Introduction of culture based fishery practices in small water bodies in Cambodia: issues and strategies

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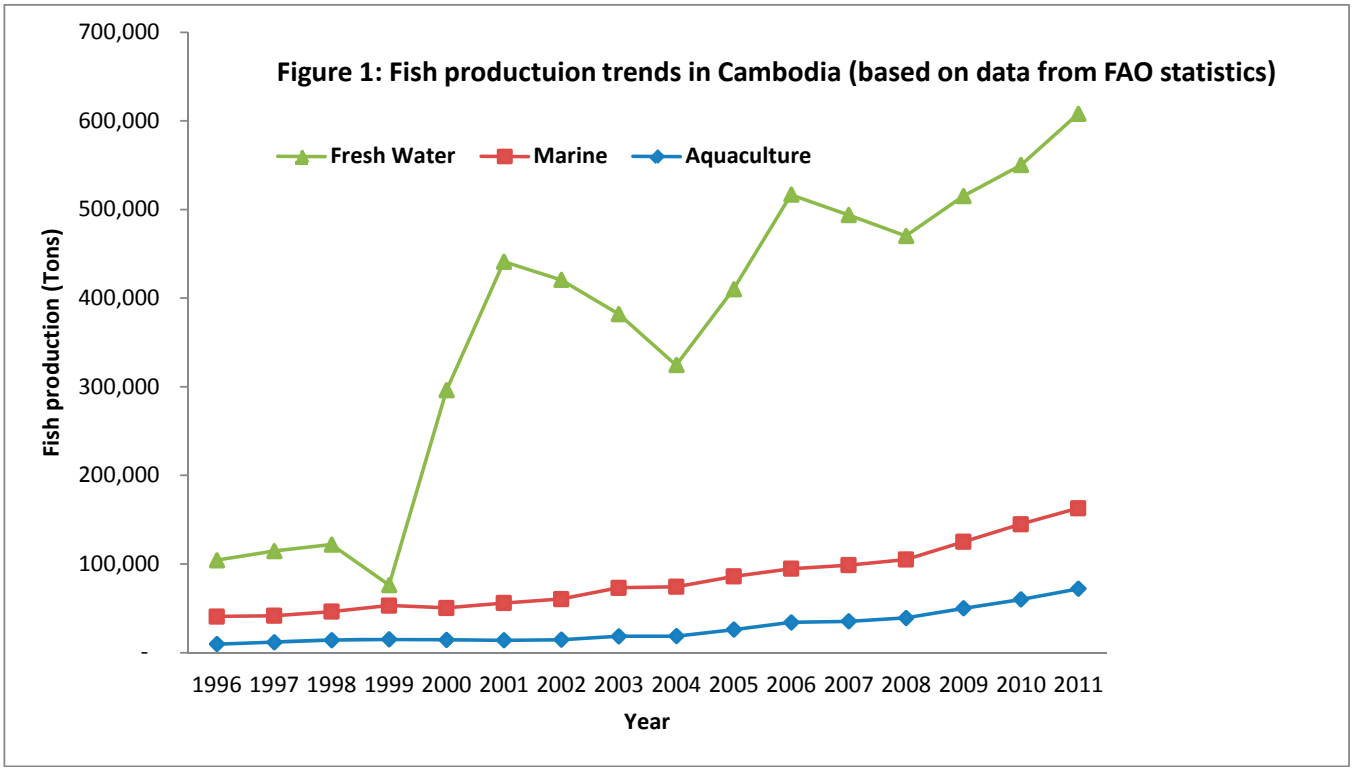
Seed stocks are blessed by Buddhist monks prior to release, in compliance with accepted custom in Cambodia.

Cambodia, bordering Thailand, Vietnam and Laos has an area of 181,035 km^2, with a coast line of 443 km bordering the Gulf of Thailand. It is a country that is blessed with a relatively large amount of inland waters, estimated at 4,520 km^2 (CIA 2013). The population of Cambodia is approximately 15 million (as of 2012). Its climate is tropical characterised by a rainy monsoon season (May to November) and dry season (December to April). Cambodian people are among the highest fish eaters in the world, perhaps reflection of the relative availability, particularly of freshwater fish and other aquatic animals, at an affordable price.

Fish is the most important source of animal protein for human consumption in Cambodia. On average it makes up more than 75% of animal protein and in some areas of the country aquatic resources make up 90% of the available animal protein. According to Ahmed et al. (1998) on average aquatic organisms make up more than 80% of the animal protein consumed in the country and, 90% in fishing dependent provinces such as Siem Reap. Overall, fish consumption is estimated to be around 52.4kg/person/year (MRC, 2007) (whole fish equivalent) and is many times greater than the global average, reflecting the importance of the fisheries sector to the diet and culture of Cambodian people. Processed fish, particularly in the form of fish paste and fish sauce, provide a daily source of fish for the national diet throughout the year and smoothen out the seasonal fluctuations in landings.

