

The Impact of Water Quality of River Ganga in Patna Urban on the Population of Fish and its Market

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Abstract: Ecologists have been unanimous in their opinion that changes in the environment, at large and the physicochemical and biological make-up of a water body, in particular, has a bearing, direct or indirect, on the distribution of its biotic communities and the fish population is hardly an exception to the rule as is borne out by its consumption in the market. A survey was carried out from September to December to analyze the water samples of river Ganges collected from the following sites in urban Patna- Digha Ghat (upstream), Rajapur Pul (mid-stream), Collectorate Ghat (mid-stream) and NIT Ghat (downstream) to study the effect of quality of the same on the population and consumption of fishes in the local market through FGD (Focused Group Discussion) methodology. The mean value of all results indicated that the quality of water at Digha Ghat characterized by pH 7.02, DO 7.82 mg/l, BOD 0.79 mg/l in monsoon period and pH 7.52, DO 7.43 mg/l, BOD 0.82mg/l in post monsoon period was much better than that found about 15 miles further downstream at NIT Ghat with the parameters exhibiting pH 7.23, DO 7.22 mg/l and BOD 1.06 mg/l in the monsoon period only and pH 7.85, DO 5.4mg/l and BOD 0.92 mg/l in post monsoon period. The coliform bacteria concentration touches a 'high' at the Collectorate Ghat crossing the upper limits of permissible level which is a testimony of the domestic and sewage effluents being discharged within the urban limits of Patna. It is hardly a wonder that the Municipal Corporation of Patna finds itself challenged with a Sewage Treatment capacity of 210 MLD for an urban agglomeration that generates approximately 450 MLD sewage/ day.

Keywords: River Ganges, Patna, pH, DO, BOD, FGD, Fish Population and Market

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I. Introduction

Water is central to the existence of humanity and although it accounts for 71% of the Earth's surface only 2.5% of the same is fresh water of which 98.8% is trapped in ice and found as groundwater (*Igor Shiklomanov 1993, Water in Crisis*). Amongst the readily accessible sources of freshwater on earth, the rivers account for the lion share. In the Indian sub-continent, the Ganges, arising from the Gangotri glacier on the southern slopes of the mighty Himalayas, boasts of a huge catchment area covering a total area of 1,000,000 sq km besides providing sustenance to one of the world's largest and densest populations in its eponymously named Indo- Gangetic plains. The rich fertile and fluvial soil is host to a vast habitat of microbial community (*Mini Tiwari et. al.; 2018; IOSR-JBB*) while the plains are interspersed with fresh water ecosystems, Wetlands and Diara lands rich in diverse floral and faunal life forms, especially the indigenous aquatic ones.

The rising pollution of river Ganges, the inability of the government to stem the rot despite its best efforts coupled with the irresponsible cultural belief and irreverence of the masses remain the most debated topics on the world environmental fora. Although, IMTECH, Punjab has isolated a number of bacteriophages and viruses that prevent the putrefaction of the water of river Ganges besides improving its oxygen content (<https://www.cntraveler.com/story/the-healing-power-of-indias-ganges-river>), all such efforts are negated by the repeated anthropic intervention of releasing untreated effluents into the river by the riparian human settlements nestled on either side along its long march from the Himalayas to the Bay of Bengal. The clean water of Ganga that enters the Varanasi is only 1%.

After entering Buxar district in the state of Bihar, the river Ganges covers a distance of almost 475 km before it leaves Bhagalpur district. On its onward journey, it traverses 19 km along the northern banks of Patna urban agglomeration between Digha Ghat and Gai Ghat in the west and east respectively. Patna district had the total population 5,838,465 and population density 1,823 people per km² recorded. Patna town is the capital of Bihar and situated lying on the south bank of the river Ganga. A feature of the geography of Patna is its convergence of rivers of Ganga and Gandak at downstream. Uniqueness of Patna is having four. The Swacch

