

July 2020

Ecological Protection and High-quality Development in the Yellow River Basin: Framework, Path, and Countermeasure

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Recommended Citation

Yong, XU and Chuansheng, WANG (2020) "Ecological Protection and High-quality Development in the Yellow River Basin: Framework, Path, and Countermeasure," *Bulletin of Chinese Academy of Sciences (Chinese Version)*: Vol. 35 : Iss. 7 , Article 9.

DOI: <https://doi.org/10.16418/j.issn.1000-3045.20200425002>

Available at: <https://bulletinofcas.researchcommons.org/journal/vol35/iss7/9>

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Ecological Protection and High-quality Development in the Yellow River Basin: Framework, Path, and Countermeasure

Abstract

This paper summarizes the characteristics of natural ecological conditions, the current situation of economic and social development, existing problems and development opportunities of the Yellow River Basin. The overall framework of the national strategy for ecological protection and high-quality development of the Yellow River Basin has been set up according to the three logical progressive links of basement-ecological priority, bearing capacity-development constraint, driving force-internal and external relevancy. It has formed the academic thinking of delimiting ecological, agricultural and urban functional areas through the evaluation of the suitability of human activities for land and space development, evaluating and calculating the resource and environment carrying capacity of the three functional areas, and then formulating high-quality development strategies for different functional areas according to the carrying capacity. The ecological restoration and protection strategies such as ecological migration urbanization construction project, agricultural planting structure adjustment, dry farming basic farmland construction, classification and batch solution to the historical problems of mined out areas of energy and mineral resources are put forward. The proposed high-quality development measures mainly include expanding the scale of renewable energy development, such as solar energy, wind energy and hydropower, developing characteristic bio-medicine and healthy food industries, developing new strategic industries such as electromechanical, electronic information and artificial intelligence with the help of "three lines" state-owned enterprises' innovation potential, innovating the mechanism of industrialization transformation of scientific and technological achievements and the system of value distribution of resource advantages, improving the modern management system such as spatial fine governance, regional differential development, and opening up.

Keywords

high quality development; ecological protection; strategic path; the Yellow River Basin

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This article is available in Bulletin of Chinese Academy of Sciences (Chinese Version):
<https://bulletinofcas.researchcommons.org/journal/vol35/iss7/9>

Citation: XU Yong, WANG Chuansheng. Ecological Protection and High-quality Development in the Yellow River Basin: Framework, Path, and Countermeasure [J]. Bulletin of Chinese Academy of Sciences, 2020 (7): 875–883.

Ecological Protection and High-quality Development in the Yellow River Basin: Framework, Path, and Countermeasure

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Abstract: This paper summarizes the characteristics of natural ecological conditions, the current situation of economic and social development, and existing problems and development opportunities of the Yellow River Basin. The overall framework of the national strategy for ecological protection and high-quality development of the Yellow River Basin has been set up according to the three logical progressive links of basement-ecological priority, carrying capacity-development constraint, and driving force-internal and external relevancy. It has formed the academic thinking of delimiting ecological, agricultural, and urban functional areas through the evaluation of the suitability of human activities for land and space development, evaluating and calculating the resource and environment carrying capacity of the three functional areas, and then formulating high-quality development strategies for different functional areas according to the carrying capacity. The ecological restoration and protection strategies such as ecology-migration-urbanization construction project, agricultural planting structure adjustment, dry farming basic farmland construction, and classification and batch solution to the historical problems of mined out areas of energy and mineral resources are put forward. The proposed high-quality development measures mainly include expanding the development scale of renewable energy such as solar energy, wind energy, and hydropower, developing characteristic bio-medicine and healthy food industries, developing new strategic industries such as electromechanical device, electronic information, and artificial intelligence with the help of state-owned enterprises' innovation potential, innovating the mechanism of industrialization transformation of scientific and technological achievements and the system of value distribution of resource advantages, improving the modern management system of spatial fine governance, regional differential development, and opening up. DOI: 10.16418/j.issn.1000-3045.20200425002-en

Keywords: high-quality development; ecological protection; strategic path; the Yellow River Basin

The Yellow River Basin, spanning across the eastern, central, and western steps of North China's terrain, is an important ecological-barrier-intensive area and an important zone of the land route of the Belt and Road initiative. The basin suffers from vulnerable ecology and short water resources, and shows regional difference in soil, energy, mineral, and biological resources. The wide and severe poverty flings the basin into a backward economic and social state. Therefore, the basin is confronted with the structural conflicts between ecological conservation and economic and social development. To address such conflicts, the CPC Central Committee has emphasized the importance of ecological protection and high-quality development, and hoisted it as a major national strategy alongside the coordinated development of Beijing-Tianjin-Hebei region, the high-quality development of the Yangtze River Economic Belt, the construction of Guangdong-Hong Kong-Macao Greater Bay Area, and the integrative development of the Yangtze River Delta.

