

Kolleru carp culture in India: An aquaplosion and an explosion

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A trial blast to demolish unauthorized fish ponds encroaching a designated wildlife sanctuary.

Andhra Pradesh, an east-coastal state in southern India leads the country in carp culture, shrimp culture and also scampi culture. Indian major carp culture in earthen dug-out ponds represents the first phase of aquaculture in the state which has sustained for more than quarter of a century. Because of rapid expansion and intensification, by 2002, the carp culture area increased to about 80,000 ha¹. Almost 98% of the carp culture in the state developed in- and around the largest fresh water lake in India, the Kolleru, which extends between the West Godavari and Krishna districts and is now recognized as the fish bowl of India. This semi-intensive carp culture system, popularly called as Kolleru carp culture, has a production range of 7.5 – 12.5 metric tonnes/ha/year and an annual state production of 600,000 metric tonnes, achieved by growing basically two species *Labeo rohita* (rohu), the dominant species², and *Catla catla* (catla), at the ratio of 80 - 90 : 10 – 20, with a rare addition of *C. mrigala* (mrigal), in heavily fed and fertilized still water ponds, supporting

thousands of farmers and hundreds of thousands of people in allied industries and services. The system has become a unique model of carp culture, not only for the rest of the India, but also for other Asian countries, for example, Bangladesh and Myanmar. More specifically, for the past 15 years, the Kolleru carp culture has become a Mecca, attracting carp farmers, scientists, fishery-policy makers and administrators from other Indian states and also from several foreign countries who are interested in understanding the unique features of the system.

However, with the unprecedented development of the carp culture system, the inherent 'socio-economic-environmental' problems and user conflicts have become increasingly more severe and complex. Because of the devastating losses to agricultural crops and human habitat due to occurrence of heavy floods in September 2005, in both the districts, severe criticism arose from the general public that the fish ponds acted

as obstructions and were responsible for the inundations and the consequent losses.

This grave situation prompted the public in the flood affected areas, environmentalists and other persons and parties claiming to have a serious interest in the restoration of the Kolleru lake to insist upon the Andhra Pradesh state government to implement Government Order number 120 (G.O. 120), which had been passed by the state government in 1999, declaring the area between the '0 to +5' contour of the lake as a wild life sanctuary (WLS) covering approximately 30855 ha. The order had also mandated the removal of all obstructions including fish ponds located within this sanctuary. With the concurrence of the state government, Mr. Lav Agarwal the District Collector of West Godavari in which major portion of the Kolleru lake located, and Mr. Naveen Mittal, Krishna, started and successfully completed the Kolleru Restoration Operation (Kolleru operation) with a minimum of conflict and with

the strong support of the state government and under the active supervision of the central empowerment committee (CEC), appointed by the Supreme court of India.

