The Experiments on Flood and Sediment Regulation in the Yellow River

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1. Brief introduction to the Yellow River

2. Objectives and Processes of the Experiments

3. Achievements and Remarks
Total length: 5,464km, Drainage area: 795,000 km²
Annual average runoff: 58 Bil. m³
Average sediment runoff: 1.6 Bil. t
Average sediment content: 35kg/m³
Maximum: 911kg/m³ (year 1977)

A = 29.6%
runoff = 55.6%
sediment runoff = 8%

A = 16%
runoff = 15%
sediment runoff = 56%

Annual average runoff: 58 Bil. m³
Average sediment runoff: 1.6 Bil. t
Average sediment content: 35kg/m³
Maximum: 911kg/m³ (year 1977)
The river course of the lower Yellow River is world-famous “suspended river”. The riverbed is typically 4-6m higher than the back side, it reaches 13m near Kaifeng city.
The discharge carrying ability of some reaches fell from 6000m³/s in 1980s to 2000m³/s in 2002.
The severe sediment deposition in the main channel in the lower YR is mainly because water and sediment relation is not in favorable condition.
There are 1.81 million farmers living in the inner-floodplain between the both banks in the lower yellow river. (25 million hec. Farmland).
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The general objective of the experiments is to model harmonious water and sediment process, so as to reduce the sediment deposition and enlarge the discharge carrying capacity in the main channel in the lower YR.
### Statistical relation of the channel morphological change with the flow and sediment combinations of 397 floods in the Lower Reach

<table>
<thead>
<tr>
<th>No.</th>
<th>Sediment content (kg/m³)</th>
<th>Average discharge (m³/s)</th>
<th>Duratio n (day)</th>
<th>Water volume (billion m³)</th>
<th>Deposition or not</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;20</td>
<td>2600</td>
<td>6</td>
<td>1.35</td>
<td>No Deposition</td>
</tr>
<tr>
<td>2</td>
<td>20-40</td>
<td>2900</td>
<td>10</td>
<td>25</td>
<td>No Deposition</td>
</tr>
<tr>
<td>3</td>
<td>40-60</td>
<td>4000</td>
<td>11</td>
<td>38</td>
<td>No Deposition</td>
</tr>
<tr>
<td>4</td>
<td>80-150</td>
<td>5600</td>
<td>12</td>
<td>58</td>
<td>No Deposition</td>
</tr>
<tr>
<td>5</td>
<td>&gt;150</td>
<td></td>
<td></td>
<td></td>
<td>Always Deposition</td>
</tr>
</tbody>
</table>
natural water and sediment should be regulated using the reservoirs on the branches and mainstream.
During July 4 to 15, 2002, natural flood and sediment process was regulated by Xiaolangdi reservoir. A better water and sediment process was created in favor of lower channel carrying sediment into the sea. The whole lower channel was scoured and the scoured sediment reached 56 million tons.
During September 6 to 18, 2003, the muddy water above Xiaolangdi reservoir and the clear water below it were mixed to form the better water and sediment process in favor of lower channel carrying sediment into the sea, which making the whole lower channel scoured and the scoured sediment reached 39 million tons.
From June 19 to July 13, 2004, artificial flood peak was made by using Wanjiazhai reservoir, Sanmenxia reservoir and Xiaolangdi reservoir. The scoured sediment reached 64 million tons.
The successive three years’ water and sediment regulation experiments during 2002-2004 increased the lowest discharging capacity of the lower main channel to 3000 m$^3$/s from 2000 m$^3$/s.
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3. Achievements
Sedimentation is reduced

- During the three experiences, totally 148.3 million tons of sediment was scoured from the lower Yellow River channel, and 256.8 million tons were transported to the sea.
- The density flow in the reservoir was artificially generated and flushed out of Xiaolangdi Dam for the first time.
Main channel is scoured

- The main river channel was deepened around 0.79 to 1.18 m.
- The bank-full discharge of the main channel was increased around 475 to 1050 m³/s, and the discharging capacity of bottleneck section increased from less than 1,800 m³/s to about 3,000 m³/s.
The experimental results provided eloquent proof that regulating the flow and sediment load is an effective measure to mitigate significant problems in flood control of the Yellow River at present. After the experiments, the flood discharging capacities of the main channels had been significantly enlarged, and the situation of “nested suspended river” had been improved. Through the experiment, a whole set of techniques have been formed such as the regulation index system, the experimental flow control technique, the technique of discharging sediment from a reservoir by the density flow, and the technique of hydrological monitoring and forecasting. Innovations have applied to improve the key techniques of flow and sediment load control.

- The scope of knowledge to manage sediment-laden River is enlarged
New approach to keeping river healthy is proved

The three experiments have obtained national wide attention, and have greatly helped all the stakeholders to recognize the importance of including sediment flushing water use as an important part of environmental flow demand in the Yellow River. The success of the experiment has provided a promising approach to improve dam management in order to balance water resources. It is proposed that the experiment is going to be extent to middle and the upper reach in near future provided that the suitable natural flow and sediment condition is available.
Thanks for your attention.