

From “Water Storage and Sand Retention” to “Upper Interception and Lower Discharge”: The Historical Evolution of Yellow River Management Strategy During the Period of National Economic Readjustment

Shulin Guo*

School of Politics and Law, Lingnan Normal University, Zhanjiang 524048, Guangdong, China

**Author to whom correspondence should be addressed.*

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Abstract: The period of national economic readjustment from 1961 to 1965 was a critical stage in the transformation of the Yellow River management strategy. In the late 1950s, the “water storage and sand retention” strategy gradually revealed problems in practice, including accelerated reservoir siltation and increasing flood control pressure in the lower reaches. Against this backdrop, the water conservancy sector, in alignment with the central government’s policy of “readjustment, consolidation, filling out, and raising standards”, and based on the laws governing water and sediment movement in the Yellow River and the realities of basin management, promoted a shift in Yellow River management strategy from “water storage and sand retention” to “upper interception and lower discharge.” The “upper interception” component involved constructing control reservoirs in the upper and middle reaches of the Yellow River and advancing soil and water conservation projects to strengthen source-level regulation of floods and sediment. The “lower discharge” component focused on the lower river channel, enhancing the river’s flood discharge and sediment transport capacity through dredging the channel, reinforcing embankments, and consolidating dangerous works. The evolution of this strategy not only effectively alleviated the prominent contradictions in Yellow River management at the time and provided support for basin security and agricultural production recovery during the economic readjustment period, but also accumulated practical experience for subsequent systematic planning of Yellow River management, carrying important historical significance and contemporary relevance.

Keywords: Water storage and sand retention; Upper interception and lower discharge; Yellow River management strategy; Evolution

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1. Introduction

In the 1950s, Yellow River management centered on “water storage and sand retention”, attempting to fundamentally resolve Yellow River flooding by constructing large reservoirs to impound floodwaters and reduce downstream sediment discharge. However, the practice of the Sanmenxia Reservoir exposed the limitations of this strategy. After the reservoir began impounding water in September 1960, within just one and a half years, sediment deposits in the reservoir area reached 1.53 billion tons. This not only caused a sharp reduction in effective reservoir capacity but also raised the Tongguan riverbed by 4.5 meters, threatening the flood control safety of the Guanzhong Plain. At the same time, downstream flood control work had been relaxed, weakening the downstream embankment works—the height of downstream levees was insufficient, the embankments were too narrow, and flood control capacity declined. Against the backdrop of national economic readjustment, the Ministry of Water Resources organized experts for a comprehensive review of Yellow River management. In 1962, the Yellow River Conservancy Commission convened a special conference to summarize the lessons of “water storage and sand retention”, recognizing the complexity of the Yellow River sediment problem: simply relying on upstream water storage could not fundamentally resolve downstream siltation; it was necessary to take into account both the coordination of “interception” and “discharge.” The introduction of the central government’s “readjustment” policy provided policy support for the transformation of the Yellow River management strategy, driving the water conservancy sector to re-plan the Yellow River management path from a whole-basin perspective.

2. Historical background for the emergence of the “upper interception and lower discharge” Yellow River management strategy

In December 1962, to implement the Tenth Plenary Session’s decisions and national economic readjustment policies, the Ministry of Water Resources and Electric Power issued the “Basic Summary of Water Conservancy Work and Future Principles and Tasks”, establishing the guiding principle of “consolidate and raise standards, strengthen management, complete supporting facilities, focus on key construction, and create conditions for development.” For Yellow River management, it proposed vigorously strengthening soil and water conservation, continuing Sanmenxia Reservoir construction while reducing its siltation, regulating the lower river channel and Wei River, strengthening embankments for safety, and piloting lower-reach silt deposition irrigation ^[1]. This provided strategic direction during the readjustment period. The Sanmenxia Reservoir’s “water storage and sand retention” operation revealed severe problems. Designed for 335-meter relocation and 333-meter post-flood storage levels, actual operation showed sediment accumulation far exceeding projections while outflow remained below estimates, causing faster siltation and more serious backwater effects than anticipated. In 1961, insufficient pre-flood releases and premature excessive storage led to significant upstream siltation above Tongguan during late-flood-season storms, damaging autumn agricultural production ^[2]. These downstream flood control and reservoir siltation challenges made stakeholders recognize that fundamental Yellow River harnessing required comprehensive, balanced consideration of upstream and downstream needs rather than relying solely on Sanmenxia facilities.