Survekshan 2020 has declared Patna as the dirtiest city of India (<https://www.timesnownews.com/mirror-now/in-focus/article/swachh-survekshan-2020>), although there is hardly any industry to boast about within its confines. According to a finding of the Bihar State Pollution Board, the pollution in river Ganges along this stretch has increased exponentially over the years which are a testimony to the haphazard urbanization taking place in this part of the country complimented by a woefully inadequate Sewage Disposal system. As millions of liters of untreated sewage water find their way into the Ganges on a day to day basis after running off the soils littered with tones and tones of Municipal solid waste including plastics and negotiating long winding but mostly damaged drains of urban Patna, a group of highly toxic compound 'phthalates' (*Preety Sinha et.al.; Journal Soil and Sediment Contamination: An International Journal Volume 28, 2019 - Issue 2*) and various harmful anthropogenic items contaminate the water of river Ganges in more than generous amounts. While the biotic community at large and the aquatic life including fishes in particular pay the price of consuming water laced with poison, the food chain ensures that many such undesirable things including traces of phthalate finally end up on the human plate. A recent study estimates that immersion of idols along the Ghats of Patna ensured at least dumping of 5,000 liters of paint along with hundreds of kilograms of Plaster of Paris and other toxic synthetic materials in the river Ganges.

Though the river just not only holds ethical value but it also have an economical importance by providing its great contribution to the fisheries industry in Patna through decades. Maintenance of healthy aquatic environment is the secret of fresh water culture activities. These factors also play an important role in governing the fish production in the Patna district. Life in aquatic environment is largely governed and their stability. The changes in physicochemical characteristics and biological parameter in healthy water distresses the existence of aquatic organisms. The determination of population of fish in water bodies are very much correlated with the chemical constituents of water dissolved oxygen, total hardness, alkalinity, temperature etc. This has also affected fish behavior which has inferred their mating patterns and ultimately fish population get affected (*John F Criag et. al.; 2015*). Microorganisms have been assigned the role of bio-indicators to monitor the prevailing physical conditions in aquatic ecosystems e.g. the total coliform count in fresh water ecosystem is indicative of portability of water.

II. Materials and Method:

The Study incorporates two sections -

Physicochemical Analysis of Water samples and its impact on the Fishing through FGD methodology (High and Lean period of Fishing) by surveying of Ghats:

Pursuant to all the precautions and norms adhered to during sampling, four sites were identified starting from upstream to downstream i.e. S1-Digha Ghat S2-Rajapur Pul Ghat, S3- Collectorate Ghat, and S4-NIT Ghat. The altitude of the study area under reference ranges from 52.7304 meters to 59.1312 meters above the mean sea level. The duration of sampling extended from July to December characterizing the monsoon period and post monsoon period respectively. The samples were collected from a depth of 10 to 20 inches from the surface. The samples were collected in properly labeled sterilized bottles in accordance with the Standard operating Procedure under APHA, 2012; Trivedy & Goel; 1986 for various tests and analytics like pH, temperature, Electrical Conductivity (EC) and DO were done at the sampling sites and rest parameters in the Environmental Sciences Department lab of A.N. College, Patna. The faecal coliform and total coliform analysis were carried out using the MPN method.

The fishery sector is a traditional income generator that provides livelihood opportunities to millions besides stimulating growth of a number of subsidiary industries apart from being a source of cheap but nutritious food in the country. The impact of physicochemical changes on the fish population in particular and the sector at large was further corroborated with oral histories and questionnaires generated from the response of fishermen and FGD(focus group discussions) as a part of Participatory Urban Appraisal (PUA). The results are attributed to both aforesaid primary sources of data and secondary sources of data like published journals, reports and research findings.

