

Brunei Darussalam: Mangrove-friendly aquaculture

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Abstract

Aquaculture in Brunei Darussalam is quite recent compared to other countries. Cage culture of marine fishes and pond culture of marine shrimp are popular. Mangrove area utilized for aquaculture (shrimp ponds) is very minimal, 190 ha of the total 18,418 ha. This report describes the status of mangroves and practices of aquaculture in Brunei Darussalam.

Introduction

Brunei Darussalam is a coastal state located in the north-western portion of Borneo island within latitudes 5° 05'N and 4° 00'N and longitudes 114° 04'E and 115° 22'E. The country has a land area of 5,765 km² (576,400 ha) divided administratively into four districts -- Brunei-Muara, Tutong, Belait, and Temburong. Its coastline is roughly 130 km long, fronting the South China Sea. The country shares a common border with the east Malaysian State of Sarawak. The main population centers are in the coastal zone, accounting for over 85% of the population (305,100 in 1996). Brunei Darussalam is a Malay Islamic Monarchy and has a stable economy largely dependent on the exploitation of petroleum products.

Status of aquaculture

Since 1965, the government has implemented a series of National Development Plans to veer its economy away from the traditional oil and gas industry. Aquaculture has been identified as one of the priority areas for development because of the availability of potential sites and the high demand for quality fish products in local and export markets.

At the early stages of aquaculture development, steps have been taken to promote freshwater fish culture in inland waters and a considerable number of small-scale farms and backyard type ponds have been developed in all districts. However, the emphasis shifted to coastal aquaculture in the late 1980s, particularly marine fish culture in floating cages and prawn culture in brackishwater ponds.

The shift is due to the industry's high profitability and improved technology which is touted to be sustainable. The Department of Fisheries (DOF) in the Ministry of Industry and Primary Resources has identified four sites for marine fish culture in the Brunei-Muara district and about 390 ha for brackishwater ponds mainly for commercial shrimp culture (DOF-MIPR 1992). The ponds are located in Telisai and Tunggulin in Tutong District (290 ha) and in Pengkalan Sibabau in Brunei-Muara district (100 ha). Most of these areas are sparsely vegetated with some fringes of mangroves, except Pengkalan Sibabau, which is entirely mangrove forest.

Aquaculture in Brunei Darussalam is still in its infancy, and its development is well-regulated. Currently, there are 18 floating cage culture farms which produced 130 tons of fish in 1997. Brackishwater shrimp pond area totals 33 ha - 16 ha in Pengkalan Sibabau (four farms), 15 ha in Telisai (six farms) and 2 ha in Serasa (a pilot project) - which produced 73.7 tons of shrimp in 1997. All shrimp farms have been developed as clusters for easy and efficient management. They follow semi-intensive culture practices with a stocking density of 15-30 postlarvae/m². Average production ranges 1.5-4.0 tons/ha/year.

The DOF has targeted a production of 233.5 tons of marine fishes and 732.9 tons of shrimp at the end of year 2000. A total of 56 ha of cage culture farms and 93 ha of shrimp farms is targeted to be developed. Further, the DOF anticipates conversion of some of these farms (plus some new farms) to follow intensive culture with stocking densities ranging from 50 to 100 postlarvae/m². The target production is 15-20 tons/ha/year. The main reason for intensification is limited land, however, intensive farms will have their own water reservoirs, bio-ponds, and silting ponds to mitigate adverse impact to the environment.

The DOF runs its own shrimp hatchery (the only in the country) to cater to the fry requirement of the industry. About 10% of shrimp fry requirement are still imported from the neighboring countries.

Status of mangrove forests

The mangrove forests in Brunei Darussalam cover 18,418 ha, representing 3.2% of the country's total land area. These occur largely in the northern part of Temburong district, along the lower reaches of Belait, Tutong and Brunei rivers and around Muara (Figure 1). Mangrove areas in the four districts are given in Table 1.

Majority of these mangrove areas are dense primary forests. Sparsely vegetated, isolated patches can be seen only in few areas. Brunei's mangroves appear to have exceedingly high regenerative capacity (Zamora 1992). Studies have shown that 78% of plants are replacement pools in some areas.

