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Impact of Hydroelectric Dams on Fisheries in the Sharavathi Estuary of Uttara Kannada District, South-West India

Mahima Bhat[1], V.N.Nayak[2], M.D.Subash Chandran[1] and T. V. Ramachandra[1]

[1]Energy & Wetlands Research Group, Centre for Ecological Sciences,
Indian Institute of Science
Bangalore – 560 012, INDIA
[2]Dept of Marine Biology, Kodibag, Karwar
Tel: 91-80- 22933099/22933503 (extn 107)
Fax: 91-80-23601428/23600085/23600683[CES-TVR]
E-mail: mahima@ces.iisc.ernet.in; mds@ces.iisc.ernet.in; cestvr@ces.iisc.ernet.in
http://ces.iisc.ernet.in/energy

Abstract

Power generation or multipurpose dams can cause various impacts downstream. The impact of hydroelectric projects on estuaries, rated among highest productive ecosystems, is not much documented more so from Indian west coast. The start of the Linganmakki hydel project in 1964, with an installed capacity of about 1000 MW, in the river Sharavathi flowing westwards into the Arabian Sea from the central Western Ghats of Karnataka, is known to have caused widespread downstream ecological changes due to yearlong releases of fresh water after power production, affecting mainly estuarine salinity and tidal conditions causing alterations in mangrove flora and decline in fisheries. The addition of another smaller dam at Gersoppa further downstream exacerbated the problems. Most such impacts went almost undocumented until the current study. The impact on fisheries in the Sharavathi estuary consequent on dam discharge related salinity reduction is discussed here in comparison with the adjoining dam unaffected Aghanashini river estuary within 20-25 km north. Prevalence of typical natural estuarine conditions in Aghanashini accounts for about 90 species of fishes, in addition to shrimps, crabs and edible bivalves. These conditions include gradual reduction in salinity from the river mouth towards the upstream areas, seasonal and daily fluctuations in salinity favour entry of several marine species into the

estuary at suitable times for breeding and feeding. Whereas input of vast quantities of organic nutrients, especially from Western Ghats, characterise Aghanashini, bulk of such inputs are blocked by dams in Sharavathi. Stretches of multi-species mangrove swamps and food and nutrient-rich mudflats favour higher fish diversity and catches in Aghanashini. Sharavathi estuary has barely half the number of fishes, most of low brackish water conditions or those tolerant of wider fluctuations in salinity like *Arius arius, Sardinella fimbriata, Mugil cephalus* etc. Sharks and rays and other marine fishes like kingfishes and Indian anchovies avoid Sharavathi altogether. The occurrence of fishes of fresh water or nearly fresh water conditions, like *Puntius filamentosus, Terapon jarbua* etc. are result of dam related fresh water flow into the estuary. Gathering of edible bivalves, a major economic activity in Aghanashini estuary has gone extinct in Sharavathi. Whereas the open estuarine part of Aghanashini, measuring 1977 ha, excluding saltpans, rice, and aquaculture, has annual fisheries (including bivalves) to the tune of estimated Rs.1,095,072,000, at Rs.553,905/ha, in Sharavathi, 977 ha of open estuary produces only Rs.12,852,500 worth, at an abysmally low of Rs.13,155/ha in comparison. Shrimp aquaculturing is widespread in Aghanashini, while practically non-existent in Sharavathi. The study highlights the need for caution on execution of hydroelectric projects in the west flowing rivers from Western Ghats to avoid fisheries collapse and dislocations in local livelihoods and economy.

Keywords: Coastal ecosystems, livelihood, fishery, estuary

1. INTRODUCTION

An estuary is a partially enclosed body of water along the coast where freshwater from rivers and streams meets and mixes with salt water from the ocean. Estuaries are the potential source for feeding, spawning and are nursery grounds for most of the fin-fishes and shellfishes. (*S. Brinda 2010)* apart from fishery development. Despite high productivity, estuaries are among the most modified and threatened of aquatic environments, causing imbalances at various trophic levels leading to loss of ecological services and biodiversity, with most Indian estuaries making no exceptions (*Blaber et.al* 2000*; Jha et.al*., 2008).

