Participatory fisheries management for livelihood improvement of fishers in Phewa Lake, Pokhara, Nepal

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This paper deals with the participatory fisheries management program, aimed at and successful in livelihood improvement of fisher community known as 'Pode' or 'Jalari' living near Phewa Lake, Pokhara, Nepal. The community, traditionally depending on fishing activities for their livelihood, led a nomadic life along the rivers and lakes, carrying cast nets to feed their families. In the early 1960s, when the fish catch declined due to over fishing, the Pode's only source of livelihood was threatened. Meanwhile, the Fisheries Development Center, now Agriculture Research Station (Fisheries), was established in Pokhara in 1962 with the objective of assisting the poorest fishing communities through cage fish culture and open water fisheries. To begin with, each family was enabled to buy a single 50 m^3 cage in order to start farming fish; the loans were underwritten by the local Agriculture Development Bank. The total fish production from Phewa Lake in 2001 was estimated at 98 mt (224 $kgha^{-1}$: 52 mt from cage culture and 46 mt from open water recapture fisheries). The income from fish production is shared among local fisher families; it has brought substantial changes in the livelihood of the fisher community. A few years ago, it was difficult to find a literate member of the Pode community, but these days many children attend school and some even college. The community has realized the importance of lake resources and devised a code of conduct for sustainable fishery. The improvement on livelihood of fisher community is attributable to the combination of participatory fisheries management with their traditional skill on fish handling as well as their easy access. Apart from supporting in livelihood of poor communities, participatory fisheries management also contributes in maintaining ecological balance of aquatic ecosystems.

Key words: 'Pode', sustainable fishery, Phewa, cage culture, livelihood

Himalayan Journal of Sciences 3(5): 47-52, 2005
Available online at: www.himjsci.com

Received: 12 Feb 2005
Accepted after revision: 20 May 2005

Small scale fishers, especially those on inland waters, are among the poorest of the rural poor in developing countries facing apparently insurmountable obstacles in the existing economic and social power structures as they attempt to better themselves (Berkes et al. 2001). However, a participatory approach can overcome these obstacles (Jiggins and de Zeeuw 1992, Van de Fliert et al. 1999). Ideally, a participatory approach to fishery creates an integrated development strategy by fostering new relationships, ways of thinking, and structures and processes (Campbell and Salagrama 2000). The participatory approach paradigm in research and development completely differs from the conventional top-down approaches, and is an essential part of Sustainable Livelihood (SL) programs (FAO 2000). It is a customer-focused program where the targeted group participates in the entire process, learning about the situation, identifying problems, discussing alternatives, selecting solutions, designing and implementing activities, evaluating and disseminating results (Chat 2000). In these processes, target groups share their traditional knowledge to identify problems and solutions, ensuring the poor and uninformed will not be excluded from development opportunities. This also creates a forum where outsiders can work with the community and help to improve their specific capacities (Chat 2000).

Nepal is rich in water resources, and fishing is a long-standing tradition. The communities involved in fishing activities are mostly Tharu, Majhi, Malaha, Danuwar, Kewat, Bote, Mushar, Mukhiya, Darai, Kumal, Dangar, Jalari, Bantar, Rai and other poverty-laden ones. Swar (1980) estimated there were about 80,000 fishers; however, it is estimated that there has recently been a three- to five-fold increase in the fishing population due to the increasing population and deepening poverty in Nepal (Gurung 2003a).

As a result of lack of appreciable management, most water bodies of Nepal are over-fished and environmentally degraded threatening the biodiversity and livelihood of traditional communities (Bhandari 1998, Karki and Thomas 2004). In this article, we present an example of sustainable participatory fishery management practices which has been successful in improving the livelihood of the fishers' community substantially around Phewa Lake (Pokhara, Nepal).

