Trade off Between Economic and Environmental Management– Socio-Institutional Analysis of a Common Property Resource

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Abstract

The degree of heterogeneity in income and cultural differences in a group of stakeholders having joint access to a commons, may have varied impact on their attitude to economic and environmental management of the CPR resource base. There is likely to be a trade off between economic and environmental management which influences the sustainability outcomes. Conservative management linked to sustainability is likely to be more effective when it involves collective action of people with relatively homogeneous income groups, similar needs and antecedents, poorer private options and high dependence on the commons together with well defined property rights. On the other hand , a resource group with greater inequality in the distribution of income opportunities and differences in socio-cultural standing in a rather hazy property right scenario, is likely to put stress on greater economic gains at the cost of environmental management. This is vindicated by comparing the institutional aspect and income and class differences in two fish production units in Burdwan district of West Bengal, India. Gini coefficient, maximum sustainable yield based on Schaefer model, coefficient of variation of profitability and marketing efficiency index etc are applied for the analytical purpose. In one case, a fish production group with lease right consists of 387 members out of whom only 12 are fishermen by birth. With majority of the members having varied white collar jobs and fishery treated as a subsidiary occupation, there exists high income inequality and exit options, less regard for sustainability of the fishery resource and urge for high profit. In the other case, permanent fishing right is granted to a primary fish co-operative society (PFCS) where all the members are fishermen by birth, having similar socio- cultural traits, low income inequality, low exit options and high dependence on the fishery resource. Here sustainable fishery management on collective action dominates the profitability criteria that involves larger harvest of the stock. A reorientation with grant of permanent fishing right to PFCS with actual fishermen as members would possibly ensure greater economic equity and environmental sustainability.

Key words: *Fishermen, Homogeneity, Sustainability, Management*

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1. Introduction

Inland pisciculture has of late assumed a great importance in India for plugging the internal supply-demand gap and generating employment in the event of an uncertain and unstable functioning of marine fish sector. Many of the inland wetlands are improperly utilized because of managerial ineptitude and lack of socio-economic – environmental co-ordination. Burdwan district in the state of West Bengal is richly endowed with a variety of environmental conditions in fishery ponds/tanks as well as diverse social groups associated with them. However difference in socio-cultural motivation and institutional perspective have diverse impact on the fishery management outcomes often manifest in the form of a trade off between economic aspects and environmental dimensions, relative neglect of the importance of maximum sustainable yield, lack of motivation and knowledge among members about ideal conditions of inputs /efforts required for effective utilization of water bodies etc. While the importance of economic benefits from aquaculture activities cannot be belittled, simultaneous care should also be given to environmental issues. Private commercial motive and relative empathy in regard to exploitation is unlikely to be in conformity with the fundamental national and social priorities regarding the conservation of environment and its components.

Conservative management linked to sustainability is likely to be more effective when it involves collective action of people with relatively homogeneous income groups, similar needs and antecedents, poorer private options and high dependence on the commons together with well defined property rights. On the other hand, a resource group with greater inequality in the distribution of income opportunities and differences in socio-cultural standing in a rather hazy property right scenario, is likely to put stress on greater economic gains at the cost of environmental management.

A large volume of literature shows that sustainable development of a resource takes place when a particular group of stakeholders has both control and responsibility for the resource (Gadgil and Berkes, 1991; Dyer and Mcgoodwin, 1996). Further, group management on a collective basis is likely to be effective when it constitutes of people with similar needs & interest, customs, antecedents and interactions. The greater the inequality in the distribution of rights and economic decision making power in the management group, other things being equal, the greater is the deviation from optimal management (Boyce, 1994). Hence it sounds rational that management of a resource is likely to be closer to optimality when persons having a stake in the sustainability of the resource base and belonging to a relatively equal income group, undertake the management of a fishery resource. According to Barbier (1987), Pezzy (1992), economic dimension of development is seen as an important part of an environmentally sound socio-cultural, political and institutional transformation. Changes in the management institution coherent with a sustained exploitation of the fishery resources is viewed as a step to achieve equity in the society both in inter as well as intragenerational sense. Now-a-days it is widely believed that aquaculture in inland wetlands should be environmentally nonpolluting, technically efficient, economically viable and sustainable.

