Effect Analysis of Soil Erosion Prevention of the Loess Plateau on Developing and Utilizing Water Resources

Jia Zexiang, Wang Daxiang and ***Wang Bo***

The Administrative Bureau of the Upper and Middle of the Yellow River,
The Yellow River Conservancy, Xi'an, 710043 China
E-mail: limind@pub.xaonline.com

Abstract: The interaction of serious soil erosion and arid of the Loess Plateau in the Yellow River basin influences the developing and utilizing water resources. The effective prevention of soil erosion can reduce the damage of arid and the force of environmental capacity, and change the time and spatial distribution of surface runoff in a region so as to raise the utilization factor of water resources.
Keywords: soil erosion, developing and utilizing water resources, the Loess Plateau

1 General condition of the loess plateau region

The Yellow River basin in the Loess Plateau locates at the area from Riyueshan in the west to Taihangshan in the east, and from the Qinling mountains in the south to Yinshan in the north, covers 640,000 km^2, including 7 provinces of Qinghai, Gansu, Ningxia, the Inner Mongolia, Shaanxi, Shanxi, Henan, 46 regions, 306 counties. There is a soil erosion area of 454,000 km^2 amongst the total area. The average annual amount of erosion material inflowing into the Yellow River is 1.6 billion tons, so this area is an area that has the most serious soil erosion and that of the most brittle environment.

The Loess Plateau region locates at arid and semi-arid region with sophisticated natural geography circumstances: various types of physiognomy, 2/3 area in mountainous, hilly, highland area, fragmentized topography, steep slopes and deep gully, most area covering with loose loess, thin plant cover, water fall concentrates in June to September with a rainstorm precipitation of 60%—70% of the annual total amount of 200mm—700mm, with a trend decreasing from south east to north west. Other than natural changes, the long term manmade irrational land utilizing and resources developing result in environment aggravation, serious soil erosion, frequently happened disaster, sand blown by the wind disaster.

2 The effect of erosion on developing and utilization of water resources

(1) Nibble at the cultivated land and lower the water accumulate capacity of the soil

The serious soil erosion in the Loess Plateau cause water soil and fertilizer washing away, further result is the decrease of the soil, aggravation of the physics and chemistry characteristics, and the topography being torn into pieces, consequently minifying the storage water of the surface of the earth and disturbing the effective utilization and regulation of water resources. thus over 60%—70% rain runs off along the slope, however the absorbed amount of water is little. The actual measurement shows that the cultivated land on the slope in Tianshui region, which locates at the loess hilly and gully region, after 14 days of one sufficient rainfall, the moisture content reduces to only 10%, 20 days later only 8% left.

(2) The sedimentation takes effect on the regulation of water resources

The sedimentation influences the service life of the reservoir, so the comprehensive utilization of the reservoir is greatly reduced. According to investigations and statistics, from 1950 to 1989, the reservoirs located at the main stream and lateral branch in the upper of the Yellow River are filled with 14.3 billion tons of sediments, as being equivalent to silting up 100 reservoirs with 0.1 billion m^3 of each. Wangyao reservoir, in Yan'an district Shaanxi Province, had been constructed in 1972 with a dam of 55m in height, the storage capacity of 0.203 billion m^3. It was filled up for 31m and reduced the storage capacity 54 million m^3, 27% of the total capacity, in only 7 years after its completion. The data show: The majority of

the minitype reservoirs lose their capacity for regulating flood and change their reservoir area into embankment in only 5—10 years after its completion. The transportation engineering will be filled up if high sediment water is used to irrigate, then the capacity of irrigation must reduce, whereas the invalid water must increase.

(3) Reduction of the utilization factor of water resources

The spatial contribution and quantity of water resources in the Loess Plateau can not meet the requirements of land, population and economy development center, the most area has the contributing water modulus of lower than 100,000 m^3/km^2, even lower than that of 1/3 of the national average contributing water modulus. The runoff of bigger branch and mainstream in the flood season accounts for about 60% of the total in a year, even 80%—90% of the total in the form of rainstorm. The serious soil erosion sharpens the coordination of the water resources distribution. Meanwhile, in order to lighten the sedimentation in the Yellow River, 20—30 billion m^3 of water must be discharged so as to transport the eroded material into the sea. From 1972 on, 29.3 billion m^3 of water flows into the sea every year, of which there is 10.5 billion m^3 of water in non-flood season, as lowers the utilization factor. Locally, from the branch stream view, there is 0.11 billion m^3 of the storage capacity lost, being equivalent to the required water of 250,000 mou land.

(4) Sharpens the water environment pollution and influences the development and utilization

Because the fine silt has more surface area and surface energy is higher, when it meets the solution of polluted material, it can substitute the polluted material. Accordingly, the water resources must be polluted and its development and utilization is influenced. Based on the measured data of polluted status in the Yellow River basin in 1990, we find out that the environment in the middle and lower stream of the Yellow River is seriously polluted, even in the one and two level of branches due to the manmade and city erosion.

