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Hilsa
An assessment in Lower Ganga River Basin, India

GRB EMP : Ganga River Basin Environment Management Plan

by

Indian Institutes of Technology

IIT Bombay | IIT Delhi | IIT Guwahati | IIT Kanpur | IIT Kharagpur | IIT Madras | IIT Roorkee

Preface

In exercise of the powers conferred by sub-sections (1) and (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government has constituted National Ganga River Basin Authority (NGRBA) as a planning, financing, monitoring and coordinating authority for strengthening the collective efforts of the Central and State Government for effective abatement of pollution and conservation of the river Ganga. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin: Environment Management Plan (GRB EMP).

A Consortium of 7 Indian Institute of Technology (IIT) has been given the responsibility of preparing Ganga River Basin: Environment Management Plan (GRB EMP) by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. Memorandum of Agreement (MoA) has been signed between 7 IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

This report is one of the many reports prepared by IITs to describe the strategy, information, methodology, analysis and suggestions and recommendations in developing Ganga River Basin: Environment Management Plan (GRB EMP). The overall Frame Work for documentation of GRB EMP and Indexing of Reports is presented on the inside cover page.

There are two aspects to the development of GRB EMP. Dedicated people spent hours discussing concerns, issues and potential solutions to problems. This dedication leads to the preparation of reports that hope to articulate the outcome of the dialog in a way that is useful. Many people contributed to the preparation of this report directly or indirectly. This report is therefore truly a collective effort that reflects the cooperation of many, particularly those who are members of the IIT Team. Lists of persons who are members of the concerned thematic groups and those who have taken lead in preparing this report are given on the reverse side.

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1. Introduction

The *Tenualosa ilisha*, belongs to the subfamily Alosinae of family Clupeidae and is largely an anadromous species. It is capable of withstanding a wide range of salinity and travels great distances up-stream up to 1,200 km in inland water for breeding. The fish is highly priced in West Bengal, Orissa, and Tamil Nadu in India and also in Bangladesh. The largest yield of the *Hilsa* fishery comes from the deltaic region of the Gangetic system of India and Bangladesh. On account of its economic importance as well as its migratory habits, the *Hilsa* received the attention of fishery workers in India at a comparatively early date. Investigations on *Hilsa* first commenced in 1907 in the Department of Fisheries, Madras, followed by the Department of Fisheries, Bengal, Bihar and Orissa. However, very little information on the bionomics of the fish existed till 1938, when the Zoological Survey of India (ZSI) incidentally became interested on finding very small *Hilsa* in the settling tanks of the waterworks. The studies of Hora (1938 and 1941), Hora and Nair (1940a and b) and Prashad *et al.* (1940) brought out interesting facts on the life history and bionomics of the fish. Prashad *et al.* (1940) reported the seaward migration of *Hilsa*, and pointed out that very little attention has been paid to the marine phase of the fish's life history in spite of regular commercial fishery.

The marine distribution of the *Hilsa* coincides with the Indian monsoon region. Generally, the lower Ganga river basin region is characterized by relatively large continental shelf, monsoon winds, medium to high precipitation rate and run-off, surface temperature of 20°C to 30°C, surface current changing with the change of monsoons, medium to low organic productivity, presence of sub-surface oxygen minimum layer and relatively low salinity of coastal waters (Pillay and Rao, 1962). The estuarine areas of the rivers and the brackish water lakes in the area are characterized by strong tidal action, high turbidity and heavy silting. The salinity fluctuates considerably; and in areas far from inland, the water may become entirely fresh during the monsoon months. The water level in the freshwater areas of rivers fall appreciably during the dry months; very often large areas and long stretches of the river bed are converted into chains of pools in which the fish fauna take~~s~~ refuge. There is a fairly rich growth of plankton, except during the rainy season with greater abundance of zooplankton than phytoplankton (Pillay and Rao, 1962).

Hilsa is known to be a fast swimmer (Southwell and Prasad, 1918). Tagging experiments have shown that the fish is capable of covering as much as 70.8 km in one day. *Hilsa* is generally found to move on the sea surface whereas in the river they move at a depth of 14-18 m (Mojumdar, 1939); though, on a cool or drizzly day they may rise to within 2 m from the surface. During their migration upstream the fishes congregate, but do not form dense shoals; however during winter months, they are found to form very large shoals. *Hilsa* assemble in large numbers below dams or other obstructions to their upstream migrations (Pillay and Rao, 1962). It was also noticed that the *Hilsa* move near the bottom of rivers and rise to the surface when they meet obstructions such as dams or anicuts (Southwell and

Prasad, 1918). During, the breeding season *Hilsa* ascends the rivers and after spawning, returns to the original habitat where they remain till the next breeding season. It has been observed that the males move in the surface zone and the females in deeper areas (Pillay, 1958). Eggs, larvae and juveniles of the *Hilsa* are found in the upper reaches of the river during the south west monsoons (July-September) and again during the second half of winter (January-February). From October till end of November and again during March, juveniles and young ones (up to 8 cm length) are found in the lower stretches and estuarine areas in lower Ganga river basin. Young fish of about 15-22 cm length occur along the foreshore areas during the winter months (December-February). The eggs occur in the sub-surface zones, while the juveniles appear to inhabit the subsurface waters, but later age groups move in deeper zones of water as well.

