Small Water Bodies For Sustainable Fisheries Production

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Introduction

Worldwide, the number of artificial water bodies being constructed for irrigation, drinking water and hydropower purposes continues to grow, especially in Asia. Along with this growth has come a host of benefits and problems for people and their affected environments.

Dam construction worldwide will continue to speed apace due to population growth and human needs. Accepting this, a new science that weaves disparate scientific and technical disciplines to design, engineer and rehabilitate a dammed watershed and its affected people with proper regard to the environment is urgently needed.

Sustainable increases in fish production from reservoirs is an essential task for fisheries scientists in the 21st century. Fisheries production in Asian reservoirs is low (Table 1) and human protein needs great.

Reservoir Fisheries Workshop

What are the critical environmental factors (natural and human) that lead to high fisheries production in tropical reservoirs? What is the carrying capacity of cages? How do terrestrial and aquatic systems and associated human activities interact to affect fisheries and aquaculture? What are the beneficial/negative relationships between capture fisheries and cage aquaculture in reservoirs? Do reservoir morphometrics accurately predict long-term fisheries potential of reservoirs? What are the institutional and research needs for enhancing fish production in tropical reservoirs?

These were some of the issues discussed at the Second Asian Reservoir Fisheries Workshop held in Hangzhou, China, October 1990, sponsored by the International Development Research Centre (IDRC) and attended by representatives of nine Asian nations.

This article gives a brief, personal view of the highlights of the workshop and the Chinese reservoir techniques and development as seen by the author. The Chinese example and its possible applicability to other Asian and African developing nations with thousands of reservoirs just waiting for some realistic vision of the fisheries future were of particular concern.

Raceways for rearing Chinese carp fingerlings for enhancing fisheries. Reservoir tailwaters are used. Large (8-15 cm) fingerlings are stocked for fisheries enhancement.

Asian Reservoir Fisheries Management

Twenty-six presentations covered the range of reservoir fisheries management options, from basic limnological research and capture fisheries to intensive cage culture.

All represented nations reported active limnological research programs oriented towards exploiting, at some future date, the fisheries potentials of their reservoirs. Three papers reported on how

Table 1. Fisheries production in Asian reservoirs. (Source: various authors)

	Natural lakes		Reservoirs		
			Area (ha)		Current
Country	Area (ha)	Yield (kg/ha/year)	Current	Future	yield (kg/ha/year)
Bangladesh	4,268,740[1]	136	58,300	800,000	46
Burma	33,130	NA	80,000	1,500,000	NA
China	7,426,000	200-300	1,400,000	NA	75-1,265
India	720,000	NA	3,000,000	6,000,000	100-202
Indonesia	13,700,000	19	53,000	500,000	15-380
Kampuchea	1,000,000	NA	80,000	2,000,000	NA
Korea (Rep.)	53,000	NA	41,000	NA	NA
Laos	500,000[2]	NA	50,000	5,000,000	NA
Malaysia	2,093[3]	NA	92,038	150,000	NA
Nepal	5,000	NA	1,500	80,000	NA
Pakistan	0	0	15,000	NA	NA
Philippines	200,000	10-3,900	19,294	500,000	NA
Singapore	0	0	2,000	3,000	NA
Sri Lanka	0	0	139,214	250,000	72-1,345
Thailand	300,000	179	285,272	3,000,000	73
Vietnam	334,000	NA	60,000	1,500,000	NA

[1]Open water capture fisheries area
[2]Includes freshwater swamps
[3]Very few natural lakes in peninsular Malaysia, nearly all from Sabah and Sarawak.
NA = not available

Bag end of the fixed filter net (see Fig. 2) being brought to shore. This catch from a 500 - ha reservoir was estimated at 20 t.

The most economically valuable crop grown in some Chinese reservoirs is freshwater pearls. Hanging mesh baskets hold 5–8 seeded mussels. The baskets are suspended at 3–10 cm depth from 50–150 m long ropes floated by bamboos. Pure white, cream and pink pearls fetch high prices in Beijing, Shanghai and Hong Kong.

limnological results could be used to predict fisheries potentials in Asian reservoirs.

Thailand is researching fisheries yield models and doing promising development work with stocking a native pelagic clupeid (*Clupeidichthys aesarnensis*). This freshwater sardine is a fully pelagic, planktivorous fish with a short life cycle amenable to intensive fishing pressure. It is light-fished in a number of reservoirs in the northern region. Cage culture of *Oreochromis niloticus* in Songkhla Lake showed good potential when fish were fed an aquatic weed pellet.

Extensive or "no feed" cage culture of the filter-feeding Chinese carps continued to expand in Nepal. Bighead and silver carps are used (stocking ratios of the two fish ranged from 42:58% to 90:10% of 20–30 g fish) at low densities (8–10 fish/m^3) in 80–125 m^3 floating net cages. Fish are harvested after 1–1.5 years. Fish production averaged 0.032.60 kg/m^3. Demand for the Chinese carps is high.

