

The Soil and Water Conservation and the Utilization of Rainfall Resources in Inner Mongolia

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Abstract: The water resources is the main factor restricting the ecological construction and economical-social development in Inner Mongolia. By analyzing the natural condition, soil and water loss and harness situation, discussing the relationship between soil and water conservation in small watershed comprehensive harness and the protection and utilization of rainfall resources, the possibility that raising the rainfall resources transform and utilization by soil and water conservation measures will be advanced.

The Party Center and the State Department work out the tactic of the West Development at the beginning of new century. It not only will reduce the difference between east, middle and west of China, and will reduce the difference of poverty and wealth between city and country of Northwest, and also will intensify the stability in frontier area, promote the nationality unity, but also take the soil and water conservation ecological environment construction as the breaking point, the higher requirement should be raised to strengthen the soil and water conservation ecological construction, which centering around the reasonable utilization of water resources.

Under the new situation and requirement of the West Development, the serious ecological problems of Inner Mongolia are: the soil and water loss, the continuous enlargement of desert area, severe over-cutting of forest resources, the destruction of natural vegetation, which reducing the ecological function of wind prevention and sand rooting, and soil and water conservation greatly. The main reason of the problems is the lack of water resources. In order to improving the ecological environment and developing the local economy, impounding, protecting, developing and utilizing the rainfall resources well is an important measure.

Keywords: Inner Mongolia, soil and water conservation, rainfall, utilization

1 Natural conditions of inner mongolia

1.1 Survey

Inner Mongolia Autonomous Region locates in the north of China, the southeast of Mongolia Plateau. It has large area and complicated landform. The altitude of more than half area is over 1,000m. It is 2,400km long from east to west, 1,700km wide from south to north, across the Northwest, North of China area and Northeast area, bordering with 8 provinces, cities and autonomous regions. The total area of it is 118.3km², accounting 12.3% of the whole area of our China. The landform character takes on the belt distribution of plain, mountain and plateau. The land types can be divided into earth-rocky mountain area, rolling area, wind area, plain area, grassland area and forestry area. The main rivers are the Yellow River, the Ergunahe, the Nenjiang, the Xiliaohe, the Liuhe, the Dalinghe, the Luanhe, the Haihe and the continental rivers. Most area of the region locates in arid, semi-arid zone. The climate belongs to temperate continental monsoon climate. It shows droughty and windy, lack of rainfall and large quantity of evaporation. Because of the restriction of the specific landform and the climate conditions, the vegetation shows obvious region characteristic from east to west.

1.2 Water resources

Inner Mongolia locates in the transitional zone of monsoon circulation. There is lack of the water resources. Except for the Yellow River, the Liaohe, the Nenjiang, the Ergunahe, the Haihe and the

Luanhe, the surface water resources also include continental rivers. The exterior rivers and the continental rivers occupy 53% and 47% of the total area respectively. The mean annual total amount of surface water resources is 50.9 billion m^3 . In which the surface water resources is 37.092 billion m^3 and subsurface water resources is 13.789 billion m^3 . The per capita water resources quantity of the region is 2,170 m^3 , which is below the average level of the whole country. Per ha cultivated land occupies water resources only 9,150 m^3 , which is below the whole country average level of 17,175 m^3/ha , is 35% of the whole country average. The distribution of the water resources of the region is unbalanced. The area of the Ergunahe and the Nenjiang is 317.1 thousand km^2 , accounting for 26.8% of the whole region area, the water resources is 32.9 billion m^3 , taking 64% of the total amount. The Liaohe water resources is 7 billion m^3 , taking 14% of the total amount. The Yellow River water resources is 5.4 billion m^3 , taking 11% of the total amount. The continental rivers water resources is 5.2 billion m^3 , taking 10% of the total amount. The Luanhe water resources is 0.4 billion m^3 , taking 1% of the total amount of the whole region.

