

## **KEEPING THE YELLOW RIVER HEALTHY**

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**Abstract:** “Keeping the Yellow River Healthy” is the new concept of river basin management. The framework of the concept is as follows: “Keeping the Yellow River Healthy” as one ultimate target; “no embankment breaching, no river running dry, no water pollution beyond standard and no riverbed rising further” as four criteria; the criteria can be realized through nine action plans; and the “Three Yellow River Projects” are essential to make sure the implementation of those actions in a modernized and an effective way.

**Keywords :** Living river, Yellow River, Basin management, Ultimate target

The essential of a living river life is water and river flow. The river life’s formation, development and evolvement is a natural process, with its own internal mechanism and interactions to the outside interference.

### **1 THE RATIONALE OF LIVING RIVER CONCEPT**

#### **1.1 River is the Origin and Carrier of Life**

Looking at the history of human being and civilization development, we noticed that a great river basin from its source to the estuary is often the common homeland for various peoples and civilizations; the riverine area is usually the political, economic and cultural center in a region, where people enjoy their life. And many brilliant civilizations arose along the rivers in the history. However, once a river loses its health, then the overall ecosystem based on the river is hardly to survive. When a river is running dry, depleting and dying, it will lead to the collapse of the ecosystem in the basin. This has been shown by many cases in the history, such as the desertification of the Heihe river terminal lake (Juyan Lake), the vanished Lop Nor and the Loulan kingdom in the Tarim river basin, and the lost Tongwan city in the Wuding river basin. Everything is prosperous when the river is running healthy and everything is going to die when the river is dying.

The river’s carrying capacity for nature and social development is limited, which should be maintained to make the river sustainable. Therefore, the social and economic development has to consider the river’s carrying capacity as the first priority, and balance the water resources demand and supply.

However, due to the effects of human activity and other influences, most of the rivers worldwide are facing various survival challenges. The Yellow River, the well known mother river of China, is also standing at the edge of survival crisis. For a very long period, no much attention was paid to the life of the Yellow River itself, and human took too much from the river far beyond its carrying capacity as the cost of social economic development. The contradiction of supply and demand of water resources is prominent. Water requirements from various sectors become larger and larger. A large quantity of water for keeping ecosystem has been squeezed out for other uses. The lower river channel is shrinking. The threat of flood becomes severe. Water pollution is more and more serious. The ecosystem of the river mouth is subject to degradation. How does the Yellow River develop? Facing the key issues related to the future and the fate of the Yellow River, The Yellow River Conservancy Commission, as

the river basin authority in charge of the Yellow River administration ought to propose the concept of river life and would be the spokesman of “Keeping the Yellow River Healthy.”

## **1.2 New river Management Concept Formulated to Face the Challenges**

With population increasing and rapid developing of economy and society of the basin and its related areas, the pressure that the Yellow River bears is increasing day by day with the mark that drying up periods in the lower Yellow River from the 1970s to 1990s got longer and longer. The whole ecosystem of the basin shows the trend of deterioration.

It is manifested by the following facts: (1) The shrinking of the river channel of the lower reach becomes obvious and the flood discharge capacity decreases sharply. People’s “reclaim land from the river” and “abstract water from the river” for a long term led to sediment deposition in the main channel of the lower reach and made the “secondary perched river” more serious. At present, the bankful discharge of the lower reach has been decreased from  $7,000 \text{ m}^3 \cdot \text{s}^{-1}$  in the 1970s to less than  $2,000 \text{ m}^3 \cdot \text{s}^{-1}$ . (2) The main stream and the tributaries of the upper and middle reaches shrink more and more, “perched river” also appears in mainstream and the tributaries of the upper and middle reaches now. Many times of long-period drying up in the Weihe River, the biggest tributary of the Yellow River, made more sediment deposition in the lower reaches and the river cross section shrunk by 1/3. Only a five-year flood in 2003 in the Weihe River made the highest water level since 1981. The constant shrinking river channels in the mainstream and the tributaries has shown the fragility of the Yellow River’s life. (3) The contradiction of supply and demand of water resources is keen. At present, the Yellow River runoff accounts for 2% of China, however it is feeding 12% of population and 15% of cultivated land in whole China. 70% of water resources in the basin have been used, which is far over the international accepted warning line (40%). The sustainable supplying capacity of Yellow River water resources is facing a severe challenge. (4) The most fragile ecosystem of the Loess Plateau has not been changed fundamentally.