Integrated management of water resources development and utilization, environmental protection, and industrial and urban layout in line with river basin has become a topic of

great concern. The Global Water Partnership puts forward an integrated water resource management approach, which calls for sustainable development, coordination and integration of economic and social development with river basin environment management, sound allocation of water resources, effective resource utilization, and systematic monitoring [1]. China has attached great importance to watershed development and management since the 1950s. However, before the 1980s, China's watershed development and management emphasized irrigation, hydropower development, shipping, flood control, as well as regional economic development. Since the 1990s, China's watershed development and management has upheld the principles of rational development, optimal allocation, water resources saving and protection, human-nature harmony, and the sustainable support of water resources for economic and social development [2]. Strict water resources management has been taken as a strategic measure to speed up the transformation of economic development mode, which stresses scientific water control by law and the construction of a water-saving society. A new discipline, watershed science, derived from the science of water

Received: 2020-7-3

Supported by: Key Program of National Natural Science Foundation of China (41630644)

resource management. Compared with other water resource sciences, watershed science is holistic, spatial, networked, and institutionalized [3].

Chinese President Xi Jinping stated that clear waters and green mountains are as valuable as mountains of gold and silver, and we should prioritize ecological conservation and boost green development...we should guarantee long-lasting security and promote the high-quality development of the Yellow River Basin [4]. Bearing this in mind, we set up the framework of the national strategy for ecological protection and high-quality development of the Yellow River Basin according to the three logical progressive links of base-ment-ecological priority, carrying capacity-development constraint, driving force-internal and external relevancy, aiming to maximize the economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. We hope to provide some implications for the national strategy of ecological protection and high-quality development in the Yellow River Basin so as to promote China's coordinated regional development, optimized productivity layout, and the land corridor construction of the Belt and Road.

1 Status quo and development opportunities

1.1 Natural background

The terrain of the Yellow River Basin is high in the west and gradually descends towards the east, with great difference in elevation, presenting west-east three steps in a descending order. The 5 464 km-long Yellow River main stream flows through nine provinces (autonomous regions): Qinghai, Sichuan, Gansu, Ningxia, Inner Mongolia, Shanxi, Shaanxi, Henan, and Shandong. The watershed covers an area of 795 000 km² (including 42 000 km²-long interior drainage region) [5], crossing 71 prefecture-level administrative regions and 1 county-level city directly under the provincial government in 9 provinces (autonomous regions). The 91 prefecture-level administrative regions mentioned in the national strategy for ecological protection and quality development in the Yellow River Basin include the whole of Qinghai, Gansu, Ningxia, Shaanxi, Shanxi, Henan, and Shandong, six cities and one league in western Inner Mongolia, and two prefectures (Aba and Garzê) in Sichuan (Fig. 1). Referring to the boundary points of the upper, middle, and lower reaches of the main stream of the Yellow River, we divided, on a provincial basis, the Yellow River Basin into the upper reaches (7 cities or leagues in Qinghai, Gansu, Ningxia, and Inner Mongolia and 2 autonomous prefectures in Sichuan), the middle reaches (Shanxi and Shaanxi), and the lower reaches (Henan and Shandong) in this study.

