Sustainability in aquaculture

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Much has been said about sustainability and sustainable aquaculture. A buzzword that is interesting to funding agencies, the topic is huge and the agenda for action overwhelming that one more foray into it is perhaps tolerable.

Sustainable aquaculture in this story is discussed vis-a-vis the loss of mangroves associated with the rapid increase in production of cultured shrimp in some developing countries in Asia. At first consideration, mangrove conversion and aquaculture seemed innocuous enough. In Indonesia, brackishwater aquaculture has been practiced since 1400; China much earlier. In the Philippines in the 1950s mangrove conversion to fishponds was encouraged by the government (to relieve pressure on catch fishery) when the first fishpond lease agreements were issued. It was not until the 1980's when the shrimp craze peaked and plummeted that the issue of sustainability was considered.

Mangrove destruction for shrimp production

Southeast Asia's development and population growth brought non-sustainable exploitation of its coastline, forests, rivers, and wetlands. The destruction has increased through the years as development proceeded and the international markets entered the scenario (Cameron 1997).

The rapid coastal degradation has been accompanied by rapid drops in fish yield, with more catches being composed of juvenile fish. Much of Southeast Asia's coastlines is used for business geared toward exports such as the intensive fish and shrimp farms. The bulk of the exports is consumed in restaurants (Cameron 1997). In 1995, Asia (67-91% of total population constitute the rural poor) aquaculture production increased by 15% - from 15.9 million in 1994 to 18.3 million which comprises 87% of total world production. China led all countries with 12.79 million tons production (see following table). But not all Asian countries in the list have increased their production. Thailand, the Philippines, and Taiwan experienced slumps in production in 1995, primarily due to decreases in shrimp production caused by diseases (Agbayani 1997).

Status of mangroves in some Asian countries

In Malaysia, the rapid growth of brackishwater pond culture was first experienced in the 1970s, stretching into the early 1990s. In South Johor 1,169 ha of mangrove forests were cleared for brackishwater farming. In Perak, 7,061 ha of mangrove land were cultivated for penaeid prawn culture (Dept. of Fisheries, Malaysia). The 1990s reflected a 29-fold increase in hectarage over a 10-year period. But problems with diseases and mass mortality, water and soil salination, land subsidence and eventually farms being abandoned were reported (Choo Poh Sze 1996). An incomplete record of abandoned farms in Johor cited reasons for its abandonment as incorrect pond designs, unsustainable practices that exceeded the carrying capacity of the farms, and poor management especially by large farms of more than 200 ha.

The Philippines had about 500,000 mangroves in 1920. In 1992, it had decreased to 140,000. Sixty percent of this decrease is due to conversion to culture ponds for milkfish until the 1970s and to prawn in the 1980s (Primavera 1993). Reports say that the shrimp farms have affected domestic and agricultural water supplies, decline of food fish catch, marginalization of coastal fishermen, displacement of labor, and credit monopoly by big business.

Fisheries statistics show that production of milkfish which was 252,000 M tons in 1982 has decreased to 164,000 M tons in 1986. The decrease has been associated with a decline in Laguna Lake pen culture but can also be traced to a shift in hectarage from milkfish to prawn. A study of two coastal villages in Panay Island, has found that it has brought about social displacement and marginalization of fishermen on top of ecological costs (salinification, lowering of the water table, pollution of mangrove areas (Primavera 1993).

In Vietnam, the use of herbicides and napalm during the Vietnam war (1962-1971) resulted in the destruction of 40% of the forests in Southern Vietnam. Before this war, mangrove forests in Vietnam was estimated to be about 400,000 ha. Of these, 250,000 ha are found in the South, 200,000 ha in Ca Mau peninsula and 40,000 ha in Rung Sat-Bien Hoa province and Saigon. According to the Forest Inventory and Planning Institute, 252,000 ha of mangrove forest remain composed of secondary

World aquaculture production of top 14 countries
(FAO Fisheries Circular No. 932, 1997)

	Country	Production (million mt)		
		1984	1995	% increase
1	China	8.800*	12.790	22.67
2	India	1.530	1.610	5.22
3	Japan	0.781	0.820	4.99
4	Indonesia	0.598	0.611	2.17
5	Thailand	0.514	0.464	(9.73)
6	USA	0.391	0.413	5.63
7	South Korea	0.343	0.368	7.29
8	Philippines	0.380	0.346	(8.95)
9	Bangladesh	0.270	0.322	19.26
10	Norway	0.218	0.282	29.36
11	France	0.281	0.281	0
12	Taiwan (P.C.)	0.282	0.278	(1.42)
13	Italy	0.180	0.220	22.22
14	Viet Nam	0.198	0.211	6.56

*1993 data

Where have all the mangroves gone? Gone to fish farms, houses, industrial estates.

