

Analysis of Resource and Economic Attributes of the Yellow River Sediment

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Abstract. With the development of market behavior and the scale of resource utilization, management of Yellow River sediment is facing challenges. Based on the analysis of the natural resources, the economic attribute of sediment resources including “the ownership”, “externality”, “supply and demand” is shown as a kind of special public goods. Reference is provided to establish a long-term management mechanism and avoid the "tragedy of the commons" of Yellow River sediment resources.

Introduction

The sediment in the Yellow River mainly is sourced from the Loess Plateau in China. Its suspended sediment is made up of mealy sand, and its bottom sediment mainly consists of fine sand. Its heavy minerals include hornblende, biotite, epidote and metallic minerals, and its clay mineral contains more montmorillonites [1]. The sediment resources in the Yellow River Basin belong to silicon and aluminium ones. With development of society and scientific technology as well as the phased implementation of various management and supporting measures, the utilization will be imperative for the Yellow River sediment resources.

According to an incomplete analytical estimation on the Yellow River sediment utilization potential in the future 50 years by the Yellow River Institute of Hydraulic Research (YRIHR), a total available sediment quantity of 1.61 billion tons can be used in the flood control safety of the Yellow River, of which is 0.42 billion tons for dike reinforcing by desilting, 0.448 billion tons for silting up village platforms, 0.7 billion tons of silt build earthwork for the secondary perched river harnessing (Silt filling river embankment and silt blocking on channel), and around 42 million tons as the materials for flood control and rescue materials such as artificial reserved bricks for floor prevention. Total 6.636 billion tons of available Yellow River sediment can be used in soil improving by desilting and ecological reconstruction, of which is 2.128 billion tons for earthwork for soil improving by desilting, around 4.2 billion tons for water and sand diversion, 0.308 billion tons for ecological reconstruction in restoration of mining subsidence areas and control of water pollution by making use of the Yellow River sediment. Total around 0.168 billion tons of sediment is transported to the estuary areas by water and sediment regulation every year in the land creation at the estuary, and the 8.4 billion tons of sediment will be transported in the future 50 years. Total 1.12 billion tons of sediment will be used in building materials, of which is 0.42 billion tons for brickwork material making, and 0.7 billion tons directly for building material. Thus, it can be seen that there is a utilization potential capacity of the Yellow River sediment up to 17.766 billion tons, and an annual sediment disposing capacity of around 0.356 billion tons in the future 50 years. It is thus clear that a relatively larger quantity of Yellow River sediment resources is demanded for social and economic development and ecological utilization, so there is a quite extensive prospect in development and utilization of the Yellow River sediment [2].

The current studies on the utilization of Yellow River sediment resources focus on the feasibility

analysis on technology of sediment resource utilization [3][4][5], as well as the long-term effect, market prospect[6][7][8] and micro-management policies[9][10][11] of sediment resource utilization. The multi-way and all-around market and non-market utilization will bring a great challenge to the management of the Yellow River sediment resources. This paper is intended to analyze the natural and economic attributes of the Yellow River sediment, and provide the references for knowing well internal objective laws of utilization of the Yellow River sediment resource and establishing its long-effect management mechanism.

Natural Attributes of the Yellow River Sediment Resource

Effectiveness, controllability and scarcity the basic attributes of natural resources. Generally, natural or artificial product with three attributes can be allocated as a resource. The effectiveness, controllability and scarcity of the Yellow River sediment are analyzed as follows [12][13]:

1) Effectiveness: The Yellow River sediment has been playing an important role in social and economic development and eco-environment based on discreteness, plasticity, handlability, adsorbability and shearing resistance. It reflects its effectiveness and resource attributes mainly in marine reclamation land, dike reinforcement by warping and silt, soil improving by desilting and building materials.

2) Controllability: The discreteness and handlability of Yellow River sediment determine the controllability. The controllability of Yellow River sediment is mainly reflected in controlling transport, transfer and allocation of sediment by applying engineering measures (water and soil conservation, blocking sand by reservoir, mechanical dredging and sand excavation) and non-engineering measures (water and sediment regulation, and erosion deposition of channel and beaches).