The climate in the Yellow River Basin is characterized by

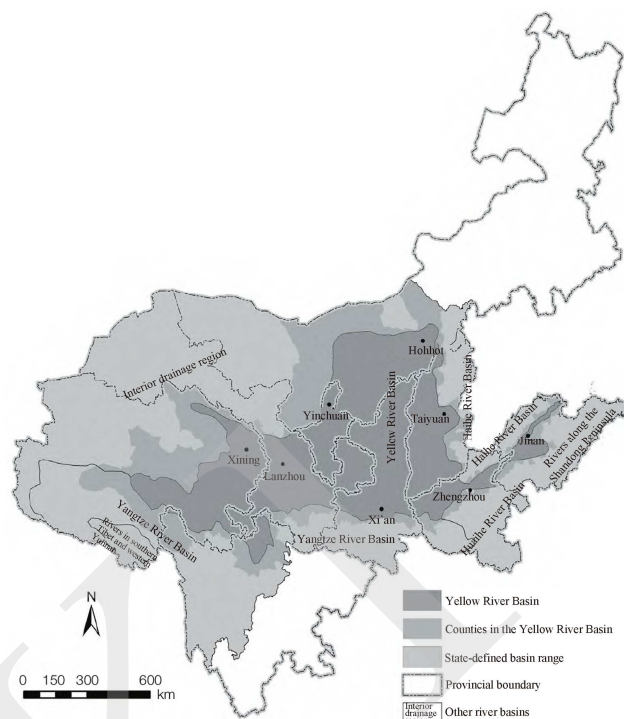


Fig. 1 The extent of the Yellow River Basin

prominent seasonal and temperature differences, concentrated and uneven precipitation, large inter-annual variations, low humidity, intensive evaporation, and frequent hail, sandstorm, and sand-blowing weather. Among them, the extreme temperature difference is striking. The temperature climbs from west to east along with the three descending steps of terrain, and the west-east temperature difference is more obvious than the north-south one. Annual precipitation in most parts of the basin ranges from 200 mm to 600 mm (Fig. 2), with extremely uneven distribution throughout the year, causing dry winter and spring while rainy summer and autumn. The precipitation from June to September accounts for about 70% of the annual precipitation [6]. Evaporation is strong, especially in Gansu, Ningxia, and central and western Inner Mongolia, where the annual evaporation was the largest in the mainland of China, with the maximum exceeding 2 500 mm [7]. Water resources in the basin are in shortage [8,9]. The hydrology and water resources feature insufficient water and massive sand, the sources of which are different. The annual average natural runoff has remained $5.92 \times 10^{10} \text{ m}^3$ over years, which accounts for only 2% of the national total and has shown a decreasing trend in recent years [10]. The per capita water resource amount in the basin is less than 600 m³, which is 1/4 of the national level. The Yellow River water mainly comes from the area west of Lanzhou and the north foot of Qinling Mountains, and the sediment mainly from the section between Hekou and Longmen, Jinghe River, Beiluo River, and the upper reaches of Weihe River.