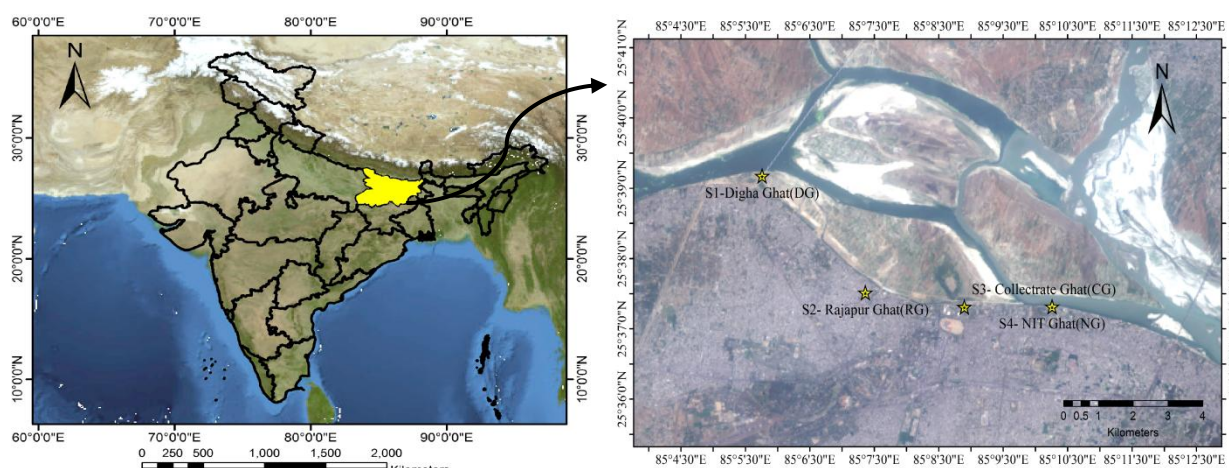


Fig: 1 Topographical Area of Patna in India and Water sampling sites on Arc GIS Map

(Sources: Oneindia.com; Arc GIS v 10.1-2012 release)

Survey of Five Prominent Fish Markets of Patna for the High and Lean Period of Purchasing/Selling/Consumptions

In order to find out the pattern of the sale, purchase and consumption of fish in urban Patna throughout the year , a survey of six prominent fish markets of Patna viz.; FM1-Adalat Ganj, FM2-Raja Bazar (Machali Gali), FM3-Hartali More ,FM4-Rajapur Pul, FM5- Machhua Toli was conducted.



Fig: 2 Survey Sites of Fish markets of Patna

(Source: Arc GIS v 10.1-2012 release)

Statistical analysis

The data shown in the study are the mean value of all the samples (with standard deviation) and calculated on MS Excel, 2013.

III. Result and Discussion

Physicochemical and biological analysis

The Physicochemical and biological analysis have shown diverse changes in the monsoon and post monsoon water sample of river Ganga from all the sampling sites mentioned in Table: 1 and Table: 2. The pH of surface water plays an important role in deciding the chemical constitution of water. In the monsoons, the pH of water sample collected from S1 (Digha Ghat -upstream) was found to be neutral; i.e. 7.02 but moving downstream, the value of pH became slightly alkaline, i.e. 6.42 at S2 (Rajapur pul Ghat-mid stream) while the pH of the water samples at S3 (Collectorate Ghat- mid stream) and S4 (NIT Ghat) was found to be 7.10 and 7.23 respectively ([https:// timesofindia .indiatimes.com/city/patna/monsoon-hits-bihar-finally/articleshow /](https://timesofindia.indiatimes.com/city/patna/monsoon-hits-bihar-finally/articleshow/))(Nitin

Kamboj et.al. 25 Jul 2019). However, in the post monsoon period, the pH of the water samples collected from all the four aforesaid sites was found to be almost alkaline. The reason behind the alkaline nature of the water samples under reference can be attributed to the festive season in this part of the country and the specific rituals to go with it. In Bihar, the end of Durga Puja celebrations is marked by the immersion of a number of idols into the river Ganges leading to a more than generous addition of synthetic materials like Plaster of Paris (PoP) and heavy metals (Pb, Hg, Cd) besides non biodegradable materials like Thermocol and plastic, courtesy the paints and materials used to prepare and embellish the idols . (<https://indianexpress.com/article/lifestyle/art-and-culture/pujo-idol-immersion-harmful-for-environment-5410637/0>).