3) Scarcity: Rapid expansion of national economy leads to a large increase in engineering construction in China, so that sand and stone demand exceeds supply with a less quantity of coarse sand in the lower reaches of the Yellow River. The land making by sediment is very important specially in some regions where there is a shortage of land resources, so the sediment is a shortage land-making resource.

Economic Attributes of the Yellow River Sediment Resource

The Yellow River sediment is a common resource essentially as a naturally-producing or existing resource. Just as E. Ostrom[14] pointed out, a common resource is of public use in utilization or consumption, of non-excludability in an occupation sense, and of competitiveness in use. Its utilization of any group members can hinder other users' utilization to some extent. Any disregard to such economic attributes as ownership, externality, supply and demand of the Yellow River sediment resources can result in the tragedy of the commons. As a common resource, major economic attributes of the Yellow River sediment mainly include such aspects as supply & demand characteristics and market failure, externalities, common products and property right structure.

Supply & Demand Characteristics and Market Failure

1) Supply & demand characteristics

Like other common resources, the Yellow River sediment is provided to consumers through market to satisfy the demands in such industries as construction and manufacturing. Beyond that, its characteristics also determine one part of it to meet the actual demand by a non-market way in dyke reinforcing by desilting, desilting in beaches (harnessing of secondary perched rivers for river embankment silting erosion ditch), soil improving by desilting and eco-reconstruction, sea reclamation, and water ecology maintenance in wetland. As a common resource, both its market and non-market supplies act and affect each other by a waxing and waning way. From current situations, the Yellow River sediment is always used for disaster control, and its exploitation is still in a starting stage at a lower marketization level. Its market and non-market supplies are greater than demands, with a less imbalance between supply and demand. Its market and non-market supplies

have a weak influence each other. From a long term, the quantity and quality of non-market supply may face challenges with increasing marketization degree of the Yellow River sediment.

2) Market failure

The ineffectiveness of common resources in market and non-market supplies results from market failure. The market failure is the situation that the free market equilibrium deviates from the Pareto Optimality economics theory shows the market economy in free competition can come to the Pareto Optimality status of resource allocation, but he the idealized assumed conditions can't conform to current situations. The common resources are different from ordinary manufactured materials. For the Yellow River sediment resource is diversified in effectiveness and functions in many aspects, and its allocative efficiency depends on market and administrative departments' understanding of all use values of the Yellow River sediment as a common resource. If only materiality and direct utility of the Yellow River sediment are concerned, the successful system arrangement meeting the market demands may realize similarly its effective allocation. However, if the direct and indirect utilities of a resource are taken into account at the same time (for example, some negative influences caused by recycling of the Yellow River sediment), and its intergeneration efficiency is analyzed in the sustainable development, then, the market efficiency is only considered as a necessary condition rather than a sufficient condition for the efficient allocation the Yellow River sediment resource according to classical economies.

There is no motivation that encourages the positive intergenerational externality and restrains negative intergenerational externality in the market mechanism, and the Cose's and Pigou's methods are powerless in solving the intergenerational externality. So the market failure of natural resources is unavoidable for the externality of time-lag effect sometimes [15].

Externalities

The externality refers to the harmful or beneficial influences by production and consumption of some products on the enterprises or individuals which can not participate in the two activities. Its beneficial influence is called the "external economy", otherwise called "external diseconomy". The externality economy refers to a phenomenon that the production and consumption of products can incur a loss to members of society out of manufacturers or consumers, but no one can bear the due costs. When the negative externalities exist, main market players arrange production and operating activities based on its own micro-economic costs but not including such external costs as environment cost and prices. As a result, the throughput is far beyond effective output. By this time, the social resources or production factors allocated by market are inefficient or non-effective. The existence of externality is the important theoretical foundation for implementation of common resource policies.