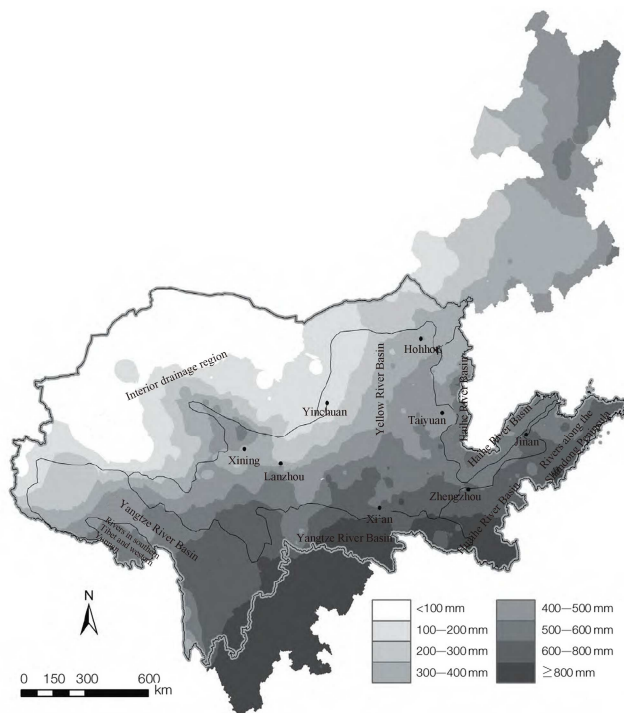


Fig. 2 Distribution of precipitation in the Yellow River Basin

The Yellow River Basin is rich in land, energy, mineral, and biological resources, whose spatial distribution varies among regions. Compared with the Yangtze River Basin, coastal areas, and Beijing-Tianjin-Hebei region, the Yellow River Basin is rich in land resources. However, the land available for human production and living is constrained by terrain and water resources. The available land in the middle and upper reaches is mainly in the river valleys and intermountain basins. The Yellow River Basin is home to plentiful energy resources such as coal (in the adjacent areas of Shanxi, Shaanxi, Inner Mongolia, and Ningxia), natural gas (in Shaanxi, Gansu, and Ningxia), solar and wind energy (in Inner Mongolia, Gansu, Qinghai, and Ningxia), and water energy (in the reaches west of Lanzhou in the main stream and the section between Shanxi and Shaanxi in the middle reaches). The basin bears rich sylvite, bauxite, and other mineral resources, and the largest sylvite deposit in China is in Qaidam Basin. Besides, the Yellow River Basin harbors most of the species in China, with distinctive regional characteristics.

1.2 Status quo of economic and social development

Overall, the economic and social development of the Yellow River Basin is lagging behind and dominated by the secondary industry^[11] with a high proportion of primary processing and the unique characteristic of energy development

and mineral mining^[12]. The proportion of tertiary industry in the basin is lower than the national average level, especially than that in coastal areas. The primary industry in the basin assumes a proportion higher than the national average level, distinct for grassland animal husbandry. The development gap within the basin is wide^[13].

The population of the Yellow River Basin totaled 324 million in 2019, accounting for 23.31% of the national total. Specifically, the population in the lower, middle, and upper reaches accounts for 60.62%, 23.39%, and 15.99%, with the density of 612.6, 209.53, and 26.62 people per square kilometers, respectively. In 2017, the urbanization rate of the basin is lower than the national average level, with large differences among provinces, being the highest in Shandong (70%, 12 percentage point higher than the national average level) and the lowest in Gansu (48%, 10 percentage point lower than the national average level).

In 2018, the total gross domestic product (GDP) of the Yellow River Basin is CNY 19.4 trillion, accounting for 21.55% of the national total. The shares of the upper, middle, and lower reaches of the basin's GDP are 14.54%, 21.27%, and 64.19%, respectively. According to GDP per capita, the eight provinces^① along the main stream of the Yellow River are roughly classified into three grades. (1) The first grade: Shandong and Inner Mongolia, where the GDP per capita is significantly higher than that in other provinces within the basin and has been higher than the national average for many years. (2) The second grade: Henan, Shanxi, Shaanxi, Ningxia, and Qinghai, where the GDP per capita is similar before 2012 and mostly 60%–90% of the national average. Since 2013, the GDP per capita of Shaanxi has been higher than that in the others of the second grade and close to the national average. (3) The third grade: Gansu, where the GDP per capita is significantly lower than that of other provinces in the basin and about 50% of the national average (Fig. 3). In general, the 8 provinces show a significant downward trend in both total economic volume and per capita level during the “13th Five-Year Plan” period, which indicates that the gap between the macroeconomic development level of the Yellow River Basin and the whole country is widening.

The population and industries of the Yellow River Basin are concentrated in the lower reaches as well as the Fene River-Weihe River valley, Hetao Plain, Hexi Corridor and Huangshui River valley in the upper and middle reaches. Urban agglomerations or state-level key development zones include the urban agglomeration of Shandong Peninsula centered in Jinan and Qingdao, the Central Plain urban agglomeration centered in Zhengzhou, Luoyang, and Kaifeng, the Guanzhong-Tianshui key development zone centered in Xi'an, Baoji, and Tianshui, the Taiyuan urban agglomeration, the Hohhot-Baotou-Erdos-Yulin development zone, Lanzhou-Xining

① To obtain the data with temporal continuity, we did the calculation for the whole region of each of the 8 provinces (autonomous regions) along the main stream of the Yellow River. Since only 2 prefectures in Sichuan are located along the Yellow River Basin and have low contributions to the provincial GDP, we included the whole region of Sichuan into the Yangtze River Economic Belt.