In this backdrop, it seems imperative to analyse the functioning of inland fishery sector under representative units of PFCS(Primary Fishermen Co-operative Society) and FPG (Fish Production Group) which vary in terms of the socio-institutional characteristics of the stakeholders. In the former case fishery unit is managed by a co-operative composed of fishermen by birth (who undertake fishing as their main occupation) and in the latter case it is managed by a group of people who pursue fishery as a subsidiary occupation. It is hypothesized that greater socio-economic homogeneity and well defined property right among the stakeholders is likely to ensure greater sustainability of the fishery resource. The purpose is to assess how far sustainability as well as economic management efficiency of pisciculture are maintained with respect to homogeneity in income and social class as well as property right scenario.

In this context, first reference to the data base and a brief socio - economic description of the two fish production units have been given. The degree of intra-class income inequality among the members of the respective units has been assessed by using Gini coefficient. Other relevant social features have been compared. Gordon-Schaefer model has been applied to regress catch per unit of effort on effort itself to derive an estimate of maximum sustainable yield (MSY). Indices related to productivity, profitability, marketing efficiency etc are analyzed to find out the relative financial efficiency of the fishery units. Comparison between the estimated results of the two fish production units have been made on the basis of the aforesaid methodology. The derived findings are used to project policy prescriptions for smooth functioning of the fish production units in the district of Burdwan.

2. Sources of Data and Socio- Economic Characteristics of the two Fish Production Units.

Field survey has been conducted to gather socio-economic data for the analysis. However, for fishery data we have relied on the reports of the fish co-operative societies and fish production groups. It is to be noted in this connection that fishery data includes total yield, total revenue from fish harvest, total cost and total profit from 1992-1993 to 2002-2003. For the construction of the price index we have collected data on the prices of different inland water species partly from the reports of the Sankai fish co-operative society and Khatpukur fish production group and also partly through the questionnaire method involving the members of the above-mentioned fish production units. For the Gini measure of inequality we have conducted a field survey for those people who are *directly* (like fish farmers by profession) or *indirectly* (like people associated with other services but are dependent on fishery as a subsidiary occupation) associated with the above-mentioned fish production units. The selection of the sample has been done on the basis of convenience sampling from the list provided by the fish production units.

Socio-economic description of the fish production units considered for the analysis are given as below.

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2.1 *Khatpukur Fish Production Group*

The Khatpukur pond is managed by a fish production group (FPG hereafter) known as *Khatpukur Matsya Utpadan Gosthi* or Khatpukur FPG. The total area of the pond is 42 bighas(including water bank) of which only 33 bighas are purely water areas. It is located at Khatpukur *Mouza,* to its east is Bamunara village, to its west is Bidhannagar, to its north is a fertilizer township and to its south is G.T Road. There are 387 members in the group amongst whom only 12 are fishermen by birth. The pond was obtained from *zilla parishad* which is the district authority. It was considered as vested and given to a group for culture of fish on a long term lease basis. This particular FPG deals with sewage fed fishery. It uses the sewage of Durgapur Municipality for fishery purposes. Its initial membership in the beginning in 1992-93 was 126. The management is run by a committee consisting of a President, one *gosthi parichalak (*group leader). One Assistant gosthi parichalak, a treasurer and 20 members. Most of the members consider fishery as the side or secondary occupation while agricultural operation and / or factory work constitute their primary job. Recently they have undertaken a proposal to embark on spawning operation in the water area for fish production. However, they have not yet undertaken or even thought of any other associated duckery, poultry or piggery project that might prove effective in the long run. It shows lack of insight and proper initiative on their part. Frequent meeting among the group members, fishermen, and co-operation by the panchayet and other local bodies may be conducive to more successful managerial operation by the group.