The main inland fisheries in Cambodia, until very recently, were the fishing lots in the Great Lake (Tonle Sap) (see for example, Chadwick et al. 2008) and the dai fishery in the mainstream of the Mekong River. The latter is a very seasonal and an intense fishery in which very large quantities of fish in their migratory route(s), primarily carp species, such as *Henicorhynchus* spp. are caught (Adamson et al. 2009). The latter fisheries provide the raw material for the preparation of the various types of fish sauces and pastes that form a crucial component of the Cambodian cuisine. In the recent past changes in the fishery regulations resulted in the prohibition of the establishment of fishing lots in the Great Lake, and thereby opening vast areas of the lake for fishing by individuals on an open access basis (FiA, 2013).

In Cambodia the great bulk of fish production is from the inland capture fishery (Figure 1). This sector has maintained its dominance over the last few decades but there are signs that the levels are plateauing. On the other hand, production from the marine capture fishery and aquaculture has increased only slightly, over the years, and the latter at higher rate. Notably, aquaculture production upsurge began



Regular community consultations are an important entity in culture-based fisheries practices.

Cambodian rural communities fish for edible aquatic food types on a daily basis for family consumption.

around 1998-2000 and has been increasing steadily. With the Government of Cambodia encouraging aquaculture developments such a trend is likely to continue, albeit slowly.

In the wake of the production almost plateauing in capture fisheries and in order to cater to the increasing demand for food fish by a growing population (1.75% per year), the Royal Government of Cambodia is making a concerted attempt to meet the gap between demand and supply through aquaculture development (Government of Cambodia 2010). Accordingly, one of the plausible strategies is to develop culture based fisheries (CBF) in small water bodies located in rural areas; a strategy that is known to be highly successful for example in Sri Lanka, Vietnam and Laos (Nguyen et al., 2005; Wijenayake et al., 2005; Saphakdy et al. 2009; Lao PDR, Ministry of Agriculture & Forestry 2010; Pearce and Templeton 2011, among others).

Culture-based fisheries

Culture-based fisheries are a form of aquaculture that utilise small water bodies, both perennial and non-perennial, which cannot support a fishery through natural recruitment processes, for food fish production through a stock-recapture strategy. Culture-based fisheries are environmentally friendly as the only external input is seed stock. It also engages a co-management approach utilising the downstream farming communities—in most instances already organised into functional entities for dry land agriculture—as the principal beneficiaries (De Silva 2003).

Accordingly, culture-based fisheries have been accepted as a significant development strategy, needing minimal capital outlay, for increasing food fish production and improving rural community wellbeing by most countries in Asia, including Cambodia and Laos (Government of Cambodia 2010; Lao PDR, Ministry of Agriculture & Forestry 2010) and also globally as an avenue for increasing inland fish production (Beard et al. 2011). Culture-based fisheries are an attractive development strategy as it mobilises dry land farming communities (e.g. rice farmers) to use existing water bodies for the secondary purpose of food fish production. Where successfully adopted, culture-based fisheries bring about communal harmony and synergies within farming communities. The strategies to optimise benefits from culture-based fisheries, however, vary in detail from country to country and across climatic regimes.

Application of culture-based fisheries in Cambodian waters

Initiation of the trials

The application of culture-based fisheries in Cambodian waters commenced with the initiation of a project under the auspices of the Australian Centre for International Agricultural Research (ACIAR Project FIS/2011/013), coordinated by NACA. For the initial trial 16 small reservoirs located in four provinces were selected (Table 1). These reservoirs differed from each other in surface area, mean depth and the catchment land use features, the latter evaluated using GIS software. In choosing the reservoirs initial consultations with the village communities responsible for the water regime management were held and their agreement obtained for monitoring and cooperating through the trial period. One common feature in all the reservoirs selected, and for that matter in all water bodies in Cambodia, is the provision of a "conservation zone", generally in the deeper areas of the water body, where fishing is prohibited.