Value of mangrove resources

From an ecological standpoint, mangroves are known to:

- export detritus and nutrients into nearby systems which form the food base of a complex of marine organisms, which in turn support valuable estuarine and nearshore fisheries
- act as nursery and breeding grounds for many economically important fishes and crustaceans
- reduce surges and strong winds associated with storms
- help prevent erosion of riverbanks which in turn protect adjacent properties

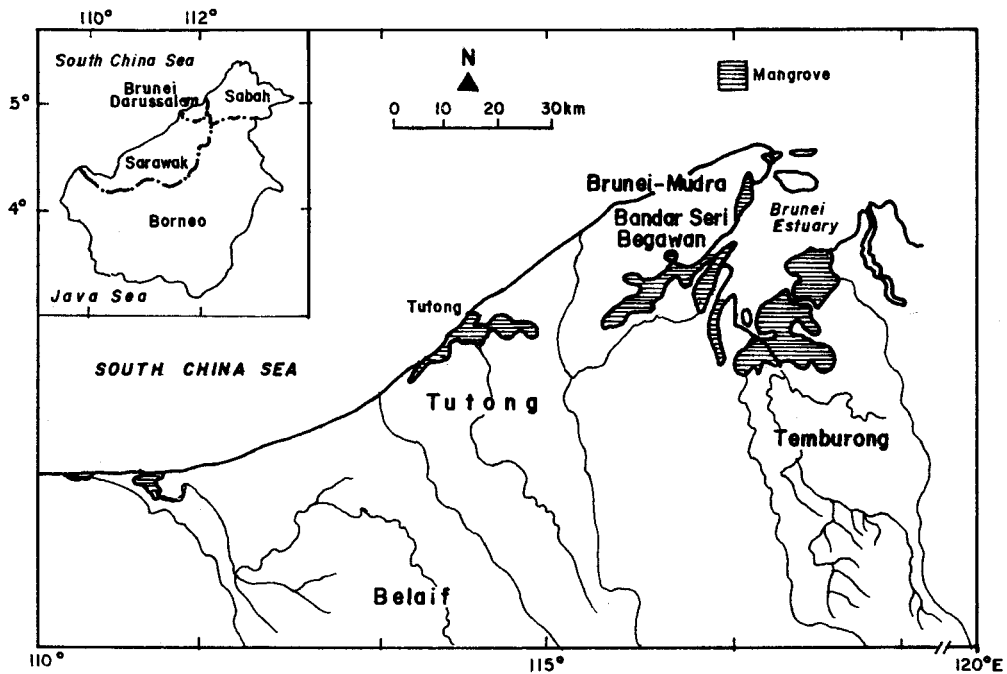


Figure 1. Distribution of mangrove forests in Brunei Darussalam

Table 1. Mangrove areas relative to total land area (Zamora 1992)

| District | Total land area | Mangrove area | % of total mangrove area |
|--------------|-----------------|---------------|--------------------------|
| Temburong | 116,600 | 12,164 | 66.0 |
| Brunei-Muara | 57,000 | 3,937 | 21.4 |
| Tutong | 130,300 | 1,784 | 9.7 |
| Belait | 272,500 | 533 | 2.9 |
| Total | 576,400 | 18,418 | 100.0 |

- harbor unusual wildlife which provides valuable opportunities for education, scientific studies and tourism

Therefore, mangroves can be considered as one of the most valuable ecosystems in the country.

Mangrove resource utilization

In the past, mangrove forests of Brunei Darussalam were a major source of wood and/or firewood (Lim & Sharifuddin 1975). It had also been a source of dye for the tanning industry. At present, mangrove forests continue to be exploited for charcoal and for poles for use in construction. Charcoal production, however, is declining because of the increasing use of natural gas (Stewart

1986). On the other hand, the demand for mangrove poles has increased markedly in recent years as a result of the substantial development of the construction industry. But even a 15-30% annual increase in demand will not deplete the country's mangrove resources (projected over a 20-year period) (Zamora 1992).