The dissolved oxygen content of the water sample is an important parameter for the determination of the biotic factor as it supports the growth of microorganism. In the monsoon period, the maximum and the minimum dissolved oxygen content were observed to be 7.82 mg/l at S1 (Digha Ghat - upstream) and 6.3 mg/l at S2 site (Rajapur Pul-mid stream) respectively. In the post monsoon period, the dissolved oxygen content of the water sample exhibited a high of 7.43 mg/l at Digha Ghat and a low of 5.40 mg/l at S4 site (NIT Ghat -downstream). The findings point out that during the monsoon period, the flooded Ganges carry a cornucopia of abiotic and biotic components in its upstream reaches but the direct discharge of effluents, and the sewage of urban Patna without proper sewage treatment into the river basin in the mid stream changes the composition of water which deteriorates further during the ensuing festivities adding to the water pollution of the Ganges (<https://www.downtoearth.org.in/news/idol-immersions-after-durga-puja-leave-rivers-polluted-yet-again-42509>).

Similarly in the monsoon period, the value of Biological Oxygen Demand of the water samples range from 1.18 mg/l at S2 (Rajapur pul Ghat-mid stream) to 0.79 mg/l at S1(Digha Ghat -upstream) while in the post monsoon period, the range trends between 1.32mg/l at S3 (Collectorate Ghat- mid stream) and 0.82 mg/l at S1 (Digha Ghat - upstream) respectively. It follows that during the monsoon period, the total coliform count of the water samples ranged between 4500 MPN/100ml at S2 (Rajapur pul Ghat-mid stream) and 3500 MPN/100ml at S1 (Digha Ghat - upstream) respectively whereas during the post monsoon period, the maximum and minimum numbers of 8000 MPN/100 ml and 5000MPN/100ml were observed at S3 (Collectorate Ghat- mid stream) and S1 (Digha Ghat - upstream) respectively. This variation is in conformity with the findings that squarely lay the blame of the ever rising pollution of the Ganges matched by its depleting fish population at the doorstep of the burgeoning population of urban Patna and their anthropogenic misadventures.

Table 1: Monsoon -Physicochemical and Biological characteristics of River Ganga from Upstream-Digha Ghat to Downstream –NIT Ghat

Sampling Sites	Tem p (° C)	pH	EC (µS/cm)	TH (mg/l)	TDS (mg/l)	DO (mg/l)	BOD (mg/l)	FC (MPN / 100lt)	TC (MPN /100lt)
S1-Digha Ghat	20	7.52	65.0	126.1	127.6	6.3	0.67	4500	5000.50
S2-Rajapur Pul Ghat	13.5	7.69	72.12	135.00	146.7	6.0	0.63	3000	5500
S3 Collectorate Ghat	14.5	7.55	66.78	168.0	235.5	5.6	0.82	6800.00	8000
S4- NIT Ghat	12.5	7.85	98.2	170.2	254.60	5.4	0.80	5200	6500

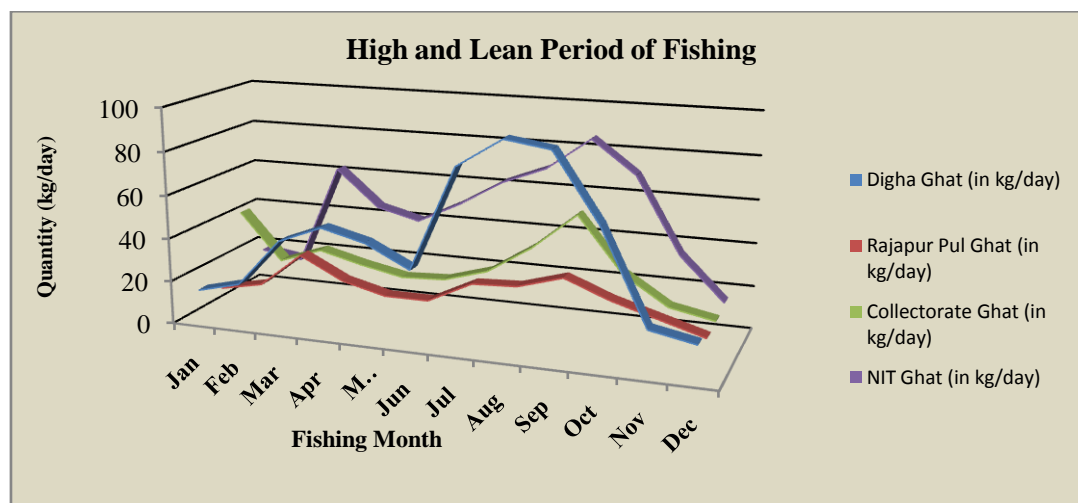
Table 2: Post Monsoon -Physicochemical and Biological characteristics of River Ganga from Upstream-Digha Ghat to Downstream –NIT Ghat

