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Case Studies V: Hydraulic Impact on Fish Migration in Sariakandhi Fish Pass of Bangladesh

Biljoy Kumar

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HYDRAULIC IMPACT ON FISH MIGRATION IN SARIAKANDHI FISH PASS OF BANGLADESH
Presented by
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INTRODUCTION

- Background of the study
- Bangladesh is a flood prone country
- Flood Control, Drainage and Irrigation (FCDI) Projects interfere with the environment and ecosystem
- FCDI Projects affect the migratory routes and nursing grounds of many species of open water fisheries.
- The fish passes is new concept in Bangladesh. Till to date two Fish passes and two Fish Friendly Structures are Constructed.
Importance of Fisheries in National Economy

- This sector accounts for 8% of GDP
- They contribute around 8% to national income, which also is 32% of the total agricultural income. About 90% of animal protein in our diet comes from fish and livestock.
- 11% of export earning and 70% of annual protein intake of its population.
- About ten million people are dependent on the fisheries sector.
- Fisheries Sector plays an important role in rural employment and poverty alleviation.
- Table 3.3: Locations and types of Fishpass and Fish Friendly Structure in Bangladesh

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Location</th>
<th>Regulator</th>
<th>Type Constructed by</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sariakandi, Bengali Nadi, Siragonj</td>
<td>Fish PassBWDB</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Kashimpur, Kawadighi Haor, Moulvibazar</td>
<td>Fish PassBWDB</td>
<td>2.Kashimpur, Kawadighi</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Jugini, Lohajong River, Tangail</td>
<td>Fish Friendly Structure</td>
<td>BWDB</td>
<td>(FAP-20)</td>
</tr>
</tbody>
</table>
Photo 3.1: Fishpass and Fish Friendly Structures in Bangladesh
Kashimpur Fishpass
Tangail Fish Friendly Structure
Chapainawbganj  Fish Friendly Structure
Mechanism of Fish Migration

- **Physical factors** include bottom materials, water depth, pressure (water and atmospheric), current and tide, turbidity, topography, gradient, temperature and light-intensity, photoperiod and quality.
- **Chemical factors** are salinity, alkalinity, hydrogen ion concentration, dissolve gases, odors, taste and pollutants.
- **Biological factors** of migration are blood pressure, sexual development, phototaxis, social response, predators, competitors, hunger, food, memory, physiological clock and endocrine state.
## Hydrology, Hydraulic and Fish Migration

<table>
<thead>
<tr>
<th>SL. no.</th>
<th>Beginning/Usual Time</th>
<th>Influence on Fish Activity</th>
<th>Influence on Fish Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Rain</td>
<td>February-April</td>
<td>Influence to breed small fishes</td>
</tr>
<tr>
<td>02</td>
<td>Thunder</td>
<td>February-March</td>
<td>Breed small fishes and prepare big fishes for breeding, spawning migration of carps and catfishes</td>
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<td>SL. no.</td>
<td>Beginning/Usual Time</td>
<td>Influence on Fish Activity</td>
<td>Influence on Fish Activity</td>
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<td>--------</td>
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<td>---------------------------</td>
</tr>
<tr>
<td>03</td>
<td>Water Level Rise</td>
<td>March-May</td>
<td>Breeding of small fishes, Spawning migration, dispersion of hatchlings of small fishes</td>
</tr>
<tr>
<td>04</td>
<td>Water Current (pre-monsoon)</td>
<td>March-May</td>
<td>Spawning migration and hatchling distribution</td>
</tr>
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<td>SL. no.</td>
<td>Beginning/Usual Time</td>
<td>Influence on Fish Activity</td>
<td>Influence on Fish Activity</td>
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<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>05</td>
<td>Inundation</td>
<td>June-September</td>
<td>Grazing and feeding in the floodplain</td>
</tr>
<tr>
<td>06</td>
<td>Flood</td>
<td>June-September</td>
<td>Mixing and dispersion of species, migration and movement</td>
</tr>
<tr>
<td>SL. no.</td>
<td>Beginning/Usual Time</td>
<td>Influence on Fish Activity</td>
<td>Influence on Fish Activity</td>
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<td>---------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>07</td>
<td>Fluctuation of Water Level</td>
<td>May-August</td>
<td>Dispersion of fish and breeding</td>
</tr>
<tr>
<td>08</td>
<td>Water Recession</td>
<td>September-November</td>
<td>Taking shelter to perennial water bodies</td>
</tr>
<tr>
<td>SL. no.</td>
<td>Beginning/Usual Time</td>
<td>Influence on Fish Activity</td>
<td>Influence on Fish Activity</td>
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<td>----------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>09</td>
<td>Drought</td>
<td>December-February</td>
<td>Shelter in deeper water bodies</td>
</tr>
</tbody>
</table>
Location of the Study Area

