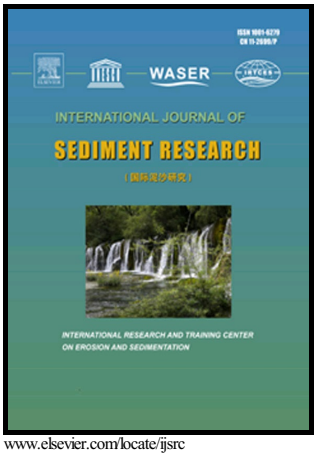

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Study on the assessment of the comprehensive benefits of the utilization of sediment resources in reservoir areas

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Study on the assessment of the comprehensive benefits of the utilization of sediment resources in reservoir areas

Abstract: The utilization of sediment in reservoirs as resources is an efficient way to reduce reservoir sedimentation and turn disadvantage into benefit. Based on economic, social and ecological functions of sediment resources, this paper puts forward a two-layer, three-dimensional evaluation index system. It also establishes six direct and indirect indicators with their formulas to calculate the comprehensive benefits of sediment utilization in the Xixiayuan reservoir of the Yellow River with a volume of 2000 m^3. The results show that social benefits would be more prominent, with the ecological benefits coming second. This demonstrates that the indirect public value of utilizing the sediment resources in the Yellow River Basin can be far greater than its direct economic value.

Keyword: Reservoir sedimentation; Comprehensive benefits; Evaluation method; Yellow River; The Xixiayuan Reservoir

1. Introduction

Reservoir sedimentation is a world-wide challenge for dam owners (Schleiss et al., 2016). It is estimated that reservoirs worldwide annually lose 0.5%-1% of their total storage volume (Basson, 2009), which reduces the water storage capacity of a reservoir (Alam, 1999; Alemu, 2016) and weakens the functions of water supply, energy production, navigation, and flood control (Brandt, 2000; Chien & Wan, 1999; Graf, 1984; Han, 2003; ICOLD, 2012; Morris & Fan, 1998). Furthermore, the sediment depositing in reservoirs reduces the global sediment delivery to deltas and coastal areas, and causes social and ecological problems (Fang & Rodi, 2003; Halcrow, 2001; Huang et al., 2015; Syvitski & Milliman, 2007).

The specific challenge may be the biggest in the Lower Yellow River than in any other alluvial rivers in the world, due to the Yellow River's hyper-concentrated flow (Fang & Wang, 2000; Li et al., 2016; Shu et al., 2016) and high-intensity human activity impact (Jia et al., 2016). Huge deposits have occurred in hydro-junctions in the main channel of the Yellow River continuously since the first dam Sanmenxia was built in 1960 (Fang et al., 2008), which reduced the water and sediment regulation ability, increased the risk of flooding over banks, and caused severe ecological and environmental problems (Huang et al., 2016). As a response, dredging the reservoir is always a focusing issue in the research and management of the Yellow River.

In general, considering the physical processes of reducing reservoir sedimentation, two methods have been adopted widely to control reservoir sedimentation. One method engineers measures that directly extract the sediments from the reservoir while the other is a flushing method that uses the bottom outlets (UNESCO, 1985). Depending on reservoir sedimentation location, the methods can also be classified in three groups: in the river catchment upstream the reservoir, in the reservoir and at the dam (Kondolf et al., 2014; Morris & Fan, 1998; Sumi & Kantoush, 2011).

Economic analysis is the key issue in dealing with reservoir sedimentation. We could neither neglect the reservoir sedimentation without any measures, nor spend excessive money beyond what benefits the outcome. Since appropriate places for dam construction are extremely finite in the world, the economics of exhaustible resources (Solow, 1974) was first applied in the utilization of sediment in reservoir as resources. Then many mature and classic economic methods were brought into the assessment of the benefits-cost in geology and geomorphology, including market value, hedonic property price, travel consume, shadow