Impact of climate change on culture-based fisheries in seasonal reservoirs of Sri Lanka and the resilience capacities of rural communities

Policy brief

Policy recommendations

- Long term simulation of water volumes of seasonal reservoirs and those associated in cascades should be combined with other models to predict reservoir filling patterns.
- Climate change has shifted the filling pattern of the seasonal reservoirs so that changes in stocking pattern are needed in culture based fisheries.
- Fish can be stocked in cages in the reservoir and released after spilling off the reservoir.
- Alternative means of stocking fish fingerlings reared by rural communities should be sought.
- Improved water management strategies should be adapted by paddy farming communities to improve water retention in reservoirs.
- Identification of alternative means of stocking (perennial reservoirs, minor perennial reservoirs, fish pods etc.) is useful to stock fingerlings produced during the instances where the seasonal tanks are not filled on time.
- Improvement of value addition and product development for harvested fish would be an alternative to overcome marketing problems of less grown fish species.

Culture based fisheries and climate change

This brief summarises the results from the interdisciplinary study conducted within the Aquaclimate project in Sri Lanka, which investigated the impacts of climate change on culture based fisheries. The brief further provides guidelines for adaptation and policy development to address the climate change impacts on culture based fisheries in Sri Lanka and how adaptation measures should be implemented.

Significance of culture based fisheries

The impacts of climate change on fisheries and aquaculture are significant as aquatic environments are very sensitive to environmental perturbation. The biophysical changes as well as the socio-economic impacts on riparian communities are major challenges in aquaculture and fisheries sectors under climate change scenarios (Yazdi and Shakouri 2010; Cheung et al. 2009). Since the early 1980s, small village reservoirs have been used for culture-based fisheries (CBF) which essentially involves stocking of hatchery reared fish fingerlings in natural or semi-natural water bodies to enhance fish production. CBF is therefore a secondary use of existing water resources which can provide substantial benefits to communities in rural areas (De Silva et al., 2006). The unique feature of CBF is that it is not a competitor with traditional paddy cultivation and as such, it has become increasingly popular among rural farming communities.

Induced breeding of major carps, rearing of post larvae to fry stage and then to fingerling stage are major pre-stocking activities associated with CBF and alternative carp aquaculture strategies (Figure 1). The absence of sufficient rainfall or shifting of inter-monsoonal rains due to climate change might influence the CBF cycle negatively. As a result, rural fish farmers might encounter significant financial losses at every stage of CBF.