1.3 Precipitation

Inner Mongolia is located in mid-high latitude of the Northern Hemisphere, deeper in continent, far from the seas. Little input with vapor, insufficient with precipitation and unbalanced distribution in time and space. All those make the unbalanced distribution of surface water and subsurface water supplied by precipitation, descending from northeast to southwest. The precipitation in most regions is under 300mm. The precipitation is mainly concentrated from June to September, accounting for 55%—85% of the whole year. The mean annual precipitation of the whole region is 319.4 billion m^3 , and the depth of precipitation is 275.4mm. That is 288.3mm in the Yellow River watershed, is 269mm in continental watershed, and is 373.7mm in the Haihe watershed. The rainfall distribution is richest in the east in North of Daxinganling with 500mm, and descending gradually to the west. The precipitation could reach 300mm in most regions. It is 100mm—200mm in the west of Hetao plain, under 100mm in Alashan Plateau, only 37mm in the furthest east of Ejina county.

1.4 Soil and water loss

Inner Mongolia has a large area and various land types. Mountain land, rolling land and plateau take 70% of the whole region, sand land (including desert) takes 20% of the whole region. At the same time, there were many developing and constructing projects that made the soil disturbance and removal. That is the main reason of the variety of soil erosion types. There are water erosion, wind erosion, freeze-thaw erosion and artificial erosion in the region, taking place separately or interlaced. According to the primary investigation and statistics data analysis of 2000 annual soil erosion through remote sensing in whole region, there is 794.3 thousand km^2 slight level erosion with the erosion types of wind, water and freeze-thaw and its erosion index over the third grade, taking 67.15% of the total area of the region, in which, the water erosion area is 147.5 thousand km^2 , the wind erosion area is 599.1 thousand km^2 , the freeze-thaw erosion area is 47.7 thousand km^2 . Soil and water loss related to most of the 101 counties and banners of the region.

The space distribution of soil erosion in Inner Mongolia is restricted by erosion external force and environment system and has obvious region distributing rule. The water erosion belt mainly lies on the southeast edge of the autonomous region, namely, the low-mountain, rolling land and mountain plain of Daxinganling; low-mountain, rolling land and terrace lying on the north slope of Yan mountain; mid-low mountain, rolling land and terrace of Yin mountain; the loess rolling area along Hohhot city and Erduos city. The water erosion was affected clearly by rainfall and physiognomy, and rainfall is the main external force leading to soil and water loss. The water erosion is mostly about 2,000 $\text{t}/(\text{km}^2 \cdot \text{y})$ —13,800 $\text{t}/(\text{km}^2 \cdot \text{y})$, the maximum reaches to 40,000 $\text{t}/(\text{km}^2 \cdot \text{y})$. The exquisite soil and water loss makes not only the limited rainfall flowing away, but also much of sediment was transported to the lower river. The sediment blocked river channels and aggraded riverbeds, gives great pressure to the flood prevention of the lower river. The soil and water loss resulted in the severe delay of economic- social development and the poverty of the mass livings in our region.

2 Soil and water loss harness

The soil and water harness in Inner Mongolia was insisted on comprehensive harness taking small watershed as unit for a long time; and implementing concentratedly in light of the actual local condition; combining engineering measures, biological measures and agricultural measures of soil and water conservation; grasping ecological benefit, social benefit and economic benefit at the same time; mobilizing the mass' enthusiasm of harnessing soil and water loss with the lead of policy and the driving of benefit. Under the effect of the projects such as the National Eight Areas Priority Treatment Project, the Soil and Water Conservation Finance Budgetary Special Funds Project, the Soil and Water Conservation Ecological Program of the Yellow River watershed, the Loess Plateau Watershed Rehabilitation World Bank Loan Project, the Sand Storm Source Harness project around Peking and Tientsin etc, the soil and water loss harness area of the whole region was increased at a speed of 5,000 thousand mu in "Eight-Five Plan stage" and 6,500 thousand mu in "Ninth-Five Plan stage". Up to the end of 2000, the total harness area of the whole region reached to 67.4 thousand km². The soil and water conservation in natural condition has been controlled effectively. It laid a foundation to improve the local productive condition and speed up the farmer's poverty eradication.