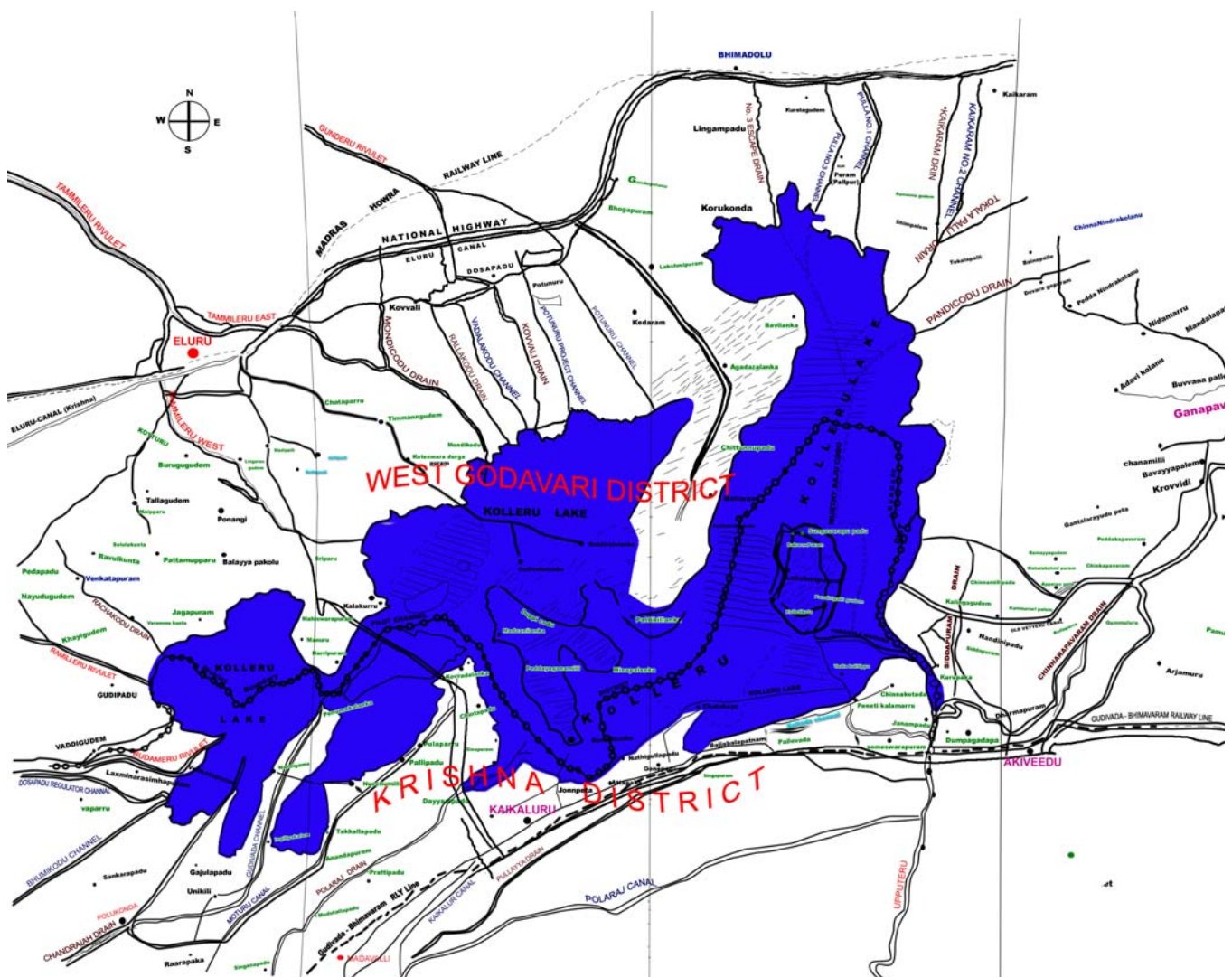
In this article I present an account of the Kolleru operation, which is hailed by the Andhra Pradesh state government as a national victory, for the benefit of fish farmers and stake holders of similar fresh water aquaculture systems either in India or rest of the world, especially Asia. The presentation includes the following: a brief historical background of the Kolleru carp culture; the evolution, environmental, social and legal issues entwined with the development of this unique model of freshwater fish culture system; the Kolleru operation itself; and the rehabilitation measures being implemented.

Kolleru restoration operation

The first phase of Kolleru operation was started in the second week of November 2005 in both West Godavari and Krishna districts by the respective District Collectors, by ordering the breach of the embankments of the fishponds to be demolished either manually or mechanically. Beside each of the breached ponds was erected a warning banner that read "This breach is made by the government; those who repair it shall be prosecuted". The second phase of operation, in the first week of Jan 2006, was marked by demolition of the identified fishponds by making breaches of more than 10 m length and deep enough for draining off pond water by gravitation. The third phase of operation, an unprecedented one in the history of world aquaculture, was started in the third week of February 2006, by blasting the embankments of the unauthorized fish ponds, especially

the bigger ones using explosives. For each pond (40 ha and more) a 150 m long embankment was blasted and the remaining part was removed. In West Godavari district a trial blast was conducted in an empty-dried pond. The third phase was also marked by setting up of integrated check posts comprising the staff revenue, police and forest departments (13 in West Godavari and 4 in Krishna district), to prevent transport of seed, feed and other inputs to the ponds in the WLS, in the personal lands (with legal rights of ownership) were also demolished in the last phase, which was started in May, 2006.

Then there was a brief pause, as the Central Empowerment Committee (CEC) suspended the operation on 26 February 2006, until 11 March the day on which CEC was meeting at Hyderabad (the state capital), to listen to the submissions of different objectors who were opposing the implementation of the Kolleru operation. The CEC,



which had previously toured the areas concerned in the Kolleru, held an open hearing session before declaring its decision on 20 March, to demolish all the remaining fishponds located in the wildlife sanctuary. On 10 April 2006, the Supreme court of India instructed the state government to implement the directions of CEC. The total operation was completed within 15 June 2006, the dead line fixed by the CEC.