Beginning of the participatory approach to fishery

The Agriculture Research Station (Fisheries), Pokhara, established in 1962 to improve the livelihood of poor people through sustainable fishery, is a major stakeholder of this participatory approach. Its relation with local fishers was strengthened in 1972 when the caged fish culture program was initiated with the cooperation of the Food and Agriculture Organization (FAO), the United Nations Development Program (UNDP) and Ministry of Agriculture and Co-operatives, His Majesty's Government of Nepal. To organize the local fishers, mainly nomadic Jalari, in a forum where issues on participatory fisheries management could be discussed, a fisheries association known as Matsya Byawasayi Samitee Kaski was founded. Fewa Matsya Byawasayi Samitee (FMBS), Nepali version of 'Phewa Committee of Fishers' was established as a wing of this organization. The District Agriculture Development Office and the Agriculture Development Bank of Kaski are also the main stakeholders in their joint effort.

At first the fisher families were trained to manage cage fish culture in the lake. Later, unsecured loans were offered for cage material and fingerlings (Swar and Pradhan 1992, Gurung and Bista 2003). The FMBS later formulated code of conduct for gill net operation (the cage fish culture in the lake), marketing and loan repayment systems. The major strategies adopted in the participatory approach were community mobilization for resource management and conservation, and fish stocking enhancement.

TABLE 1. Cage fish culture production rate ($kg \cdot m^{-3} \cdot y^{-1}$) in Phewa Lake

Year	Production rate	Source
1979	5.5	Pradhan and Shrestha (1979)
1980	3.4	Wagle (2000)
1985	3.4	Swar and Pradhan (1992)
1990	1.33	Sharma (1990)
1998	5.0	Wagle (2000)
2000	3.5	Present study
2001	4.3	Present study
2002	4.4	Present study

TABLE 2. Family number, cage holding and fish harvest from cage fish culture in Phewa Lake

Year	Number of families	Number of cages	Fingerlings stocked	Fish harvest	
				Number	Weight (kg)
2000	56	213	107500	63500	37274
2001	58	227	144500	68100	47000
2002	58	253	127000	75900	48300

Source: Fish Grower's Association, Phewa Lake, Pokhara

Characteristic features of Phewa Lake

Phewa Lake is situated at the southwestern edge of Pokhara Valley (28° 1' N, 82° 5' E, alt. 742 m) with a watershed area of approximately 110 km^2 (Ferro and Swar 1978). The total surface area of the lake was estimated at 500 ha by Ferro and Swar (1978), while Rai et al. (1995) reported 523 ha. More recently, Lamichhane (2000) estimated 443 ha of water surface area with a maximum depth of 23 m. Phewa Lake is fed by two perennial streams: Harpan Khola and Andheri Khola, as well as several seasonal streams.

The lake has a single outlet, where water is diverted for irrigation and hydropower generation. About 1700 wooden plank boats and other craft are operating in the lake, mainly for tourism services. It is estimated that 16% of Pokhara's total income is generated through tourism (Oli 1997), and the shorelines of Phewa Lake, especially the western side, comprise one of the most popular tourist spots, with many hotels and restaurants.

Several studies have revealed the mesotrophic status of Phewa Lake (Ferro 1980, 1981/82, Fleming 1981, Nakanishi et al. 1988, Rai 1998, Davis et al. 1998). Presently, the lake is facing severe environmental problems as a result of nutrient loading from agriculture, landslides, and rapid urbanization in the surrounding area. Sewage from the surrounding settlements is directed into the lake (Lamichhane 2000), and the volume