2.2 Sankhai Fish Co-operative Society

Fishing is carried on by the society members in ponds as well as in the adjacent Bhaghirathi river. The society has ownership of 7 ponds (with area of about 8 acres) which were purchased by them and not taken on lease from the govt. The society was first initiated in the year 1976 with a membership of 153 fishermen .At present the membership has increased to 273 members all of whom are fishermen by birth. Membership fee stands at Rs 10/- per annum. At present share capital of the society amounts to Rs 13090/-.The society is run by a managing committee of 9 persons consisting of a president, a vice president , secretary, an assistant secretary, and 5 directors. The society does not have any bank loan. It has however in the past obtained some lump sum aid from the govt. About 50 members has got fishing training from govt institutes. Fishing is supposed to be their primary occupation. The FEO gets in touch with the co-operative members. The society members understand the importance of poultry / goatery etc or fruit plantation around the pond sides but due to lack of funds, proper motivation or even lack of appropriate management alternative, guarding cost etc, these have so far not been undertaken. The members are mostly dependent on fishing in the river which is carried on the year round whereas pond fishing is carried on 6/ 7 times a year. Organic fertiliser is used for manuring fish ponds. Works like stocking, feeding, manuring in the ponds are usually undertaken by the members themselves at a remuneration of Rs 40 /45 per day. At the time of netting they also get

250 gm of fish per fishermen in addition to usual wage charges of Rs 40/45 per day. The success of the co-operative according to the members depends on the availability of more of fishing ponds. If more such ponds come under the grip of the co-operative more people would have the opportunity of getting employment and probably chances of catching more fish would be enhanced. At present availability of fish in the river is getting reduced. As an alternative to fishing in the river , pond fishing becomes important and hence permanent leasing of some more ponds to them can probably resuscitate their condition.

3. State of income inequality and socio-economic status of fishermen.

It is considered that functional cohesion, concern and dedication for maintaining a resource base is likely to be greater on the part of a group of stakeholders who emerge from a relatively homogenous group and share similar kind of interest compared to some other. Seen in this backdrop, it seems imperative to compare the degree of intra-class inequality in the two fish production units.

Gini measure of income inequality is found to be 0.517 in case of Khatpukur while 0.311 in case of Sankai PFCS. This is indicative of relatively greater socio-economic heterogeneity and cultural diversity among the stakeholders of Khatpukur FPG compared to that of Sankai PFCS. This might be attributed to the fact that in Sankai the gains obtained by the cooperative are much more uniformly distributed among its members and the members come from relatively homogeneous income classes.

Apart from this Sankai PFCS enjoys relatively homogenous social background of the members compared to Khatpukur FPG as evident from the following table.1

Table 1: Socio-economic data for Khatpukur FPG and Sankai PFCS

F.PG/F.C.S	S.C (%)	G.C (%)	House type (Pucca/ mixed)	Literacy	Perceived improvement in socio-economic condition (%) Yes	No
Khatpukur	80	20	*30%*	42%	40	60
Sankai	100	0	59%	62%	20.58	79.42

It is observed that in case of Sankai all the sample members fall in the homogeneous category of scheduled caste while in case of Khatpukur, 80% of the members fall in S.C category and 20% belong to the upper strata in the society. Again only 30% of the members in Khatpukur case have pucca houses while the majority are deprived of this luxury. This implies that better housing facility is enjoyed by a relatively small fraction of people In case of Sankai majority enjoy good housing facility and so the difference is less sharp. In terms of literacy also majority of the members in case of Sankai fall in the homogeneous literate group as contrary to the case of Khatpukur. In terms of perception about betterment in socio-economic condition, members are more or less evenly poised in the positive and negative category in Khatpukur case while a greater majority in case of Sankai belong to the homogeneous feelings of no improvement. Apart from this, a number of members in Khatpukur case follow fishery as a subsidiary occupation without taking a great stake in its improvement while in case

of Sankai all are fisherman by birth having a great stake in its sustainability. So on the whole socio-economic homogeneity seems to be on the stronger side in case of Sankai compared to that in Khatpukur region.

