

Estimation of Bank Stability in Yangling Section of Weihe River Basin

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Abstract

The stability of the river bank directly affects the integrity of the physical structure of the river, which in turn affects the ecological security of the river, and it also affects the safety of the people on both sides of the river. Construction near the banks of the Yangling section of the Weihe River Basin may cause disturbances to the stability near the riverbanks, and the stability of the riverbanks is also an important indicator of river water ecological security. Therefore, in view of the riverbank stability in the Yangling section of the Weihe River Basin, the bank stability of the Yangling Section of the Weihe River Basin is evaluated, and then effective suggestions are put forward for the later construction. The results show that: (1) The riparian stability of the river reaches is considered unhealthy.(2) For construction in the river course, the river channel should be stabilized by smooth excavation along the bank slope, cutting and straightening, etc., to improve the effect of water flow conditions and reduce the scouring of the river bank. (3) Standardize the behavior of sand mining and soil borrowing in the river channel, and minimize the disturbance to the river bank.

Keywords

Riverbank Stability; Yangling; Wei River; Assessment.

1. Overview of the Study Area

Yangling Agricultural High-tech Industrial Demonstration Zone is located in the middle of Guanzhong Plain, Shaanxi Province, 85km west of Xi'an City, between 107°59'-108°08'E and 34°14'-34°20'N. Dazhuang Town in the county is bounded by Qishui River, facing Yabai Town in Zhouzhi County across the Wei River in the south, bordering Jiangzhang Town in Fufeng County in the west, adjacent to Wugong Town in Wugong County and Xinglin Town in Fufeng County in the north, and is long from east to west. About 16km, the north-south width is about 7km, the total area is 135km², and the urban planning area is 35km²[1]. Among them, the Weihe River is the largest tributary of the middle reaches of the Yellow River. It originates from Niaoshu Mountain, Weiyuan County, Dingxi City, Gansu Province. It mainly flows through Tianshui, Gansu, Baoji, Xianyang, Xi'an, Weinan and other places in the Guanzhong Plain of Shaanxi Province, and reaches Tongguan County, Weinan City, Yellow River[2].

The Weihe River Basin suffers from frequent catastrophic torrential rains and floods, with obvious heterogenous characteristics of water and sediment. In addition to the influence of the main and tributary storage, water diversion project construction and river sand mining, the

scouring and undercutting of the riverbed in the middle reaches of the Weihe River has continued to intensify[3]. At present, it is planned to carry out construction near the Yangling section of the Weihe River Basin, which may disturb the stability near the riverbank, and the stability of the riverbank is also an important indicator of river water ecological security. Therefore, it is necessary to evaluate the riverbank stability of the Yangling section of the Weihe River basin in view of the riverbank stability within the affected area of the construction of the Yangling section of the Weihe River Basin.

2. Method

Referring to the technical regulations on river sub-assessment in the "Technical Guidelines for River and Lake Health Assessment", according to the project assessment needs, combined with the Weihe landform in Shaanxi Province, tributary inflow, land use (urban river section, rural river section), water function District, administrative division, etc., a total of 7.92km of river sections near the project area were extracted for evaluation.

Referring to the "Technical Guidelines for River and Lake Health Assessment", the evaluation elements of river bank stability include: bank slope inclination, bank height, matrix characteristics, bank slope vegetation coverage and slope toe scour strength. The index expression is as follows [4]:

$$BKSr = \frac{SAr+SCr+SHr+SMr+STr}{5} \tag{1}$$

Where:

BKSr——Scoring of the bank slope stability index;

SAr——Bank slope inclination score;

SCr——Slope coverage score;

SHr——Bank slope height score;

SMr——Riparian matrix score;

STr——Scour strength score of slope toe.

Table 1. Scoring criteria for river bank stability assessment indicators

Slope Features	Stable	Essentially Stable	Substable	Unstable
Score	90	75	25	0
Inclination of slope (<)/°	15	30	45	60
Vegetation Coverage (>)/%	75%	50%	25%	0%
Slope height (<)/m	1	2	3	5
Matrix (category)	Bedrock	Rock bank	Clay bank	Non-clay bank
River bank erosion	No sign of washout	Light wash	Moderate washout	Heavy washout
General Characterization	In the near future, the river bank will not be deformed and damaged, and there will be no soil erosion.	The riparian structure shows signs of loosening and development, and there are signs of soil erosion, but Will not deform or break in the near future.	The development trend of river bank loosening cracks is obvious, which can lead to river bank deformation and damage under certain conditions, and moderate soil erosion.	The river bank has serious soil and water loss, with the possibility of major deformation and damage, or damage has already occurred.

The scoring criteria of the river bank stability evaluation index are shown in Table 1.

Referring to the "Technical Guidelines for Health Assessment of Rivers and Lakes", the stability of river banks is divided into five levels: ideal, healthy, sub-healthy, unhealthy, and ill. The scoring range is shown in Table 2.

Table 2. Classification standard of river bank stability status

Grade	Health Status	Category Points
1	Ideal condition	80~100
2	Health	60~80
3	Sub-health	40~60
4	Unhealthy	20~40
5	Sick	0~20

The river bank stability assessment index data comes from the field investigation and monitoring. In accordance with the "Technical Guidelines for River and Lake Health Assessment", combined with the river landform characteristics of each river section, the setting of water quality monitoring sections, the comprehensive utilization of river banks and their representativeness, etc., a survey and monitoring section is set up in the assessed river section, and the survey and monitoring time is 2021. July to August. The specific monitoring points are N34°12'46" and E108°13'3" on the left bank, and N34°12'55" and E108°13'11" on the right bank. ArcGIS software was used to extract the slope based on DEM data with a resolution of 30 m, and the vegetation coverage was calculated based on remote sensing images[5-7]. The riverbed matrix was consulted from relevant literature.

The focus of river bank stability investigation and monitoring is to measure the slope angle and slope height of the left and right banks on-site, to identify the type of river bank matrix, to investigate the scour status of the river bank slope foot, and to comprehensively describe the overall stability of the river bank.

3. Results

According to the extracted data, the evaluation results of the Yangling urban area of the Weihe River Basin are as follows: the slope angle of the left bank is 50.23°, the vegetation coverage rate is 76.09%, the slope height is 0.7m, and it is slightly scoured; the slope angle of the right bank is 43.67°, and the vegetation coverage rate is 23.76%. The slope height is 3.55m, and it is also lightly scoured. According to the above-mentioned scoring standards, the river bank stability index was assigned, and the evaluation score of the river bank stability in the Yangling urban area of the Weihe River Basin was 39.76 points, of which the left bank slope stability index was assigned a score of 45.26, and the right bank slope stability index was assigned a score of 34.26. The assessment results show that assessing the stability of the riparian zone of the reach is unhealthy.

4. Conclusion

- (1) If it is necessary to construct in the river channel, the river channel should be stabilized by smooth excavation along the bank slope, cutting and straightening, etc. to improve the effect of water flow conditions, and diversion dikes, spur dams, submerged dams, spur dam groups, etc. should be set up to improve the trend of the river, reducing the scouring of the river bank welt.
- (2) In addition, behaviors such as sand mining and soil borrowing in the river channel should be regulated to minimize the disturbance to the river bank. At the same time, the river bank

stability should be taken as a long-term monitoring index, and the monitoring scope and monitoring sample points should be expanded to provide technical support for improving the river bank stability.

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