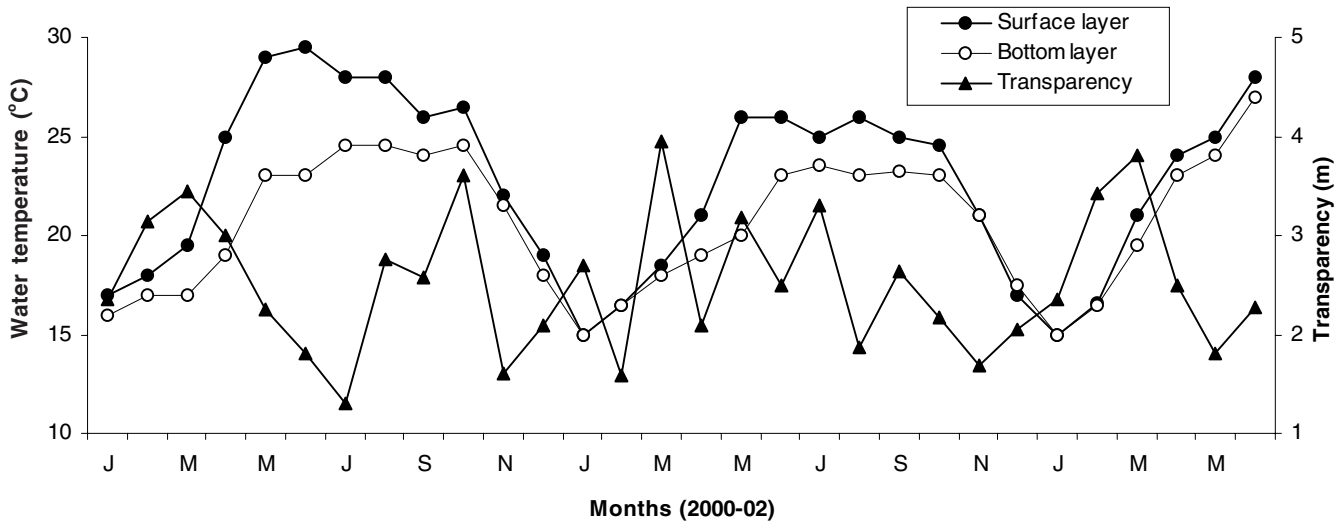

FIGURE 1. Seasonal changes in water temperature and transparency in Phewa Lake

continues to rise dramatically in response to increased tourism (Oli 1997). The recent trend is toward rapid eutrophication (Oli 1997, Lamichhane 2000, Rai 2000). However, the lake is also seasonally oligotrophic due to heavy rainfall in its wider catchment area (Rai 2000). Phewa Lake receives as much as ten times more run-off during the monsoon season that the rest of the year (Ferro 1981/82). The lake is now infested with a floating macrophyte, the water hyacinth, *Eichhornia crassipes,* and blue green algae indicating enriched nutrient loading into the lake.

Phewa Lake's water temperature ranges between 15 and 29° C and transparency varies between 1.2 to 4.1 m (**Figure 1**). In the study period, the lowest transparency was recorded in July 2000 due to monsoon siltation, and the highest in March 2001, probably due to the low productivity of the water in winter.

Cage fish culture in Phewa Lake

Fish in the cages at Phewa Lake exclusively depend on plankton that contains nitrogen (N) and phosphorus (P). These two nutrients are major elements responsible for eutrophication. Since fish becomes the food for humans, N and P are displaced from the lake to the land (Pradhan and Pantha 1995). Therefore, the subsistence cage farming is often cited as an environment friendly livelihood approach.

Cage fish culture of plankton feeder fish in nylon or polyethylene knot-less floating cages of approximately 5 m x 5 m x 2 m is a popular method of fish production in the lake (Swar and Pradhan 1992, Gurung 2001). Silver carp (*Hypophthalmichthys molitrix*) and bighead carp (*Aristichthys nobilis*) are reared at the rate of 10 fish m^{-3}. The farmer stocks 25 g fingerlings in 25–35 mm mesh cage and they become harvestable at 500–1000 g in 12–15 months (Rai 2000). Cages may yield 1.33–5.5 kg of fish per cubic meter per year, depending on the trophic status of the lake (**Table 1**), excluding losses of 10–20% due to mortality and escape.

Fish production from cage culture was 37 mt in 2000, while in 2002 it reached to 48.3 mt (**Table 2**). In addition, 6–8 mt of fish are produced annually in experimental cages by the Fisheries Research Station, Pokhara. In 2001, the total cage fish production was estimated to be 52 mt.