A review of reservoir research in India reported that four years of research in reservoir ecodynamic principles had increased fish production in small water bodies (150–646 ha) from 100 to 202 kg/ha/year. Using these principles it was forecast that total fish production from Indian reservoirs could reach 322,000 t by year 2000.

The Chinese Example: Its Potential and Pitfalls

We all looked forward to seeing and hearing firsthand from our Chinese colleagues how reservoir management in China was organized, managed and developed. Nine detailed reviews were presented and two days of visits to small and large reservoirs in the Hangzhou region

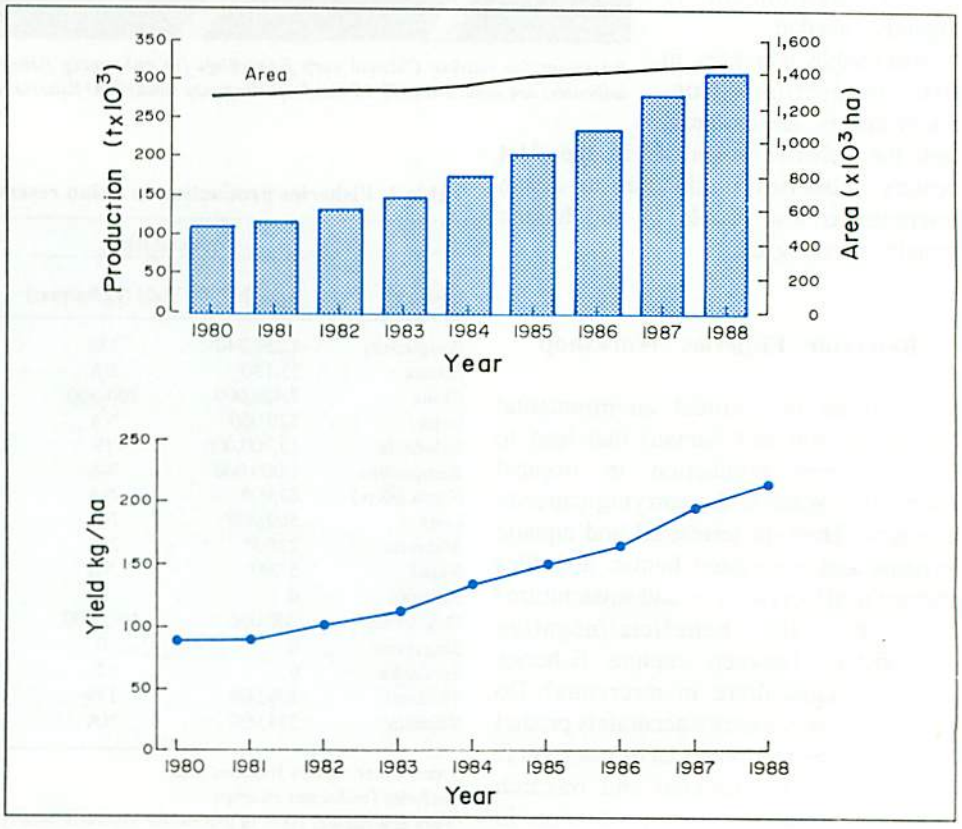

Fig. 1. Fisheries yield and production in Chinese reservoirs, 1980-88. (Source: Li 1990)

(about 4 hours west of Shanghai) were made. Visits and presentations came from a number of organizations, including the Institute of Reservoir Fisheries, Academia Sinica, and the Ministry of Water Resources.

In 1988, China had over 1,400,000 ha of reservoir surface area and average fish production of 210 kg/ha/year (Fig. 1).

Technological development cannot be separated from the biosocial background and traditional knowledge systems existing in a society. China is an exceptionally good example of the connection between aquaculture development and its role in meeting societal needs.

Workshop participants were interested in the reasons why reservoir fisheries in China are so productive and in the underlying technical and biosocial principles accounting for the widespread adoption of such a successful technology.

The unique historical background of China is well known. In modern terms, however, less is known about the nation's special climatic, political, land tenure, economic, demographic, market and cultural situations that so differ from any other nation, and how these factors have influenced aquaculture development. A holistic view is necessary if any attempt to transfer China's advanced reservoir management technologies to any other nation is attempted.

Market demand is the engine which drives the chain of aquaculture systems development. An enormous demand for fish exists in China. Cultured fish are expensive protein commodities. Due to market forces, Chinese managers think of huge expanses of reservoir waters as large fishponds and, as such, seed, feed, fertilize and harvest them. Large blocking nets, set over a 24-hour period, are used to harvest fish (Fig. 2).