The Kolleru operation was the culmination of a complex mixture of economic, social, environmental, legal and political issues and user conflicts, all of which are focal points of national and international importance in the field of aquaculture.

Demolition of fish ponds

In the Kolleru operation a total of 1,776 fish ponds covering an area of 17,890 ha were demolished. In the West Godavari district 1,140 fish ponds covering 11,580 ha, and in the Krishna district 636 fishponds with an area of 6,310 ha were demolished. In total 2,916 fishponds built in occupied lands covering an area of 29,470 ha, were destroyed.

Why was the Kolleru operation executed?

Dr. T. Pantanjali Sastry, an environmentalist, filed a writ petition³ in 1998, in the Andhra Pradesh High Court, pleading for appropriate measures to restore the Kolleru lake to its original state and pristine glory, by stopping the discharge of industrial effluents in to the lake, construction of houses and roads in the catchment area and conversion of hundreds of hectares of land into fish ponds. Through another petition⁴ in 2001 in the same court, Mr. Y. Nagendranath, a former drainage board member sought for the removal of all kinds of obstructions in the Kolleru lake to facilitate free flow of water and also to prevent discharge of all types of effluents. On the other hand, several individual farmers and cooperative fish culture societies also fielded petitions in the state high court requesting the court not to disturb fishponds located within the wildlife sanctuary.

The High Court delivered judgment on 13 July 2001, and declared valid the notification issued by the Andhra Pradesh state government in G.O.120, notifying a 30,855 ha area in '0 to +5' contour as a wildlife sanctuary and prohibiting all kinds of aquaculture and agriculture except for traditional fishing and traditional agriculture practices. In the judgment, the court also directed the state government to take immediate steps for stopping and regulating the effluents being discharged in to the lake, and also to endeavor to remove all encroachments to bring back Kolleru its pristine glory.

Mr. Pranay Waghay, Executive Director of Nallamala Foundation, an environmental working group, filed an application (No. 381) before CEC, raising the issue of destruction and degradation of Kolleru lake in general and Kolleru Wildlife Sanctuary in particular. The CEC heard the parties concerned on 8 July 2004 and 31 January 2006.

In a parallel development, heavy floods occurred on 19 and 20 September 2005 due to cyclonic rains, causing devastating losses to rice agriculture in thousands of hectares in upstream areas of West Godavari and Krishna districts. The inundations continued for a prolonged period of over 40 days. This alarming situation drew the serious attention and concern of general public, district administrators, the state government, and print and electronic media as well, and lead to the allegation that the fish ponds in the lake and surrounding areas the Kolleru were responsible for obstructing the flood water, with the resultant inundation and losses. The cabinet sub-committee, headed by the minister for agriculture, Andhra Pradesh state, toured the villages covered in the wildlife sanctuary in April and again in October 2005. The cabinet sub-committee directed the collectors of the two districts to take immediate measures to remove obstructions in the lake to ensure free flow of flood water so that farmers would be able raise the rice crop in the immediately following season. In the first week of November 2005, the District Collector, West Godavari constituted 14 action teams, with officials from revenue, police, irrigation and forest departments for the execution of Kolleru operation phase 1. Almost simultaneously Kolleru operation phase 1 was started in Krishna district also.

To assist the administration of the two districts in the execution of Kolleru operation, special officers, one each from Indian administrative service, police service, and forest service were also appointed by the state government on a temporary basis till the operation was completed.

Kolleru operation: Support and opposition

The Kolleru operation naturally attracted both considerable support and opposition. While many of the reasons for conducting the operation are outlined above, many people also opposed it on the basis of their economic interests in the area or activities. Opposition groups in general also argued that the livelihoods of Kolleru people should be given priority over protecting birds or wildlife.

A prominent person from Andhra Pradesh opposed Kolleru operation, not as a whole, but the manner in which it was implemented. He was Dr. Jayaprakash Narayan a voluntarily retired officer from Indian Administrative Service, to lead two important social movements "Lok Satta" and "Vote India" in both Andhra Pradesh and rest of the India. He toured the Kolleru during the last phase of the operation, addressed the Kolleru people and advocated that:

1. The ponds built obstructing the drains and channels only must be demolished;
2. the large farmers should be sent out of the Kolleru;
3. fish culture should be placed in the hands of poor people in Kolleru; and
4. that the Wild life sanctuary should be restricted to "0 to +3" contour (rather than the 0+5 contour).