2.1 The obvious improvement of ecological environment

The accumulative total harness area of the whole region has been finished 24.6 thousand km² through many years' comprehensive harness. The vegetation coverage of the key harness area has a great increase. Yuanbaoshan district Chifeng city has completed soil and water comprehensive harness area 4,200 thousand km² after many years work. Through such measures as slope land harness, forestation, grass planting, terrace building, warping land, warping dam, small reservoir, soil and stone check dam, working road etc, the harness degree reached by 87.8%, forest coverage reached to 37.5%, forest and grass preserving area accounting for 94% of the suitable forest and grass land, the preserving rate of comprehensive harness measures was over 95%, the soil erosion modulus was depressed greatly, the sediment-reducing rate of the small-scale rivers in this area reached to 76%. Chuanzhanggou in Erduos city Zhunger banner, which is the First-Term National Eight Areas Priority Harness Project, soil and water loss was very serious, drought and flood disaster happened frequently before harness. After some ten years comprehensive harness, adopting forest and grass planted on the mountain and farmland cultivated on the plain, forest and grass area of key harness watershed take 87% of the suitable area, and increased 75% compared with the former, vegetation coverage was increased up to 70% from 9% of the past.

2.2 Notable benefits of flood detention and sediment reduction

The small watersheds were taken as units in soil and water conservation comprehensive harness. It insisted that hydro project should combine with the soil and water conservation project from mountaintop to the slope and to the bottom of gully, that is, building storage works and planting trees and grass on mountaintop and slope, building terrace on gentle slope, building border on gully head and side, building reservoir, small reservoir and check dam in the gully. All these come into being a comprehensive prevention and cure system of fortifying and impounding layer by layer, soil and water loss was controlled effectively. According to the 103 small watersheds in which the National Eight Areas Priority Harness Project had implemented, the rates of water storage and soil conservation are mostly over 70% and 80% respectively. After analysis and calculation to the reservoir sedimentation in Liuhe and Dalinghe, the annual sediment reduction is about 3,980 thousand tons, the flood peak reduction index is about 70%. Especially on Jul 13, 1994, there had a rainstorm at a level of one time a century in the large area of the upstream of Luihe, the daily precipitation reached 255.7mm. Due to the impounding function of the soil and water conservation measures, the flood peak and flood volume were reduced to under the level one time a twenty years. The runoff coefficient is only 0.07—0.08 in harness area, but is 0.4 in no harness area. It showed that the soil and water conservation measures impounded 81% of the flood volume,

decreased greatly the pressure of flood prevention in the main branch of the Liaohe, it played an important role to ensure the safety of the people's property of Liaonan area in the lower river.

2.3 Advancing the transformation and utilization of rainfall resources

The soil and water conservation comprehensive harness impound surface runoff, conserve water resources and increase ground water level effectively. Undercurrent interception and diversion, dam and pond building were adopted, irrigation by lift and irrigation by gravity were realized in part of the farmlands, so the ability of counteracting the natural disaster is enhanced, the crop output is increased in a large range. In the small watershed comprehensive harness area of Yuanbaoshan district Chifeng city, the water resources conserved by soil and water conservation measures was realized to irrigate the farmland by gravity through undercurrent interception and diversion construction. In the soil and water conservation project of Dongsheng district Erduos city, the slope harness and the gully treatment were combined, built earth dam to impound water and sediment in the gully, the water storage ponds were dug in the lower reaches of the earth dam. The dams impound rainfall and supply the ponds. Then the water in the ponds was used to develop lift irrigation, so the limited rainfall resources was used and transformed effectively.

