impact of traditional wild-catch fishing methods. The country with its coastal area, river structure, and high rainfall has the right condition for aquaculture. The lack of expertise and human capital should be the initial strategy to empower aquaculture activities. These shortcomings are currently being attended by the related government agencies, and it is anticipated aquaculture activities and its productions will be increased in the next decade as more local talent are being trained. Although being a small country, Brunei Darussalam is capable to become competent and even a reference country, with its capital ability and the short distance between major aquaculture facilities.

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