This communication is based on the investigations in two adjoining estuaries of rivers Aghanashini and Sharavathi, within 20-25 km distance from each other, in the Uttara Kannada district (hereafter referred to as UK) of Karnataka State. Aghanashini is unaffected by any major developmental activity, in the context of this paper without any hydro-electric projects or other kinds of dams, unlike Sharavathi which contributes towards major share of the hydro-electricity of the State. Estuarine fisheries are a major traditional economic activity of the coast. The present work highlights as to how the dams affected the fish diversity and fisheries income in the Sharavathi estuarine belt as compared to dam free Aghanashini estuary.

2. OBJECTIVES

Objectives of this research are to:

- document the fish diversity in the estuaries of case study rivers;
- assessment of the possible impact of dams on fisheries in Sharavathi estuary; and
- estimate income generated from fisheries from both the estuaries

3. MATERIALS AND METHODS

Study Area: The study was conducted in the Aghanashini River estuary (Lat 14.391^{O} to 14.585^{O} N Long 74.304^{O} to 74.516^{O} E) of Kumta taluk and the Sharavathi River estuary

(Lat to74°67 11″–75°30′63″E and 14°7′27″–13°77′08″N) of Honavar taluk in the Uttara Kannada district of central west coast in Karnataka, India (Figure1). The Aghanashini originating in the Sirsi taluk of UK runs its short course of about 70 km through Western Ghats valleys widens into an estuarine expanse in the Kumta taluk where it opens into the Arabian Sea. The Sharavathi River, famed for the Jog Waterfalls, originates in the Tirthahalli taluk of Shimoga district. The 128 km long river winding through the deep gorges of Western Ghats spreads in to an estuarine expanse, three km at its widest part, in the Honavar taluk of UK. Its river mouth is quite narrow due to a sand bar across.

Study on fish diversity: Fish catches from both the estuaries were routinely monitored for a year, and fishermen interviewed on month-wise income from catches of commercial fishes. Fishes collected were identified using keys provided by Talwar (1991); Day (1967, 1971) and Munro (2000). In cases of unidentified fishes the local names given by the fisher-folks have been used.

Salinity measurement: Salinity was measured for one year in both the estuaries using a portable salinity refractometer. Most of rainy season from June to September salinity was very low (less than 1 ppt from mid June to August). Whereas salinity started increasing from the weakening of rainy season by September and reached peak (> 24-34 ppt) during April and May in Aghanashini, in most of Sharavathi estuary it remained less than 1 ppt only during peak summer months also bringing adverse conditions for typical estuarine and marine fishes.

Income estimates from fisheries: Details regarding number of estuarine village-wise number of fishermen were collected from the local gram panchayat offices. Details regarding village-wise numbers of active fishermen were collected through household surveys covering 5-15 households in every village. These numbers were extrapolated for all the fishing community households to arrive at village-wise number of active fishermen. All the fishermen interviewed were asked about average days spent on fishing month-wise, and on average fishing income per fishing day, and the figures arrived at extrapolated for the households of all active fishermen. These ground level data collections helped in arriving at total annual income generated from fisheries from both the estuaries. Tables 1 and 2 provides the details of economic valuation of Aghanashini and Sharavathi estuaries respectively.

4. DISCUSSION AND CONCLUSION

Fish diversity: A total of 90 fish taxa have been recorded from Aghanashini of which 59 identified ones are given in the Table no.3. About 22 collected are yet to be identified; as such they are known only from local names and descriptions given by fishermen. The rest, the rarer ones, are to be traced out in the estuaries through subsequent ongoing studies. Only 43 fish taxa, known by their local names, are known from the Sharavathi estuary, which is impacted by hydro-electric projects. Of these 26 taxa are identified to species level; and efforts are on to trace out the rest, rarer ones, known by local names and descriptions given by fishermen. As far as the regularly traded species are concerned all have been identified from both the estuaries. (Table 3 and 4).