4. Estimation of Maximum Sustainable Yield (MSY) and its Significance.

It seems imperative to analyze whether the cooperative/group members are pursuing the policy of sustainably managing the resource. If the annual catch displays the tendency of reaching the value of maximum sustainable yield then there exists a dormant threat to sustainability. For this purpose, we propose to fit Schaefer's model where catch per unit of effort (Y/E) is assumed to be proportional to the density of fish. Density of fish is assumed to be proportional to stock whereby the harvest level Y is written as

$Y = qEX.$ --------(1)

where q= catchability coefficient, X = total amount of fish production and E is some effort index. It is noted here that the yield rate positively depends on aggregative inputs, termed here as effort E.

The net growth of fish population X can be expressed as the difference of the well known logistic specification, $F(X) = r X (1 − X/K)$ (where r is the intrinsic growth rate and K is the environmental carrying capacity), and the fish harvest given by Y. Thus

$dX/dt = r X (1 − X/K) − Y$

Now for sustainability, we should have

$F(X) = Y$ or, $rX (1 − X/K) = qEX$ whereby we get

$X = (1 − qE/r)$ ------- (2)

After some manipulation, we get

$Y = a E − b E^2$ ------- (3)

Where $a = qK$ and $b = q^2 K / r$

The optimum effort level and maximum sustainable yield corresponding to this equation can be found (by using the first order condition) as

$E = a/2b$ and $MSY = a^2 /4b$.

These coefficients a and b can be estimated through use of least squares technique by converting equation (3) in the form

$Y/E = a − bE$ ---------- (4)

MSY helps to determine the future fishing policy regarding application of fishing effort.

In the present context the index of effort is estimated by computing the fishing labour cost per unit of fishermen as a percentage of other input costs. Input costs incorporate the cost of lime, mahua cake, mustard cake, cow dung as well as fingerlings. Yield of fish is taken care of by considering the annual harvest of fish in terms of kg.

In the case of Khatpukur the following table depicts the results of estimation of the aforesaid equation. The equation is found to be good fit as the R^2 value is rather high and significant and the t values are also found to be significant.

Table- 2: Results of estimation of the Yield -Effort equation for Khatpukur FPG.

FPG	Constant	Coefficient of independent variable	R^2	F	MSY(kg)	Average yield(kg)
Khatpukur	737.813 (t = 6.311)	-6.548 (t = -2.707)	.478	7.327 sig. 0.025	20783.752	16058.93

Sustainable management of fish whereby sufficient stock is left for future reproductive capacity is supposed to be one important criteria for fishery management. In this regard it is considered imperative to find out whether their annual catch lie below the MSY level or fall on the border line case or surpass it.

Year wise variation of actual yields from MSY value and their implication are depicted in table –3.

For Khatpukur in quite a number of years the ratio of actual yield to MSY is rather high. Harvest at a level close to MSY indicates disregard for environmental sustainability. It implies less concern for stability of residual stock and hence for future growth of the resource. The mean actual yield is found to be rather high at a value of 16058.93. It is also found that the absolute deviation of the ratio Y_a/Y_m from 1 for the respective years are, excepting year 1992-93 , in general on the lower/moderate side and actual deviation of this ratio from 1 for the year 1995-96 even turns out to be negative. The percentage average catch to MSY is estimated to be 77.27 leaving relatively smaller portion for stock generation.