The significance of Kolleru Lake

Geographical details

The Kolleru Lake is a natural geological depression formed as a balancing reservoir between the West Godavari and Krishna districts. The lake is demarked into '0' to '+10' contours with the mean sea level as the reference point. Kolleru is a pulsating lake; when in full flood the water level expands to over 901 km² at +10 contour and recedes to 125 km² at +3 contour during the lean season⁵.

Four rivulets, eighteen drains and 22 irrigation channels empty in to the lake and along with them the effluents from industries, agriculture, urban sewage and fish ponds also. A 63 km long brackish water creek 'Upputeru' drains Kolleru water into the Bay of Bengal. The lake has a catchment area of 3,403 km² in the uplands and 1,360 km² in the delta areas⁵.

Ramsar lake

The Ramsar convention held in Iran in 1971 which has a status of an international treaty identified the lake as one of the wetland ecosystems of International importance⁶. The environmentalists contend that as a signatory of the Ramsar convention, the Indian Union Government, and by that obligation the state government also, have the responsibility to protect the lake and make it free from pollution and all kinds of unauthorized occupation and obstructions.

Villages and population

The bed area of the lake (which corresponds to the area declared for the wildlife sanctuary) has 50 villages (island or bed villages), while the marginal area has 98 (belt) villages spread over in 73 revenue villages, including hamlets. These villages together comprise about 300,000 people, most of whom belong to scheduled castes and tribes⁵. Fishing is the dominant occupation for the lake population.

Wild fishery

Traditionally, the Kolleru is a rich source of wild fishery with significant biodiversity, and a primary source of livelihood for thousands of families dependent on traditional fishing. 128 species of fish and 12 species of prawns were recorded from the fishery catches of the lake and 35 species were recorded in the tidal zone of Upputeru⁵. During 1988 to 1991 fishery production ranged between 2,950 and 3,417 metric tones with an average yield ranging from 218-253 kg/ha⁸. Duck rearing, by maintaining flocks on the natural food available in the open lake, was also an important occupation. In fact, some fish farmers were duck farmers before the advent of carp culture.



Manual breaching of fishpond embankment, (a warning banner can also seen).

Fishing craft and gear in Kolleru

The individual fishermen in Kolleru conduct fishing by using locally developed craft and gear, perfected over ages by tradition and experience. Generally each fishermen is equipped with the following craft and gear: *Doni* – a 10-12 feet long, single person driven canoe, made by scooping out the plinth area of a palm tree of a selected (bent) shape; rowing boats – both small and large. The smaller boats are 5-6 metres long with a 90cm beam width and used for transport of harvested fish and also passengers from village to village within the lake. Bigger boats are about 10 metres long and are used exclusively for transporting cargo. The fishermen use different types, and sizes of traps, locally called *mavus*, to catch different species and sizes of fish.

Wild fishing in Kolleru

Four main types of fishing are practiced in the lake: 1. Individual fishing – by operating *doni* by a single fishermen; 2. *dadikattu* - a wall like structure made with split bamboo strips, enclosing a specified area, traps are fitted to the vents; 3. *doddi fishing* – *doddis* are relatively deeper areas in the lake, where more fish tend to congregate and in this method of fishing the *doddis* are dewatered and harvested; 4. *kampagari fishing* – in certain pockets in the lake the water flow is obstructed by placing weeds and branches of trees, thus encircling and blocking the area from which fish is to be harvested.

Agriculture

Though the Kolleru lands are fertile, agriculture has long been beset with serious problems⁷ specific to this low lying area (last to irrigate and first to inundate; frequent loss of crops properties and lives due to frequent occurrence of devastating floods; exclusive dependence on boat transport; necessity of pumping out water to make the field ready; storing water in temporary reservoirs and providing it back for feeding the rice crop; persistent skin diseases due to constant contact with water, severe leech infestations etc). Naturally, for decades, the Kolleru inhabitants suffered from malnutrition, ill-health, and abject poverty.

