Integrating Environmental Flow Assessment for the Lower Yellow River

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Outline

1. Background
2. Integrating environmental flow assessment for the lower Yellow River-ACEDP
1. Background

1.1 Project and Study Area Description

Aus AID-CHN MC

ACEDP: RH & EF

IWC  MEP  MWR

YR-pilot  PR-pilot  LR-pilot

Yellow River Conservancy Commissions
1.2 Change of flow regime in the lower Yellow River

Mean monthly discharge in different periods at Huayuankou gauging station
The changes of spell event in different periods at Huayuankou gauging station

<table>
<thead>
<tr>
<th>Period</th>
<th>Total times</th>
<th>Annually Mean times</th>
<th>Duration (d)</th>
<th>Mean peak flow (m³/s)</th>
<th>The longest duration (d)</th>
<th>Maximum peak (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949-73</td>
<td>105</td>
<td>4.2</td>
<td>11.9</td>
<td>2670</td>
<td>100</td>
<td>7180</td>
</tr>
<tr>
<td>1974-86</td>
<td>64</td>
<td>4.9</td>
<td>7.6</td>
<td>2315</td>
<td>38</td>
<td>4670</td>
</tr>
<tr>
<td>1987-99</td>
<td>71</td>
<td>5.5</td>
<td>6.4</td>
<td>1964</td>
<td>51</td>
<td>5060</td>
</tr>
<tr>
<td>2000-05</td>
<td>13</td>
<td>2.2</td>
<td>11.3</td>
<td>2173</td>
<td>34</td>
<td>3100</td>
</tr>
</tbody>
</table>
1.3 The effect of runoff change on the river ecosystem

River channel capacity decrease in past 50 years in Huayuankou
Plankton production has declined from 8 million kg/year in 1950's to .01 kg/year today.

The number of fish species has also declined from 152 in the 1950s to 47 today.

Compared with 1986, the total area of wetlands of Yellow River decreased by 16 % in 1998.
1.4. Review of environmental flow study of the lower Yellow River

A certain number of hydrological, sedimentological, morphological, environmental, ecological and socio-economic studies, each with specific objectives, have been carried out separately on this Basin. However, integrated study of environmental flow is not yet completed.
Because of lack of understanding of the relationships between flow and ecosystem structure/processes, and no clear objectives for environmental flow, so the study above can not gave integrated environmental flow assessment for the lower Yellow River. can not be used to river management.
2. Integrating Environmental Flow Assessment for the lower Yellow River-- ACEDP

2.1 Frame for environmental flow assessment

Integrate to provide a flow management recommendation

- Agreed
- Implementable
- Clear objectives (ecological, geomorphological and hydrological)
• Holistic approach will be followed:
  – project include a wide range of assets (from perceived lower to higher value)
  – project cover entire lower river (from Xiaolangdi to delta)
  – project cover a wide range of processes (fish, birds, vegetation, geomorphology, water quality, hydrology, hydraulics)

• Present a range of environmental flow options to YRCC:
Step for environmental flow assessment:

1. Set reaches and sites
2. Identify assets
3. Conceptual models
4. Set objectives for each asset
5. Apply hydrological and hydraulic model
6. Model e-flows and security of supply against targets
7. Monitor e-flows + response
2.2 River assets in the lower Yellow River

Sediment transfer
fishery

Power generation and flood control
Biology diversity
Water quality
2.3 environmental objectives

<table>
<thead>
<tr>
<th></th>
<th>Status</th>
<th>Reference</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood capacity</td>
<td>4000m$^3$/s</td>
<td>No</td>
<td>4000m$^3$/s</td>
</tr>
<tr>
<td>Water quality</td>
<td>Reach water quality for Grade II, III is 1656.0km, 45.8%, Grade IV, V is 1746km, 99.5km, 48.3%, 2.8%, worse than V is 111.5km, 3.1%.</td>
<td>Water function zone</td>
<td>Water function zone</td>
</tr>
<tr>
<td>Wetland</td>
<td>Natural reserve wetland</td>
<td>Natural reserve wetland</td>
<td></td>
</tr>
<tr>
<td>Aquatic</td>
<td>1980s</td>
<td>National protection animal</td>
<td></td>
</tr>
</tbody>
</table>
2.3 E-flows recommendation