Monetary income from 4–5 cages was adequate to cover all expenses of a typical fisher family comprising 5 members for a year (Swar and Pradhan 1992). To begin with, each family was given a single cage, which only provided partial support for the family (Sharma 1990), but the number of cages was increased later (**Table 2**). The supply of quality fingerlings became the main bottleneck. This was resolved when a fish hatchery constructed in Pokhara under the aegis of HMG Nepal and Japan International Cooperation Agency (JICA) (Gurung and Bista 2003)

Now some fishers owning as many as 16 cages are producing about 3000–4000 kg of marketable fish per annum (**Table 2, 3**). The annual income of these fishers comes to approximately 200–300 thousand Nepalese rupees, equivalent to US $2850–4280 at the current exchange rate of 70 NR = US$ (Gurung and Bista 2003). The fishers now pay 30–50 thousand Nepalese Rupees annually as an income tax to the District Development Committee after the fish harvest. Most families now own their land, have houses with toilets, gas stove, and TV; a few also possess motorbikes. With the increased income and improving livelihood, community members are able to send their children to school; at present, a dozen students are ready to attend university. A few years ago, it was difficult to find a single literate member of the community (Gurung and Bista 2003).

Open water fishery

Fishing is the traditional occupation of Pode or Jalari in Pokhara, capture fishery using gill nets of mesh size up to 200 mm was widely adopted during the 1960s (Rajbanshi et al. 1984, Swar and Gurung 1988). Since 1975, the participatory approach has been encouraging the fisher community to utilize their

TABLE 3. Number of production and nursery cages hold by fisher's family in Phewa Lake

Number of families	Number of cages owned by each family
5	15–20
10	10–15
34	5–9
8	1–4

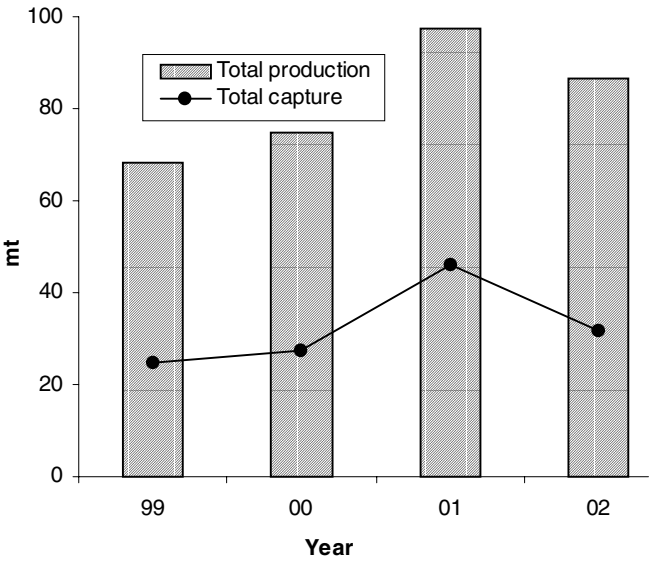

FIGURE 2. Total fish production and contribution of total captured fishery in Phewa Lake (Source: FMBS, Pokhara)

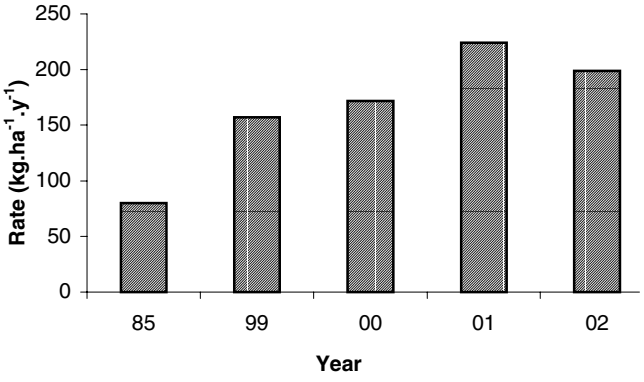

FIGURE 3. Annual fish production rate of Lake Phewa

traditional skills and helping them earn livelihood easily. This requires releasing (restocking) finger sized baby fish (fingerling) into the lake and re-catching later (recapture) when they grow bigger (Swar and Gurung 1988, Shrestha et al. 2001) using fishing devices like gill net, cast net, line, hook etc.