3 Function on water resource application of prevention of soil erosion

3.1 To increase the water holding capacity of field and raise the utilization ratio of rainfall water resource

The prevention of soil erosion can increase the effect use ratio of water resource by scientifically laying the measurements of storing water and consternating soil. The biologic treatments can effectively relief the strength and density of rainstorm eroding the ground; the treatments of cultivation and engineering can reduce slope gradient ratio and slow down the direct surface runoff, to increase the capacity of impoundment and delay the time for influent seepage of rainwater, to increase the velocity of influent seepage; to increase the water-holding capacity of field, to decrease the water consume factor, so as to improve the local capability of resisting a drought. The analysis from relative business agency shows that water consume factor of crops in hillside-cultivated field is 2.59 while the factor in level terraced field is 1.76, the rate of water utilization of crops in level terraced field is 47.2% more than that in the hillside-cultivated field, production increase 20%; it also show that effect of water utilization of crops and production incensement in channel-dam field is even more evident. As of every treatment for water and soil conservation in The Yellow River Basin, the average impoundment per year was 1.3 billion m^3 in 1950s, almost 5.4 billion m^3 in early 1990s; the water impounded by these of treatment has play a progressive role on the able of continually developing and using the water resource of The Yellow River.

3.2 To cut down flood peak, to detent flood flow and to improve the use rate of the rainstorm flood

Prevention of **s**oil and water loss can cut down peak, reduce flood flow, detent the flood by rainstorm, change the short-during flood to slow rate stream flow, so make the rainstorm flood flow, which is difficult to use, be usable ground runoff. First, prevention of soil and water can cut down flood peak, detent flood flow and reduce the loss from the disaster of flood. The runoff measurement by

Tianshui Water conservation station of Yellow River Water Conservation Committee can prove the following flood reduce factor at variety flood frequency by the water conservation treatment: at 5% flood frequency, the quantity of store floodwater by terrace is 6 m^3/km^2—12.6m^3/km^2, the rate of floodwater-cut is 59%—88%; the quantity by artificial forest is 2.9 m^3/km^2—5.11 m^3/km^2; the quantity by artificial grass is 1.05 m^3/km^2—3.4 m^3/km^2, the rate of floodwater-cutting is 12%—27%. The skeleton channel-treating engineering, as the master of channel controlling, its design criterion during is 20—50 years, the checked criterion during is 200—500 years, the floodwater at that lever can be fully held up and stored. Comparing the 5 time floodwater information record of Chabagou small river basin at Wuding River Basin prior of and posterior of prevention, it can be found that the rate of peak-cut is 64.1%, the rate of water-reduction is 42% and the rate of sand-reduction is 51.4%. According to relative research of floodwater information of the Yellow River arterial channel at Huayuankou hydrometric station, during 1950—1985, the floodwater whose peak flow rate larger than 4000m^3/s appears 3—7 times per year, the floodwater whose peak flow rate larger than 8,000m^3/s appears once per year; after 1986, the floodwater whose peak flow rate larger than 4,000m^3/s appears only 1—3 times per year, there is no floodwater whose peak flow rate larger than 8,000m^3/s. The floodwater probability at downriver has been reduced, this effect primary relative to human beings activity, although relative to rainfall. It shows that the treatment of water and soil conservation has also played a role of flood detention and flood reduction at the Yellow River arterial channel.

3.3 Reduce the sand fill up of river and hydraulic engineering, improve the capability of synthetically exploitation and use water resource for hydraulic engineering

The prevention of **s**oil and water loss at small watershed has evident effect. The Jiuyuangou small watershed at Suide County, Shaanxi Province started the prevention at 1953, the cure degree reached 56.3% in 1988, according to the analysis of survey information, the year average sand-transferring modulus is 19,738$m^3/(km^2 \cdot a)$ before cure and that is 7,944$m^3/(km^2 \cdot a)$ after cure, the modulus decreases 59%. The Chabagou small watershed of Wudinghe River decreased 32.1% of runoff quantity and 80.5% of sand transfer quantity in 1980s compared with 1960s. Prevention of **s**oil and water loss has produced evident sand reducing effect at bigger branch river. According to the analysis of survey, The Sanchuanhe River Basin, which began curing in early 1980s, decreased 51.8% of runoff and 73.8% of sand in 1980s, decreased 24.5% of runoff and 68.3 % of sand in 1990s; The Weihe River Basin began the Prevention of **s**oil and water loss in 1970—1996, year average water reduction quantity 2.158 billion m^3, year average sand reduction quantity is 64,000,000t. As to The Yellow River arterial channel, the prevention has also evident effect, the information from *The cause and developing trend of water-sand variety at middle of the Yellow River full of coarse sand area* (published by the water conservancy publishing company) shows that the water and sand property has varied greatly at the middle of the Yellow River full of coarse sand area after prevention.The numerical analysis using water conservation method and hydrological method to the information above-mentioned indicted that the water reduction ratios are 16.7% and 17.7% respectively, the sand reduction ratios are 31.0% and 26.3% respectively.

References

[1] The Committee of The Yellow River water resource, Ministry of Water Resources. The water and soil conservation plan at The Yellow River Basin. Published by the water conservancy publishing company. Zhengzhou, China, 1997.

[2] Xi Jiazhi.The water resource of The Yellow River. Published by the water conservancy publishing company. Zhengzhou, China, 1996.

[3] The Bureau of middle The Yellow River, the Committee of The Yellow River water resource. Record of the water conservation of The Yellow River. Published by the Henan People's publishing company. Zhengzhou, China, 1993.

[4] The composite expedition of The Loess Plateau of Chinese Academy of Science Problems and solutions on the water resource of The Loess Plateau. Published by China Science and Technology publishing company, Beijing, China, 1990.
[5] Tianshui Station of Water Conservation and Science Test, the Committee of The Yellow River Water Resource. Symposium of the water conservation. Published by Gansu publishing company of science and technology, Lanzhou, China, 1992.