Natural bird habitat

The imperial Gazette described Kolleru as "a peerless fishermen's paradise" and "bird heaven"⁵. Ornithologists compared the natural food available for birds with a 'bird-buffet'. The lake was providing shelter, breeding and propagation grounds for about 188 species of migratory and local birds, belonging to 46 families. Out of these, 20 species have been classified as endangered⁵. The Andhra Pradesh government, in 1963, declared a 20 km area in the lake as closed area for the protection of pelicans.

Ironically, many inhabitants in the lake derive part their income through illegal hunting and sale of Kolleru birds. As back as in about 1937, the famous poet from Andhra Pradesh 'Chalam', in his popular book 'Musings', besides depicting the scintillating experience of

boat travel in the pristine Kolleru waters, the joy and pleasure of watching the beauty of Kolleru lake scenarios, and also the gracious moments of innumerable mating, nesting, and brooding birds and their offspring, also mournfully narrated the human cruelty displayed in hunting those birds and birdlings, through various hunting methods including shooting.

Brief history and status of the carp culture

History

A joint team, appointed by the state government, comprising officers from agriculture, fisheries and cooperative departments submitted its report in 1974. In this report were mentioned the first ever suggestions for the development of the fisheries in the lake. In 1976 another special team was appointed entrusting the task of identifying the lands between the +3 and +5 contours, to be used for constructing fishponds. To provide Kolleru people an alternate source of livelihood, Mr. J. Vengala Rao, the then Chief Minister of the state encouraged them to take up pond fish culture. In 1977 and 1978, a total of 133 fishponds, with an area of 2,914 ha were constructed in West Godavari and Krishna districts to benefit 9,493 members of the 132 newly formed Co-operative Societies⁵. This was the start of commercial fish culture in the lake. But, soon, the unsuccessful cooperative societies were forced to hand over fish ponds to financially resourceful private farmers for a specified but extendable lease period, in order to pay off their loans. The private farmers achieved successful crops with sound profits that attracted other private persons, thus, heralding an era of rapid expansion and intensification of fish culture in both Kolleru lake area and also in the neighbouring non-Kolleru areas in both the districts, witnessed in the subsequent 20-25 years. This culture became popular in the name of 'Kolleru carp culture' and evolved in to a model of carp culture for the rest of the Indian states and also some other countries mentioned already.

But it is true that in many instances, the expansion propelled by small number of commercially-oriented farmers for possessing increasingly larger area for culture, was indiscriminate and not in accordance with the principles of

sound and sustainable aquaculture. In the process of expansion thousands of acres of government land, and land allotted by the government for purposes other than fish culture, was occupied without authorization and converted into fishponds of up to 200 ha and farms up to 1000 ha. Despite the picture painted of these larger farmers by the media, in fact, the bulk of the farming community were small and marginal farmers.

These were the people that were really concerned with the sustainability of carp culture as it was the only source of their livelihood and also of developmental activities of their families (children's education, marriages etc.) and also health care expenditure.

In general, Kolleru carp culture mostly comprises farmers from the two districts belonging to a cross section of society with diversified professions, although certain classes of society have been the dominant fraction. In the later phases of expansion, private entrepreneurs from other districts of Andhra Pradesh, and even from other states of India also took up fish culture on a significant scale.

The other factor contributed for the expansion of the carp culture was the conversion of lands possessed by the local population, either legally or illegally, as a common property of a particular village. In most instances these lands were leased out by the villagers, in an open auction to the outside entrepreneurs, before, or, after the construction of fish ponds. The income was shared by the villagers. But in many villages the residents formed into cooperative groups (locally called 'bantas') and undertook culture on their own, by raising finances from money lenders from outside, or, alternatively, these ponds were leased out to selected persons, usually to the leaders at the village level. Misappropriation of the funds and resources of the banta owned ponds is not infrequent.

Present status of the Kolleru carp culture

After the Kolleru operation, the estimated area of carp culture in the Kolleru and surrounding areas in the districts now stands at around 60,000 ha, producing about 450,000 metric tonnes, valued at Rs. 1,035 crores (US\$25.28 million). Almost all this produce is exported to nineteen Indian states with West Bengal followed by Assam at the top. There are 63 carp hatcheries and nursery units in the state producing an

estimated 700 crores of spawn (7 billion three-day old seed) and 210 crores of fry (2.1 billion of around 2.5 cm size). Andhra Pradesh is self-sufficient in seed production and also exporting the Indian major carp seed to the neighbouring states Karnataka and Tamilnadu, Orissa and Maharashtra.