Table 3: Comparative data for actual yield (Y_a)and MSY (Y_m) ratio for Khatpukur FPG and Sankai PFCS

Year	Khatpukur Ratio of Y_a to Y_m	Khatpukur $\lvert Y_a/Y_m - 1 \rvert$	Sankai Ratio of Y_a to Y_m	Sankai $\lvert Y_a/Y_m - 1 \rvert$
1991-92			.083	.917
1992-93	.124	.876	.264	.736
1993-94	.515	.485	.235	.765
1994-95	.966	.034	1.374	.374
1995-96	1.527	.527	.636	.364
1996-97	.658	.342	.943	.057
1997-98	.982	.018	.124	.876
1998-99	.549	.451	.650	.35
1999 –2000	.989	.011	.748	.252
2000-2001	.613	.387	.405	.595
2001-2002	.804	.196	.291	.709

In all the years the ratio of actual yield to MSY has remained well below unity for the Sankai co-operative. In the case of Sankai the following table depicts the results of estimation of the aforesaid equation.

Table- 4: Results of estimation of the Yield -Effort equation for Sankai PFCS.

PFCS	Constant	Coefficient of independent variable	R^2	F	MSY(kg)	Average yield(kg)
Sankai	1208.991	-324.847 (t = -1.816)	.268	3.297 sig. 0.103	1124.882	588.31

Environmental concern for sustainability reigned supreme as excepting 1994-95, in other years the sustainability ratio was maintained   below 1. Because of injection of heavy dose of productive inputs in the earlier period there was massive harvesting in this period which surpassed the MSY level. On the average 52 % of MSY is realized leaving relatively a substantial part for stock generation. However in this case it can be said that even with this substantial regard for sustainability, there remains ample scope for raising the average yield if financial and managerial inputs can be provided in an augmented and effective manner. Lack of adequate economic inputs and regard for sustainability combined together explain the lower average yield for this PFCS compared to the FPG.

5. Analysis of economic achievements of the two fish production units

In this section we analyse whether sustainability concerns are reflected in the economic achievements of fish production units. Economic efficiency of the fish production units are supposed to be reflected in the values and extent of variation of a number of economic parameters. In order to analyse the economic achievements we consider here productivity, profitability and marketing efficiency of the fish production units.
Productivity is defined as = total yield of fish in real term/effort
Profitability is defined as = net profit in real term/ effort
Marketing efficiency
 = (revenue from selling fish in money term/marketing cost in money term) – 1

From the following table we can have a glimpse about the achievements of Khatpukur fish production group in terms of the aforesaid economic parameters

Table-5: Economic Achievements of Khatpukur FPG

Year	Productivity	Profitability	Marketing Efficiency
1992-93	40.142	130.863	63.865

1993-94	530.965	153.084	13.515
1994-95	791.778	67.121	20.022
1995-96	348.428	17.908	17.667
1996-97	799.342	109.508	116.309
1997-98	372.685	90.543	102.768
1998-99	347.565	85.739	151.400
1999-'00	329.317	183.081	152.956
2000-'01	439.545	189.484	130.093
2001-'02	595.758	178.961	132.58

The Khatpukur FPG is not self sufficient in the supply of fish fry , fish seed etc. New scheme for spawning has recently been undertaken. This FPG is fully governed by profit maximising motive. As a result, there has been found to be consistently positive values of profit over the years. The management is concerned about its consistency in performance as is reflected in comparatively lower values of coefficient of variation, viz 43.5138 for productivity,46.9456 for profitability indices and 62.6311 for marketing efficiency series. The availability of urban infrastructure conducive to the development of fish culture helped them to reach relatively high marketing efficiency and attain positive profits.

Condition of economic performance of Sankai PFCS is really deplorable as these people do not feel incentive to take active interest in its management. Increasing dearth in the availability of fish in flowing river as well as lack of adequate pond water areas commensurate with   the number of members have gradually worsened their economic condition. They don't properly participate or monitor the financial achievements of the PFCS. Absence of   needed guarding facilities may have caused losses of the society through unregulated theft of the fish resources. The management seems to be indifferent to that as is evident from very low or even –ve profitability figures in some years Lack of bank loan provision also has led to unsteady supply of inputs and hence production. The productivity and profitability figures are highly fluctuant in character (coefficient of variation being 126.35 and 214.6 respectively) and having virtually no systematic trend. Same are the features of marketing efficiency. In short the society seems to be in need of a sound managerial and financial guidance towards a consistent achievement.