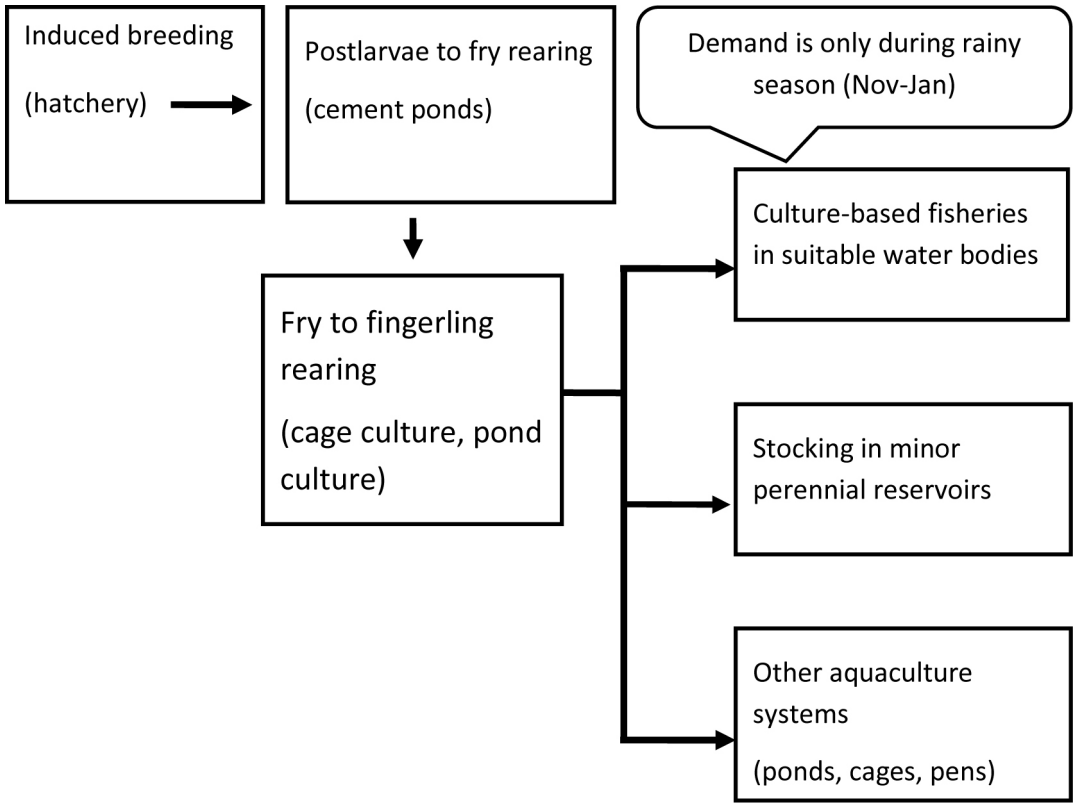
Rural agriculture activities and CBF in Sri Lanka are based on the two rainy seasons during April-May and October-December. Stocking fish fingerlings in reservoirs for CBF is carried out in December to January when the reservoirs are at their full capacity and harvesting is carried out in the dry period which usually falls in July-September. When the development of CBF is carried out in seasonal reservoirs, one of the major requirements would be to make available fish fingerlings for stocking at the correct time coinciding with reservoir filling following inter-monsoonal rains in October-December (Figure 2). The time of the onset of the rainfall as well as the duration also alter the traditional crop calendar of farming. Similarly, it can be expected that CBF calendar would also be affected by changes in rainfall patterns.

Major challenges to culture based fisheries in Sri Lanka

Frequent fluctuation of reservoir volume

Frequent fluctuation of water levels in seasonal reservoirs in the recent past can be observed from most of the selected reservoirs for this study. Figures 3 a and b show the changes of volume of Wawewgma Wewa reservoir in Hambantota district in the period of 1961-1970 and 2001-2010, respectively. Graphs indicate the frequent drying off of the reservoir in recent decades.

Figure 1. Various options for carp aquaculture in Sri Lanka.



Increased drawdown of reservoirs

Figure 4 indicates comparatively high drawdown of water level from 2001 - 2010 compared to the 1960s. Among the all reservoirs the drawdown volume has been increased compared to the volume in the 1960s. Although the drawdown volumes of the reservoirs have been increased, reservoirs in Anuradapura and Kurunegala have less drawdown compared to reservoirs in Hamabamtota District. Several authors have revealed that the reduction of rainfall over the country in recent past (de Silva 2009; Ranatunge *et al*., 2003). Eriyagama *et al.* (2010) indicated that the reduction of annual rainfall over the country from 1961 to 1990 compared to the period of 1931 to 1960 was 144 mm. As such an increased drawdown of the volumes in reservoirs would be expected with the climate change scenario.