Carp culture is a direct source of livelihood for about 8,000 farmer families. Also, it provides an indirect employment to about a million people, especially in the rural areas, including women, engaged in supporting industries or activities. These are production and supply of seed, supplementary feed, organic and inorganic fertilizers, water and soil quality amendments, fish health management chemicals, and also pond (farm) management, harvesting, ice manufacture, packing, processing and transport. The Indian major carp culture system as with any other successful aquaculture system may be compared to a big Banyan tree providing support, shelter for thousands of birds belonging to many different species and families.

Despite laden with serious problems such as recurring diseases, water quality problems etc. the Kolleru carp culture has proved itself to have the inherent strength to thrust forward even in the troubled waters. One of the contributing factors for the sustainability of the Kolleru carp culture is that, unlike in shrimp and scampi culture in the state, disease issues are minimal thus far⁹.

After Kolleru restoration operation

By the end of September 2006 four months had passed since the completion of the Kolleru operation. Presently there are signs of an emerging and sprouting lake in the 'demolished area', and the local fishermen have resumed traditional fishing. During the Kolleru operation and before also, the district administrators promised the implementation of various rehabilitation programmes to the people who would lose their livelihood and they paid special attention to implement the schemes even as the Kolleru operation was in progress.

Programmes of livelihood and restoration

The various kinds of livelihood programmes were: Support for self employment by granting loans on subsidy (through different state government departments) to buy net materials; to start dairy; buy autos or tractors; sewing machines etc.; educational tours for the villages covered in the operation to Chilka lake (the biggest brackish water lake in India, also another Ramsar lake, situated in the neighbouring Orissa state). The idea of the administrators was that the Kolleru people can witness first hand the cooperative efforts of the local fishermen for earning their livelihoods after implementation of a similar but earlier operation in the Chilka lake. Study tours were conducted to Kerala, a southern state on West coast of India, to learn from the local cooperative societies in the production of value added fishery products. Demonstration on the preparation of ready to cook value added products from the Indian major carps rohu and catla by staff of the Central Institute of Freshwater Aquaculture (CIFA), functioning in the Krishna district so that interested Kolleru people may start mobile fishery canteens.

On 6 October 2006, a central government official declared that US\$1.28 million would be made available to provide livelihoods for Kolleru people, adopting measures to attract migratory birds, and developing Kolleru as a tourist centre.

The expert committee, formed by the special officer on Kolleru operation recommended various fishery related and other rehabilitation measures which were: establishment of post harvest, fish processing centers to be run the self help fishery groups to produce and market value added products from fishery catches from Kolleru such as pickles, fillets etc., establishment of craft and gear manufacturing centres for commercial production of nets, net materials and rafts; marketing Kolleru fish, shellfish and fishery products through a brand signified by Kolleru; developing schemes for the promotion of eco-tourism and health tourism.

Ranching of fish and prawn

Also several measures were recommended for enhancing fishery production and restore ecology of the lake. These were: ranching the seed of Indian major carps *L. rohita*, *C. catla*, *C. mrigala* and grass carp *C. idella*, and also self-reproducing, high value prawn species i.e. *M. rosenbergii*, *M. malcolmsonii* to enhance the economic value of fishery catches from wild Kolleru; declaration of fishing holiday during specific seasons; declaration of fish sanctuaries in the deeper, specified areas of Kolleru lake to protect breeding grounds of the species important from commercial and biodiversity points of view; re-establishment of 'Kolleru Lake Development Board', consisting of experts from different fields concerned, including fisheries, to monitor and ensure the implementation of several related issues mentioned already. According to the state fisheries commissioner 5.6 million fingerlings of Indian major carps have already been released into the lake.

It remains to be seen how far a Kolleru inhabitant, who, so far, enjoyed a regular income from carp culture at about US\$400 per year, will be satisfied with the livelihood programmes being implemented, for, most of the beneficiaries have to acquire new skills and adapt to a changed life style demanded by the new professions.

In July 2006 the CEC members visited, for the first time after the Kolleru operation, to evaluate how efficiently the operation had been executed, and also how the rehabilitation schemes were being implemented. The members participated also in carp seed ranching programme in Kolleru.