- **Sariakandi fish pass** is located at the western part of the Bolai canal - a link canal between the Jamuna River and the Bangali River close to Pardevdanga village under Sariakandi Upazila of Bogra district.

- **Bangladesh Water Development Board (BWDB)** established the fish pass in the year 1999.
The site of the fish pass is located about 25 km from Bogra district town and 3 km from Sariakandi upazilla head quarters.

Fish fry, hatchling, and spawning movement from Jamuna to Bangli river was the main objectives of Sariakhandi fishpass project.

The construction work of embankment on eastern bank of Jamuna River started in 1996-97 and completed in 1998 while the construction work of the fish pass started in 1998 and completed in 1999.
Figure 1.1 Location of Sariakandi Fishpass in Brahmaputra Right Embankment. Source: (CNRS 2002)
Photo 1.1: Fishpass structure in Jamuna to Bangli river at Sariakandhi.
**METHODOLOGY**

- **Data Collection**: The data which have been collected by the questionnaire survey was verified through Focus Group Discussion (FGD).
- **Questionnaire Survey**: Questionnaire Survey is a special decision making tool that will analyze the criteria to attend the management goals and will present the alternatives with scope the managers to take decisions.
- **Focus Group Discussion (FGD)**: A total of four FGDs were carried out at the study site.
To calculate the total catch, the relationship is:

\[
\text{Total catch} = (\text{catch per unit effort}) \times (\text{total effort})
\]

The amount of catch per unit of fishing effort is termed as Catch per Unit Effort (CPUE).

\[
\text{Total effort} = (N \text{ fishing unit}) \times (\text{days in the month}) \times \text{CA}
\]
The local fishers categorized whitefish (carp fish) and blackfishes (catfishe) based on their migratory movements.

In this study, it is found that the black fishes are Boal, Pabda, Tengra, Magur, Rita, Air, Koi, Shing, Gulsha, Chital etc. Among them Chital, Gulsha and Rita were more dominant species than other species.

The white fishes are Rui, Catla, Mrigel, Kalibaush, Gonia, Sarputi, etc, of which Rui, Mirgel, Kalbaush are more dominant species than other species.
RESULTS AND DISCUSSION

- **Water Level**: The water level data (1999-2001) at fishpass site has been collected from BWDB office of Sariakandi, Bogra.

- The data shows that there are two peaks in this river system.

- One minor peak develops at the onset of monsoon in July with major peak at the end of August. The duration of minor peak is higher than the major peak.

- The peak migration timing for carp and catfish is May to July. The carp and cat fishes start migration from April. In this river system the water levels start rising at this time which provide favorable environment for migration.
Figure 3.1: Variation of water levels in Jumuna and Banglai Rivers at Fishpass site
The maximum velocity that an adult fish and juvenile can tolerate varies from species to species.

For upstream migratory fish species threshold velocity (minimum velocity, which leads to an orientation reaction to move against the current, values range from 1-30 cm/sec) is another important parameter needs to be looked after.