At the same time, the siltation situation in the lower river channel continued to worsen. In 1963, the measured sediment load at the Huayuankou station in the lower Yellow River reached 1.88 billion tons, far exceeding the multi-year average. The flood-conveying cross-section of the channel kept narrowing, and

embryonic forms of a “second-level suspended river” appeared in some sections—even a moderate flood could overflow and cause disaster. Soil and water loss problems in the upper and middle reaches also became increasingly prominent. In the loess hill and gully areas along the Shanxi-Shaanxi gorge, annual soil erosion moduli exceeded 10,000 tons per square kilometer, and large amounts of sediment entered the main stem of the Yellow River directly, becoming the primary source of downstream siltation. In this situation, water conservancy experts gradually recognized that the Yellow River management needed to build a collaborative system of “upper and middle reach sediment interception and reduction—lower reach sediment discharge and transport.” One could neither rely solely on upstream reservoir impoundment nor ignore the development of downstream channel sediment discharge capacity; it was necessary to break free from “single-purpose water storage” thinking and place upper and middle reach soil and water conservation on an equal footing with lower reach channel regulation.

3. The proposal of the “upper interception and lower discharge” Yellow River management strategy

After problems emerged with the Sanmenxia Reservoir, the Yellow River Conservancy Commission began to re-examine the “water storage and sand retention” strategy and pursue new explorations. In March 1962, the Sanmenxia Reservoir’s operational mode was changed from “water storage and sand retention” to “flood detention and sediment discharge”, indicating that the Yellow River Conservancy Commission had already recognized the necessity of changing the Yellow River management strategy, but had not yet fully broken free from the “water storage and sand retention” management thinking. In April 1962, at the Third Session of the Second National People’s Congress, representatives from Shaanxi Province submitted Proposal No. 148, demanding that additional flood discharge and sediment release facilities be built at Sanmenxia. The Yellow River Conservancy Commission opposed this, arguing that the best solution at the time was to construct sediment-trapping reservoirs on the main stem and tributaries above Sanmenxia to reduce the sediment entering the Sanmenxia Reservoir. This shows that overcoming the ideological constraints of the old Yellow River management strategy and generating a new management strategy required a process.

In March 1963, the Yellow River Conservancy Commission convened a Yellow River management work conference. Wang Huayun, then Director of the Yellow River Conservancy Commission, proposed in his report “Basic Summary of Yellow River Management Work and Future Principles and Tasks”: “If, under conditions of appropriately controlled flooding and appropriately reduced sediment (say, a reduction of about 50%), we envision using the lower river channel’s sediment discharge capacity and adopting the method of concentrating water to scour sand to discharge sediment and floodwater into the sea, allowing different floods to pass through a compound channel, so that the lower river channel silts up less, does not silt at all, or develops into an underground river—this should be the goal we strive to achieve. Based on the above vision, intercepting sediment and storing water in the upper and middle reaches while preventing floods and discharging sediment in the lower reaches—that is, upper interception and lower discharge—is the overall direction of future Yellow River management work” (Page 257) ^[3]. Thus, the “upper interception and lower discharge” strategy for managing the Yellow River from a whole-basin perspective was explicitly proposed for the first time. The proposal of this Yellow River management strategy resulted from reflection on long-term Yellow River management practice. In October 1963, Wang Huayun, then Director of the Yellow

River Conservancy Commission, explained this in his “Report at the Conference on Management of Lower Yellow River Embankments, Sluice and Dam Works”: “We have proposed the management direction of ‘upper interception and lower discharge.’ This direction only adds two characters—‘lower discharge’—but these two characters were obtained after nine years of practice at great cost. Previously, we believed that the fundamental solution for the Yellow River lay in the upper and middle reaches, and that once the upper and middle reach problems were solved, the lower reaches would have nothing to worry about—this was why some momentum was lost in lower reach flood and sediment control work after the Sanmenxia project was constructed. This shortcoming in understanding stemmed from an insufficient grasp of the Yellow River’s laws; only through practice have we now gained a further understanding. Whether this is entirely correct remains to be verified through further practice. Based on current understanding, the fundamental solution to the Yellow River is no longer just a matter for the upper and middle reaches, but a long-term whole-basin task encompassing upper, middle, and lower reaches” (Page 267) ^[3]. This shows that managing the Yellow River is a long-term task, and the valuable spirit of Yellow River management workers who constantly summarize through practice and constantly innovate through summarization is worthy of emulation.