The Kolleru carp culture had all the ingredients required for the initiation, expansion and intensification of which the crucial ones were: suitable soil and water resources, highly entrepreneurial and resourceful farmers, peaceful social and political situation conducive for the growth of an aquaculture system, strong support by research and extension agencies, accommodating market for constantly increasing production, well developed supporting industries and transport net work. However, the Kolleru operation reveals that all these are essential, but not sufficient in themselves, for the permanent success of an aquaculture system. Some other essential characters required are: clear

ownership rights of land concerned; active support of the government; winning good will and encouragement of not only neighbors but also the general public and other user groups; strict adherence to the best management practices so as to protect the quality of pond water, the fish produced, and also the environment; ensuring judicious and proportionate sharing of the fruits of aquaculture by all the social classes involved.

The difficulties of the genuine carp farmer

If one considers the support of society in general for carp culture in the state, there is little sympathy in any section of the society for the farmers who lost ponds that were in the wildlife sanctuary. But the real agony is of the genuine carp culturists in the rest of the culture area, in both the districts, who have dedicated all the prime of their lives, and invested their hard earned financial resources, most of them for two generations, for the development of carp culture in the state, but who are now left with a diminished self respect. Along with the fish farmers who built ponds in unauthorized lands, these genuine farmers are also looked down upon, as if their growing fish is an illegal or a prohibited activity. It will require a concerted effort to erase the tarnished image of a general carp culturist depicted by the ill-informed general public, print and electronic media, fumigated with many misconceived opinions about aquaculture in the state, disregarding the invaluable contribution of aquaculture and farmers to the economy and nutritional needs of a society.

Still, two thirds of intact carp culture area (about 60,000 ha), is in the hands of legal right holders in West Godavari and Krishna districts. Though located in the non Kolleru area and above +5 contour of the lake, the effluents from most of these ponds are destined ultimately to be discharged into the Kolleru Lake itself. For the restoration of Kolleru Lake, prevention of the discharge of fish pond effluents, besides industrial and urban effluents, is an inevitable measure. The prevention of effluent discharge into the lake was supported in the judgments of the Supreme court of India and the High court, Andhra Pradesh. It is known that the character of fish pond effluents is also determined

and impacted by the important management practices implemented during the on-going culture. In future also there is every possibility that the state and central governments and the courts will take a serious view of aquaculture, if it violates sound management principles, induces user conflicts and affects other user groups, the rights of consumers and other sections of the society. On the other hand, unsound management practices drastically decrease the economic efficiency of the carp culture in several ways and ultimately may result in serious losses, which, in turn, may force the farmers to abandon the culture. To ensure further sustainability of this un-paralleled carp culture system in Asia, for decades to come, it is time that a thorough and urgent review of the entire carp culture system in the state is undertaken, problems identified, and remedial measures implemented.

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The business approach to operating national broodstock centres: An innovative strategy for developing the freshwater aquaculture seed industry in Viet Nam

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The freshwater fish seed industry in Viet Nam supports a dynamic freshwater aquaculture sector, which has made significant contributions to incomes and food security. Freshwater aquaculture production has been growing rapidly since the late 1980s, with output value reaching US\$ 585 million in 2001 (FAO, 2004). The Ministry of Fisheries (MOFI) of Viet Nam projects production to grow by 11.4% annually from 1999 to 2010 (MOFI, 1999). Likewise, seed demand is projected to grow annually by 4.9% from 2005 to 2010 (MOFI, 2003).

Recently however, deterioration in seed quality has been cited as a major constraint to the growth of downstream freshwater aquaculture. This has been attributed to poor broodstock quality and poor management practices. In

response, the Government of Viet Nam has recently approved the establishment of three National Broodstock Centres (NBCs) under MOFI, to maintain and upgrade seed quality nationwide.

Establishment of the NBCs occurs within the context of doi moi (reform or renewal) policy, which mandates market-oriented reforms. Hence, while the government subsidized the construction of broodstock centre facilities, it delegated responsibility to finance operating or running costs to the NBCs themselves, essentially as self-sustaining businesses. The adoption of a business strategy for broodstock centres is an important institutional

innovation that could possibly be a model for seed industry development in other countries.

Implementation of the new strategy soon made clear the need for sound business planning to support operations and financing. Hence the MOFI, with support of the Danish Agency for International Development, undertook a capacity-building initiative for the NBCs based on a systematic assessment of business conditions and participatory business planning. This paper presents the framework, method, and outcomes of this initiative.