

# Approach to the Distribution and Design of Ecological Civilization Construction for the Loess Plateau Area: Taking the Upper Reaches Area of Zhihe River in Yonghe County as Example

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**Abstract:** The distribution and design of ecological civilization construction was studied for the area of Loess Plateau taking the upper reaches area of Zhihe river in Yonghe county as example. The basic problems of the study area were found as poor natural environment conditions, backward environment for economic development, unreasonable land utilization and limited industrial development scale. Based on comprehensive investigation and analysis, it raised that the overall strategy of ecological civilization construction is to distribute control measures reasonably on the space, to coordinate comprehensive control and industrial development in time, and to reinforce the prevention, protection, supervision and management. The specific methods are proposed as: the first is to adjust measures to local conditions to give full play to the ecological benefits of trees, shrubs and grass, and to control soil and water loss from gully and slope with engineering measures; the second is to develop characteristic industrial taking advantage of local resources; the third is to strengthen scientific experiments, demonstration promotion of science and technology and infrastructure construction; and the fourth is to improve the life and culture environment and labor quality.

**Key words:** Loess Plateau, ecological civilization construction, distribution, design.

## 1. Introduction

The Loess Plateau is located in the upper reaches of the Yellow River and the upper reaches of the Haihe river. Since ancient times, the watershed of the Yellow River is the birthplace of human civilization, the world's largest loess distribution area. However, due to the inherent vulnerability of the natural environment in the Loess Plateau, the ecological environment of the area has undergone profound changes in the past two or three thousand years because of the irrational use of land, the serious loss of soil and water, the destruction of resources and the

deterioration of the ecological environment. The soil and water loss becomes an important constraint to regional economic development. In the face of the realization of the Chinese dream, the main task of ecological civilization construction in this area is to control soil erosion, improve the ecological environment, natural landscape and social human environment, develop economy and improve the level of local material and spiritual civilization through various technical measures and management measures to monitor, plan, design and supervise.

In order to explore and develop the way of ecological civilization construction in the region, according to the survey results of the upper reaches of Zhihe river in Yonghe county, Linfen district in Shanxi province, it puts forward the main path of soil

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erosion control and industrial development distribution and measures for ecological civilization construction on the basis of comprehensive analysis.

## 2. Material

Zhihe river is the 1st grade tributary of the Yellow River and the upper reaches of it are close to source of the river with a total area of 165.62 km<sup>2</sup>, being an important part of Yonghe county, accounted for 13.59% of the total area. The geographical position is between east longitudes of 110°31'38"-110°46'30", north latitudes of 36°45'51"-36°56'8". The upper reaches of the Zhihe river area are characterized with wilderness of gully area. The highest elevation is over 1,520.9 m and the minimum elevation is 890 m, so the relative height difference is 630.9 m. The whole terrain is gradually reduced from northeast to southwest. The main form of soil erosion in the upper reaches of the river is the gully erosion and slope erosion. It is seen that the hills and valleys are with a wavy motion, ridge and mound is continuous and vertical and horizontal gullies are densely covered, so the topography is fragmented in the territory and the gully density is 3.70 km/km<sup>2</sup>. Soil erosion is over 16,313.56 hm<sup>2</sup>, accounted for 98.50% of the total area. Erosion modulus is 11,490 t/km<sup>2</sup> [1].

### 2.1 Natural Resources

(1) Land resources. The total land area of the upper reaches of Zhihe river is 16,561.86 hm<sup>2</sup>, of which the land area for agricultural production is amounted to 16,110.55 hm<sup>2</sup>, accounting for 97.28% of the total, including 4,461.60 hm<sup>2</sup> of farmland, 7,584.49 hm<sup>2</sup> of forest land, 23.45 hm<sup>2</sup> of orchard and 4,041.01 hm<sup>2</sup> of grassland. Slope farmland area is larger, accounting for 53.54% of farmland area. Due to poor resistance to drought, the productivity of farmland is low [2].

(2) Water resources. The precipitation in this area is mainly concentrated in the flood season from June to September, accounted for 58.08% of the total. The surface water is mainly from the surface runoff caused

by precipitation. The averaged annual runoff is 6.8522 million m<sup>3</sup> and the runoff in the flood season is taken up for 58.08%. In the upper reaches of the river, there are no entry water resources and the surface water resources are 6.6 million m<sup>3</sup>. However, the utilization rate is very low as there is no storage works [2].