Facing such a severe situation, calling on people Keeping the Yellow River Healthy has been our utmost task.

## **2 THE FRAMEWORK OF THE CONCEPT OF “KEEPING THE YELLOW RIVER HEALTHY”**

“Keeping the Yellow River Healthy” should take the sustainable utilization of water resources and the ecological rehabilitation of the basin as the top priority. An insurmountable “protected area” should be set up for the expanding human activities. A quantitative index system in which human and nature can live together peacefully should be established.

“Keeping the Yellow River Healthy” is a new river training concept, the preliminary framework of the concept is as follows. “Keeping the Yellow River Healthy” is the ultimate target; “no embankment breaching, no river running dry, no water pollution beyond standard and no riverbed rising further” are four criteria; the criteria can be realized through nine action plans; and the “Three Yellow River Projects” are essential to make sure the implementation of those actions in a modernized and an effective way.

### **2.1 The Ultimate Target**

The Yellow River itself should have a healthy life so as to provide sustainable support for the whole basin, especially the large ecosystem and economic and social system along the lower reach. Its life embodies many elements such as the total amount of water resources, river channel of flood discharging capacity, sediment carrying capacity of water flow, self-purifying capacity of water flow, the capacity to maintain the ecosystem of river course, etc. “Keeping the Yellow River Healthy” is to maintain the life function of the Yellow River,

which will be the highest aim of long-term Yellow River management and development.

## **2.2 Four Criteria**

“Keeping the Yellow River Healthy” is to hold back deteriorating trend of the whole river situation in order to make it restore to reach the healthy standard a river should have. But what is the main criteria? That is the “4 nos”: “No embankment breaching, no river running dry, no water pollution beyond standard and no riverbed rising further”.

“No embankment breaching” requires the flood control security of the Yellow River to be ensured, which is built up on two bases: One is confining floods by controlling structures such as reservoirs, embankment, etc. Another depends on the function of the river course’s flood draining and flood detention areas, which have the capacity of safely storing and releasing flood within the design standard. “No river running dry” requires the following “three ensures ” in the aspect of water resources management: to ensure the drinking water security of the inhabitants along the Yellow River, to ensure the water requirement of river ecosystem, and to ensure the water resources supply for a certain sustainable economic development of the society. “No water quality beyond standard” requires the water quality of the Yellow River to meet the sustainable demand of the essential function for living and the production of industry and agriculture. Therefore, the total amount of pollution drainage of the whole river and the amount of pollution drainage of each province (autonomous region) should be controlled under this standard. “No riverbed rising further” is to solve the sediment problem by taking integrated measures. The measures mainly are: large-scale construction of “warping dam” is carried out in Loess Plateau to conserve water and soil to hold up sediment into the Yellow River; “discharging sediment” is carried out in Xiaobeiganliu (the reach from Yumenkou to Tongguan); the experiment of regulating water and sediment should be done to regulate the relationship of water and sediment by manpower in the middle and lower reaches. The life of the river will be kept and prolonged maximally by taking these measures.

The Yellow River would be a lively and healthy river when the Yellow River training reaches the standard of “4 nos”. The river training concept centering on human and river living together peacefully would have its precondition only when the natural law of river evolvement is better mastered and adapted and the carrying capacity of the river is sufficiently considered.

## **2.3 Nine Action Plans**

The target of “Keeping the Yellow River Healthy” can be realized by the following nine ways: (1) take measures to reduce sediment inflow to the Yellow River; (2) manage effectively the water resources utilization of the Yellow River basin and its related regions; (3) strengthen the study on water transfer plans to increase the water resources of the Yellow River; (4) establish water and sediment regulation system; (5) work out a scientific and reasonable general plan for the control and management of the lower river course; (6) create favorable hydrological process to mitigate the shrinking of the main channel; (7) meet water demands to maintain river itself cleaning capacity; (8) carry out Yellow River Delta management to reduce seawater impact to the lower reach; (9) maintain the ecological system sustainable in the Yellow River delta.