growth, plantations, and bushes, while natural forests occupy only a small area. In other areas, mangroves were destroyed and replaced by agricultural and shrimp farms (Hong, 1993). Although shrimp farming has generated jobs and income for the dwellers in the surrounding mangrove areas (for felling of trees, construction of canals, platforms, embankments) and generated foreign exchange earning, the importance of mangroves to fishery resources cannot be discounted. It has been found that the reclamation of mangrove for shrimp farms decrease shrimp production in the natural habitat. Mudcrab population has also recently decreased while the large embankments of shrimp farms have caused saline water to penetrate inland. In 1991, more than 2,000 ha of rice fields at Can Gio District, Ho Chi Minh City were destroyed due to saline water intrusion. An outbreak of a disease associated with mountainous and coastal settlements which was believed to have already been eradicated occurred recently in two areas (Hong 1993). The clearing of mangrove forests for brackishwater shrimp ponds and rice fields has been implicated. It has been noted in some countries that the conversion practices bring side effects in the form of stagnant water pools and ponds which become breeding places of mosqitoes. Otherwise, in thick mangrove forests, the mosquito is flooded by sea water.

In India, low lying areas and estuaries are used for brackishwater fish farming. Recently, the concept of hatchery has been introduced. This has boosted aquaculture. In Tamil Nadu, about 27,500 ha of mangroves were converted to brackishwater ponds for the culture of fish and prawns as well as *Artemia* spp. in salt pans. In 24-Pargana district alone, about 35,000 ha has been converted to fish farming. Kerala is also known for brackishwater prawn and fish farming known as *Pokkali* culture.

In 1984, Indonesia reported a total mangrove coverage to be 4.25 million. The most extensive form of mangrove land conversion, among others, is the *tambak* or brackishwater fishponds. In 1980 there were 155,018 ha of *tambak* in Indonesia distributed in Java, Sulawesi, and Sumatra (1980). In 1984-1989, the Directorate General of Fishery drew a plan to convert 100,000 ha of mangrove areas into brackishwater ponds in efforts to enhance foreign exchange earnings. The plan was carried out mostly outside Java, primarily in the provinces of Aceh, North Sumatra, South Sulawesi, South East Sulawesi, South Kalimantan, and Bali (Soemodihardjo 1987). Until recently, the mangrove forest in Irian Jaya was believed to be still in pristine condition. But in 1982, 163,000 ha of the resource were already on lease and no less than 10 private corporations were ready to get a share of the remaining 205,000 ha of the allocated 368,000 ha.

In Thailand, the mangrove forests as of 1979 is 287,308 ha. The area for shrimp ponds has increased from 12,000 ha in 1975 to about 25,000 in 1979. But the shrimp ponds traditionally constructed by clearing the mangrove forest lasted for three or four years, after which the farms cease to operate due to insufficient food or nutrient supply. The shrimp farmers move to another areas and build new ponds (Aksornkoae 1986). In many areas in Thailand, large abandoned shrimp ponds are testimonies of lost mangroves.

Taiwan has 1,400 km shoreline. As in most developing countries, the deterioration of marine environment is a big problem. Contributing to coastal deterioration are industrial and municipal activities; aquaculture, tidal flat reclamation, and oil operation. According to the Environmental Protection Administration (EPA) of Taiwan the western and southern sea areas are polluted, identifying pollutants as heavy metals (e.g., copper). Efforts to rehabilitate several polluted aquaculture sites are ongoing. For example, the heavy metal pollution resulting from burning waste wires in the Erh-jen estuary destroyed all culture oyster fields costing US$1.7M. A program "Monitoring Network for Marine Enviroment," US$21M has been created to establish a computerized database for management (Wen Yan Chiau 1994).

Worldwide remedies for sustainable aquaculture

Southeast Asia's record for mangrove destruction shows its efforts to integrate with regional and global systems of development. Habitats are lost to the construction of harbors and industrial installations, growth of cities, and development of tourist facilities, and mariculture. Destruction

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Fisheries production in quantity by sub-sectors 1979-1993 (x 1,000 tons)