Table 6 :Economic Achievements of Sankai PFCS

Year	Productivity	Profitability	Marketing Efficiency
'91-'92	1.2044	-.8585	9.144
'92-'93	.6888	.0104	8.314
'93-'94	1.1252	.0194	7.473
'94-'95	5.4722	1.3027	28.767
'95-'96	25.2658	8.7580	25.135

'96-'97	20.9149	12.1823	17.937
'97-'98	1.9044	1.9564	69.3
'98-'99	5.0982	.9058	20.294
'99-'00	2.5209	.2806	62.781
'00-'01	3.4757	-1.2824	14.425
'01-'02	5.2345	-.9698	13.209

Table 7 :Coefficient of Variation

	Productivity index	Marketing efficiency	Profitability index
Khatpukur FPG	43.51	62.63	46.95
Sankai PFCS	126.35	84.91	214.8

In short it can be argued that over time Khatpukur has been more consistent regarding the financial management despite their relative neglect of sustainability aspect. Relative heterogeneity in aspects of socio-economic – features possibly resulting in difference in outlook for sustainability   and   fishery considered as a subsidiary occupation by a number of members in the FPG help explain their attention more on short term profits compared to environmental perspective.

6. Concluding remarks:

The efficient alternative for the government is to exercise prudence in releasing the reins of control of this kind of water bodies by leasing them out to a selected group of people who are likely to show   their genuine interest   in the development of the said wetland for fishery purposes. Besides this, concern for social equity should govern government's decision of granting lease rights to the individuals associated with development of wetlands. It also needs mention that development of a fishery wetland guided solely by profit motive in the short run may lead to its unsustainability in the long run. Hence in granting lease of a wet land to a particular group of people, government should take care that the relevant stakeholder group keep in mind the importance of maintaining the long run sustainability of catch from the wetland in question.This is largely conditioned by the managerial motivation and efficiency of the co-operative/group and the socio-economic features of the stakeholders associated with the co-operative/group. For a cohesive functioning of the fishery co-operative, it is desirable that there be socio-economic homogeneity in the conditions of the stakeholders associated with the co-operative, participation by all in its management , unity in their perception about development alternative, knowledge about the best timing for stocking and harvesting. In other words, the concept of social capital evinced in the homogeneity of income, interest and concern of the stakeholders, their mutual trust, cooperation and support and their symbiotic association with a resource may greatly matter in its upkeep while Govt /NGOs should provide for necessary financial /managerial inputs or assistance.

References:

Barbier E.B, The concept of sustainable economic development. Environmental Conservation, 14(2):101-110. (1987)

Basu I , 'Socio Economic Studies,' Centre for Environment and Development, Jodhpur Park, Calcutta – 700068, mimeo. (2000)

Berkes F, Common property Resources: Ecology and Community-Based Sustainable Development. Belhaven Press, London, U.K., 302 pp. (1989)

Boyce J K, Inequality as a cause of environmental degradation, Ecological Economics, 11: 169-178. (1994)

Capistrano D A, M Hossain and M Ahmed, Poverty Alleviation, Empowerment, and Sustainable Resource Use: Experiments in Inland Fisheries Management in Bangladesh, paper presented at the 3rd International Conference of the International Society for Ecological Economics in San Jose, Costa Rica. (1997)

Clark C W, 'Mathematical Bioeconomics : The Optimal Management of Renewable Resources,' Wiley - Interscience, New York. (1976)

Dyer C L and J R Mcgoodwin, Eds. Folk Management in the World's Fisheries: Lessons for Modern Fisheries Management. University Press of Colorado, Niwot, CO. (1996)

Gadgil M and F Berkes, Traditional resource management systems. Resource Management and Optimization, 8(3-4):127-141. (1991)

Pezzy J, Sustainable Development Concepts: An Economic Analysis. World Bank Environment Paper Number 2. The World Bank, Washington, D.C. (1992)