FLOOD CONTROL IMPACTS ON FISHERIES:
GUIDELINES FOR MITIGATION

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Background

This presentation is one of a series of five presenting key outputs from FMSP floodplain projects, carried out in the Asian region between 1992 and 2005. The five papers focus on:

- General management guidelines for floodplain river fisheries (as published in FAO Fisheries Technical Paper 384/1)
- Selection and management of harvest reserves (key messages)
- Materials for a training course on harvest reserves
- Flood Control Impacts on Fisheries: Guidelines for Mitigation
- Modelling floodplain river fisheries

This presentation was prepared by FMSP Project R8486 – ‘Promotion of FMSP guidelines for floodplain fisheries management and sluice gate control’
Introduction

• Flood Control Drainage and Irrigation (FCDI) structures exist widely in Bangladesh and other parts of Asia.

• Built to control water levels to improve agricultural production based upon HYV of rice (cannot tolerate rapid inundation or require irrigation).

• Provide protection from extreme flood events.
Introduction

- Benefits to agricultural sector significant (80% more production inside) but...
- Fish production typically lowered.
- Halls et al (1998; 1999) found that in Bangladesh fish yields were 50% lower yields inside FCDIs compared to outside with up to 25 species of fish absent or less abundant.
- Lower rates of recruitment of migratory whitefish species found largely responsible (Hoggarth et al 1999).
- Migrations obstructed by embankments.
Introduction

- Predicted effects of climate change in South Asia include:
  - more extreme flooding
  - hotter and more arid dry season conditions

- May necessitate the construction of more FCDI schemes! (to control floods and provide dry season irrigation)?
Introduction

• Q: How can we mitigate the impacts of FCDI Schemes?

• A: Improve the management of sluice gates to:
  - (1.) Improve the recruitment (access) of migratory fish to FCDIs.
  - (2.) Improve production of resident (non-migratory) fish populations.

Whilst minimising impacts to agriculture sector
(Integrated floodplain management - IFM)
1. Improving fish access to FCDIs

- Based on fisheries monitoring and mark-recapture studies undertaken at 3 sluice gates (Halls 2005a; Halls et al. 1998; Halls et al. 1999; Hoggarth et al. 1999), the following guidelines have been developed to improve the access of migratory fish to FCDIs...
1. Improving fish access to FCDIs

- **1.1 Sluice gate managers should aim to maximise the flow of water (and therefore fish) into FCDI during the rising flood period.**
- Aids the passive inward migrations of fish.
1. Improving fish access to FCDIs

- 1.2 Sluice gate managers should aim to open sluice gates as frequently as possible and attempt to minimise the turbulence of water outside sluice gates during the rising flood period.

- Anecdotal evidence (Halls et al 1998; 1999; Hoggarth et al 1999) suggests that biodiversity & fish production benefit from more frequent gate openings, particularly during rising flood period.

- Turbulence in front of gate may act as an obstacle to induction and smooth passage of fish.
1. Improving fish access to FCDIs

• 1.3 Sluice gate managers could control ebb flows from sluice gates to attract more fish towards sluice gates but that do not exceed the maximum swimming speeds of fish.

• The figure opposite shows how the abundance of fish caught trying to migrate towards the Talimnagar sluice gate in NW Bangladesh varies in response to out-flowing current velocity.

• It suggests that best attraction velocity is about 0.1 ms\(^{-1}\).
Calculating maximum current speeds

• Maximum swimming speeds of fish, thus maximum permissible ebb current speeds flowing out from sluice gates (Max Outflow Velocity), can be easily estimated using the current empirical formulae ($R^2=0.80$):

$$Max\ Outflow\ Velocity < U_{ms} = \frac{L(n (1.1(W)^{-0.14}))}{100}$$

• Where $U_{ms}$ = maximum sustainable swimming speed, $L$ = mean length of migrating fish, $W$ = mean weight of migrating fish, $n$ = constant = 3.