Reservoir culture-based fisheries production, in a 1,700-ha reservoir, averaged 547 kg/ha/year. Smaller reservoirs (160–570 ha) averaged 525–600 kg/ha/year*. Outside Beijing, intensive cage culture of *Oreochromis niloticus* at stocking densities of 9–20 kg/m³ with 22–28% protein feeds, produced yields of 100–240 kg/m² in 120 days**.

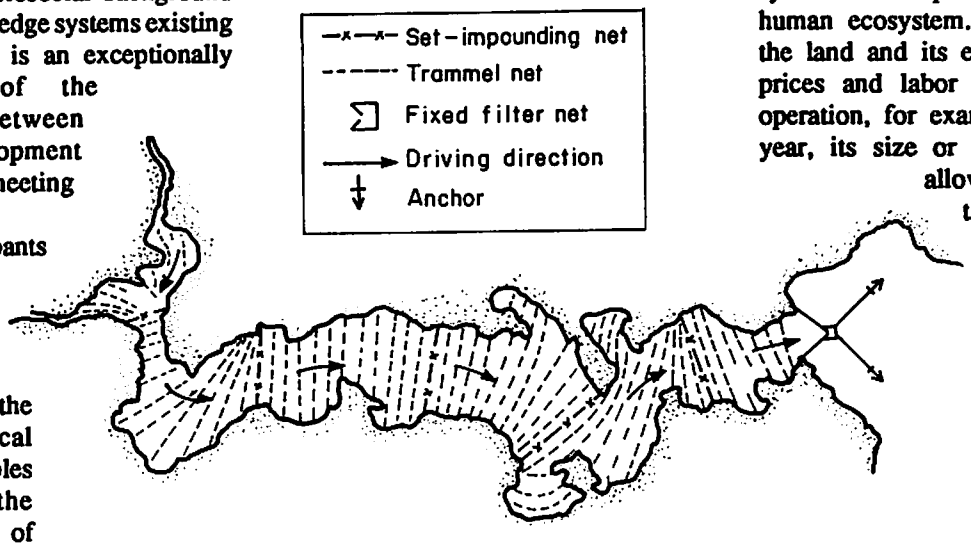

Fig 2. Fishing nets used to capture Chinese carps in a bay of a medium-size reservoir in China. Operations are discussed in Xu, S. 1988. Fishing techniques in Chinese reservoirs, p. 169-175. In S.S. De Silva 1988.

Many of the problems voiced by our Chinese colleagues were those normally faced by aquaculturists in the West; namely, pollution from cage farms, diseases and parasites, and the high cost and availabilities of formulated feeds. While land-based aquaculture in many Asian nations is no less sophisticated than in China, reservoir fisheries and aquaculture development in China were deemed more akin to commercial aquaculture development in the West than the rest of the Asian nations represented.

We witnessed during the field trips impressive watershed rehabilitation and management systems. Bamboos were planted on reservoir slopes for erosion control. These bamboos will later be sources for building materials for houses and flotation for hanging baskets for pearl culture and fish cages. Forage grasses were managed for erosion control in proximity of the reservoir and for fish feeds (grass carp in cages). Animal pens were situated on a reservoir bay so that their wastes fertilized the water and increased fish (silver and bighead carp) production. The reservoir and its surroundings were part of an integrated ecological system whose component technologies were designed and engineered to "fit together".

This ecologically designed and managed system was unique to China and its special human ecosystem. The state owned all the land and its enterprises, determined prices and labor allocation. If a cage operation, for example, lost money one year, its size or management was not allowed to change, since the priority was not economics but production.

In many respects, the Chinese example of reservoir fisheries management was so technologically and socially unique, that transfer of any of their techniques to other Asian nations would be difficult without a great deal of adaptive research. China's major contribution may be the development of applied ecological management principles for sustainable development of reservoir fisheries and environmental rehabilitation.

The proceedings of the workshop will be published by IDRC in 1991.

Further Reading

Costa-Pierce, B.A. and O. Soemarwoto, Editors. 1990. Reservoir fisheries and aquaculture development for resettlement in Indonesia. ICLARM Tech. Rep. 23, 378 p.

De Silva, S.S., Editor. 1988. Reservoir fishery management and development in Asia. International Development Research Centre, Ottawa.

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*Li, S. 1990. Recent advances in freshwater aquaculture in China, p. 141-161. *In* M.M. Joseph (ed.) Aquaculture in Asia. Asian Fisheries Society, Indian Branch, Bangalore, India.

**Xue, J., L. Su, H. Gu, J. Fan, G. Tian and D. Liu. 1990. Tilapia (*Oreochromis niloticus*) cage culture in a reservoir of north China. Paper presented at the Second Asian Reservoir Fisheries Workshop, 15-19 October 1990, Hangzhou, China.