The core of the nine action plans lies in solving the problems of “less water”, “more sediment” and “the imbalance of water and sediment conditions” and promoting benign development of river ecosystem centering on the Yellow River.

“Less water” can be solved by “managing effectively the water resources utilization of the Yellow River basin and its related regions” and “strengthening the study on water transfer plans to increase the water resources of the Yellow River.” The natural law of river evolvement should be abided by. Integrated administration of water resources should be strengthened. The notion of water utilization “to develop according to water availability”

should be formed. Measures of saving water should be extended out positively. Water-saving society should be gradually constructed. From a long-term view, water shortage can be solved only by the south-to-north water transfer project.

To solve the problem of “less water” is to increase water. Saving water is one aspect, and it should focus on inter-basin water transfer, the South-to-North Water Transfer - Western Route Project. The water transfer could be related with the management of the lower reach. The overall Yellow River basin should be the beneficiaries of the water transfer project, which is also an important aspect to keep Yellow River Healthy. So are the South-to-North Water Transfer Project - Eastern and Middle Routes. Considering the uneven distribution of water resources, the South-to-North Water Transfer Projects will transfer water from the Yangtze River to the north, that is, water flowing from south to north; whereas at the same time we see that water flows from north to south in the irrigation area of the Yellow River south bank. In this case, the efficiency of water transfer project is reduced. Therefore, increasing the Yellow River water will be solved when all the problems are solved properly.

“More sediment” can be solved in three steps. Firstly, control soil erosion in the sediment source area. the Loess Plateau, among which, especially, the heavy and coarse sediment area of 78,600 km<sup>2</sup>, which most severely affect sediment deposition in the lower reaches. Quite a lot of “sediment traps” should be constructed to hold up sediment. The Loess Plateau will be gradually changed from eroded area to deposited area. Secondly, positively take measures to return farmland to woodland or grassland and to adopt grazing-ban policy in order to restore ecology and preserve soil and water, depending on the self-rehabilitating ability of the nature. Thirdly, large-sized reservoirs will be constructed to hold up and store up sediment on the mainstream and the tributaries. Warping projects should be taken on the middle reaches, Xiaobeiganliu section, to further reduce sediment into the lower reaches.

Experiment of warping projects in Xiaobeiganliu is another strategic measure to make use of sediment in the Yellow River. In the reach of Xiaobeiganliu from Yumenkou to Tongguan, the area of river course is 1,000 km<sup>2</sup>, of which the area of floodplain is over 600 km<sup>2</sup>. Because it is a “perched river” from Yumenkou to Tongguan, land along and below the levees is a large area of alka-salinization land. Over 1 billion tons and even over 10 billion tons of sediment that equal the sediment storage of the Xiaolangdi project will deposit there. By measuring and calculating, coarse sediment accounts for a large proportion of the deposits in the Lower Yellow River. Most of the sediment with particle size finer than 0.025 mm can flow into the sea with water if they reach the lower reaches. Therefore, “warping” in Xiaobeiganliu should insist on the principle of “depositing the coarse sediment and discharging the fine sediment.” The method of sediment sorting formed by applying hydraulics of wandering channel and turbulence flow etc. will be explored. We should use high-tech to scientifically control the opening time, opening degree and operating time of the sluice gates of diversion and recession in order to store the coarse sediment ( $d > 0.05\text{mm}$ ) and discharge the fine. We try to store more coarse sediment affecting sediment deposition in the Lower sediment Yellow River by using the limit floodplain resource.