Sampling Sites	Temp (° C)	pH	EC (µS/cm)	TH (mg/l)	TDS (mg/l)	DO (mg/l)	BOD (mg/l)	FC (MPN / 100lt)	TC (MPN /100lt)
S1- Digha Ghat	22.25	7.02	72.9	103	98.5	7.82	1.18	2500	3500
S2- Rajapur Pul Ghat	23.25	6.42	63.75	133.25	109.5	7.1	0.79	2200.25	4500.00
S3-Collectorate Ghat	25	7.10	86.25	157.5	127.2	7.27	0.86	1800.75	4000
S4- NIT Ghat	23.52	7.23	92.7	142	119.25	7.4	1.02	1800	3800

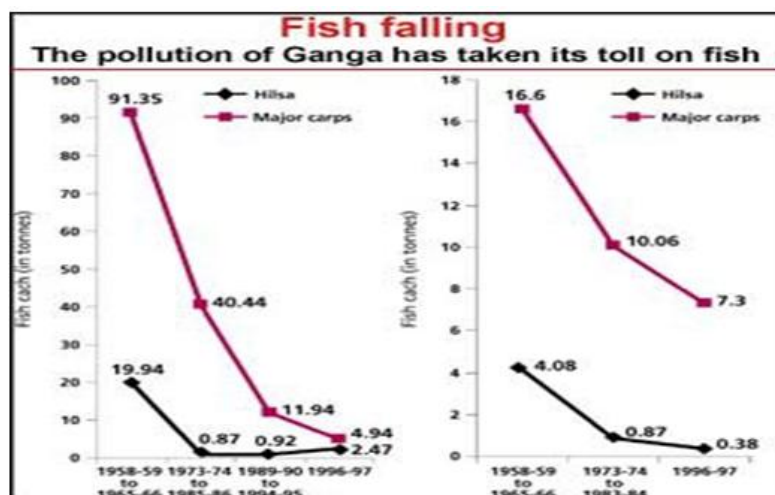
Survey of Ghats during the high and lean fishing periods:

The study of fishing activity coupled with its marketing exhibiting the familiar path vis-a-vis the movement of fish : River- Fishermen — Vendors — Consumers was compared with the ever-changing physicochemical attributes of water and the findings were as follows : The per day availability of fish in the month of July ranged from a low of 25 kg at S2 (Rajapur pul) and 24 kg at S3 (Collectorate Ghat) in the mid stream of Ganges to a high of 82 kg and 62 kg at S1 (Dighat Ghat upstream) and S4 (NIT Ghat -downstream) respectively. The reasons of the lows and the highs can be attributed to the distribution and density of population of urban Patna and the effluents and sewage draining into the Ganges as a result. A dip in the dissolved oxygen content along with a reduction in infiltration of light have a deleterious effect on the self purification capability of the water in the river which is central to the cropping and harvesting of its flora and fauna .