Impact of dams on fisheries: Tropical estuarine areas, free from major developmental projects are well known for their extremely productive fisheries. All along the Indian west coast the estuarine banks are densely populated with fishing hamlets. Yet practically very little

efforts were made hitherto to ascertain how much of income from fisheries is generated estuary-wise, and what happens if the estuary is threatened by industries set up on their banks, or flourishing cities in their vicinities. No study so far also assessed what happens to estuarine fisheries if a hydro-electric project is commissioned in any of the several rivers from Western Ghats. Results of the present investigation shows that Sharavathi estuary, with two power projects in the upstream areas, at Linganmakki and Gersoppa suffered a serious setback in the fisheries sector with significantly low diversity (only 43 taxa), just about 50% of the total fish taxa from the neighboring Aghanashini, which has about 90 taxa of fishes. The construction of dams are reported to have caused reduction of water depths in the estuaries and loss of spawning and breeding grounds of fishes (Dandekar 2012). Whereas fish migrations upstream in the rivers are affected even by even a single dam (Chicharo *et.,al. 2004)* multiple dams could obviously worsen this situation as the case study of Sharavathi shows. Decline in fish species and their populations are obviously due to lowering of salinity conditions in the Sharavathi estuary due to almost constant release of huge quantities of fresh water from the upstream dams after power generation. Salinity measurements from six stations in the estuary at different intervals upstream reveal that most of estuary has salinity below 0.5 ppt, indicating fresh water conditions. Lowered salinity is the prime factor in bringing about an ecosystem collapse in Sharavathi, an estuary that was in the past visited by several marine fishes also seasonally for spawning and feeding, according to the local fishermen. Moreover the dams also act as barriers for downstream transportation of nutrient rich silt from the Western Ghats. Decreases in estuarine salinity can adversely affect most estuarine organisms as their distributions are determined primarily by salinity tolerance. In addition to their affects on flow and salinity, dams impact estuarine water quality as well (Weitkamp, L. 1994, Storm, D.2000).

Estimation of income from fisheries: Annual income from fisheries as well as number of fishing days generated by both Aghanashini and Sharavathi were estimated (Tables 1 and 2).

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Figure 1. Locations of Aghanashini and Sharavathi estuaries