1.1 Reproduction

The species is mainly heterosexual. The breeding of *Hilsa* in the Ganga appears to be with the onset of the monsoon in July; with peak breeding from September-December (Motwani *et al.,* 1957). The peak periods were found to be co-related with the flooding of the rivers owing to the south-west monsoon. As for the factors influencing spawning, it is generally held that the upstream migration of fish during the monsoon period is largely dependent on the flooding of the rivers. The second spawning migration was attributed to the general rise in temperature of water in the estuaries after the end of winter (Jones, 1957). Further, it has been stated that the temperature has some influence on the ripening of the gonads and rainfall provides favorable conditions for spawning, during heavy rains the rivers are flooded, water becomes more turbid, current flow is faster, temperature is high and also there is low plankton production (Nair, 1939). Southwell and Prasad (1918) opined that in the absence of any fixed breeding grounds, the fish generally accepted sense of the term and that they probably breed during the rains when conditions such as weather, temperature and other undetermined factors are suitable. De *et al.* (1994) have reported that during the post Farakka period *Hilsa* underwent spawning in the entire freshwater and gradient stretches of the Hooghly estuary. Thus, there was a considerable extension of the spawning ground of *Hilsa* in the estuary during the post Farakka period. The distribution of *Hilsa* eggs in the estuary is greater than it was before barrage. This increase is largely due to the increased flow of fresh water into the estuary following construction. The higher rate of fresh water discharge into the Indian part of the rivers has significantly reduced the salinity downstream. As a result, the downstream zone is now almost fresh water and therefore better for spawning. The rate of development of *Hilsa* embryos is purportedly influenced by temperature conditions. Presently, there has been disappearance and decline in the number of larvae due to increase in water temperature in the lower Gangetic belt, because larval development is inversely proportional to increase in temperature. Before Farakka barrage, *Hilsa* ~~were~~ ascended only Hooghly estuaries. Now adult *Hilsa* ascend the Thakuran and Matlah estuaries as well. *Hilsa* fry, between four and nine centimeters long are also recorded in most of the West Bengal estuaries. Landing statistics for *Hilsa* shad show a large increase after the construction of Farakka barrage. Unfortunately, Farakka barrage has caused the decline of the *Hilsa* stock in the Padma river (Bangladesh) which was once more famous than that in the Ganga.

1.2 Migration

The upstream migration during the main breeding season depends vitally on the commencement of the south-west monsoons. The variations in the intensity of the monsoon during the breeding season appear to cause considerable fluctuations of the fish catches in different places. Day (1873) expressed the opinion that the fish spends a part of its life in the sea not far from the shallow coastal belt. Naidu (1939) added that the general migration pattern of adult *Hilsa* take place in the Ganga from May-June and they disappear by the second week of October. Hora (1941) pointed out that among the mature *Hilsa,* which swarm into the rivers during the flood season for spawning purposes, there are a number of young individuals also and these travel far up before they become sexually mature. He stated that spawning takes place in the tidal waters and in the middle reaches of the large rivers and inferred that the floods and sexual maturity induce the fish in the sea to undertake the upward migration. Pandit and Hora (1951) summarized the extant hypothesis on the movements of *Hilsa viz.*, (i) during the flood season, the adult *Hilsa* swarm up the rivers for breeding. While they probably breed in the lower reaches of the rivers, some immature fish associated with these swarms move up and probably breed much higher up next year; (ii) the young fish fall back to the sea or estuarine areas in large numbers during October-November; the numbers get reduced by February; (iii) at about the same time, November-February, the young which had migrated to the sea during the flood season and had grown to 7”-9” form a big fishery; (iv) during March-April, the young ones known as *Jatka* enter East Bengal waters in large swarms for feeding and form an independent fishery; (v) These swarms move up the river and fatten as they grow and mature in the middle and upper reaches, the movement being facilitated by the increase in the volume of water in the rivers due to the melting of the snow in the Himalayas during the spring hot months.