Catchment land use patterns (detailed in De Silva 2013) were used to estimate the optimal stocking densities for each reservoir. This was based on the principle that catchment land use patterns impact on fish yield in perennial reservoirs (see De Silva et al. 2001) and application of this principle in the absence of any other plausible ways to computing the stocking densities. Based on these computations the reservoirs were stocked with *Pangasius* spp. and *Punitus gonionotus* (silver barb) fingerlings and post larvae of *Macrobrachium rosenbergii* (giant freshwater prawn) in November-Dececember 2012. A total of 1,518,000 seed were used. The choice of species to be stocked was based on preferences of the individual stakeholder communities. In this regard the provincial community groups were requested to indicate the most preferred species, and based on the biology and availability of seed stock of each a rank order was developed. The first five preferred species were used for stocking the water bodies in each province.

Although there was general agreement with the village communities in the immediate vicinity of each water body to refrain from fishing after stocking, for a period of four to six months, it could not be avoided fully. This is because Cambodian fishery laws permit free access to any water body, and secondly the rural poor often fish daily for their food fish needs, often catching very small sized, naturally recruited fish. The weed/forage species most commonly caught belonged to ten families of which those of the Cyprinidae were the most common: *Mystus nemurus*, *M. wolffi* (Family Bagridae), *Channa striata* (Family Channidae), *Clarias meladerma* (Family Clarridae), *Cirrhinus microlepis*, *Cirrhinus*

Table 1. The reservoirs and the surface and catchment areas of each used in the culture-based fisheries trial in each of the provinces (T. = Tumnop - the Cambodian term for Reservoir).

Province/area	Reservoir			
Siem Reap P.	T. Makak	T. Trapeang Toteung	O Kandol	Travkaud
Lake area (ha)	16.9	11	36.30	22.24
Total catchment (ha)	180,376	10,462	5,911	5,478
Kampong Thom P.	Boeung Krochap	Boeung Meas	Boeung Leas	Boeung Trapeang Russey
Lake area (ha)	7.77	20.4	12.5	23.6
Total catchment (ha)	7511	7230	2343	5794
Uddor Meanchey P.	Boeung Lorlom Vean	T. Ta Mok	Boeung Rolom Taneat	Trapeang Ampil
Lake area (ha)	9.5	24	10	44.5
Total catchment (ha)	34231	2034	11859	13581
Preah Vihear P.	T. Trapeang Prey	Srey Snam	T.Meun Reach	T. Kav Pram
Lake area (ha)	2.30	12.2	7.8	54.4
Total catchment (ha)	72.5	1247	664	4666

Table 2. The number of species caught, the number of active fishers and the monthly total estimated catch May 2013) during the CBF trial in each of the reservoirs in each of the provinces.

Province/area	Reservoir			
Siem Reap P.	T. Makak	Toteung T. Trapeang	O Kandol	Travkaud
No. of species caught	14	10	12	11
No. of active fishers	15	5	16	5
Estimated catch (May)	562.5 kg	150 kg	621 kg	150 kg
Kampong Thom P.	Boeung Krochap	Boeung Meas	Boeung Leas	Boeung Trapeang Russey
No. of species caught	13	16	13	10
No. of active fishers	5	15	10	15
Estimated catch (May)	112.5 kg	445 kg	270 kg	600 kg
Uddor Meanchey P.	Boeung Lorlom Vean	T. Ta Mok	Boeung Rolom Taneat	Trapeang Ampil
No. of species caught	11	14	11	12
No. of active fishers	15	12	7	7
Estimated catch (May)	562.5 kg	360 kg	140 kg	105 kg
Preah Vihear P.	T. Trapeang Prey	Srey Snam	T.Meun Reach	T. Kav Pram
No. of species caught	8	10	8	12
No. of active fishers	5	16	6	15
Estimated catch (May)	40 kg	720 kg	180 kg	900 kg

molitorella, *Cyclocheilichthys apogon*, *Dangila* sp.cf.*cuvieri*, *Dangila spilopleura*, *Hampala dispar*, *Henicorhynchus* spp., *Osteochilus hasselti*, *Osteochilus schlegeli* , *Hypsibarbu* spp., *Leptobarbus hoeveni* , *Puntioplites falcifer, Puntius brevis*, *Rasbora tornieri*, *Thynnichthys thynnoides* (Family Cyprinidae), *Oxyeleotris marmorata*, (Family Eleotridae), *Notopterus notopterus* (Fam: Notopteridae), *Trichogaster pectoralis* (Family: Osphronemidae), *Pangasius larnaudiei* (Family: Pangasiidae),

Acantopsis (Family: Percophidae), *Pristolepis fasciata* (Family: Pristolepididae), *Boesemania microlepis* (Family: Sciaenidae), and *Hemisilurus mekongensis*, *Micronema bleekeri*, *Ompok hypophthalmus*, *Wallago attu* (Family: Siluridae).