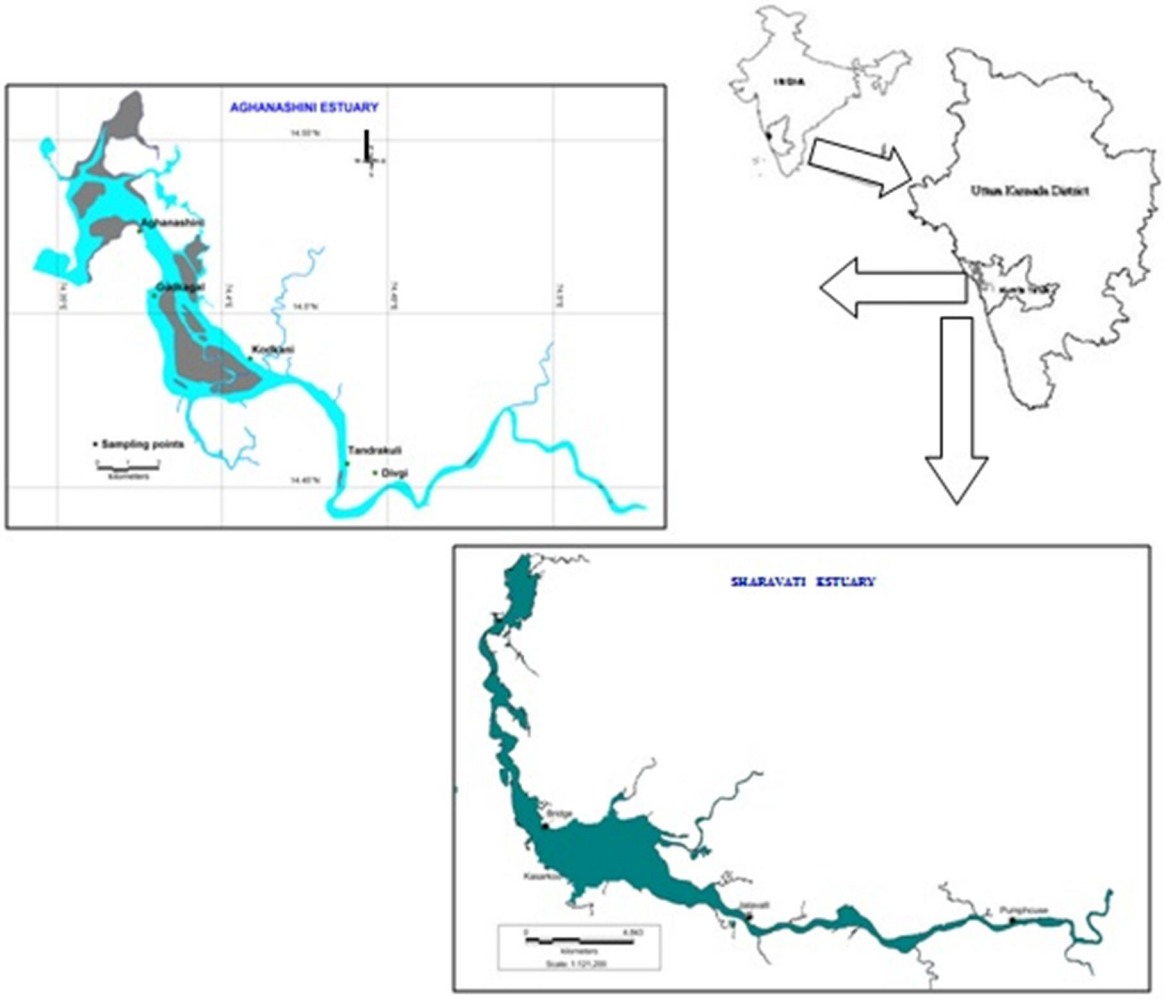

Table 1: Aghanashini estuary

Villages	Fishing community houses	Houses with estuarine fishermen	No. of houses visited	Active fishermen/ house	Tot. estuarine fishermen	Avg. fishing days/head/ yr	Tot. fishing days/yr	Avg income/ day/person Rs	Total Income/yr Rs.
Madangeri	200	125	30	2	250	120	30000	250	7500000
Nushikote	148	75	18	2	150	240	36000	200	7200000
Toregajani	100	75	20	2	150	120	18000	250	4500000
Morba	139	80	25	3	240	240	57600	350	20160000
Tadadi	82	50	32	4	200	365	73000	400	29200000
Hosakatta	450	250	23	4	1000	300	300000	300	90000000
Moodangi	105	90	24	3	270	180	48600	200	9720000
Bargi-gajani	50	30	16	2	60	180	10800	150	1620000
Aghanashini	242	242	35	4	968	365	353320	350	123662000
Gudkagal	65	50	19	4	200	300	60000	250	15000000
Kagal & Hni	430	375	40	3	1125	180	202500	250	50625000
Hubbana-geri	270	200	24	2	400	120	48000	300	14400000
Kodkani	72	65	22	3	195	300	58500	200	11700000
Mirjan	78	78	20	4	312	300	93600	350	32760000
Halkar	64	45	17	3	135	120	16200	150	2430000
Gude-angadi	65	45	10	3	135	120	16200	150	2430000
Hegde	77	77	23	3	231	180	41580	250	2430000
Lukkeri	33	30	18	2	60	365	21900	350	7665000
Divagi	25	25	5	2	50	180	9000	150	1350000
Antravalli	8	4	2	2	8	300	2400	300	720000
Total	**2703**	**2011**	**423**	**----**	**6139**	**---**	**14,97,200**	**---**	**43,50,72,000**