Some mangrove areas are being developed as residential, industrial, and coastal aquaculture sites in Brunei-Muara district. These include 154 ha resettlement project and 10 ha shrimp farm in Pengkalan Sibabau, and 33 ha industrial site in Kg. Lumut. Two other sites in Temburong district have been developed as mangrove forests reserves (the 2,566 ha Silirong Forest Reserve and the 14,348 ha Labu Forest Reserve) for protection of genetic resources and biological diversity, and to enhance ecotourism.

Biodiversity

Mangrove forests in Brunei are among the best preserved in the region, rich with different types of flora and fauna. Zamora (1987) listed 81 species of vascular plants in the mangrove swamps. These consist of 47 flowering plants, 1 gymnosperm, and 33 ferns and fern allies. The most dominant species are *Rhizophora apiculata* (bakau minyak) and *Nypa fruticans* (nipha) while *Kandelia candel* (aleh-aleh), *Bruguiera cylindrica* (berus ngayong), *B. parviflora* (berus linggadai) and *B. sexangula* (berus pulut) are rare. The country's mangroves are home to several unique and endangered wild-life including the proboscis monkey (*Narsalis larvatus*), crab eating macaque (*Macaca fascicularis*), silver leaf monkey (*Presbytis cristata*) and large fruit bat (*Pteropus vampyrus*). Mangrove and associated mud flats are also used by migratory birds as wintering habitats.

Preservation of mangroves

The DOF implemented a mangrove management program in 1992 (DOF-MIPR 1992) to promote sustainable development of Brunei's mangrove resources and optimize benefits to the present and future generations. The program pursues the following specific objectives:

- Preserve mangrove systems needed for the protection of genetic resources and biological diversity and as sources for restoring areas where management has failed or accidents have occurred
- Conserve mangrove resources (plants, animals, physical space or land) for maximum benefit of the people
- Minimize or avoid conversion (e.g., housing, aquaculture, and agriculture) that eliminate mangrove resources

To achieve these objectives, a mangrove use zonation scheme (Zamora 1992) has been proposed to allocate the country's 18,418 ha mangrove area, as follows:

- 58% (10,686 ha) for conservation and environment protection
- 41% (7,533 ha) for wood production (poles, charcoal) on a sustainable basis
- 1% (199 ha) for conversion into brackishwater aquaculture and human occupancy

Distribution by district of this proposed zonation is given in Table 2. A high proportion of mangrove resources (58%) is earmarked for preservation or conservation in the belief that it is more ecologically and economically beneficial to the country over the long term. However, with the increased need for land, more mangrove areas might need to be sacrificed for development projects.

Table 2. **Proposed zonation of mangrove areas** (Zamora 1992)

| District | Total mangrove (ha) | Zoned area (ha) | Land use |
|--------------|---------------------|-----------------|--|
| Temburong | 12,164 | 393 | Preservation |
| | | 4,238 | Conservation |
| | | 7,533 | Environmental protection; timber production |
| Brunei-Muara | 3,937 | 3,738 | Preservation |
| | | 187 | Conservation |
| | | 12 | Human occupancy; brackishwater aquaculture |
| Tutong | 1,784 | 1,774 | Environmental protection |
| | | 10 | Brackishwater aquaculture |
| Belaït | 533 | 533 | Protected area |
| Total | 18,418 | 18,418 | |

Silirong and Labu forest reserves have been developed under this scheme and some areas in the Labu reserve is allowed for wood production on a sustainable basis. A limited number of licenses has been issued each year for the harvest of wood for pole and charcoal production. A reforestation scheme has been proposed under this program particularly for wood production areas.

Sound utilization of mangrove areas for aquaculture

Intensive brackishwater shrimp farming has been blamed for the massive destruction of mangrove forests in many parts of the world. The estimated world-wide loss of primary mangrove forests due to shrimp farming in the last two decades is about one million ha (Greenpeace 1997). The industry has been highly criticized by environmentalists for massive clearance of mangroves, releasing chemicals and wastes, and inadvertently releasing genetically altered species into the marine environment. The industry has also been blamed for heavy siltation and destruction of important habitats such as seagrass beds and coral reefs.