2.4 The enhancement of the agriculture and stockbreeding production ability

Through soil and water conservation comprehensive harness, the accumulative area of the terrace in the whole region is 8 thousand km², the warping land is 2.4 thousand km², the soil and water conservation forest is 46 thousand km², the artificial grass is 10 thousand km². The economic frame was changed into agriculture, stockbreeding and forestry integrated organically and whole developed on the base of the reasonable adjustment of land utilization from single production of agriculture or stockbreeding. It was in favor of developing commercial economy been up to the local economic foundation gradually.

3 Usage of water resources

By the end of 2000, the works had been built include: 457 reservoirs of large, middle and small scale with total storage capacity of 7.478 billion m³; 165 irrigation areas over ten thousand mu, 248.7 thousand matched machine and electricity driving wells, the total irrigated area is 2,826.9 thousand ha, in which effective irrigated area is 2,371.7 thousand ha, grazing irrigation area is 335 thousand ha, forest and others irrigation area is 120.3 thousand ha. Annual water supply volume of water construction is 17.768 billion m³, in which the volume for agriculture is 16.648 billion m³, taking 93.7% of the total water consumption, for industry is 0.487 billion m³, for city and town living is 0.601 billion m³. In the annual water supply volume, the Liaohe watershed supplied 7.376 billion m³, taking 18.5% of the total volume of the watershed; the Yellow River watershed supplied 9.523 billion m³, which far exceeded the river's resources. The development and utilization degree of the surface water in the different section of the whole region were: the Song-Liao watershed is 36.5%; the Hai-Luan watershed is 15%; interior rivers is 47.4%. The supplied water of the Yellow River comes from lifting the pass-by water of the main river. In the surface water supplying volume, water storage works supply 9.1%, diversion works supply 77.9%, water-lifting works supply 13%. In the recent years, cited area water yield of the whole region surface water consumption takes about 12.3% of the total volume of the surface water resources of the whole region, the rates of impounding, transformation and utilization were very low. Lacking sufficient impounding rainfall and gully runoff controlling constructions are the main reasons, it made the limited rainfall resources lose.

4 Soil and water conservation and rainfall utilization

The most of Inner Mongolia area located in arid and semi-arid region, high temperature, poor rainfall, much wind and violent evaporation. The natural disasters such as drought, black calamity, white calamity, wind damage, flood and waterlog happened frequently. Especially in recent years, sandstorm,

raising-sand and raising-dust happened frequently in Midwest area, that endangered Peking and North-china area directly, even spread to the southern area to the Yangtze River. The soil and water conservation ecological construction in Inner Mongolia will become a barrier protecting Peking, Tientsin and North-China directly, which has a great significance.

Water is the key of the ecological environment construction. The area having water is green, the opposite is barren.

With the distribution of the water resources, forest, grassland and desert lie from east to west in Inner Mongolia. In the area being abundant in water, the vegetation of arbor, shrub and grass are very good, on the contrary, the vegetation is bad, even come forth desertification. If the ecological environment in these areas would be improved and recovered, the limited water resources must be developed and used in reason. And the water circulation of the watershed is not only the resource foundation of social economic development and the controlling factor to ecological environment, but also the common sticking point of a lot of problems about water. The basin water resources reasonable utilization in most area of Inner Mongolia, especially the loess plateau in western, is mainly to regulate and control comprehensively to every link of water circulation, and take the on-site utilization of water resources as the main point.

The soil and water conservation is centered on keeping soil and water, takes water erosion as the main prevention and cure object, improving ecological environment through small watershed comprehensive harness, it will has prominent function naturally.