Table 2: Sharavathi estuary

Villages	Fishing community houses	Houses with estuarine fishermen	No. of houses visited	Active fishermen/house	Tot. Estuarine fishermen	Avg. fishing days/head/yr	Tot. fishing days/yr	Avg income/ day/person Rs	Total Income/yr Rs
Jalavalkarki and Jalavalli	74	6	3	2	12	200	2400	300	720000
Geresoppa	81	15	5	3	45	120	5400	400	2160000
Kavur	7	5	2	3	15	150	2250	200	450000
Mavinkurva and Hosad	60	25	5	3	75	190	14250	250	3562500
Upponi	17	10	3	2	20	120	2400	300	720000
Toppalkeri	100	20	4	3	60	65	3900	350	1365000
Malkod	4	4	2	2	8	70	560	250	140000
Molkod	55	6	4	3	18	70	1260	250	315000
Balkur	79	6	5	2	12	300	3600	200	720000
Anilgod	6	6	2	3	18	300	5400	500	2700000
Total	**483**	**103**	**35**	**----**	**283**	**----**	**41420**	**----**	**1,28,52,500**

Table 3: Fish diversity in Aghanashini estuary

Sl.No.	Family	Scientific name	Local names(Kannada)
1	Ambassidae	*Ambassis commersoni*	Burante
2	Apogonidae	*Apogon hyalosoma*	Burante 2
3	Ariidae	*Arius arius*	(Cat fish Bilisady)
4	Ariidae	*Arius sps*	Cat fish (Gonde Sady)
5	Batrachoididae	*Austrobatrachus dussumeri*	Gonke/Gorke
6	Belonidae	*Strongylura leiura*	Burkaandi
7	Carangidae	*Caranx Praeustus (Marine)*	Guruku1
8	Carangidae	*Carangoids chrysophrys*	Kokkara
9	Carangidae	*Carangoids preustus*	Haluguruku
10	Carangidae	*Carangoides sps*	Halu kokkara
11	Carcharhinidae	*Scolidon sps*	Shark(sora)
12	Cichilidae	*Etroplus suretansis*	Banded pearl spot(Kagalse)
13	Clupeidae	*Sardinella fimbriata*	Pedi
14	Clupeidae	*Opisthopterus tardoore*	Pachage
15	Cynoglossidae	*Paraplagusia biliniata*	Leppe 2
16	Cynoglossidae	*Cynoglossus macrostomus*	Leppe 3
17	Engraulidae	*Stoliphorus indicus*	Indian anchovy (Belanji)
18	Engraulidae	*Stoliphorus commersoni*	Commerson's Anchovy (Dodda danashi)
19	Gerridae	*Gerries filamentosus*	Girbaingi
20	Gerridae	*Gerres limbatus*	Mundbaingi
21	Gobiidae	*Glossogobius giuris*	Bili Mandli
22	Lactariidae	*Lactarius lactarius*	Samdale
23	Latidae	*Lates calcarifer EST-MAR*	Seabass (Kurude)
24	Leiognathidae	*Secutor insidator*	Guruku 2
25	Lutjanidae	*Lutjanus johni*	Hottekemsa
26	Lutjanidae	*Lutjanus ruselli*	Russell's snapper (Kemsa)
27	Lutjanidae	*Lutjanus argentimaculatus*	Eri
28	Mugilidae	*Mugil cephalus*	Madle
29	Mugilidae	*Liza parsia*	Madle
30	Muraenidae	*Eel*	Aragotka
31	Nemipteridae	*Nemipterus japonicus*	Rane menu
32	Paralichthyidae	*Pseudorhombus javanicus*	Nengu
33	Platacidae	*Platax orbicularis*	Round bat fish
34	Platycephalidae	*Platycephalus scaber*	Vadati
35	Pomadasyidae	*Pomadasys maculatus*	---
36	Rhinobatidae	*Rhinobatus halavi*	Balagende Torke
37	Rhinobatidae	*Rhinobatus sps*	Kari Balagende Torke
38	Rhinobatidae	*Rhinobatus sps*	Hullu Torke
39	Rhinobatidae	*Rhinobatus sps*	Hakki torke
40	Rhinobatidae	*Rhinobatus sps*	Het Torke
41	Scatophagidae	*Scatophagus argus*	Spotted scat(Hulka)
42	Sciaenidae	*Otolithus ruber*	Banagu, Dodi
43	Scombridae	*Rastrilliger kanagurta*	Mackerel(Bangade)