On the other hand critical velocity is appeared as another important parameter. Each species has a distinctive range of critical velocities (the minimum velocity at which fish just begins to be carried away by the water flow) which represents the maximum permissible velocity through the fish friendly structure or fish pass.
# Measured velocities at the left vent for different head differences at Fish pass area

<table>
<thead>
<tr>
<th>Head difference for Fish pass area (m)</th>
<th>Position and Velocity (m/s) (Left Vent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upstream</td>
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<tr>
<td></td>
<td>(m/s)</td>
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<tr>
<td>0.50</td>
<td>1.00</td>
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<tr>
<td>0.85</td>
<td>1.16</td>
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<tr>
<td>0.95</td>
<td>1.19</td>
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<tr>
<td>1.10</td>
<td>1.25</td>
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</tbody>
</table>
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</thead>
<tbody>
<tr>
<td></td>
<td>Upstream (m/s)</td>
</tr>
<tr>
<td>1.15</td>
<td>1.28</td>
</tr>
<tr>
<td>1.20</td>
<td>1.30</td>
</tr>
<tr>
<td>1.28</td>
<td>1.35</td>
</tr>
</tbody>
</table>
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<td></td>
<td>Upstream (m/s)</td>
</tr>
<tr>
<td>0.50</td>
<td>1.12</td>
</tr>
<tr>
<td>0.85</td>
<td>1.19</td>
</tr>
<tr>
<td>0.95</td>
<td>1.22</td>
</tr>
<tr>
<td>1.10</td>
<td>1.27</td>
</tr>
</tbody>
</table>
Measured velocities at the left vent for different head differences at Fish pass area

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<td></td>
<td>Upstream (m/s)</td>
</tr>
<tr>
<td>1.15</td>
<td>1.30</td>
</tr>
<tr>
<td>1.20</td>
<td>1.31</td>
</tr>
<tr>
<td>1.28</td>
<td>1.37</td>
</tr>
<tr>
<td>Side</td>
<td>Average Head difference (m)</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Left Vent</td>
<td>1.00</td>
</tr>
<tr>
<td>Middle Vent</td>
<td>1.18</td>
</tr>
</tbody>
</table>
# Velocity and Migratory species of U/S Bangali River

<table>
<thead>
<tr>
<th>Side</th>
<th>Average Head difference (m)</th>
<th>Average Velocity m/s</th>
<th>Migratory speacies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Vent</td>
<td>1.00</td>
<td>1.02</td>
<td>Rui, Mrigel, Calbasu, Catla</td>
</tr>
<tr>
<td>Middle Vent</td>
<td>1.18</td>
<td>0.94</td>
<td>Batasi, Chitol, Garua, Kazoli, Tenga,</td>
</tr>
</tbody>
</table>
6.1.1 Monitoring of Fish Movement

Information on movement of fish through the fish pass was acquired primarily by the fishermen who are used to catch fish in the fish pass area, and secondarily from visual observations of the water surface of the pools during seasonal basis, during a period from 10 March, 2005 to 10 March 2006. Migratory fish species are as groups categories like Carp, Catfish, Eel, Spiny eel, Knife fish, Sardine, Needle fish, miscellaneous species and prawns. Generally these fish species take shelter in the Bangali river during flood recession period. During sampling period presence of these fish species in the catch from the Bangali river, were collected. From the abundance of species in the catch and the catch frequency related that 2004-05, the Knife fish (Chital) movement was high, but in this year 2005-06, the Carp fish as (Rui and Catla) are dominant species in the study area. The major migratory fish species, which moves through the Shariakandhi Fishpass, are listed in the table 6.1
The migratory species collected from the study area are analyzed and it is found that the dominant fish species group is Carp and the second dominant group is Catfish whereas, Needle and Losch fish group is found only 1 percent. The percentage of each group of fish species is shown in figure 6.1 and carps, catfish, and other fish species found in study area are shown in photo 6.1 and 6.2.
## Group wise migratory species through Shariakandhi Fishpass

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Group</th>
<th>Average catch (%) of total collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Native Major Carps</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Minor Carp</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Minor Carp</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>Large Catfish</td>
<td></td>
</tr>
</tbody>
</table>
Group wise migratory species through Shariakandhi Fishpass

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Group</th>
<th>Average catch (%) of total collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>Small Catfish</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td>Spiny eel</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Losch</td>
<td>1%</td>
</tr>
<tr>
<td>05</td>
<td>Knife fish</td>
<td>6%</td>
</tr>
</tbody>
</table>
### Group wise migratory species through Shariakandhi Fishpass

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Group</th>
<th>Average catch (%) of total collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>Sardine</td>
<td>1.5%</td>
</tr>
<tr>
<td>07</td>
<td>Needle fish</td>
<td>1%</td>
</tr>
<tr>
<td>08</td>
<td>Miscellaneous species</td>
<td>14%</td>
</tr>
<tr>
<td>09</td>
<td>Prawns</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td><strong>Total =</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
Figure 6.2: Percentage of different migratory species caught at Shariakandi Fish pass area.