(3) Biological resources. Biological resources mainly include agricultural crops and livestock and poultry farming. Crops are mainly seen to be wheat, corn, sunflower, soybeans, castor and small grains, and the natural vegetation is mainly longflower stringbush (*Wikstroemia chamaedaphne Meisn*), wild mustard, artemisia, mountain cotton, bison grass and so on. The artificial vegetation is constituted of pine, cypress, acacia and poplar, etc.. The economic forest is composed of red dates, walnuts, apricots, apples and pears. Livestock and poultry are mainly captive cattle, mules and horses, pigs, small tail sheep, cashmere goats and chicken [2].

(4) Light and heat resources. The upper reaches of the river are covered with continental monsoon climate of warm temperate, where it is measured that the annual average temperature, extreme high temperature, extreme low temperature were recorded as 9.5 °C, 35.8 °C and -22.2 °C, respectively. The frost-free period is average as long as 183 days and the longest and the shortest are observed as 199 days and 161 days. It is with adequate light. The annual sunshine hours are accounted to 2,541.7 in average; annual accumulated temperature above 10 °C is over 3,674 °C in average; and the annual averaged rainfall is 554.3 mm. The dominant direction of wind is northwest orientation with wind speed of 2.4 m/s in average. The main disaster comes from drought, wind, hail and so on [2].

### 2.2 Socio-Economic Conditions

The upstream area of Zhihe river involves 4 townships of Zhihe, Nanzhuang, Potou and Dashiyao including 10 village-committees and 36 natural villages and state owned forest farm of Yonghe county

and part of Hongqi forest farm. Agricultural population in 2011 was accounted as much as 4,144, and labor force was 1,580 people. The grain output there was of 6.5123 million kg, the total annual income was summed as 15.9190 million yuan, and the gross income per capita was 3,839.50 yuan [3, 4].

In the project area, most agricultural products were characterized with low scientific and technological content, low added value, small scale and poor market competitiveness. Jujube was not in deep processing products. Leading enterprises to process it was not formed. The lower level of the industry could not increase income for farmers strongly. It is a pity that the high-quality jujube did not produce higher benefit [3, 4].

The industrial development base is weak. To the “Eleventh Five-Year” period, only there was mining industry in Zhihe town of the project area, i.e. brick factory soil, quarrying plant and sand-based plant. Of the manufacturing industry, the agricultural and sideline products processing and storage were the main. The characteristics of the primary industry of industrial enterprises are obvious: the enterprises were small in size and scattered in layout; the contents of science and technology in products were low; the market competitiveness is poor; the export radius is small and the sustainable development ability is not strong. Industrial added value was accounted for less than 8% of GDP, the degree of industrialization was very low [3, 4].

More than 90% of the labor force engaged in farming and forestry production, while some farmers engaged in animal husbandry. In 2011, the incomes from farming, forestry and animal husbandry of the project area were accounted for 81.86%, 7.43% and 10.72% of the total, respectively. The main crops planted are wheat, corn, sorghum, milleta and beans. Cash crops are sunflower, castor, flax, cotton and potato. In recent years, the agricultural structure was regulated continuously and the proportion of fruits and vegetables was increased gradually. Except the

various expenses, the net income per capita of farmers in the project area was 1,535 yuan, which is the level of high input and low yield [3, 4].

With the strengthening of rural infrastructure construction in recent years, the hydropower and living conditions of the project area had been improved gradually. The village road had been fully covered with cement and rural simple roads had been extending in all directions. The problem of the draft and village power of the masses had been solved basically. In recent years, the village communication facilities have basically reached the needs of external contact.

### **3. Factors Affect the Construction of Ecological Civilization**

The construction of ecological civilization involves the understanding, utilization, transformation and exertion of various ecological and environmental factors, which is a specially artificial process for the purpose of ecosystem. The main task of ecological civilization construction is to adopt economic, reasonable and scientific measures of engineering, vegetation and management according to the purpose of living and production, such as reduction of the wind-sand through afforestation, control of traceability erosion by ditch head protection, prevention of deforestation by development of rules and regulations, in order to optimize the environmental factors, processes or results, which are not conducive to the survival and development of the locality, and to achieve the harmonious development of man and nature. In the upper reaches of the Zhihe river basin, it is the core task for ecological civilization construction to control soil erosion, improve natural landscape and accelerate industrial development and new rural construction by engineering measures, biological measures and comprehensive management measures [5]. The local ecological and environmental factors and socio-economic factors are closely related to the

construction of ecological civilization. It is very important to analyze the main influencing factors and put forward the countermeasures to the construction of ecological civilization.