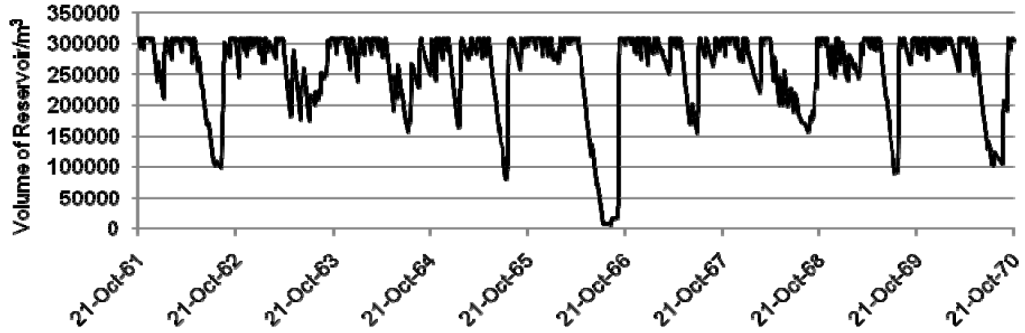
Shifting of drawdown

Shifting of the drawdown period can be observed from the reservoirs in the last decade compared to the 1960s. Figure 4 indicates the forward shifting of drawdown in the period of 2005-2010 in Wewegama Wewa reservoir in Hambantota District. This shifting was observed in most of the reservoirs in the sample. The shifting of drawdown is a potential risk on the duration of the culture period of the stocked species in non-perennial reservoirs. Highly shifted drawdown periods can be observed in the Wewegama Wewa reservoir in Hambantota District (Figure 4), with a shift of one month in 2005 to 2010 compared to 1960s pattern.

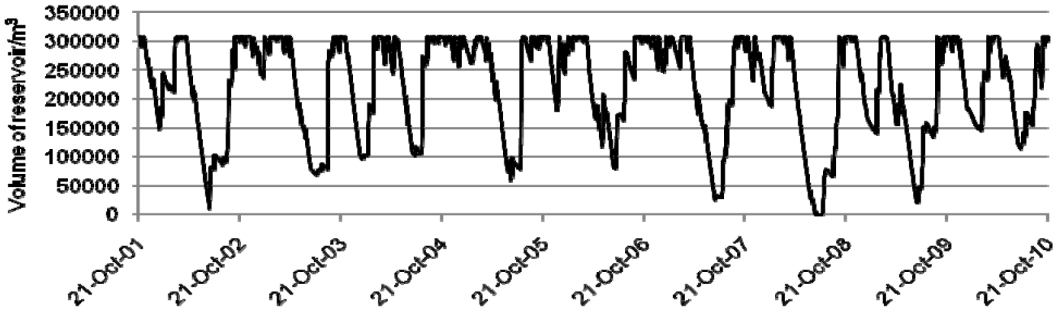
Figure 2. Correct timing of culture-based fisheries in seasonal reservoirs of Sri Lanka. Rainy seasons (N, D, J) are shaded. Adopted from Amarasinghe and Weerakoon (2009).

Months																		
M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
Induced breeding carps		Fry rearing			Fingerling rearing			Storing in reservoirs				Culture period					Harvesting	

Figure 3. Fluctuation of reservoir volume of Wewegama Wewa reservoir in Hambantota district. (a) and (b) indicate the fluctuation of reservoir volume from 1961 to 1970 and 2001 to 2010.



(a)



(b)

Impacts of climate change on culture based fisheries

This creates uncertainty of water availability in reservoirs and stocking of fingerlings at the correct time was problematic due to non availability of water in reservoirs when fingerlings are ready for stocking. This issue also alters culture period (shortened culture period and/or inability of harvesting due to reservoir filling).

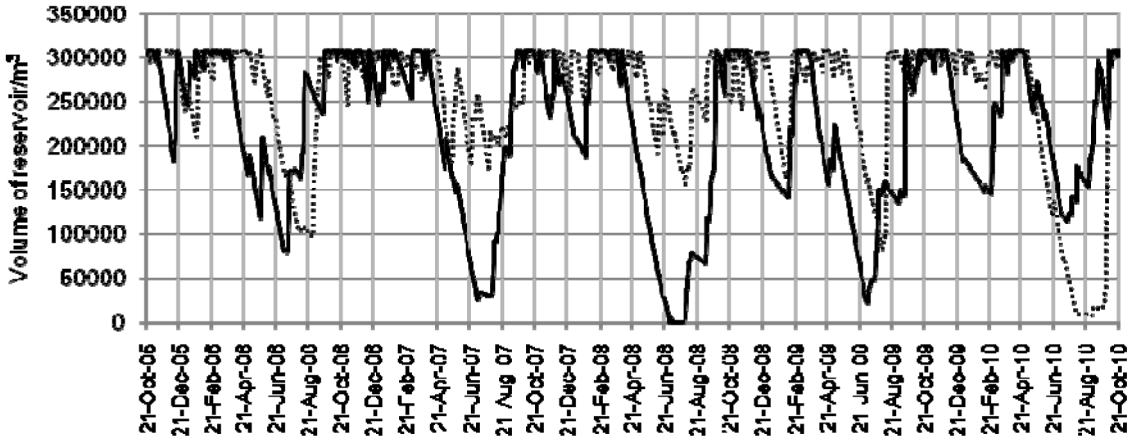
Increased drawdown and the shifting of the drawdown period in seasonal reservoirs would impact on the sustainability of the CBF in seasonal reservoirs. Early draw down leads to shortened culture period causing marketing difficulties and low production. Frequent fluctuations of reservoir volume potentially create the stressful conditions to stocked fish species and may increase the mortality due to disease and increased vulnerability to predators and poaching. The frequent fluctuation can create intolerable water quality extremes causing massive deaths of stocked fish. Therefore, identification of strategies to improve the resilience of vulnerable fish farming communities to climate change impacts is important for the sustainability of CBF in seasonal reservoirs.