In October 1964, Wang Huayun, Director of the Yellow River Conservancy Commission, elaborated on the “upper interception and lower discharge” strategy at the Beijing Yellow River Management Conference. He argued that historical experience proved single-minded “interception” without “discharge” would cause massive siltation, increased meandering, and recurrent flooding disasters. Similarly, relying solely on soil conservation and the Sanmenxia Reservoir’s capacity to trap 80% of sediment while ignoring “discharge” was unworkable. Wang emphasized comprehensive whole-river planning combining interception and discharge to resolve sediment issues. However, at this stage, the Commission still prioritized constructing sediment-trapping reservoirs above Sanmenxia rather than treating both aspects equally, indicating the strategy remained immature and required further refinement.

In January 1965, the Yellow River Conservancy Commission and the Yangtze River Basin Planning Office separately conducted experiments and drew up plans. The planning policy of the Yellow River Conservancy Commission at the time was: “Yellow River management should employ upper interception and lower discharge, eliminating harm and bringing benefit, gradually transforming a harmful river into a beneficial one. In the middle reaches, actively take measures to control soil and water, reduce sediment, ensure the safety of Xi’an, maintain long-term operation of the Sanmenxia Reservoir, and change the lower river channel from serious siltation to slight erosion or slight siltation, while also utilizing water and soil to develop production. In the lower reaches, continue to reinforce and transform the embankments on both banks, further improve flood detention works, gradually carry out river channel regulation, and ensure that the 22,300 m³/s flow at Huayuankou does not cause dyke breaches or course changes.” ^[4]. The proposal of the “upper interception and lower discharge” Yellow River management strategy liberated thinking and was conducive to further carrying out Yellow River management work. Subsequently, following the “upper interception and lower discharge” strategy, while vigorously carrying out soil and water conservation in the upper and middle reaches, sediment-trapping test dams were begun. In the middle reaches, the Sanmenxia Reservoir began to be reconstructed to enhance discharge capacity. In the lower reaches, dams were demolished and embankments reinforced, with the goal of discharging most of the sediment into the sea.

4. Implementation of the “upper interception and lower discharge” Yellow River management strategy

After the “upper interception and lower discharge” strategy was proposed, the Yellow River Conservancy Commission began implementing “upper interception” management measures. On the question of reconstructing the Sanmenxia Reservoir, the Yellow River Conservancy Commission argued that constructing sediment-trapping reservoirs on the main stem and tributaries above Sanmenxia to reduce sediment entering the reservoir was an active and proactive measure. Therefore, in the 1960s, multiple surveys and plans were conducted around the issue of constructing sediment-trapping reservoirs. In order to explore ways to slow siltation in the Sanmenxia Reservoir, in the early 1960s, Wang Huayun, then Director of the Yellow River Conservancy Commission, led relevant personnel to Shaanxi, Gansu, and Shanxi provinces and to the sediment-laden tributaries of the Jing, Luo, and Wei rivers for investigation and research ^[5]. Based on field surveys, he concluded that the sediment-trapping reservoirs selected in the 1954 Yellow River Plan had the problems of being “small, scattered, and distant” (small control area, small storage capacity, dispersed works, far from Sanmenxia), and should be changed to “large, concentrated, and close” (large control area, large storage capacity, concentrated sediment trapping, close to Sanmenxia). In November 1963, the Yellow River Conservancy Commission proposed in “Concepts for Comprehensive Harnessing of Yellow River Water Hazards and Development of Yellow River Water Resources”: “Under current conditions, relying solely on soil and water conservation will result in reservoirs filling up with silt quickly without being able to play their proper role; many reservoirs already built will also become silt repositories in the not-too-distant future. Therefore, on sediment-laden rivers, researching the separation of water storage and sediment trapping—constructing sediment-trapping dams and sediment-trapping reservoirs in appropriate locations, respectively—may be appropriate (sediment-trapping dams and reservoirs can develop silt irrigation and power generation benefits).”