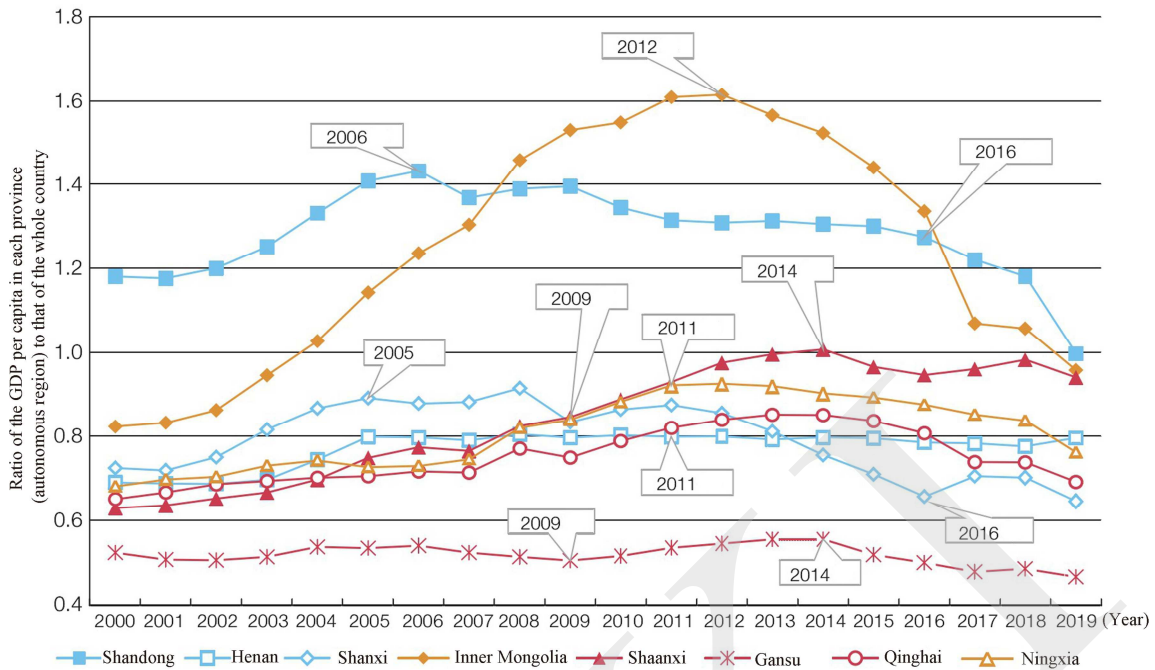


Fig. 3 Ratio of GDP per capita of the 8 provinces (autonomous regions) along the main Yellow River to that of the whole country (2000–2019)

development zone, and Hexi Corridor development zone. Compared with the above-mentioned areas, there are still extensive and severe impoverished areas in the upper and middle reaches of the Yellow River Basin, including the southeastern Qinghai-northwest Sichuan Tibetan-inhabited area, Liupan Mountains, Lvliang Mountains, Qinba Mountains, Taihang Mountains, and Dabie Mountains. According to the statistics on residents' income in *China Statistical Yearbook* [14], since 2013, the average per capita income in the 8 provinces along the main stream of the Yellow River has been declining, compared with that in the whole country and 9 provinces (autonomous regions) and 2 cities in the Yangtze River Economic Belt (Fig. 4). The large absolute gap of residents' income reflects the lack of economic vitality for rural development.

1.3 Key problems and development opportunities

The Yellow River Basin is subjected to not only ecological and hydrological problems (e.g., soil erosion, desertification, surface mining collapse, water resource shortage, and downstream flood threat) but also many economic and social development problems (e.g., overall backward development, wide regional gap, low-end industry, and extensive and severe poverty). These problems are manifested mainly in three aspects. (1) The fragile ecological background and limited water resources make the basin incapable of carrying unreasonable and large-scale human activities. In particular, the translocation for non-agricultural industries has not been realized since the large overloaded population in the ecologically fragile areas has to sustain their livelihoods with the support of agriculture and animal husbandry dependent on