The main native species that form the basis of Phewa Lake fishery are *Tor* spp, *Acrossocheilus hexagonolepis, Labeo dero, Cirrihina reba, Mastacembelus armatus, Barilius* spp., and *Puntius* spp. (Ferro 1980, Bista et al. 2002). The fishery in Phewa Lake is comprised of exotic and indigenous fishes with substantial contribution of the former (Wagle and Bista 1999). The native and exotic fish species contributing to capture fishery are listed in **Table 4**. Their contribution is ranked as high, medium and low on the basis of annual abundance in catch statistics.

The total annual fish production ranged from 65 to 98 mt in Phewa Lake between 1999 and 2002, out of which 46 mt were captured in 2001 and 31 mt in 2002 (**Figure 2**). Wagle and Bista (1999) reported a 50.7 mt fish catch in Phewa Lake which included a 20% augmentation of the recorded catch to account for unrecorded harvest.

The total fish production in Phewa Lake reached about 98 mt in 2001 (**Figure 2**) contributing up to 219 $kg \cdot ha^{-1} \cdot y^{-1}$ (**Figure 3**). Mean fish production rate from reservoirs in Asia was estimated to be 20 $kg \cdot ha^{-1} \cdot y^{-1}$ (De Silva 1988) suggesting that Phewa Lake is much more productive than average Asian reservoir.

Market channeling

Pokhara city is a traditional market for fish products; however, market channeling must be improved. Given the national consumption rate of 1.5 kg per capita (Gurung 2003a) and Pokhara's population of about 300,000, approximately 1.5 mt of fish can be easily sold every day in the local market. Only a small portion of the total fish production of Pokhara valley is marketed in adjacent districts and Kathmandu, mostly during winter when yield surpasses local consumption. In summer, when fish catch is low, fish is supplied to Pokhara from outside sources.

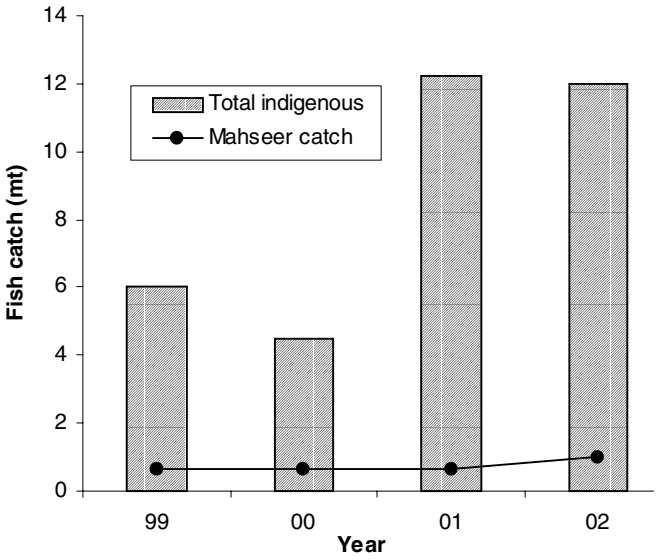

FIGURE 4. Total indigenous fish catch and contribution of *T.* spp (Mahseer) in Phewa Lake

Market arrangement for cage cultured fish and loan repayment

A multi-stakeholder body that includes FMBS, Agriculture Research Station (Fisheries), Agriculture Development Office and local fish-marketers determine the wholesale price of fish. The FMBS determines the turn for marketing each owner's fish. Fish are harvested early in the morning and brought to the office premises located nearby the lake around 6 AM, where, farmers are given a coupon to specify what was delivered, and the fish is turned over to a contractor for marketing. The contractor returns to the fisheries office to pay for the fish after selling it. The fishers are then paid according to the coupon