Needless to say among these catches were stocked species, caught under-sized, long before attaining a marketable size, which would result in obtaining sub-optimal yields from the culture-based fisheries activities. However, the results thus far indicated that the yields have risen considerably over pre-stocking levels and the mean size of fish caught was also considerably higher. Table 2 provides information on catches in May 2013. It is evident, and as expected the yield varied considerably among the different reservoirs. Attempts to ascertain for the reasons for this wide range in yield will be made later at the end of the study when a complete data set for two growth cycles are obtained. Importantly all indications are that the fish production in all the reservoirs have increased considerably and the communities are satisfied with the outcome thus far. However, if the culture-based fisheries practices could be improved as considered in the following sections the gains could be increased significantly.

Issues associated with optimisation of returns from culture-based fisheries

The best results in culture-based fisheries are obtained when:

- The natural productivity (e.g. chlorophyll content, and nutrient loads) are relatively high, often brought about from the runoff from a catchment with considerable proportion of forest/grass cover etc.
- Forage fish and other predatory aquatic organisms are eliminated and or minimised.
- Correct species combination is utilised at stocking.
- Seed stock is of good quality and of appropriate size (larger fingerlings generally have better survival).
- The water level recedes at a suitable rate.
- Poaching is curtailed.
- Fish sanctuaries are established in all project sites.
- Fishing does NOT take place for a four to six month period after stocking.

Overall management of the water body, including the maintenance of suitable water regimes in the grow out period is effective and efficient.

It is seen from the above that yield optimisation will depend on the nature of the water body as well as on some management criteria, such as for example use of the correct species combination and prohibition of fishing for four to six month period after stocking. The question therefore is to what extent do the Cambodian water bodies, in general, comply to the above criteria. Obviously, one would not expect each and every water body to satisfy all of the criteria.

Aspects that negatively impact on the practice of culture-based fisheries in Cambodia

Firstly, culture-based fisheries are new to Cambodia. In the past with an abundance of fish from the Great Lake and also in the Mekong and associated waterways there was no dire need to adopt culture-based fisheries and the like. However, as previously stated the situation has changed and there is an urgent need to step up food fish production to meet the shortfall in demand. The water levels in small water bodies in Cambodia, unlike most other Asian countries where culture-based fisheries are practiced, do not recede to a great extent. As such the former are mostly perennial. This makes it difficult, if not impossible, to eradicate weed/ forage fish and other predators prior to stocking. On the other hand, the continued fishing helps to keep weed/ forage fish abundance in check, and also provides an important food fish source.

Perhaps the most detrimental aspect is the continued fishing, even immediately after stocking, which does not provide sufficient time for the stocked fish to reach a marketable size. The communities in the immediate vicinities of the trial sites, when explained, understand the need to refrain from fishing for a few months after stocking. Because of this understanding the fishing pressure in the immediate post stocking period has decreased and hence the increased size of the landed fish and the overall increased yields. However, it is desirable to adopt strategies, within the framework of the Cambodian fishery regulations, and the rural cultural habits to further enhance the fish production.

Plausible strategies to enhance the outcome from culture-based fisheries in Cambodia

It is evident from the foregoing sections that in spite of the negatives practices in Cambodia are beginning to yield favourable results and are likely to take root throughout the country. One of the plausible strategies to further optimise the outcome from culture-based fisheries practices will be to utilise the “conservation zone” in each water body, in an effective manner.

Cambodian people adhere strictly to avoid fishing in the conservation area in a water body; this is ingrained into the public mind set. From a culture-based fisheries view point it will be desirable to increase the conservation area by a further 10 to 15 % and then cordon off this area with a net or bamboo fencing. Always introduce the seed stock into the conservation area and the netting it off would minimise the movement of the fish to the rest of the water body, thereby giving a higher probability for them to grow to a bigger size and avoid predators later on. The netted fish may be released after four to five months and the normal fishing activities

could resume. It is also suggested that the catches two days after the netting is removed be designated a "communal catch', and this catch be sold in the open market and all the proceeds be used for the purchase of seed stock for the next growth cycle. In this manner it is expected not only a significant increase in fish yield but also ensure the sustainability of the process and become independent of external sources to fund the cost of seed stock and expenditure incurred on improving the physical structure of the water body.

The above strategy has been accepted in principle by all the communities engaged in the present trial. Indeed, in the consultations the communities were of the view that this strategy is easily implementable. The next growth trial will estimate the impact of this strategy and if the results are positive will advise the Government to follow this path in extending culture-based fisheries to other provinces. It is important to note that this proposed strategy does not interfere with the Cambodian fishery regulations and nor does it interfere with the rights of access to fish in water body.