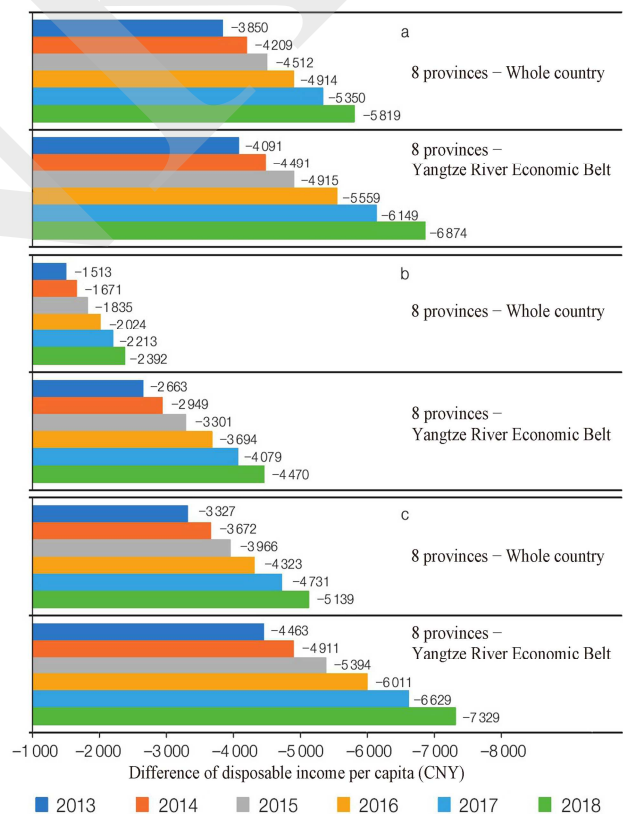


Fig. 4 Per capita disposable income difference: 8 provinces along the main stream of the Yellow River v.s. the whole country and the Yangtze River Economic Belt

(a) Disposable income per capita of urban residents; (b) Disposable income per capita of rural residents; (c) Disposable income per capita of residents.

land resources. (2) The development scale of the secondary and tertiary industries in the upper and middle reaches suitable for population and industrial agglomeration is limited, without capacity to attract the overloaded population living on agricultural and animal husbandry from ecologically fragile areas. In some areas rich in energy and mineral resources, resource development has long been low-end, specifically, mining and rough processing. There is a serious lack of medium- and high-end industries with high value-added and employment opportunities. (3) Although the past ecological protection and restoration measures such as establishment of the Three-North Shelterbelt, conversion of farmland to forest and grassland, sandstorm source control project, and natural forest protection as well as the measures for improving people's living standard through poverty alleviation, migration, and agricultural restructuring have produced significant effects, they tend to focus on single aspect of ecology or development, without taking into account the integration between ecological protection and economic development^[15].

The ecological civilization construction, the Belt and Road Initiative, and the protection and restoration of mountains, rivers, forests, farmlands, lakes, and grasslands, especially the ecological protection and high-quality development of the Yellow River Basin, have brought strategic opportunities to solve the above-mentioned problems^[16]. The concept of ecological civilization construction has laid a solid theoretical foundation for human-land harmony in the Yellow River Basin. The protection and restoration of mountains, rivers, forests, farmlands, lakes, and grasslands is a concrete implementation measure^[17]. The Belt and Road Initiative provides the impetus for the high-quality development of the basin through international exchanges.

2 Framework of ecological protection and development of the Yellow River Basin

In view of the key problems and the strategic opportunities for development in recent years, high-quality development is a path to the ecological restoration and protection in the Yellow River Basin, which in return is one of the components and objectives of high-quality development. To this end, we must build a framework comprising basement-ecological priority, carrying capacity-development constraint, and driving force-internal and external relevancy (Fig. 5). Through the interaction between ecological, agricultural, and urban development, we can solve the major strategic issues of ecological restoration and protection, high-quality development, and their coordination.

The general framework for ecological protection and high-quality development of the Yellow River Basin (hereinafter referred to as "the framework") can be understood in four dimensions. (1) The ecological protection and high-quality development of the basin can be divided into

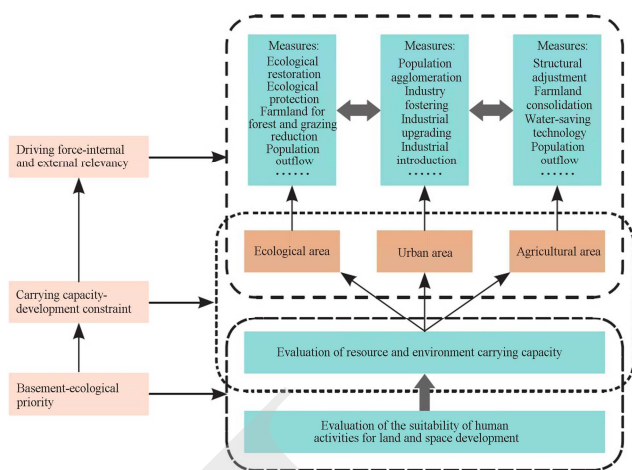


Fig. 5 The framework of ecological protection and high-quality development of the Yellow River Basin