Fish passes constructed at the Farakka barrage also proved futile for the species (Malhotra and Shah, 1979). Besides, the obstructions of rivers by the construction of weirs and anicuts, silting also appears to affect the *Hilsa* migration. The occurrence of two runs of *Hilsa* in the main river system, one during the south west monsoon and the other during late winter has been established. The late winter run is of a smaller magnitude while the estuarine stocks migrate up the river for spawning and return to the river mouth and adjacent foreshore areas. Temperature, current, velocity, and volume of discharge are probably the significant directive factors to which *Hilsa* responds in its movements from the sea to the estuary (Pantulu *et al.,* 1966; Gopalakrishnan, 1973). The general assumption is that the maturing

Hilsa ascend the river till they reach the spawning grounds and after spawning they migrate downwards.

1.3 Decline in *Hilsa* fishery

Loss of habitat, directly and indirectly through fishing or other processes, poses major threat to the continued existence of many marine species (Roberts and Hawkins, 1999; Rodwell *et al.,* 2003), particularly those that are already endangered (Wilcove *et al.*, 1998). Undeniably, mistreatment is alleged to have caused 55% of marine extinctions, while habitat degradation explains a further 37% (Dulvy *et al.,* 2003), emphasizing the importance of these two processes for both conservation, sustainability and subsistence. Some studies have concluded that habitat is more important than fishing (Grigg, 1994), whilst others have found that the effects of fishing are still prevalent when accounting for spatial variation in habitat (Chapman and Kramer, 1999). The relative consequence of these two processes is likely to depend on the extent of fishing pressure compared to variations in habitat (Russ *et al.,* 2005) and will vary depending on species vulnerability to fishing versus habitat dilapidation (Wilson *et al.,* 2008).

The river Ganga has greatly influenced human habitations along its littoral zone, supporting the livelihoods of many people, but suffered from unregulated fishing, environment degradation, water abstraction and encroachment. The amplified fishing pressure due to higher claim for *Hilsa* fish, followed by indiscriminate fishing methods increased the fishing effort leading to over exploitation, which gradually led to a drop in the catch per unit effort. With the decreasing natural stocks, the fishers had to augment fishing effort for whatever species or size of fish were available to support their livelihoods. Interventions like regulations, wise use, or increased awareness may not yield desired results, and to reverse the trend, as fisher's livelihoods are affected. Although the ecology, fish species composition and landing trends are studied in Ganga, there is also acute paucity of sound empirical information on the fish population, maltreatment levels and sustainable yields from the river to implement effectual resource management plans.

It has been reported by several workers that variability of the monsoons cause considerable fluctuations in the *Hilsa* catches. The intensity of monsoon, its arrival, and the consequent flooding of the rivers along with high turbidity of the waters have been included as causal factors for *Hilsa* fishery decline. Hora and Nair (1940a) and Hora (1941) have recorded that besides the annual fluctuations, there is a five-year cycle in the *Hilsa* fishery. This view was supported by Biswas (1954) on the basis of the trend in prices. Hora and Nair have also observed that the long range fluctuations are due to large populations attaining maturity at particular periods. They have inferred that a majority of the fish attain maturity when they are five years old and hence every five years bulk of the stock on becoming mature swarms up the river and provides bumper catches. Dunn (1982) has also considered water level fluctuations and turbidity values, expressed as index of sediment load compared with water flow, as causal factors in the fluctuations in the *Hilsa* fishery.

In the recent years there has been a declining trend in the catches of *Hilsa* along the upstream and downstream (Digha, Talsari and Frazerganj) of the Hooghly estuarine region. Being a migratory fish, the adults that swarm at the lower estuaries and mature adults that make long journeys into the rivers are subject to noticeable fishing stress. Similarly, the fry that spend their life for a season in the river and juveniles that make long trip into the sea through the river and estuary are also subjected to extreme fishing stress. It is also a matter of concern that huge quantities of pre-adults are caught in the inshore areas by *jangal* and *kachal* fishing gears even before the fish attains size at first maturity (370 mm). Fishing on the migrating ripe *Hilsa* is also a matter of concern, causing failure of *Hilsa* fishery. The small mesh size of *jangal* and *kachal* and fishing in the river during September and February when large scale movement of ripe fish is expected in the river, is a major cause of *Hilsa* decline. The overall rise in global temperatures has also affected the *Hilsa* migration.

In India, the *Hilsa* fishery is managed by the state, rather than by the central government. This is likely to mean that there is less capacity and resources to actively implement management measures. There is currently no control on fishing effort, that small size mesh nets are widely used to catch *jatka* and similar-sized juveniles of many species. Other scientist also undertook an assessment of the "total catchable potential" (TCP) of the Hooghly river system and some of the main species, including *Hilsa.* They estimated that the TCP for *Hilsa* was 3507.6 tons and this has already been exceeded. Thus, the limited studies on *Hilsa* suggest that *Hilsa* are almost certainly over-exploited in India. Thus, if India were to use management measures to improve sustainability, then major spawning and nursery areas need to be identified and mapped. Researches and investigators have also identified pollution and poor environmental flows as serious problems that are affecting *Hilsa* and other riverine and estuarine fishes in West Bengal.