Intensive shrimp culture is one of the major causes of mangrove destruction. In Asia, an average intensive farm has been reported to survive only 4 to 6 years before serious pollution and disease problems compel shutdowns. Generally, these farms shift their operations to new areas with crop failures but not after vital habitats have been permanently lost for fishes, molluscs, and crustaceans, as well as numerous birds, migratory species, and endangered species.

With understanding of the consequences faced by other countries with mangrove destruction, Brunei Darussalam is taking necessary steps to develop a sustainable aquaculture industry without or minimal destruction to mangrove forests or the environment as a whole. To achieve this, the government is implementing a well-managed program with the participation of the private sector.

The objectives of the program are:

- prevent uncontrolled expansion of the aquaculture industry
- assess environmental impacts before proceeding with any particular method or site-specific development. Where negative impacts are possible or likely, such projects will be stopped or modified
- ensure the protection of mangrove forests, wetlands, and other ecologically sensitive areas
- ensure that aquaculture development does not limit access to coastal resources by coastal communities and artisanal fishers
- ensure the implementation of regulations and continuous monitoring of operations
- ensure that abandoned or degraded aquaculture sites are ecologically rehabilitated
- ensure that aquaculture is integrated in a compatible manner with the social, cultural, and economic interests of the country

DOF is solely responsible for the aquaculture industry, and the persons or organizations that plan to develop aquaculture farms are required to register with DOF and obtain a permit. The farms are required to strictly follow the instructions of the DOF on site selection, pond construction and subsequent operations.

Mangrove-friendly aquaculture

The aquaculture practices in Brunei Darussalam are generally mangrove-friendly, as follows:

- **Zonation of area for aquaculture**

DOF controls aquaculture development by identifying suitable areas and allowing farms only in identified or zoned area. Development of areas other than the identified is not allowed and a license is mandatory for anyone who will go into aquaculture. The identified area has a master plan of development, i.e., the area is subdivided into farm lots. The access road, main water supply and discharge canal and electricity are provided by the government. Initially, a successful applicant is granted 4 ha. After a year or two, the farm operator may apply for expansion. Additional area is given subject to the operator's performance. At the moment, there are two areas developed under this scheme, located in Pengkalan Sibabau, Brunei-Muara District (100 hectares) and in Telisai, Tutong District (90 hectares).

This zonation system seems to be successful in preventing indiscriminate exploitation of mangrove areas for aquaculture. Moreover, in these two areas zoned for aquaculture, mangrove buffer zones of at least 50 meters from the river bank are maintained. Other areas planned for aquaculture development are located in non-mangrove areas.

- **Use of bio-pond**

Incorporation of a bio-pond in newly developed shrimp farm is required by DOF. A bio-pond will receive all the water discharged from ponds, contain and process (oxidize, settle sediments) the water for few days, and discharge it back to the main canal. This will minimize the loading of the surrounding area with polluted farm water.

The effectivity of the bio-pond in minimizing pollution is not yet well-established. Water quality and other pertinent data will be gathered to evaluate and further improve the bio-pond system, if necessary.



Figure 2. Crab culture farm at Kampung Serdang in Brunei-Muara

The future development of shrimp farming industry in the country will not cause significant damage to mangrove forests. In fact, lands where mangroves have grown have proved less than ideal for shrimp farming. Mangrove soils are often acidic, so that ponds excavated in these soil have to be heavily and expensively limed to maintain suitable pH. Leaving the mangrove forests intact is now recognized as yielding positive benefits. Hence, future farms will be established in areas just inland from a mangrove forest with the effluent trickling down and being filtered. Mangrove forests are superb natural filters for organic matter and what reaches the sea is more-or-less pristine water. Further, DOF will be looking for barren lands near the coasts instead of mangrove lands for the new prawn farms.

- **Silvofisheries**

Fitzgerald (1997) reviewed the effectiveness of different silvofisheries models in Brunei Darussalam, in particular mangrove crab (*Scylla serrata*) culture. There is only 1 crab farm with 4 modules of crab pen. Each module is 30 x 30 m. The pen is made of palm tree locally known as "nibong." Inside the pen, small trenches 30-50 cm wide and 20-30 cm deep are provided to hold water. Trenches cover about 10% of the pen area. Mangrove crab juveniles are stocked in each pen at 30-50 kg per stocking. Stocking frequency is dependent on the estimated quantity of the harvested crab and on the availability of crab juveniles. The crabs are fed trashfish. Figure 2 shows the crab culture farm at Kampung Seralang in Brunei-Muara area.