three logical progressive links: basement-ecological priority, carrying capacity-development constraint, driving force-internal and external relevancy. (2) According to the principle of ecological priority, three functional areas (ecological, agricultural, and urban areas) can be identified. Such identification aims at pointing out spatial differentiated functions for ecological protection and high-quality development and facilitating the calculation of the carrying capacity of resources and environment in line with different functional areas. (3) On the basis of the functional areas and the carrying capacity of resources and environment, differentiated strategies for ecological restoration and protection and economic and social development can be formulated respectively. (4) The framework highlights the logical progressive relation and spatial differentiation between ecological protection and high-quality development. It should be specifically stated here that the measures taken for the three functional areas and the interaction between different measures are complicated, and the framework only outlines the strategy and the relationship without giving more details.

(1) Basement-ecological priority. This link indicates areas suitable for ecological protection as well as agricultural and urban development. Basement refers to the natural ecological conditions and the basis of resources and environment. Ecological priority refers to putting ecology first in the evaluation of ecological conditions, resources, and environment. To meet the need of ecological protection, agricultural development and urbanization, we use land, water resources, ecology, disasters, and environment as indicators to evaluate the suitability of human activities in the development of land and space of the basin, and on this basis divide the basin into ecological, agricultural, and urban areas.

(2) Carrying capacity-development constraint. This link describes the carrying capacity of resources and environment. According to the ecological, agricultural, and urban areas designated by the suitability evaluation of human activities, the carrying capacity of resources and environment in various functional areas can be calculated^[18], with emphasis on the

available land resources, available water resources, environmental capacity and their spatial distribution. On this basis, the scale of population and industries that can be gathered in different functional areas can be defined before the strategies for productivity layout and the adjustment of different functional areas are proposed.

(3) Driving force-internal and external relevancy. This link emphasizes the high-quality development of different functional areas, especially the driving force for ecological protection and high-quality development in the Yellow River Basin, by addressing historical sedimentation and regional disharmony. The measures for ecological functional areas mainly include ecological restoration, ecological protection, farmland for forest and grazing reduction, and outflow of overloaded or rural poverty-stricken population. The measures for agricultural functional areas include agricultural planting restructuring, basic farmland consolidation, agricultural water saving, and rural population urbanization. The measures for urban functional areas mainly include the spatial concentration of population and industry, the fostering of new industries, the upgrading of existing industries, and industrial introduction.

3 Paths and countermeasures for ecological protection and high-quality development in the Yellow River Basin

The Yellow River Basin, rich in energy and mineral resources, has long been an important coal-based energy exporter in China. However, compared with the Yangtze River Basin, the Yellow River Basin faces a fragile ecological background and suffers from serious ecological problems. Since the end of the 20th century, the extensive conversion of farmland to forest and grassland has slowed down the environment deterioration. However, the long-term development of energy and mineral resources and backward industrial structure have forced ecological protection still a grim problem.

3.1 Ecological restoration

(1) Based on ecological protection and restoration, ecology, poverty, and the issues relating to agriculture, rural areas, and farmers should be considered in an integrated way. Ecological conservation and high-quality development are inseparable from each other. There is a heavy overlap between key ecological areas and severely impoverished areas in the Yellow River Basin, especially in rural areas. The excessive pursuit of short-term benefits of energy and mineral resources in some areas hinders the normal ecological restoration of rural area and destroys the agricultural production system. Major ecology-immigration-urbanization projects should be carried out in the middle and upper reaches of the basin in response to the serious lack of development capacity

of key ecological areas and dire poverty areas. According to the idea of “being able to be relocated, being able to migrate to cities, being able to become rich, and being willing to stay,” we need to make efforts to promote the ecological construction of key ecological functional areas and dire poverty areas, facilitate the coordination of regional development, and fundamentally solve the long-standing problems of ecological poverty and farmers’ development.