Hilsa was the main fishery in comparison to major carps during the period between 1963-1971. But, with the commissioning of Farakka barrage, the fishery declined sharply between 1972-1980. Ghosh (1976) has mentioned that the production of the *Hilsa* fishery above the Farakka barrage has dropped from 116.1 kg/km^2 pre-construction to less than 1 kg/ km^2 post construction. Catches of *Hilsa* dropped to just 1.01 tons at the same time the miscellaneous fishery recorded an increase. Total fish catch from this centre registered improvement, but shift in species composition was a direct result of hydrological changes caused by barrage. The fishery declined both in quantity and quality in time scale due to various anthropogenic factors. It has been reported by Gupta and Tyagi (1992) that the fishery is being harvested at much higher effort than the optimum fishing effort. Therefore, urgent steps are required to reduce the fishing pressure to achieve the goal of sustainable fishery from the river system. *Hilsa* fishery suffers badly. The per unit yield of major carps dropped to 46.0 kg/km from 143.5 kg/km recorded during the 1960s while *Hilsa* yield was only 7.1 kg/km. With the construction of Farakka barrage, the fishery scenario at Lalgola center about 45 km. below Farakka, showed a major change in stock structure. Prior to Farakka, the *Hilsa* used to be the main fishery (92.02%). With the commissioning of the barrage, *Hilsa* contribution came down to merely 16.8% and the niche was replaced by other species. In recent years, between 1998-99 and 2002-2003, the average annual catch of *Hilsa* has been estimated at 10382.9 tons with an impressive increase of 63.3% from the corresponding five years (6279.6 tons). The average annual landing showed a sharp increase in the post barrage period. It was 1457.1 tons (15.3%) prior to 1975 and increased to 7352.9 tons (13.2%) during 1994-95 to 1999-2000. This unusual increase in the catch of *Hilsa* may be also due to the barrage construction, and due to migration of the *Hilsa* to areas above the barrage, resulting in severe depletion of *Hilsa* fisheries in the middle stretches of river Ganga. *Hilsa* juveniles (fry and fingerlings) constitute a substantial part of *Hilsa* catch from the upper freshwater stretches of the estuary. Indiscriminate exploitation of the young ones of *Hilsa* through small mesh nets took a heavy toll on the *Hilsa* juveniles, on the onset of downward migration of the young ones. Mitra *et al.* (2001) estimated *Hilsa* juvenile catch between 50.9-63.3 tons (57.5 tons) from Hooghly estuary, during the period 1994-1995 to 1999-2000, numerically when estimated it results to 13.1 million of young fish (weight range 2.2-27 g). In addition to this, wanton killing of *Hilsa* juvenile has been rampant in the upper stretch of the estuary, especially during November to May due to development of small mesh net.

Low water discharge from the river Ganga at the Farraka barrage and associated heavy siltation, indiscriminate exploitation of juveniles (*jatka*), disruption of their migration routes, loss of spawning, feeding and nursery grounds and increased fishing pressure have all contributed to a decline in the catch per unit effort in both the marine and river *Hils*a fishery. The radical decrease of catches of both mechanized and non-mechanized boats indicate the excess of fishing effort, which could lead to over-exploitation and vulnerability of the fishery. The declining trend of catch per unit effort of *Hilsa* fishing is threatening the livelihoods of about 464 thousand *Hilsa* fishermen. Fish stocks are renewable and a pragmatic approach is essential to maximize the sustainable benefits they can generate. It must be ensured that the resources are protected from the irreversible damage and managed on a sustainable basis. Dams and barrages constructed across the river to supply irrigation water, flood protection and hydropower not only prevent migration, change migration routes, and alter spawning and nursery grounds, but also concentrate the shad population in certain areas, thereby subjecting them to over-fishing. The average landing of *Hilsa* in metric tons is illustrated in Table 1.

Table 1: Average *Hilsa* landings (in metric tons) from the Hooghly-Matlah estuary during the pre- and post-Farakka Periods (Source: Sinha, 2004)

Period	Landings (in metric tons)
Pre-Farakka (1966-1975)	1,457.1
Post-Farakka (1975-1978)	2,126.2
Recent (1984-1994)	2,135.4

2. Conclusions

Thus, it can be concluded that the *Hilsa* decline thoroughly indicates habitat destruction and degradation in the lower Ganga river basin and at the same time it projects the rapid alteration in the ecology of the section concerned. The existing situation of the *Hilsa* fishery suggests that proper assessment is necessary and there is a need to find a way to stimulate the recovery of the fishery and make it sustainable, while maximizing economic benefits.

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