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Sustainable Management of Ecosystem and Control of Natural Secondary Disaster in Soil and Water Loss Regions

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Abstract

Water and soil resources are the foundation of Agriculture high-quality development. Water and soil loss is a serious natural secondary disaster and affects the redistribution of Water and soil resources and land productivity. Soil and water conservation influence high-quality development. After about one hundred years of efforts, soil and water conservation has developed rapidly, for example in China, the surface runoff and soil loss in soil and water loss areas have decreased rapidly. The people's living conditions have gradually improved as economy and society development. Now, economy and society development enter a new time, people living level increase and put forward higher requirements for soil and water conservation because the current efficiency of soil and water conservation cannot meet people's higher requirements. In this paper, a new theory of soil and water conservation developed. The results shows that soil and water losses refer to the process of transferring soil and water resources from one place to another, and the consequences of these losses can be divided into positive and negative effects on high quality development. Soil and water conservation is not only the use of some methods or measures to reduce soil erosion to soil allowable loss requirements, but also to make efficient use of soil and water resources. The construction standard of soil and water conservation measures must be based on the allowable amount of soil erosion and be applied using spatially optimal allocation, and the high-quality sustainable management of soil and water conservation should be made to ensure regional ecological security and realize the high quality and sustainable development of soil and water conservation.

Keywords: *Soil and water loss, Soil and water conservation, Food and ecological security, Soil and water conservation measure, Most optimum distribution of resources, Sustainable development*

Introduction

Neotectonic movement is tectonic change occurring in the Tertiary and thereafter, and is characterized by vertical and horizontal movement. Under the influence of many natural background factors, such as mountainous terrain and unstable monsoon precipitation, formed by intense neotectonic movement, as well as the long history of agricultural development and the large population, China has become one of the countries with the most serious soil erosion, notably on the Loess Plateau .Water and soil loss affects the carbon and nitrogen cycles of terrestrial ecosystems, vegetation ecosystem products and services, the ecological environment and economic development, and ultimately the quality of life and sustainable development of the public. Over the past 100 years, great progress has been made in the work of soil and water conservation in China with the unremitting efforts of the vast number of soil and water conservation workers. For example, as evidenced by the establishment of the State Key Laboratory of Soil Erosion and Dryland Agriculture in Yangling, China, the concept of cover degree and cover rate of water conservation forest has been developed [1,2]. The degree of vegetation coverage is the percentage of the total area covered by the vertical projection area of the tree canopies, and the vegetation cover rate is the proportion of high-quality grassland or forestland area of the total land area in a region or a country. The vegetation coverage includes the effective cover degree, critical degree, and potential coverage [3,4]. The establishment of a large area of soil and water conservation vegetation has been established in the area of in the area of soil and water loss region, such as water conservation forest (or vegetation), Windproof and sand-fixing forest, water source conservation forest, and adult forest construction standards and their construction scale and suitable developmemt scale have also been established; the effective coverage rate of wind-proof sand forest, of water conservation forest, and of water conservation forest [1-9], the theory of soil water resources utilization limit by plants and the soil moisture vegetation bearing capacity appeared in 2000 [3,4,9,10]. However, due to the lag in theoretical research, construction standards of soil and water conservation measures are low with small range of water conservation measures, the spatial allocation of soil and water conservation measures is unreasonable, the work of soil and water conservation attaches importance to quantity and not quality, and its efficiency is low, which cannot meet the modern needs of high-quality development of soil and water conservation. Such incidents as drought, forest fires, extreme weather

and precipitation, hurricanes, and flash floods lead to widespread erosion of soil and water conservation vegetation, collapse of dams and other incidents, resulting in serious soil erosion, destruction of farmland, villages, roads, and vehicles, which affects transportation, food and ecological security, and cause large losses to the state and society. In order to overcome these difficulties, promote the high-quality development of soil and water conservation, and meet current requirements of the public for soil and water conservation, it is necessary to develop a new theory of soil and water conservation. Through comprehensive analysis of relevant literature, a new theory of soil and water conservation is proposed. The purpose of the paper is to better understand the new theory of soil and water conservation and carry out High-quality sustainable development of soil and water conservation. The main content as the followings [11].