Graph: 1, exhibit the annual high and lean periods of fishing in the Ganges along the banks of urban Patna. It is crystal clear that the natural migration of fishes is unusually high post monsoon. According to *Jitendra Kumar et.al;(2001)*, pollution increases the chances of exposure of the aquatic life at large and the fish community in particular to various diseases which affect their overall rate of ability to survive while having a deleterious effect on the overall aquatic environment. (*Marcos Tavares et. al; July 2017*). According to the **Indian Environmental Knowledge Portal (1998 revised 2011)**, pollution is one of the chief cause of death of inland fish. According to *K Gopa Kumar, Deputy Director-General (fishery), Indian Council of Agricultural Research (ICAR),New Delhi*, the traditional fishing community of the Indo-Gangetic belt has been affected very badly in last three decades owing to the rising pollution of river Ganges(<https://www.downtoearth.org.in/coverage/orphans-of-the-river-14068>). The data from the Central Inland Capture Fisheries Research Institute (CICFRI), Barrackpore shows (**Pic:1**) that the fish catch in most Riverine fisheries is steadily declining. The Ganges is a living embodiment of pollution as it receives untreated effluents and sewage from its riparian human settlements which boasts of 29 cities, 70 towns and thousands of villages.



Graph 1: Data of Fishing from four sampling sites in the Year 2018

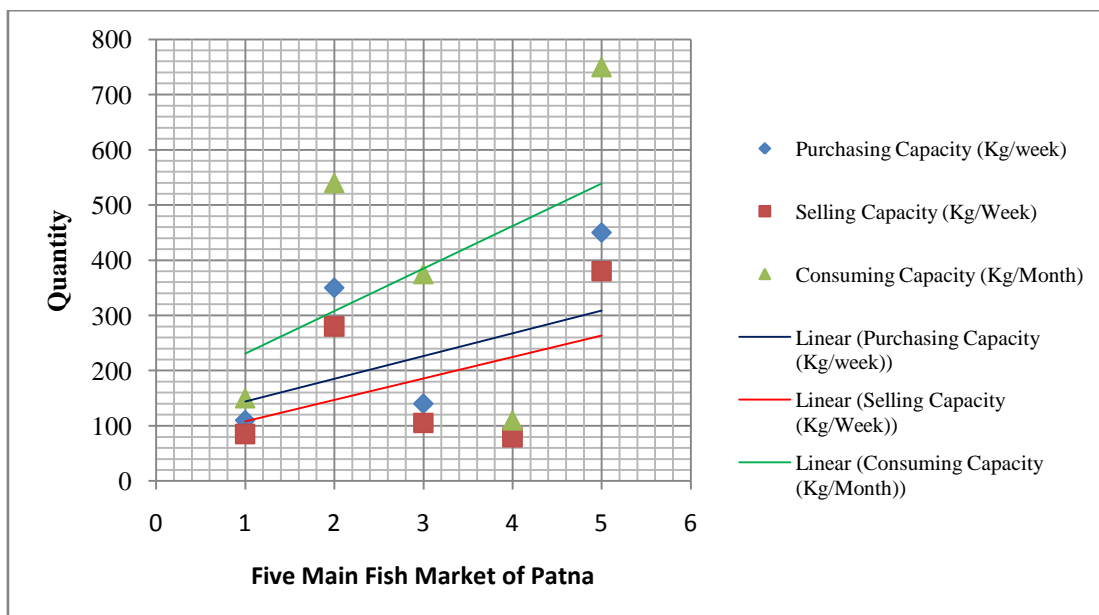


Pic: 1 The decline of Fish Population in Ganga river due to Polluted Water
(Source : M.Sinha et.al .2011;The Ganga-Environment and Fishery CICFRI, ,Barrakpore)

Survey of Five Prominent Fish Markets of urban Patna to assess the impact of river pollution