Li Fudu, then Deputy Director of the Yellow River Conservancy Commission, advocated the overall river management direction of intercepting sediment and storing water in the middle reaches of the Yellow River while preventing floods and discharging sediment in the lower reaches, with interception as the primary approach. The methods employed to realize this river management direction, beyond actively promoting soil and water conservation work in the water-loss areas of the middle Yellow River to reduce sediment generation, involved vigorously carrying out gully management work centered on building silt-retention dams in this region, and constructing sediment-trapping reservoirs on tributaries with serious soil and water loss and at appropriate sections of the main Yellow River stem above Sanmenxia ^[6]. In December 1964, at the Beijing Yellow River Management Conference, Premier Zhou Enlai expressed agreement in his concluding speech when Yellow River Conservancy Commission Director Wang Huayun proposed constructing the Bajiazui sediment-trapping test dam. In January 1965, the Ministry of Water Resources organized an on-site review group to conduct a review at the Bajiazui construction site, indicating: “In order to study the gradual reduction of siltation in the Sanmenxia reservoir area and the lower river channel, and to create conditions for developing water conservancy in the middle and lower Yellow River regions, we agree to carry out experimental research at Bajiazui on the technical and economic problems related to large-scale sediment-trapping reservoirs, so as to gain experience for gradual promotion as one of the Yellow River management measures” ^[7]. In March 1965, in order to properly carry out the significant experimental task, the Yellow

River Conservancy Commission specifically established the Bajiazui Sediment-Trapping Dam Experimental Engineering Office. Thanks to the concerted cooperation of all parties, the task of raising the earth dam by 8 meters was basically completed in July 1966, with a total of 470,000 cubic meters of earthwork and stone completed.

Simultaneously, “lower discharge” management measures were implemented in tandem. After the Sanmenxia Reservoir’s operational mode was changed from “water storage and sand retention” to “flood detention and sediment discharge”, downstream flood control became a highly prominent issue. To ensure flood control safety in the lower Yellow River, it was necessary to strengthen “lower discharge” measures: first, to properly maintain and reinforce the main embankments to ensure no dyke breaches; second, to demolish the diversion weirs in the lower reaches to facilitate flood and sediment discharge. To strengthen flood control works, a second major reinforcement of downstream embankments began in the winter of 1962. This project primarily targeted defense against a peak flow of 22,000 cubic meters per second at the Huayuankou station; in accordance with the 1957 embankment standards, 580 kilometers of main Yellow River embankments and North Golden Dyke were reinforced, and 1,000 kilometers of damaged embankment sections were repaired and restored. After four years of major reinforcement, the Yellow River downstream maintenance and repair work was significantly strengthened. From 1962 to 1965, the second major embankment reinforcement lasted four years, completing a total of 60 million cubic meters of earthwork and stone; some relatively weak, dangerous embankment and dam works were also prioritized for reinforcement, and river channel regulation work was resumed, thereby gradually restoring downstream flood discharge and sediment transport capacity (Page 225) ^[4]. In order to adapt to changes in the Sanmenxia Reservoir’s operational mode and quickly restore the flood control capacity of the lower Yellow River channel, the diversion weirs at Huayuankou and Weishang were demolished in 1963. The demolition of the diversion weirs at these two hubs demonstrates that, in the process of Yellow River management, a scientific attitude is required, continuously exploring and understanding the laws of the Yellow River, and subjective and arbitrary decision-making must be strictly avoided.

5. Conclusion

The evolution of Yellow River management from “water storage and sand retention” to “upper interception and lower discharge” during the national economic readjustment period represented both a deepening scientific understanding of water-sediment dynamics and a strategic adaptation to national development needs. This transformation marked a shift from single-project engineering approaches to comprehensive basin-wide management, progressing from reservoir-based sediment trapping to integrated whole-basin water and sediment regulation.

This strategic shift alleviated lower river channel siltation and flood pressures while improving riparian ecology. Through standardized flood detention works and embankments, flood control capacity was significantly enhanced, alongside wetland restoration and floodplain management. The experience demonstrates that effective Yellow River governance requires balancing ecological security, economic efficiency, and social stability through dynamic adjustments. Entering the new era, people must employ scientific basin perspectives, systematic engineering layouts, and smart regulatory means to protect this mother river, ensuring its peaceful flow and eternal benefits to the people.

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