Give an example on e-flow recommendation for Yellow Carp.
Concept model Model

Flow regime

Low flows
- Maintain depth of water in refuge pools
- Maintain adult fish population

Flow pulses
- Stimulate spawning

High flows
- Maintain larval and juvenile habitat in river channel

Floods
- Sediments from upstream and catchments increase, and DO decreases
- Maintain backwater refuges and food resources for fish. Fish mortality increases.

Food resources

The links between individual flow components and flow requirements for carp
Table. Flow components and hydraulic criteria relevant to Yellow River Carp requirements.  
D = depth, V = velocity

<table>
<thead>
<tr>
<th>Objective</th>
<th>Flow component</th>
<th>Hydraulic criteria</th>
<th>Timing</th>
</tr>
</thead>
</table>
| Maintain sufficient water depth in pools for large bodied fish | Low flow | Max D > 1.5 m  
V: 0.1-0.8 ms\(^{-1}\) | Nov-Mar, April-June |
| Stimulate spawning | Flow pulse | D: 1-2 m at peak of flow pulse. 
Inundated beach area, and increase back water 
V<0.3 ms\(^{-1}\) | April - June |
| Provide new habitat and feeding opportunities for fish | High flow | Average D > 0.7 m; 
V: 0.3 ms\(^{-1}\)-1ms\(^{-1}\) | July-October |
| Provide new habitat and feeding opportunities for fish, but increased sediment and low DO may increase mortality | Flood | Average D > 0.8 m; 
V: 0.5 ms\(^{-1}\)-1.2ms\(^{-1}\) | July-October |
Hydraulic Model

- Requirement for ecological habitat (depth, velocity, migration and so on) of Yellow River carp
- Hydraulic model simulate cross section hydraulic characteristic in different discharge

Get different environmental flows

Used River 2D model to research local flow velocity and water depth distribution in the river and identify the relationship between flow and fish habitat.
Morphology survey site

River channel

YiluoRiver junction

Huayuankou

Lijin

1

2

3
Figure 5. Simulated distribution of depth (A) and velocity (B) at 1,000 m3/s discharge
Figure 6. Simulated distribution of preferred hydraulic habitat for the spawning period at 1,000 m3/s discharge, showing habitat distribution meeting depth condition only (A), velocity condition only (B), and both depth and velocity conditions (C).
Figure 7. Simulated distribution of preferred hydraulic habitat at 1,000 m$^3$/s discharge for juvenile fish (A) and adult fish (B).
Figure 8. Available habitat area for Yellow River Carp for three life stages as a function of discharge.
# E-flows recommendation for Yellow River Carp

Environmental flow requirements at Huayuankou site in the lower Yellow River

<table>
<thead>
<tr>
<th>Flow component</th>
<th>Timing</th>
<th>Months</th>
<th>$Q_{Daily}$ m$^3$s$^{-1}$</th>
<th>Frequency</th>
<th>Duration</th>
<th>Rise/fall target (max) m$^3$s$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low flow</td>
<td>Drier season</td>
<td>Nov-Mar</td>
<td>200-400</td>
<td>continuous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low flow</td>
<td>Drier season</td>
<td>Apr-Jun</td>
<td>200-800</td>
<td>continuous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow pulse</td>
<td>Drier season</td>
<td>Early April</td>
<td>1400-1700</td>
<td>1</td>
<td>4 consecutive days</td>
<td>+723 -193</td>
</tr>
<tr>
<td>High flow</td>
<td>Wet season</td>
<td>Jul-Oct</td>
<td>About 4000</td>
<td>2-4</td>
<td>5 consecutive days</td>
<td>+1006 -507</td>
</tr>
</tbody>
</table>
THANK YOU FOR YOUR ATTENTION