TABLE 4. Fish species and their contribution in capture fishery of Phewa Lake

Scientific name	Local name	Contribution*
Tor putitora (Hamilton)	Sahar	Low
Tor tor (Hamilton)	Sahar	-
Acrossocheilus hexagonolepis (McClelland)	Katle	Low
Cirrihina reba (Hamilton)	Rewa	Medium
Mastacembelus armatus (Lacepede)	Chuche bam	Low
Xenentodon cancila (Hamilton)	Dhunge bam	Medium
Channa gachua (Hamilton)	Bhoti	Low
Channa striatus (Bloch)	Bhoti	Low
Barilius barna (Hamilton)	Lam Fageta	High
B. bola (Hamilton)	Fageta	High
B. vagra (Hamilton)	Faketa	High
Barilius bendelisis (Hamilton)	Fageta	High
Mystus bleekeri (Day)	Junge	Low
Puntius sophore (Hamilton)	Bhitte	High
P. sarana (Hamilton)	Kande	High
P. titius (Hamilton)	Bhitte	High
P. ticto (Hamilton)	Bhitte	High
Nemacheilus rupicola (McClelland)	Gadela	Low
Garra annaldalei (Hora)	Buduna	Low
Clarias batrachus (L.)	Magur	Low
Psilorynchus pseudochenesis (Menon & Dutta)	Tite	Low
Cirrhinus mrigala (Hamilton)	Naini	Low
Catla catla (Hamilton)	Bhakur	Low
Labeo rohita (Hamilton)	Rohu	Medium
Aristichthys nobilis (Richardson)	Bighead carp	High
Hypophthalmichthys molitrix (Valenciennes)	Silver carp	High
Ctenopharyngodon idella (Valenciennes)	Grass carp	Low
Cyprinus carpio (L.)	Common carp	Low

tendered. If they have to pay loan, 50% amount of earning is deducted for repayment. In order to secure the best price, many fishers deliver their live product.

Market arrangement for recaptured fish

The marketing of recaptured fish (caught after being restocked; restocking is the act of releasing baby fish into the lake to increase fish population) is well organized. Women fisher themselves sell smaller fish weighing less than 2 kg each collected near the shoreline in the local market. A contractor may purchase recaptured fish larger than 2 kg each, which are collected every morning and brought to a chilling center located at the southern edge of the lake, where fresh, processed fillet and smoked products are sold.

Conservation initiative

A substantial quantity of Mahseer (*Tor* spp.) and other native fish were caught every year during '60s in Phewa Lake (Ferro 1980). However, the population was largely depleted and the catch fishery of Mahseer declined sharply, contributing less than 1.4 $mt \cdot y^{-1}$ (**Figure 4**).

There are 23 native fishes reported in Phewa Lake. The abundance of some fish has changed over time. For instance, *Channa* spp. and *Clarias batrachus* have been appeared more frequently in catches, which was not the case earlier. Katle *(Acrossocheilus hexagonolepis)* populations have decreased noticeably. Until 1960s, people catched a mahseer as big as 40 kg (personal communication with local fishers), but now only smaller individuals ($\leq$10 kg) are caught. Mahseer is vulnerable during spawning season, when they migrate towards shallow inlet stream for breeding. To protect these spawners, the fisher community has formed groups on their own initiative to patrol inlet streams during the breeding season (monsoon) and suppress illegal fishing (Gurung 2003b). Women's groups have also been mobilized, and they have proven more effective than their male counterparts at controlling fishing. It appears that few traditional fishers indulge in non-conventional techniques such as the use of electricity, explosives and poisons. Instead, these practices are more typical of urban people visiting the Phewa Lake area. Recently, the fisher community has also been engaged in manual removal of water hyacinth and other invasive macrophytes from the lake.