### *3.1 Poor Natural and Production Environment*

The unfavorable natural factors in the area are mainly manifested in 5 aspects, i.e. scarce vegetation outside the forest area, frequent runoff in heavy rain, loose soil due to vertical joint development of the loess, special topography of deep gully, steep and long slope, and broken terrain, dry climate drought with great and frequent wind. During the flood season (June to September), the erosion modules in the gully areas of the upper reaches of Zhihe river and the ridge-hilly gully area along the Yellow River in the northwest were as high as 13,000 t/km<sup>2</sup> to 15,000 t/km<sup>2</sup> per year. Heavy soil erosion in the upper reaches of the river results in ferocious water disasters, flooding the fields and villages and causing huge losses of people's lives and property [6].

The area of sloping land in the upper reaches of the river is accounted for 38.82% of the total area. The area of slope land steeper over 25° was accounted for 65.41% of the total area. That of poor resistance to drought, grievous effects from drought, low productivity of agricultural land and other constraints of natural conditions seriously restrict the industrialization, large scaling and intensive development. The grain production capacity is very fragile, facing the severe food safe question. Farmers live relatively scattered and the population density is only 25 people/km<sup>2</sup>.

### *3.2 Backward Environment for Economic Development*

As a result of population, transportation, education, science and technology, industrial development and other factors, in order to meet the needs of food and other living materials, the local people were forced to reclaim blindly and graze excessively, resulting in

vicious circle of "the harder reclaim (graze) the poorer, the poorer the harder reclaim (graze)", causing more serious soil erosion. Some other traditional infrastructure such as road construction and brick fabrication was not with soil conservation measures.

Rural economy and culture is relatively closed and backward and a large number of cultural and knowledgeable rural youth would rather be migrant workers. The elderly and young women and children at home were difficult to accept new ideas, thought and technology. It is very difficult to lead the area development with a modern concept [7].

### *3.3 Unreasonable Land Use*

The land area of farming, forestry and animal husbandry in the upper reaches of Zhihe river was amounted to 16,087.10 hm<sup>2</sup>, being 97.27% of the total area and accounting for 26.94%, 45.80% and 24.40% of the total area, respectively. The slope farmland is made up of 53.54% of the total area of farmland. The ratio of wasted grassland area was larger with lower quantity and quantity of grass and the carrying capacity of livestock has been declining in years.

The economic forest area was accounted for only 10.8% of forestry land with poorer species. Per capita possession of arable land was 1.08 hm<sup>2</sup>, but the extensive management of agricultural production and extensive cultivation with thin income could not achieve intensive management and increase labor productivity [8].

### *3.4 Less Scaling of Industrial Development*

At present, the industrial development of the area is weak and the industrialization degree is low. Extraction industry of the Zhihe town was mainly made up of soil brick factory, quarrying plants and sand mining plants. The manufacturing industry mainly included sideline products processing and storage of agricultural products. Industrial added value was accounted for less than 8% of GDP with lower industrialization degree. Most agricultural products

were with low scientific and technological content, low added value, small scale and poorer market competitiveness.

Products are basically sold dates, and the industry level is low and has not formed processing enterprises that could lead to the increase of income [9].

Special products of jujube were basically sold in the original date of lower industry level, which did not form a large-scale processing enterprise to lead farmers to increase income. Rural market system, agricultural intermediary organizations and the development of the logistics industry were not well developed. Purchasing and saling information for bulk of agricultural products and circulation channels are sluggish. The means and facilities to develop modern rural logistics industry of chain management, e-commerce, etc. were falling behind.

The local harsh natural environment and the relatively backward level of social and economic development have challenged ecological civilization of the area.

#### **4. Conclusions and Suggestions**

To build ecological civilization in the loess hilly and gully region is to use land rationally, optimize land use structures of farming, forestry, animal husbandry and industrial development, improve forest and grass cover rate, control soil erosion, beautify the living environment and improve the material and spiritual civilization level of masses [10].

Based on the actual situation of the upper reaches of the river, the goal is to promote regional economic development and farmers' income and improve the ecological environment. It is suggested that the basic idea of ecological civilization construction should be to optimize and adjust land use structure of farming, forestry and animal husbandry and industrial structure by the research methods of system science, to control soil erosion by engineering, biological and other comprehensive measures in combination and to develop the industry with their own advantages

targeting the market demand, in line with the national western development strategy and the overall development plan of Shanxi and Linfen areas, understanding and analyzing the resources, environment and economy and society problems of the reaches from new perspective. Through effective control of soil erosion and significant increase of economic income, the goals of production development, better-off lives and sound ecological effects could be realized [11].