The survey of Fish markets of the five study areas viz. Adalat Ganj, Rajabazar (Machli Market), Hartali more, Rajapur Pul and Machua Toli and FGD with vendors revealed that post monsoon, the production of fish increased but was outmatched by the very high consumption ratio. The sites i.e. FM1-Adalat Ganj, FM3-Rajapur Pul and FM4-Hartali More access their supply of fishes from the midstream Ghats of river Ganges which is a testimony to the impact of pollution during the monsoon period and finds expression in the overall supply and sale of fish as a commodity. The sale of the commodity witnesses a spike in the Fish markets of F2-Rajabazar (Machli Gali) and F4-Machua Toli. In order to meet the splurge in demand during the lean season, the whole sale auctioneers and suppliers make a killing with their purchases from the far coastal regions of Andhra Pradesh and other coastal regions. A number of such consignments reach Patna, Muzaffarpur, Katihar and Rohtas districts, from where they are transported to other parts of the state to meet the spike in demand. An estimated 55,000 metric tonnes of fish imported from Andhra Pradesh is consumed in Bihar every year. Accordingly to a state government report, Bihar produces 5.87 lakh tonnes of fish against an annual requirement of 6.42 lakh tonnes. In the year 2018, the Health Department of Bihar banned the entry of Fishes from Andhra Pradesh due to the presence of unusually high amount of Formalin as a preservative. (<https://www.newindianexpress.com/nation/2018/oct/02/bihar-plans-to-ban-entry-of-fish-from-andhra-pradesh-1880162.htm>).

A number of problems facing the fishermen and the trading community were highlighted owing to the fast depleting indigenous species of fishes in the Ganges which have been exacerbated by a lack of adequate infrastructure like specialized transportation, cold storage facilities, display stalls, cleanliness and earmarked vending zones which have a rather telling effect on the already highly perishable nature of fish. *Ayo-Olalusi et al.(2010)* conducted a similar study in the Liverpool fish market in Lagos State, Nigeria by highlighting the major problems faced by fish vendors while *Ganesh Kumar Balasubramanian. (2008)* has reported the challenges facing the domestic fish markets and fishery products in India. Yet another study conducted by *Sathiadhas & Narayana kumar in September 2013* reported that the fluctuation in prices of fish is very high because the supply of fish is highly inelastic. The reasons elaborated in the study brings home the predicament with regard to the inability of Bihar blessed with a number of perennial rivers besides the Ganges, to leverage and unlock its potential in the fishery sector.



Graph :2 Showing the High and Lean Period of Fish Market in Five sites of Patna
1.Adalat Ganj, 2-Raja Bazar (Machali Gali), 3-Hartali More , 4-Rajapur Pul, 5- Machhua Toli