(2) Efforts should be made to step up the compensation for environmental damage by carrying forward the ecological restoration policies, especially conversion of farmland to forest and grassland. According to the temporal and spatial distribution of precipitation and water resources, we should restructure agricultural planting (by reducing the planting scale of winter wheat and expanding the planting area of forage grass) to alleviate spring drought and water shortage and reduce the Yellow River diversion irrigation area in southern Ningxia and Hetao Plain. With the 500 mm multi-year average annual rainfall line as the boundary, terraced fields and silt storage dams should be expanded respectively in the south and north of Loess Plateau to further expand the scale of conversion of farmland to forest and grassland. On this basis, the exit path and mechanism of national compensation for ecological restoration and protection should be put forward. In response to the flood threats to important river sections and urban bank sections in the lower reaches of the Yellow River, the flood control standard of bank embankments should be improved. The flood control standards for cities in key control areas, key towns, and other areas should be raised to 200-year event, 100-year event, and 30-year event, respectively. River bank management should be strengthened. The ecological landscape along the Yellow River can be improved through protection and utilization of natural resources such as water systems, wetlands, forests, and grasslands.

(3) It is essential to improve rural environment through the protection and restoration of mountains, rivers, forests, farmlands, lakes, and grasslands. The historical problems of energy and mineral mining areas in Shanxi, northern Shaanxi, north of Weihe River, and eastern Ningxia should be solved in batches by engineering measures such as relocation and resettlement of ground residents, underground blasting or backfilling. The discharge of pollutants from living and producing space in towns, industrial parks and mining areas should be brought under control. A new model of rural centralized and decentralized sewage treatment should be proposed. Intensified efforts should be made to control water environmental pollution in Fenhe River, Weihe River, and other tributaries of the Yellow River.

3.2 High-quality development

(1) With the available resources and technologies, the deep processing of resources should be promoted for the upgrading of energy industry structure. We should take advantages of renewable energy (e.g., solar energy, wind energy, and

hydroenergy) and mineral resources, biological resources, and natural and cultural landscape to expand the development scale of renewable energy, accelerate the upgrading of green mining and processing technologies for mineral resources, and form a green basic industrial system.

(2) Efforts should be made to innovate the commercialization of science achievements and value distribution of advantage resources and encourage new strategic industries for the shaping of an integrated high-quality national economy system. First, biomedicine and health food industries with medical healing effects or healthcare effects should be developed with biological, agricultural, and sideline native resources. A special research team integrating planting, breeding, research, and development and demonstration of new technologies for product refined processing should be established to provide technical support for the development of local characteristic industries in the ecotone between agriculture and animal husbandry, the date belt in Shanxi and Shaanxi, the high-quality apple belt in Gansu, Shaanxi, and Shanxi, and the selenium-contained watermelon planting area in Ningxia. Second, the innovation potential of the state-owned enterprises should be activated, especially for the development of new strategic industries such as electromechanical industry, electronic information, and artificial intelligence. Third, the tourism industry and national parks should be established with the unique historical culture and ecological landscape. Efforts should be made to boost the Yellow River culture the spirit of human-nature harmony and unity, as well as the history of *Important Arts for the People's Welfare*. Carrying forward the hard-working tradition of Yan'an, the spirit of building the Hongqi Canal, and the spirit of westward academic relocation of Xi'an Jiaotong University, we will build a new dynamic system guided by national strategy, driven by the demand of the Belt and Road Initiative, and supported by the ideology of the Yellow River culture and socialist core values.

(3) The modern management systems such as fine spatial governance, differentiated regional development, and opening to the outside world should be improved. Detailed and differentiated spatial governance and regional development policies should be formulated based on the resources and environment carrying capacity of ecological, agricultural, and urban areas as well as the new land and space planning program. Efforts should be made to consolidate the land route of the Belt and Road Initiative and build three core cities (Xi'an, Zhengzhou, and Taiyuan) to drive the development of Guanzhong-Tianshui Economic Zone, Central Plains urban agglomeration, and Taiyuan urban agglomeration and form a strategic leading position in the high-quality development of

Central China. The Hohhot-Baotou-Yinchuan (Hetao Plain) Economic Zone, Lanzhou-Xining Economic Corridor, Hexi Corridor, and other western high-quality development growth areas should be fostered. The integration of Jiaodong Peninsula with Beijing-Tianjin-Hebei region for coordinated development should be promoted to shape the Bohai Economic Rim.

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(Translated by WEN JX)



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