In order to achieve the objectives, it is required to implement different land use methods, soil erosion control, industrial development and various measures for new rural construction, i.e., closure measures would be taken for the timber forest, shelter belts, shrubs, non restocking forestland; exclusion measures for the sparse woodland to achieve ecological restoration and promote vegetation growth for the protection of the ecological environment; preventive and protection measures for capital farmland, rivers, water area, scenic spots and special land and land hard to use; the supervision and management measures for the mining land to prevent the occurrence of soil erosion and ecological damage; and the terracing and planting trees and grass for slope and grassland to control the soil loss and improve the productivity of land.

The economic development would be promoted through the cultivation of walnut, Xanthoceras fruit and forsythia, basic construction for vegetable greenhouses and green corn, development of industries by breeding of chicken, sheep and cattle. To improve and increase soil erosion monitoring and experiment facilities could serve the soil erosion control better.

It is thought that research on the projects related to comprehensive management and production construction could be a good way to transform scientific research achievements into productive forces by active promotion of mature and effective research results.

It is suggested that the specific measures for layout and design of ecological civilization construction could be as follows.

#### *4.1 Layout of the Measures Should Be Reasonable in Space*

In the space layout, the first is to adhere to the principle of optimal allocation, that is, optimizing the land use structure, rationalizing the layout of various project, improving land use conditions and land quality, increasing land use and output rate. The second is to adhere to the principle of unified harmonization. Land use must meet the goal of land use planning in Yonghe county. To determine the objectives of renovation planning of the dam beach land should be coordinated of relevant departments in planning. The third is to adhere to the principle of comprehensive benefits. The measures should be integrated to consider social, economic and ecological benefits, persist in the sustainable use of land resources. The fourth is to adhere to the principle of common participation. Decisions at all levels of county and township governments must be have participated by public.

#### *4.2 Comprehensive Management and Industrial Development Should Be Coordinated in Time*

The measures in the planning should be arranged in accordance with the needs of the funds, the amount of construction, the construction period and the time of benefit production for each year and work type. The first arrangement is for infrastructure and biological measures. Monitoring and prevention serving the comprehensive management is raised to be arranged in the first year of the implementation of the project.

In land use, gentle slope farmland with slope less than 15° should be given priorities. For the slope land of 15°-25°, it is designed to build terraced land in accordance with the principle of centralized connection and conformity to local conditions to form a scale. Also, it is asked to adhere to the simultaneous

comprehensive management with industrial development, priority of ecological restoration and prevention supervision. It is requested to carry on monitoring and prevention in the process of comprehensive management. Sci-tech demonstration and construction of new villages serve the rural economic development and improvement of living environment.

#### *4.3 Prevention, Protection, Supervision and Management Should Be Strengthened*

It is raised to establish and perfect the system assorted of soil and water conservation, perfect the law enforcement agencies, improve the quality of law enforcement team, standardize technical services, implement the “Three-simultaneity” system of soil and water conservation comprehensively and fulfill the responsibility of management and protection to control the soil erosion caused by human factors effectively. The preventive and protect measures should be taken for dam land, gully land, terraced fields, orchards, rural roads, inland tidal flat, bare land, rivers and water areas. Supervision and management measures could be adopted for mining land, scenic spots and special land use.

#### *4.4 Full Play Is Given to the Ecological Benefits of Trees, Shrubs and Grasses According to Local Conditions*

The measures of afforesting barren hill, implementation of barren hills, development of economic forest (*Xanthoceras sorbifolia*, *Robinia pseudoacacia* × *Platycladus orientalis*, *Caragana* × *Amorpha fruticosa*), grass planting, road greening and others should be implemented. Closure measures would be adopted for timber forests, shelter belts, shrubs and immature forest land; for sparse woodland enclosure, cultivation measures were adopted to promote growth of vegetation, protect ecological environment and obtain economic benefit; for the desolate grassland, it is suggested to obtain stable and

sustainable stand environment by the ways of adapting trees properly and suit measures to local conditions and centralized connection. Suitable native species or adaptable species are to be selected to increase the survival rate of afforestation; to maximize the multiple benefits of the land productivity of various site conditions would be given full play.