Policy measures

The measures suggested are based on scientific analysis and stakeholders' inputs.

- Long term simulation of water volumes of seasonal reservoirs and those associated in the cascades should be combined with other models to predict reservoir filling patterns
- Reservoirs prone to early drying out due to changes in rainfall pattern can be earmarked by using historical analysis of water level fluctuations.
- This can also be used to rank the reservoirs, in terms of both high and low vulnerability to climate change impacts. Accordingly stocking programmes can be prioritised on the basis of less vulnerable reservoirs.
- Climate change has shifted the filling pattern of the seasonal reservoirs so that changes in stocking pattern are needed in culture based fisheries
- The filling pattern of the seasonal reservoirs in different agro-ecological regions in the country has changed. This needs further studies in order to identify the exact filling patterns of these reservoirs in order to plan stocking of fingerlings.

Figure 4. Increased drawdown and Shifting of drawdown period of Wewegama Wewa in 2005-2010 compared to 1965-1970. Dotted line indicates the fluctuation of reservoir volume in 1965-1970.



- Fish can be stocked in cages in the reservoir and release them after spilling off the reservoir

Current analysis has shown that the reservoirs have reached full capacity in the period of September-November in most reservoirs. However, farmers are reluctant to stock fish in reservoirs until spilling off has completed. If fish can be stocked in cages in the reservoir and released after spilling off the reservoir, an extra two-three month can be added to the culture period, where reservoirs have shifted drawdown.

Alternative means of stocking fish fingerlings reared by rural communities should be sought

Alternative means of stocking fish fingerlings reared by rural communities should be sought. Hence, harmonisation of agricultural and CBF activities in minor perennial reservoirs as well as in seasonal reservoirs, depending on the water availability, is recommended to improve climate change adaptation of rural communities.

Improved water management strategies should be adapted by the paddy farming communities to improve the water retention in reservoirs

Improved water management strategies should be adapted by the paddy farming communities to improve the water retention in reservoirs. Therefore, managerial decisions for CBF should be taken at the "Kanna Meeting" (a seasonal meeting conducted by paddy farming community before starting the cropping cycle). Close communication with government institutions directly involved in water management and aquaculture such as the Department of Agrarian Development and National Aquaculture Development Authority of Sri Lanka would be helpful for communities to have good managerial practices.

Stakeholder consultative workshops in Batticaloa.

Identification of alternative means of stocking (perennial reservoirs, minor perennial reservoirs, fish pods etc.) is useful to stock fingerlings produced where the seasonal tanks are not filled on time.

If the seasonal tanks are not filled on time, the hatchery reared fingerlings have to be stocked elsewhere. It is essential to identify alternative means to stock fingerlings. Means to facilitate income generation of the affected fishers / farmers also has to be sought.

Improvement of value addition and product development for harvested fish would be an alternative to overcome marketing problems of less grown fish species

Capacity building in the postharvest processing and value addition can draw the attention of woman to CBF activities and improve the household income of vulnerable communities. Technical know-how should be developed for preparing more palatable fish stuff such as fish balls, fish fingers, etc. using carp flesh.

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