Average Catch (%) = Total Collection

- Carp fish: 40
- Cat fish: 33
- Spiny eel: 16
- Losch: 14
- Knife fish: 12
- Sardine: 3
- Needle fish: 3
- Miscellaneous species: 1
- Prawns: 1
Photo 6.1: Carps, catfish and other fish species found in the study area
Photo 6.1: Carps, catfish and other fish species found in the study area

- Miscellaneous Species
- Major Carp
- Minor Carp
Photo 6.2: Carps, catfish and other fish species found in the study area
Photo 6.2: Carps, catfish and other fish species found in the study area
Migrational Behaviors of Different Fish Species

- **Potamodromy or Limnodromy** - when fishes move within the fresh water bodies the migration is called as Potamodromy or Limnodromy, and the fishes as Potamodromous or Limnodromous fishes.

- In this movement some species prefer to move upstream for spawning whereas, their feeding ground is at a lower range, for example, the major carps.
2. Diadromy – when fishes are moving freely between fresh and marine water. The migration is called as diadromy, and the fish as diadromous fish.

This migration is divided into two phases according to the habitat towards which the movement is occurring. The types of diadromy migration are:

- Anadromy – when fishes are moving from salt water into fresh water
- Catadromy – when the fish is moving from fresh water into salt water area.
**Spawning Migration Time**

- Spawning migration period of different fish species in the study area.

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
</table>

Carp fish migration

Catfish migration
Seasonal migration of major carp fish (white fish) at different stage of life cycle

<table>
<thead>
<tr>
<th>Periods</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
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<th>N</th>
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<tbody>
<tr>
<td>Spawning migration</td>
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<tr>
<td>Fingerling migration</td>
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<tr>
<td>Dispersal of young over Floodplain</td>
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<tr>
<td>Return of young to Beel and river</td>
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<td>Harvesting Beel and River</td>
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</table>
### Seasonal migration of Catfish (Black fish) at different stage of life cycle

<table>
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<th>Periods</th>
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<tr>
<td>Spawning migration</td>
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<tr>
<td>Dispersal of Floodplain</td>
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<td>Dispersal and Growth</td>
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<tr>
<td>Return of Standing of young's</td>
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<td>Harvest</td>
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<tr>
<td>Dry Season Resident in Standing water</td>
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</tbody>
</table>
Types of Migrations per Season in Major Carps and Catfishes

- Seasonal migration of major carp fish (White fish) at different stage of life cycle.
- Seasonal migration of catfish (Black fish) at different stage of life cycle.
CONCLUSIONS

1. The fish pass is contributing positively for growth of open water fishery resources in the study area.

2. The fish pass area fish catch before the construction of BRE was higher than the present situation. However the present situation is better than that of just after construction of BRE.
3. Spawning migration mainly in carp fish, in the study area was found to begin at the 2nd week of May and continue up to the 3rd week of July. Catfish migration began at the last week of March and continues up to the 2nd week of June.

4. All the fish species during the study period showed patamodromous migration.

5. Carpfish migrates in a higher velocity, whereas, catfish migrates in a lower velocity.
RECOMMENDATIONS

1. Study on morphological control on fish movement:

A detail study should be carried out to identify the morphological controls over the fish movement during the migration period. More specifically, to know the carp breeds, whether outside the territory.
2. Study on fish mortality rate
A study should be initiated to assess the mortality rate under different velocity, head and turbulence and different sediment concentrations.

3. Study on effect of hydraulic characteristics on migration
A study should be initiated to assess the relationships between hydraulics characteristics and migrational behavior of different fish species.
THANKS FOR PATIENCE HEARING