In resource utilization of the Yellow River sediment, its "external economy" and "inappropriate sand excavation" can cause the environment problems, and the "disaster risk can cause the "external diseconomy". With people's demands for social environment and water & sand resources, the sediment resources are understood step by step, and widely used in production and practice. the Yellow River sediment resource is abundant with a low cost of exploitation and fat profits. The Yellow River sediment shows its growing economic values and external economy as a common resource with advancement of technology, social and economic development, increasing shortage of land and mineral resources, enlargement of construction market demands, and the unveiling of related policies. With the breakthrough of key techniques in the Yellow River sediment reclamation and the improvement of its marketization level, the "external diseconomy" occurs as the contradiction stands out constantly between the sand mining in the riverway and flood prevention, channel improvement and river management.

Public Goods Attributes

Another important theoretical basis for common resource regulation is common product, which is stated relative to the private product. The common products which have non-excludability and non-competition are used as the ones meeting the social public demands in consumption. The Yellow River sediment resource has the attribute of common goods. The market means the

institutional arrangement for private goods, while the government will provide the system arrangement for public products. Even if in one properly developed private market, the market supply of public goods may still be inefficient, and it can be improved in efficiency only by the government's intervention.

However, the government's intervention is a double-edged sword because of solving market failure and facing failure of government management. In the development of the Yellow River sediment, the administrative departments can intervene in market operation of sediment resource by law and administrative authority as well imperative means. Naturally, the activities to seek for economic interests occur with gains in rents.

Conclusions

The following conclusions can be drawn from the analysis results of economic attributes of the Yellow River sediment:

1) Governments and controlling authority should strengthen the regulation and control for popular market failure in the marketization of Yellow River sediment. In reality, the Yellow River sediment resources should be categorized in quantity and space. It is made clear which should be allocated by market, which should concern the safety of riverways, which should be banned to be exploited but be exploited by the state independently. By this, good utilization of the Yellow River sediment can be rationally utilized by the non-market supply and mark resource-allocating quantity.

2) The state or administrative departments should work out the laws, regulations and industrial rules with authority and implementation for different problems in different stages, so as to standardize the market orders and blow the illegal actions. Arbitration and punishment should be made for any behaviors that violate regulations in market, and any law breaker should be brought to justice. The good operating order of the sediment mining market should be maintained by the powerful state apparatus, in order to reduce the environment problems by the improper sand excavation and the external diseconomy by disaster risk.

3) Well handling the relation between administrative departments and market. The administrative departments should intervene as less as possible in the fields which can give play in marketing functions or by some measures to promote market operation. Meanwhile, they should come into more play in the fields which can't depend on market or the market doesn't work. Their role is to supplement the market rather than replace the market.

To sum up, the long-effect management mechanism should be established for the Yellow River sediment resource from the following aspects:

1) Design the management mechanism framework of sand excavation in downstream river channel of the Yellow River in three aspects: administrative system, management system and management measures. The Yellow River Conservancy Commission (YRCC) takes the charge of the united management and supervision for the sand excavation in the downstream river channel of the Yellow River in the administrative system. The Shandong and Henan Yellow River Affairs Bureaus and their river affiliated affair administrative departments at municipal and county levels is in charge of management, supervision and inspection management of sand excavation in the managing scopes of their administering river channel. In the management system, the uniform planning system, "one license-one fee" system, and sand excavation licensing system are carried out in the downstream channel of the Yellow River. In management measures, some measures are taken such as total quantity control of sand excavation, sand excavation ship management, and severely investigating illegal sand excavation; it is studied that the measures for the systematic management is taken by different utilization ways.

2) Establish the Yellow River sediment management mode of "government guidance and market operation. The Yellow River sediment should be developed as an emerging industry by resource transformation and utilization. It requires the "visible hands" of the government, but it can't do without the "invisible hands" of the market. In current indistinctive economic benefit, the governmental policies are required to encourage and guide the sediment development. On the other hand, the larger investment for transformation and utilization is needed, and a long-term period of

cost recovery is required, so the government should not take on all things, and the sediment industrialization is available by market, that is, carrying out the new mechanism of Yellow River sediment utilization—the “government guidance and market operation”. The administrative departments in the Yellow River Basin cooperating with local governments along the Yellow River bring into play of the government’s leading role to cultivate market and promote sediment industrialization by marketization.