Code of conduct for sustainable fisheries management

Citizens of both developed and developing countries have a stake in environment, for both their health and that of their children (Downes and Brennan 1998). They now understand that environmental protection and sustainable use of resources such as lake and forest are fundamental to long-term prosperity (Downes and Brennan 1998, FAO 2002). Accordingly, the fisher community in close cooperation with other stakeholders has formulated the following code of conduct:

i. Fishing zone: Fishing in lake by any means is prohibited around 100 m of the Ratna Mandir, Fisheries Research Center, the *Barahi* temple and the inlet stream of Harpan Khola.

ii. Fishing method: Fishing using explosive, chemicals and battery operated electric rods are prohibited. Fishing by hook and line, gill net, and cast net are allowed, except in restricted areas and monsoon seasons. However, gill nets with mesh smaller than 100 mm is not allowed in the offshore of the lake.

iii. Fish culture areas: Cages for fish culture can only be set at three locations in the lake. The permitted sites are *Khapaudi,* in front of Fisheries Research Center and *Sedi* Area.

Lessons learned

The lessons learned from the participatory fisheries approach in recent decades are:

- Participatory programs in a community, which comprises socially deprived and ethnic minorities takes a long time to become self-sustaining in the mainstay of the society.
- The participatory approach to fishery can only be sustainable if the income generated is substantial and adequate to support the involved families.
- Deprived communities are inclined to depend on their stakeholder for various needs in addition to technical support
- The quality of twine, cage and net materials available in Pokhara for fish farming is very poor. In the near future attempts should be made to initiate local production of quality gear for fishing and fish farming.

Implications

The successful application of the participatory fisheries program of Phewa Lake has been implemented in other lakes of Pokhara Valley, Kulekhani Reservoir in Makawanpur District, and some parts of mid and far western development regions of the country. In Kulekhani area, community displaced by the construction of the Kulekhani hydropower dam has been resettled and provided a source of income and employment through cage fish culture and capture fisheries management. Besides the hydropower reservoirs, hundreds of shallow lakes, swamps, wetlands and inundated areas exist in southern plains (Bhandari 1998). In such waters implementation of participatory fishery managements can improve the livelihood of local communities and protect aquatic environments.

Costa-Pierce (1998) argued that cage aquaculture in Indonesian Reservoir is neither environmentally nor socially sustainable. The cage aquaculture was originally guaranteed to the displaced people by provincial legislation, and they were supposed to be granted exclusive control of production and marketing. However the rewards of cage culture have been usurped by the politically powerful and consolidated in the hands of the urban rich. On the other hand, management of the extensive cage fish farming system in Phewa Lake is fully controlled by the fisher community; it is essential that this system be maintained. Recent reports indicate that tourism activities can adversely affect the ecology of pristine ecosystems through the loading of nutrients into the water column (King and Mace 1974, Liddle and Scorgio 1980, Hadwen et at. 2003). Such studies have not been yet carried out in Nepal, though Phewa Lake is under intense pressure from tourism development (Oli 1997, Lamichhane 2000). Since tourism is one of the most lucrative economic sectors fostering around Phewa Lake, adequate attention must be paid to sustainable management of the lake ecosystem so that tourism and fishery may develop

synergistically rather than adversarially.

Conclusions

The threats to sustainability of Phewa Lake are sedimentation, eutrophication and heavy infestation of water hyacinth. If these are controlled, the life of the lake could be improved and lengthened. It is anticipated that fishers can contribute to the sustainable management of Phewa Lake, if they are allowed to participate fully and share their skills and traditional knowledge. Since, the participatory management of natural resources in Phewa Lake has been proved to be an important avenue for sustainable livelihood enhancement of poor, it is anticipated that several other water bodies could be wisely managed to bring deprived fisher communities into the mainstream of society. ■

Acknowledgements

Our work was supported by a series of grants from the Ministry of Agriculture and Cooperatives, Nepal Agriculture Research Council (Project No.62359001), FAO/UNDP, JICA and Hill Agricultural Research Program (HARP: PP: 00/46) of Department for International Development (DFID).

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