4.1 Strengthen soil and water conservation slope harness, enhance rainfall impounding ability

The slope harness in rolling and gully parts in soil and water loss area, such as land preparation, forestation, grass planting, enclose, terrace replaced slope land, soil and water conservation cultivation etc to enlarge vegetation area, increase soil water storage, impound rainfall and advance the usage rate of rainfall resources. Especially, to the horizontal ditch preparing land, the effect to impound rainfall is more distinct. According to the soil and water conservation comprehensive harness technology criterion, the protection standard of land preparation construction is the maximum rainfall volume of ten-twenty years a time and three-six hours last. The rainfall characteristic in Inner Mongolia behaved that one time rainfall covered small area, but with great intensity and short time. Based on the statistical analysis about the short-time rainfall characteristic values from 28 hydrologic stations of the western area of Inner Mongolia, the average amount of the six-hour annual maximum rainfall is between 17.3mm—49.6mm, the twenty four-hour annual maximum rainfall average amount is between 23.0mm—73.7mm, and the twenty-hour amount is about 10mm—20mm more than the six-hour's. The land preparation construction are designed for twenty four-hour annual maximum rainfall, which can impound water over 10 thousand m^3 in one time rainfall per sq.km area. Toward to Inner Mongolia, an area with poor water resources, if the protection standard of land preparation construction was advanced properly, that is changing earthwork volume of 10 thousand m^3 into equal volume of impounded water per km^2 , the benefit is very remarkable. Contrasting harness area with non-harness area, there was 40 thousand m^3 impounded water in harness area more than non-harness area in one km^2 after advancing the protection standard, the effect is very distinct.

4.2 Enhancing the construction of gully runoff control, increasing runoff impounding ability

The gully harness in rolling and gully area with soil and water loss took small watershed as a unit, from branch gully to main gully, from the upper to lower, according to the different landform and gradient, adopting gully head protection, check dam, pond dam, warping dam, key dam and small reservoir which was integrated one another, to reach the effect that controlling the gully erosion together, developing warping land, impounding rainstorm and flood. In the small watershed of $30km^2$ — $50km^2$, the controlling area of single dam under $3km^2$ — $5km^2$, the warping dam, pond dam, key dam and the small reservoir with the designed flood standard of 20 years were distributed in reason, 10 construction impounding rainfall and warping land were built. The volume of the rainfall one time twenty years is between 50mm—120mm in west Inner Mongolia. After harness, according to the calculation of the west

of Inner Mongolia with 50mm to 120mm rainfall one time in 20 years, the soil and water conservation construction in the small watershed could impound rainfall from 1,500 thousand m^3 —2,500 thousand m^3 to 3,600 thousand m^3 —6,000 thousand m^3 . One key dam and small reservoir could impound 150 thousand m^3 —600 thousand m^3 rainstorm flood. Through construction of these works, it not only can develop warping land, but also can develop irrigation area which all improved the productive condition.

4.3 Soil and water conservation comprehensive harness in favor of water circulation virtuously

After soil and water conservation comprehensive harness of the slope and gully, the rainfall was impounded effectively. Except the invalid evaporation, part of the impounded water by slope project was used to soil and water conservation biological measures to supply the vegetation growth, changing invalid evaporation into valid transpiration, part seep into the soil to increase the soil water storage, supply the undersurface water of lower river. And it also changed the circulation and the volume distribution in time and space of the water resources of the slope rainfall, surface runoff, subsurface runoff in natural condition. The gully comprehensive harness advance greatly the regulating and controlling ability of water resources in the small watershed. Putting up concentrated comprehensive harness to small watershed slope and gully in a large area, all measures work jointly, can alter in a certain extent annual distribution of river runoff, deter and store flood, reduce peak flood, increase gully free flow in drought period, aggrandize markedly watershed usable water resources in a whole.

Through small watershed comprehensive harness in Inner Mongolia for many years, to increase vegetation, enlarge basic farmland, impound mud and store water, reduce soil erosion, harness soil and water loss, increase usable water resources, improve the ecological environment, improve productive and living condition of harness area people, and promote the economic-social development. There were many successful models, it provide the demonstration for soil and water conservation small watershed comprehensive harness. In the future, as long as increasing the investing and harnessing strength of soil and water conservation ecological construction in Inner Mongolia, carrying out small watershed comprehensive harness scientifically and reasonably, it is absolutely possible to increase the utilization rate of rainfall resources in this region.

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