• Liftnet sampling of fish during ebb flow will give estimates of $L$ and $W$. Liftnets could also be sampled for CPUE data to estimate optimal attraction velocities.
1. Improving fish access to FCDIs

- **1.4 Managers should control fishing activities along channels connecting the sluice gates to the main rivers.**

- In Badia River biomass of immigrating fish was reduced by 40-50% along 5km stretch from mouth to gate (Halls 2005).
1. Improving fish access to FCDIs

- Controlling fishing in these channels may be as important as fine tuning sluice gate operations.
- First step in right direction - avoids any potential impacts to farmers arising from sluice gate operations.
- Should benefit the wider fishery (fishing during this period exploits sexually immature fish that are still growing rapidly).
- Reducing effort during this period could increase size of spawning stocks and thus overall yield, as well as yield-per-recruit.
2. Improving Production of Resident Fish

• 2.1 Sluice gate managers should consider closing sluice gates towards end of ebb flood to retain more water within FCDI schemes during the dry season.

• Fish over-winter in permanent channels and residual waterbodies on floodplain. Area of water remaining on the floodplain may be less than 5% of that during the flood season!

• Model predictions indicate that fish production is more sensitive to the amount of water remaining during dry season than flood season conditions (see accompanying floodplain modeling presentation).
2. Improving Production of Resident Fish

• Studies (Halls et al 2001; Shanker et al 2004; 2005) at the PI RDP have predicted that raising dry season water levels by as little as 0.25m, could increase fish production by about 9% at a loss of only 8 ha of rice production, mainly from marginal, low-lying land.

• Increased availability of dry season water would help reduce pressure placed upon critical dry season fish habitat resulting from dry season crop irrigation strategies.

• Such irrigation strategies are likely to become increasingly necessary in the face of climate change (Halls 2005b).
2. Improving Production of Resident Fish

- Managers should seek to encourage alternative cropping strategies and the retirement of marginal low-lying agricultural land that is prone to early flood risk.

- Dry season (boro) rice production based upon high yielding varieties (HYV) often relies upon small-scale irrigation systems e.g. low lift (taxi) pumps (LLPs) to abstract water from dry season waterbodies.

- But these residual water bodies provide critical dry season habitat for floodplain-resident fish.
2. Improving Production of Resident Fish

- Studies (Shanker et al. 2004; 2005) have predicted that beyond some threshold, floodplain fish production is highly sensitive to removals of water from these bodies impacting upon fish catchability, natural mortality rates and recruitment.

- Switching to alternative dry season crops such as wheat or onions that require less irrigation (less frequent and smaller applications of water) could alleviate this problem to some extent.
2. Improving Production of Resident Fish

- Switching to other dry season crops such as spices and vegetables that are harvested several weeks before boro rice, and greater emphasis on more flood-tolerant Aman rice would also allow for earlier, more frequent opening of sluice gates for longer periods during the rising flood (Shanker et al 2004; 2005).

- Such adaptive strategies are likely to become increasingly necessary in South Asia where precipitation is predicted to increase during the flood season, but decrease during the dry season in response to climate change (Halls 2005b).
References

http://www.fmsp.org.uk/FTRs/r8210/.htm


http://www.ecohydro.pl/index.php


Project details and credits
FMSP Project R8210 – *The Use of Sluice Gates for Stock Enhancement and Diversification of Livelihoods*

- **Start Date:** 03/2003
- **End Date:** 02/2005

- **Project Collaborators:**
  - MRAG (Ashley Halls, Ian Payne)
  - IIED (Hannah Reid, Saleemul Huq);

- **Key References:** Halls (2005).
- **Project web page:** [http://www.fmsp.org.uk/FTRs/r8210/](http://www.fmsp.org.uk/FTRs/r8210/)
FMSP Project R5953 – *Fisheries dynamics of modified floodplains in southern Asia*

- **Start Date:** 03/1994
- **End Date:** 03/1997

- **Project Collaborators:**
  - MRAG (Dan Hoggarth, Ashley Halls);
  - CRIFI, Indonesia (Fuad Cholik, Agus Utomo, Ondara);
  - BAU Mymensingh (M.A. Wahab, Kanailal Debnath, Ranjan Kumar Dam)

- **Key References:** MRAG (1997); Halls et al (1998); Hoggarth et al (1999); Hoggarth et al (1999b).

- **Project web page:** [http://www.fmsp.org.uk/FTRs/r5953/.htm](http://www.fmsp.org.uk/FTRs/r5953/.htm)
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