Different silvofisheries techniques are being practiced in other countries. Indonesia's "empang parit model" and Hong Kong's "gei wai system" have been proven to be successful and mangrove-friendly (Fitzgerald 1997). However, these systems are labor-intensive and follow extensive cul-

ture methods which require larger areas for production. These might not be suitable for Brunei Darussalam because of limited mangrove areas and expensive labor. Instead, the modern “closed system” shrimp aquaculture will be more appropriate. It has been proven to be more applicable and environment-friendly for intensive shrimp farming.

Plan implementation

The agencies responsible for implementing plans on development, conservation and management of mangrove resources in the country are as follows:

| Area | Implementing agency |
|--|---|
| Planning and management of mangrove forest production and protection | Department of Forestry |
| Fish production and development of aquaculture in mangrove areas | Department of Fisheries |
| Use of mangrove areas for agriculture | Department of Agriculture |
| Development of mangrove areas as sites for residential, industrial and commercial development | Department of Town and Country Planning |
| Land uses in mangrove areas | Land Department |
| Establishment of mangrove areas as reserves, conservation sites and wild life sanctuaries and for research | Museum Department |

Problems affecting wise utilization of mangroves

The major problems observed on the implementation of a sound program for the proper utilization of mangroves in the country are (1) lack of awareness among the public on the importance of mangroves for the environment and the country's economy and (2) lack of clear understanding on the ecology of mangrove forests.

Unlike other countries in the region, Brunei Darussalam has no serious poaching or encroachment problems or uncontrollable illegal development of mangrove areas. Still, irresponsible activities of some public members and fishers that cause forest fires and pollution due to indiscriminate release of oil and garbage could cause significant damage to the mangrove environment. The damage could be prevented by creating awareness among the public on the value of mangrove ecosystems. This will further help obtain support for conservation and rehabilitation programs and reduce pressure on conversion uses. Public awareness programs can be carried out via publication of leaflets, TV programs and encouraging eco-tourism.

Lack of sound understanding on the ecology of mangrove forests is another set back. The best example for this is the recent excavation in the upper reaches of the Brunei estuary for a river widening and drainage project, without knowing that soil in the area contain high levels of pyrite. This created severe environmental problems due to the increase in water acidity, badly affecting capture and culture fisheries in the Brunei estuary. Understanding mangrove ecology needs implementation of research programs. Currently, DOF, in collaboration with University Brunei Darussalam

(UBD) is carrying out a research program for this purpose. More research programs are being planned.

It is expected that development projects including aquaculture will not cause significant damage to the mangrove resources in Brunei Darussalam and that those resources will be conserved for the benefit of future generations.

References

DOF-MIPR (Department of Fisheries, Ministry of Industry Primary Resources, Brunei Darussalam). 1992. The integrated management plan for the coastal zone of Brunei Darussalam. ICLARM Tech. Rep. 29, 122 p

Fitzgerald JW. 1997. *Aquaculture Asia* (July-Sept. 1997), p 9-17

Lim TS and Sharifuddin PM. 1975 Charcoal production on Brunei. *Brunei Mus. J.* 3 (4): 201-220

Stewart MB. 1986. *A geography of Negara Brunei Darussalam* Dewan Bahasa dan Pustaka Brunei, Bandar Seri Begawan, Brunei Darussalam

Zamora PM. 1992. Mangrove resources of Brunei Darussalam: status and management. In: Silvestre G, Matdanan HGH, Sharifuddin PHY, de Silva MWRN and Chua TE (eds). *The coastal resources of Brunei Darussalam: status, utilisation and management*. ICLARM Conference Proceedings 34, 214 p. Department of Fisheries, Ministry of Industry and Primary Resources. Bandar Seri Begawan, Brunei Darussalam, and International Center for Living Aquatic Resources Management, Manila, Philippines, p 39-58