References

Adamson, E.A.S., Hurwood, D.A., Baker, A.M., Mather, P.B., 2009. Poulation subdivision in Siamese mud carp *Henicorhynchus siamensis* in the Mekong River: implications for management. Journal of Fish Biology, 75, 1371-1392. Doi:10.1111/j.1095-8649-2009.02369.x.

Ahmed et al. 1998. Socio-Economic assessment of Freshwater Capture Fisheries of Cambodia. Report on a Household Survey 3; 49 pp.

Beard T.D. Jr, Arlinghaus R., Cooke S.J., McIntyre P., De Silva S., Bartley D., Cowx I.G. 2011. Ecosystem approach to inland fisheries: research needs and implementation strategies. Biology Letters 7(4), 481–483.

Chadwick, M.T., Juntapas, M., Sithirith, M. (eds). 2008. Sustaining Tonle Sap: an assessment of development challenges facing the Great Lake. Sustainable Mekong Research Network (Sumernet), Bangkok, 144 pp. ISBN 978-91-86125-06-6.

Central Intelligence Agency (accessed 2013). The World Factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/cb.html

De Silva S.S. 2003. Culture-based fisheries: an underutilized opportunity in aquaculture. Aquaculture 221, 221–243.

De Silva, S.S. 2013. Use of 'Catchment Land Use Pattern Data', based on GIS analysis, to determine the potential stocking densities for the reservoirs in Cambodia. Internal report, January 2013 (Revision.3), NACA , Bangkok, 21 pp.

De Silva, S. S., Amarasinghe, U.S., Nissanka, C., Wijesooriya, W.A.D.D., Fernando M. J. J., 2001. Use of geographical information systems as a tool for fish yield prediction in tropical reservoirs: case study on Sri Lankan reservoirs. Fisheries Management and Ecology 8; 47- 60.

Fisheries Administration (FiA), 2012. Cambodia Fisheries Annual Report 2012. 16 pp

Government of Cambodia 2010. The Strategic Planning Framework for Fisheries 2010–2019. 57 pp.

Lao PDR, Ministry of Agriculture & Forestry, 2010. Agricultural Master Plan, 2011 to 2015. Vientiane, Lao PDR. 122 pp

MRC (Mekong River Commission), 2007. Consumption and yield of fish and other aquatic animal from the lower Mekong Basin. MRC Technical Paper No.16; October 2007, 65 pp.

Nguyen H.S., Bui A.T., Nguyen D.Q., Truong D.Q., Le L.T., Abery N.W., De Silva S.S. 2005. Culture-based fisheries in small reservoirs in northern Vietnam: effect of stocking density and species combinations. Aquaculture Research 36, 1037–1048 Pearce D., Templeton D. 2011. Adoption of ACIAR project outputs: studies of projects completed in 2006–07. ACIAR: Canberra. 69 pp.

Saphakdy B., Phomsouvanh A., Davy B., Nguyen T.T.T. and De Silva S.S. 2009. Contrasting community management and revenue sharing practices of culture-based fisheries in Lao PDR. Aquaculture Asia 14(3), 3–7.

Wijenayake W.M.H.K., Jayasinghe U.A.D., Amarasinghe U.S., Athula J.A., Pushpalatha K.B.C., De Silva S.S. 2005. Culture-based fisheries in non-perennial reservoirs in Sri Lanka: production and relative performance of stocked species. Fisheries Management and Ecology 12, 249–258.

A case study on polycheate fishery by the Irular tribal fishing community on the Tamil Nadu Coast

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The Irulars are a non-traditional fishing community living in the Pitchavaram region, primarily harvesting the fishery resources of the mangroves for their livelihood. Historically their ancestors migrated from Andhra Pradesh and engaged mainly in a hunter-gatherer lifestyle. As the years rolled by some of them started serving in the casuarina and coconut plantations of local farmers as bonded labourers, eventually developing their own unique fishing methods and transitioning into fisheries as a mainstay occupation. Most Irular fishers eke out a living capturing shrimp by hand from mangrove areas. This activity is principally conducted by women.

Fishers sit on their knees in shallow mangrove waters, stretching out their arms and moving their hands across the surface of the mud from the sides to the front. If they feel they have made contact with a shrimp, they grasp it and bring it to the surface to be washed and placed in a pouch, which is held between their teeth. Repeating this process the fishers move forward until they reach deeper waters. They may fish for shrimp in this method for five to six hours at a stretch until the end of the low tide period with a break in between. They cannot fish during the high tide. Almost the entire Irular