State - Bihar		Production in TMT											
S.No	Name of The District	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
1	Patna	8.00	9.50	8.50	8.50	9.65	8.73	11.00	14.57	12.09	14.01	15.47	15.63
2	Bhojpur	8.30	9.70	9.10	9.10	4.30	8.25	9.00	11.80	12.60	9.32	10.05	10.07
3	Buxer	6.00	5.75	5.00	6.25	5.20	4.10	5.98	7.00	8.80	6.42	6.91	6.92
4	Gaya	3.60	2.50	3.90	3.50	4.65	2.70	5.60	7.08	5.27	2.54	6.50	6.50
5	Rohtas	6.80	7.00	6.55	8.00	7.00	4.75	5.29	5.60	6.85	6.30	6.75	6.78
6	Kaimur	0.00	0.00	0.00	0.00	0.00	3.70	3.50	3.75	4.85	7.00	9.95	9.98
7	Jahanabad	2.13	2.75	4.01	4.02	5.36	0.47	2.70	5.78	4.08	3.15	1.26	1.26
8	Arwal	0.00	0.00	0.00	0.00	0.00	0.00	1.76	1.95	2.20	1.76	1.37	1.37
9	Aurangabad	5.28	5.00	2.40	1.45	7.60	2.45	4.92	5.50	3.29	5.03	7.02	8.13
10	Nawada	1.86	3.36	5.76	6.08	4.09	3.53	4.06	5.96	5.93	5.20	5.40	5.50
11	Nalanda	4.00	7.50	9.50	7.50	10.00	13.64	14.76	16.82	21.12	16.59	17.61	17.62
12	Muzaffarpur	12.91	12.40	13.46	15.01	14.00	12.80	16.58	19.90	19.98	20.15	21.75	21.75
13	Vaisali	10.40	10.20	10.80	11.60	9.40	9.00	13.00	15.49	6.28	13.40	15.09	15.09
14	Sitamarhi	10.85	9.95	10.35	11.00	15.03	15.75	15.75	19.20	16.80	11.15	12.24	12.25
15	East Champaran	14.45	13.00	13.70	14.60	12.65	15.50	18.16	19.85	23.00	36.88	50.40	50.00
16	West Champaran	12.92	12.95	13.25	13.04	14.30	14.15	14.00	17.80	17.09	22.17	23.10	23.20
17	Saran	18.77	14.99	14.00	15.00	13.09	14.85	19.10	18.50	22.91	9.49	9.71	9.71
18	Siwan	15.72	5.40	11.30	8.30	3.35	6.10	10.40	14.02	17.95	16.96	6.21	6.22
19	Gopalganj	9.00	8.00	9.00	10.00	9.80	7.76	8.20	11.50	16.47	8.50	9.25	9.41
20	Sheohar	0.00	0.00	0.00	0.00	0.00	0.00	1.25	4.90	2.68	1.85	2.05	2.20
21	Saharsa	10.00	11.00	10.00	11.50	12.00	10.98	13.95	12.93	17.16	8.18	6.70	6.85
22	Supaul	4.51	3.92	4.75	4.89	5.50	8.00	8.05	8.15	6.85	8.78	10.54	8.10
23	Madhepura	8.80	8.00	9.00	10.00	10.55	10.60	9.46	7.10	12.75	2.90	3.73	3.82
24	Purnea	10.00	11.00	10.00	9.85	8.50	11.61	12.35	13.60	15.00	13.65	12.05	12.10
25	Araria	3.45	3.25	3.64	3.17	3.92	4.41	5.37	6.98	6.86	9.99	10.85	10.85
26	Kishanganj	5.03	5.15	4.38	5.35	4.46	5.36	6.60	7.88	7.10	6.03	6.17	6.19
27	Katihar	10.90	11.05	10.45	11.45	12.30	12.40	12.60	11.80	14.80	36.96	23.50	23.85
28	Bhagalpur	8.50	8.70	8.00	9.07	7.96	7.66	10.94	10.96	10.90	13.58	13.60	13.61
29	Banka	4.47	4.45	4.00	4.92	5.00	4.02	4.90	5.50	8.04	8.26	9.89	9.91
30	Munger	6.70	5.56	10.10	10.75	9.30	4.90	5.20	5.70	4.83	6.20	9.40	9.40
31	Lakhisarai	0.00	0.00	0.00	0.00	0.00	2.50	2.70	3.51	4.43	7.31	7.90	7.90
32	Shekhpura	0.00	0.00	0.00	0.00	0.00	2.35	0.17	1.28	0.05	3.01	2.93	2.93
33	Jamui	2.12	2.60	4.12	3.90	3.75	2.10	3.08	5.56	6.34	2.10	2.35	2.35
34	Begusarai	6.35	7.60	12.00	11.50	9.90	12.76	12.05	14.27	7.22	23.24	21.76	21.81
35	Khagaria	10.80	10.80	10.00	12.10	9.00	6.50	7.05	7.25	18.38	18.75	18.90	20.00
36	Darbhanga	14.01	12.76	14.94	15.05	16.90	15.35	16.50	19.00	26.35	38.67	44.00	44.00
37	Madhubani	16.00	15.20	15.25	17.25	16.49	13.13	19.15	20.35	23.60	42.30	51.45	51.80
38	Samastipur	6.90	6.05	7.15	6.95	12.40	6.05	9.34	11.35	11.40	12.02	13.08	14.02
	State Total	279.53	267.04	288.36	300.65	297.40	288.91	344.47	400.14	432.30	479.80	506.89	509.08

Pic:2 Fish production in Bihar (2005-2017)
(Source: Bihar animal and fisheries department, Govt. of Bihar)

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