Year	Total	Capture fisheries				Aquaculture			
		Marine	%	Inland	%	Coastal	%	Fresh-water	%
1979	1,946.30	1,802.30	92.60	103.7	5.33	10.9	0.56	29.4	1.51
1980	1,989.01	1,756.90	88.57	110.4	6.16	60.1	3.36	34.5	1.92
1981	1,792.99	1,587.90	88.33	116.5	5.86	67.5	3.39	48.1	2.42
1982	2,120.10	1,949.70	91.96	87.7	4.14	36.9	1.74	45.8	2.16
1983	2,255.40	2,055.20	91.12	108.4	4.81	44.8	1.99	47.0	2.08
1984	2,134.80	1,911.50	89.54	111.4	5.22	61.5	2.88	50.4	2.36
1985	2,225.20	1,997.20	89.76	92.2	4.14	60.6	2.72	75.2	3.38
1986	2,536.30	2,309.50	91.06	98.4	3.88	39.1	1.54	89.3	3.52
1987	2,779.10	2,540.00	91.40	87.4	3.14	61.9	2.23	89.8	3.23
1988	2,629.70	2,337.20	88.88	81.5	3.10	108.9	4.14	102.1	3.88
1989	2,740.00	2,370.50	86.51	109.1	3.98	168.7	6.16	91.7	3.35
1990	2,786.40	2,362.20	84.77	127.2	4.57	193.2	6.93	103.8	3.73
1991	2,967.70	2,478.60	83.53	136.0	4.58	230.4	7.76	122.7	4.13
1992	3,239.80	2,736.40	84.46	132.0	4.07	229.3	7.08	142.1	4.39
1993	3,327.10	2,752.50	82.73	135.0	4.06	295.6	8.88	144.0	4.33

Source: Division of Fisheries Economic. Department of Fisheries,Thailand.

grove was destroyed for land settlement, shrimp farms, among others. This destruction has affected the spawning grounds of aquatic organisms. The wastewater discharges of industries, domestics, and aquaculture activities has been quoted as causing a deterioration in coastal natural resources and the environment.

The table above summarizes fisheries production in Thailand by caputre and culture.

References will be provided upon request.

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of coral reefs and wetlands, mangrove forests, as well as increasing erosion of the shore are evident. With the exception of one or two countries in Asia that have not ventured into large-scale aquaculture but have converted to other uses as well, mangrove degradation.

Reports say that attempts to form strategies for sustainable development have been hampered by defective knowledge of the nature and rate of degradation. This particular information is considered essential for a proper understanding of environmental problems. It is also necessary for the development of accurate intervention models for future environment change (Parnwell and Bryant 1997).

At least three international organizations have taken the lead to talk about the sustainability of aquaculture and on the encroachments on the margins of the sea. In 1997, a meeting to discuss the effects of the use of chemicals in aquaculture, especially those which appear likely to be hazardous to man, cultured stock, and the environment was organized by SEAFDEC/AQD, FAO Fishery Resources Division, CIDA's ASEAN Canada Fund and the World Health Organization. The findings of the meeting were discussed in the Joint Group of Experts on the Scientific Aspects of Marine Pollution. The need to synthesize and disseminate information on the use and management of "aquachemicals" has been recognized. The meeting prepared a set of guidelines to address major problem areas and possible solutions particularly intensification, fishhealth management and access to information, prophylactic use of antibacterials, and lack of data on the quantities of chemicals used. The role and responsibility of the government, the private sector, and the academe with regard to legal and institutional frameworks to govern chemical usage in aquaculture were also discussed and incorporated in the guidelines (SAA March 1997).

In 1982, the United Nations Convention on the Law of the Sea provided a new framework for the better management of marine resources. The law of the ocean gave coastal states rights and responsibilities for the management and use of the fishery resources within their EEZs. Many coastal states lacked experience and financial and physical resources as they continued to extract fisheries within their EEZs. Later, it became clear that fisheries resources could no longer sustain the rapid and uncontrolled development that new strategies for conservation had to be formulated. In 1995, the Food and Agriculture Organization of the United Nations formulated the Code of Conduct for Responsible Fisheries which established principles and standards applicable to the conservation, management, and development of all fisheries. Further, it provides a necessary framework for national and international efforts to ensure sustainable use of aquatic living resources in harmony with the environment. Article 9 pertains to responsible aquaculture development. The Code promotes the responsibility of the state regarding aquaculture development in areas under its jurisdiction, within transboundary aquatic ecosystems, the use of aquatic genetic resources for aquaculture and culture-based fisheries, and production. On 31 October 1995, the Code was unanimously adopted by 168 countries at the FAO Conference.

In 1997, the draft of the New Holmenkollen Guidelines for Sustainable Aquaculture was endorsed in a symposium on 2-5 November 1997. The new guidelines expanded the Holmenkollen Guidelines for Sustainable Industrial Fish Farming formulated in 1994. In the symposium, the participants were guided by the premises that aquaculture can become an important provider of food for a growing world population, and that "aquaculture can be undertaken in harmony with the environment." The guidelines were based on the following principles: the Principle of Sustainable Development which was endorsed by 167 states in the Rio-Declaration 1992, interpreted as comprising the inter-relation of natural and technological aspects on the one hand, and socio-economic and value-based considerations on the other; the Precautionary Principle, which reflects concern for human interaction with the environment; and the Principle of Human Equity as a goal for economic and technological development, implying that satisfactory development presupposes that both the global and the local distribution of benefits should create real improvements for poor and underprivileged people and satisfy their needs before other needs are met.

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