“Imbalance of water and sediment” is the fundamental cause of deposition and difficulty of flood control in the Lower Yellow River. The key to solve the problem lies in “establishing water and sediment regulation system”, “working out a scientific and reasonable general plan for the control and management of the lower river course”, “keeping the quantity of water and the mode of hydrological course to avoid the shrinking of the main channel”, “managing the river mouth to reduce its feedback effect to the lower reaches”. Firstly, water and sediment regulation system will be constructed by keeping on constructing key projects. After the construction of Xiaolangdi multi-purpose project, the controlling projects such as Guxian, Qikou, Daliushu, etc. should be built. A water and sediment regulation system taking the seven large controlling projects of Longyangxia, Liujiaxia, Daliushu, Qikou, Guxian,

Sanmenxia multi-purpose and Xiaolangdi multi-purpose reservoirs as the key project will be formed at last to increase human ability of controlling flood and sediment. Secondly, train the river course and manage the floodplain scientifically and rationally. While making the main stream flowing along the river channel and controlling the river regime, reduce the effects of human activities on the river course furthest to avoid “reclaim land from river” make room for the flood. Thirdly, unremittingly regulate water and sediment, try to change the disadvantage of water and sediment process into positive water and sediment process to transport sediment to sea and reduce sediment deposition in the lower reaches. Rehabilitate river course to restore and increase the flood carrying ability of the river course. Fourthly, strengthen the training of river mouth, the dredging of rump and the discharging of sediment to sea in order to form retrogressive erosion to increase the sediment transport capacity of the river course.

#### **2.4 Construction of “Three Yellow Rivers” is the Essential Tool to Ensure the Implementation of those Measures in a Scientific and an Effective Way**

“Physical Yellow River”, the actual Yellow River is the object we train, develop and manage. “Digital Yellow River” is the simulation of “Physical Yellow River”, or putting the Yellow River into the computer. It builds the integrated digital platform and conjecture environment, involving natural, economic and social factors of the river basin and related areas through modern and traditional measures to collect data. In this platform and environment, various schemes of harnessing, development and management of the Yellow River are simulated, analyzed and studied by powerful system software and mathematic models, and a decision-making support is provided visually which assures reasonableness and farsightedness of the decisions; “Scaled Yellow River” refers to the Yellow River in laboratories. It is to simulate and experiment on the natural phenomenon of “Physical Yellow River” in order to disclose the natural law of it. “Scaled Yellow River” may provide directly training and developing plan for “Physical Yellow River” and also essential parameters for “Digital Yellow River”.

The constructions of “Physical Yellow River”, “Digital Yellow River” and “Scaled Yellow River” relate to and effect on one another. We should propose different demands of training, developing and managing of the Yellow River through the research on “Physical Yellow River”, apply “Digital Yellow River” to simulate the plan of training, developing and managing in computer, and propose some possible schemes, apply “Scaled Yellow River” to study the possible schemes proposed by “Digital Yellow River”, and put forward feasible ones; at last, we should carry out the possible schemes in the “Physical Yellow River”, and through the practice in the “Physical Yellow River”, gradually adjust, and stabilize them to make various harnessing and developing schemes scientific, economic and safe for the “Physical Yellow River”

“Keeping the Yellow River Healthy” and the construction of “Three Yellow River Projects” are the new concept and the master plan of the Yellow River training and development in new stage. As the ultimate aim of the Yellow River training, modern concept of water conservancy should be set up with the help of modern science and technology in order to realize the aim of “Keeping the Yellow River Healthy”. Modern concept of water conservancy means the modern river training measures taking the construction of “Three Yellow River” as the frame and system and centering on high and new technology. Only through perfecting constantly the system of “Three Yellow River” each measure and plan can be carried on effectively, economically, rationally and safely.

One ultimate target, four criteria, nine action plans and three measures work together interactively, which forms primarily the framework of the concept of “Keeping the Yellow River Healthy”. It is an organically linked system involving in water resources, nature, politics, economics, society, culture, ecology, environment, etc. To set up new river

management concept and to realize “Keeping the Yellow River Healthy” need wide participation and common efforts of the whole society and still one generation after another who devote themselves into the Yellow River Management. Following this plan, years later, we will have a living and healthy river again which benefit the Chinese people.