#### *4.5 Soil and Water Loss of the Channel and Slope Is Controlled by Engineering Measures*

According to different terrain, geological and channel characteristics, from upstream and downstream of the main gullies, two types of engineering measures could be constructed. One is to construct dam and terrace slope land, which could reduce soil erosion and ensure the basic farmland area. In the area, there are 2,388.94 hm<sup>2</sup> of slope land. The remaining 2,170.84 hm<sup>2</sup> slope farmland should be terraced by machine construction besides 1.36 hm<sup>2</sup> occupied for channel change in channel management project and 216.74 hm<sup>2</sup> occupied for cultivation of grass to develop animal husbandry. The other is to build a gully control engineering, including gully head protection works, the construction of intermittent storage gully head protection ridge, the construction of water-retention well, retention of runoff, improvement of water supply conditions for crop and orchard to raise agricultural production.

#### *4.6 Special Industries Are Developed Taking Advantage of Local Resources*

On the basis of the area and distribution of forest resources herbage planting area, labor force, traffic conditions, grain production capacity and market demand in the upper reaches of the river, it is raised to develop breeding industry of chicken, meat sheep and meat cattle. The main measures include planting 553.09 hm<sup>2</sup> of *Xanthoceras sorbifolia* on the ridge of terraced fields, constructing 24.67 hm<sup>2</sup> of vegetable greenhouses and 224.31 hm<sup>2</sup> of green corn, planting 499.0 hm<sup>2</sup> of herbs (*Forsythia*) and 216.74 hm<sup>2</sup> of

grass, raising 3,000 pheasants through building fence and sheds and 1,000 sheep and 500 cattle by construction of sheepfold and cattle farm.

#### *4.7 Scientific Experiments, Science and Technology Demonstration and Popularization as well as Infrastructure Construction Are Strengthened*

It is asked to carry out research on monitoring and evaluation of comprehensive management benefit on the cultivation techniques of *Xanthoceras sorbifolia*; it is going to construct 1 set of observation station in project area and 6 plots of runoff test, to construct sci-tech demonstration and popularization base to promote industrial development through technology spreading surrounding. Five matured scientific and technological achievements, including “techniques to increase soil fertility and yield for new terraced fields” and “cultivation techniques of high yield walnut on dry land”, are demonstrated and popularized to promote soil and water loss control and development of industries, providing experiences for adjacent or same type areas.

In order to facilitate the production activities, it is needed to alter the road 2.336 km, laying drains at the side of the roadbed.

In the field, the head of land, roadside and courtyard where more runoff is concentrated are planned to build dry wells (cellars) to meet the requirement of moisture in farmland, woodland and orchard. Interval planting of *Spruce* and *Sophora japonica* on both sides of the road embankment is to be implemented to beautify the environment.

#### *4.8 Living and Cultural Environment Is Improved and the Quality of Labor Force Upgraded*

Planting is encouraged around houses, along ways and villages to increase cover rate of trees as high as 30%. It is also planned to build new library reading room, cultural and recreation room and medicine room configured with computer, to improve lighting conditions and environmental health, to provide 1

time of free physical examination for villagers over 50 years every two years, to strengthen the democracy and legal system and the construction of spiritual civilization of the two villages. It is demanded in speciality to strengthen the training of agricultural technology and labor skills for the labor force mainly on advanced and practical technology, including recipe fertilization, conservation tillage, vegetable cultivation of facilities, harmless ecological control of fruit and vegetable, shape transformation fruit trees in high efficiency of light, tree transformation, etc.. For the rural youth and surplus labor forces, the training content includes home decoration, housekeeping, home appliance repair, computer, construction, beauty salons, catering and other vocational skills, and the training rate would be 90% or more, that could improve skills of farmers in production and management.

The implementation of ecological civilization construction measures will optimize the land use structure. The capital farmland and economic forest could reach per capita 0.92 hm<sup>2</sup> and 0.44 hm<sup>2</sup> respectively per capita; cover rate of vegetation reaches 83.63% and degree of soil erosion control reaches 95.18%. Agricultural infrastructure and rural production and living conditions would be improved, and land productivity increased significantly. In the premise of ensuring grain 500 kg per capita, the income is grown for 922.9292 million yuan. The industrial structure adapting to the market economy is formed initially the upper reaches of the river for the development of green basis. The foundation is laid for the green development in the upper reaches of the Zhihe river.

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