45	Serranidae	*Cephalophalis boenak*	Gobrya(Kallumurge)
46	Siganidae	*Siganus vermiculatus*	Baana/Padiyar
47	Sillaginidae	*Sillago sihama*	Nogla
48	Soleidae	*Synaptura commersoniana*	Commerson's sole (Leppe 2)
49	Sphyraenidae	*Sphyraena baracuda*	Onakaandi
50	Sphyraenidae	*Sphyraena obtusata*	Hallin kaandi
51	Sphyraenidae	*Sphyraena spp*	Suji kaandi
52	Sphyraenidae	*Sphyraena spp*	Bura kaandi
53	Stromatidae	*Pampus argenteus*	Bili manji
54	Stromatidae	*Parastromateus niger*	Kari manji
55	Synbranchidae	*Monopterus albus*	Kolav
56	Teraponidae	*Terapon jarbua*	Kumbari(garge)
57	Tetraodontidae	Puffer fish	*Chonja*
58	Triacanthidae	*Tricanthus biaculeatus*	Kudure meenu
59	Trichiuridae	*Trichiurus haumela*	Barik hamle

Known by local names only (22. No's): *Hemalga, Koligarge, Bombale ,Ramachi, Karchi, Galse, Tenli, Keke, Hola, Mara Vadati, Haambi, Kolicheri, Vaintali, Mullante, Kari Mandli, Chanakala, Hembale, Soge, Adaga, Kandali, Baalya, Murugundu.*

Unidentified taxa: 9.No's.

Table 4: Fish diversity in Sharavathi estuary

Sl.no.	Family	*Scientific name*	Local name(kannada, konkani)
1	Arridae	*Arius arius*	Sady(Sangat)
2	Belonidae	*Tylosurus strongylurus*	Green kaandi
3	Carangidae	*Carangoides chrysophrys*	Konkar
4	Cichilidae	*Etroplus suretansis*	Kagalsi
5	Clupeidae	*Sardinella fimbriata*	Ker(pedi)
6	Cyprinidae	*Puntius filamentosus*	Pidtol
7	Engraulididae	*Stoliphorus commersoni*	Matiyal(danashi)
8	Engraulididae	*Stoliphorus indicus*	Silverfish(Belanji)
9	Gerreidae	*Gerries filamentosus*	Baingi(Shetuk)
10	Gobidae	*Glossogobius giuris*	Karchi(Mandli, Kdachi)
11	Hemirhamphidae	*Hyporhampus xanthopterus*	Soundkaandi
12	Latiidae	*Lates calcarifer*	Kurude(Gur)
13	Lutjanidae	*Lutjanus argentimaculatus*	Eri
14	Lutjanidae	*Lutjanus johni*	Hottekevsa
15	Lutjanidae	*Lutjanus ruselli*	Tamse(kemsa)
16	Lutjanidae	*Lutjanus argentimaculatus*	Palu(eri)
17	Mugillidae	*Mugil cephalus*	Kodavi,(Madle, shevatale, shevate)
18	Paralichthyidae	*Pseudorhombus javanicus*	Lemp(leppe)
19	Platycephalidae	*Platycephalus scaber*	Vadati(Bovante,Byanti)
20	Scatophagidae	*Scatophagus argus*	Hulka
21	Scianidae	*Otolithus ruber*	Banagu(Dhodi, Golas)

23	Sillaginidae	*Sillago sihama*	Nogla
24	Sphyranidae	*Sphyraena baracuda*	Kaandi(Toli)
25	Teraponidae	*Terapon jarbua*	Kumbari
26	Trygonidae	*Ray fish*	Torke(Vagale)

Unidentified known by local names only (17. No's*):* *Avalumeenu, Ante, Bale, Gobro, Guruka(khamp), Hallmeenu, Kadas , Kelas menu, Kukla, Malli, Mogane, Mullante, Mumb, Murugunda, Ravs, Susila, Vante.*