3) Improve the supervision management system of sand excavation in the downstream channel of the Yellow River by making full use of administrative, economic and technical means. Establish the long-term mechanism of the united law enforcement. The Yellow River affairs departments take charge of establishing the united supervision mechanism, jointly law-enforcing mechanism, regular consulting mechanism, major issue coordination mechanism and information resources sharing mechanism, so as to restrain and suppress illegal sand excavation activity.

4) Establish the support security system of the Yellow River sediment resource utilization in government guidance, market operation, technical promotion and legal protection; it is proposed that the policy measures are taken such as government purchase, and the financing mode of resource compensation project (RCP), to effectively promote the development of the sediment utilization industry.

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References

- [1] Wang Lachun, Chen Xiaoling and Chu Tongqing. Comparative analysis of the Yellow River and Yangtze River sediment characteristics [J]. *Geography Research*. 1997, 16(4):71-79.
- [2] Jiang Enhui, Cao Yongtao, Dong Qihua et al.. Long-term effect of the Yellow River sediment resource utilization [J]. *The Yellow River*, 2015(2): 1-5.
- [3] Wang Tinggui & Hu Chunhong. Reclamation and realization approaches of basin sediment [J]. *Journal of Hydraulic Engineering*, 2006,37(1): 21-27.
- [4] Wang Zhuofu, Yang Gaosheng et al. Theory and practice of sand excavation in the channels [M]. Beijing: China Water Power Press, 2012.
- [5] Zhou Haiyan & Xue Rusheng. Feasibility analysis of dyke and ditch control and artificial land making [J]. *Shandong Territorial Resources*, 2005, Z1:54-56.
- [6] Dong Lie. Practice and thinking for developing the Yellow River sediment resources and water conservancy economy, and making use of waterlogged lowland silted by the Yellow River sediment [J]. *China Rural Science and Technology*, 2014, 07:66-67.
- [7] Wang Lijiu, Yao Wenyi and Ling Yuanbao. Utilization way and principles of the Yellow River sediment resources [J]. *The Yellow River*, 2014, 07:9-12.
- [8] Geng Mingquan, Lv Xiuhuan and Zheng Hui. An Exploration of resourceful treatment and utilization ways of the Yellow River sediment [A]. The symposia of special topic seminar on water resource integrated utilization in the middle and lower reaches of the Yellow River in the 10th annual meeting of the Chinese Association for Science and Technology [C]. 2008:9.
- [9] Song Wanzeng, Liu Hu, Ling Yuanbao. Analysis of current situation of the Yellow River sediment utilization [N]. *Yellow River News*, 2012-03-08003.

- [10]Jiang Enhui, Cao Yongtao, Dong Qihua, Gao Guoming, Li Junhua and Jiang Siqu. Long-term effect of the Yellow River sediment resource utilization [J]. The Yellow River, 2015, 02:1-5+12.
- [11]Wu Hailiang, Li Jiwei, Liu Juan and Wu Jian. Way, pathway and potential of the Yellow River sediment utilization [A]. The symposia of special topic seminar on water resource integrated utilization in the middle and lower reaches of the Yellow River in the 10th annual meeting of the Chinese Association for Science and Technology [C], 2008:9.
- [12]Wang Lachun, Chen Xiaoling and Chu Tongqing. Comparative analysis of the Yellow River and Yangtze River sediment characteristics [J]. Geography Research. 1997, 16(4): 71-79.
- [13]Wang Zhaoyin et al. Mineral components and distribution rules of the sediment in the Yellow River Basin [J]. Journal of Sediment Research. 2007.10.
- [14]A·Ostrom. Governing the commons: the evolution of institutions for collective action [M]. Shanghai: Sanlian Bookstore, 2000.
- [15]Luo Liyan. Why doesn't the natural resource market work? [J]. Finances and Economics, 2004(2): 24-28.