Soil and Water Loss

Soil erosion is a natural phenomenon, and it originated in China as a technical term in the early 20th century [12], where it was applied to the Northwestern Loess Plateau [13]. The forces that cause soil and water loss are called external soil and water loss forces, including water, wind, temperature (freeze–thaw) and son on. The term erosion has long been used in geology, mostly to express the flattening due to external force, and soil erosion was first mentioned in the book of Kozmenko in 1909 [12]. It was then widely used and was introduced into China in the 1930s. Soil erosion refers to the whole process of soil and its parent material, as well as the destruction, stripping, transport, and deposition of surface components of the land under external forces such as hydraulic, wind, freeze-thaw, and gravity [12]. Water power is the force produced by the flow of water and wind is the magnitude of the force that air exerts on an object. Temperature is the measure of the average translational kinetic energy of the molecular motion, and is the collective expression of molecular thermal motion. At present, people's understanding of water and soil loss is not uniform. It has been argued that soil erosion refers to the destruction and loss of soil and water resources and land productivity under the action of external forces, including surface erosion and soil erosion; most believe that water and soil loss is equivalent to soil erosion, i.e., soil erosion by hydraulic, wind, or gravity erosion, resulting in soil dispersion, transport, and accumulation processes. However, we are entering a new period. In order to promote the high-quality development of soil and water conservation in this new period, we should first unify the understanding of water and soil loss. The water and soil loss are the process of soil and water resources transferring from one place to another, which includes both generalized and narrow-sense soil erosion. Generalized water and soil loss refers to the process of carbon and nitrogen cycle, land productivity, and ecological environment change caused by the transfer of soil and water resources induced by external forces. Water and soil loss in the narrow sense is equivalent to soil erosion [14].

Consequences of Soil and Water Loss

The influence of Water and soil loss on high-quality development of soil and water conservation can be divided into positive and negative effects as follows:

Water and Soil Loss Leads to Decline or Even Loss of Soil Fertility and Land Productivity in the Water and Soil Loss Regions

The term soil fertility refer to the capability of soil to support plant production in agricultural contexts [15]. Serious water and soil loss will affect carbon and nitrogen cycles in agriculture ecological systems and result in surface soil thinning of fertile soil in the water and soil loss region, and decreases in cultivated land area, soil fertility, and crop [16].

Soil Erosion Affects People's Daily Activities

Water and soil loss destroys house, farmland, roads, bridge and silts up rivers, lakes, and reservoirs, which affects People's Daily activities. Floods, landslides, mudslides, and other serious soil erosion results in siltation of channels, lakes, and reservoirs.

Water and Soil Loss Pollution Water Quality and Affects Ecological Balance

Water and soil loss accelerates non-point source pollution. When heavy rain happens, strong surface runoff will pile up surface garbage into rivers, seriously affecting their water quality and irrigation. A typical example is the poor water quality of the Yangtze River.

Typhoons, Haze, Dust, and Dust Storms Affect People's Health, Travel, and Social Activities

As the economy and society develops, people are increasingly interested in health, and travel and social activities are becoming more frequent, while typhoons, haze, dust-raising weather, and dust storms affect flights and road traffic, and seriously hinder people's rapid travel and social activities.

Water and Soil Loss Accelerates the Formation of Unique Landforms and Promotes the Development of Eco-tourism

Soil and rock through hydraulic, wind, freeze/thaw, and joint action of other external forces form a number of magic, wonderful natural landscapes, which raise living standards and accelerate the high-quality sustainable development of eco-tourism. For example, there are some famous eco-tourism sites such as Keshiketeng stone array scenic spots in the northeast of Keshiketeng County, Danxia natural scenic spots in Yulin city, and Zhashui cave in the Qinling Mountains. Zhashui cave is the result of long-term dissolution of groundwater. Calcium carbonate in limestone forms micro-soluble calcium bicarbonate under the action of water and carbon dioxide. Because the limestone layer contains different lime quality with different erosion degrees, it is gradually dissolved and divided into independent, diverse, steep and beautiful peaks, and caves in a strange landscape, which promotes eco-tourism and local economic development. Hukou waterfall was a Hukou waterfall but now has become a tourist hot spot.

Water and Soil Loss Forms Silt Plains and Expands Land Area in Estuaries

A large amount of sediment is deposited in estuary areas, over time forming silt plains and expanding the land area, which increase

nitrogen density in soil, soil fertility, land production, and carbon dioxide fixation; for example, Chongming Island at the mouth of the Yangtze River and the Huanghe Delta at the mouth of the Yellow River. Chongming Island was originally only a small sand dune and, as more sand was deposited, the sand dunes grew larger and became an island where fishermen lived.

Soil and water conservation workers should broaden their horizons, make best use of the advantages of water and soil loss and bypass the disadvantages of water and soil loss. Thus, they can meet the requirements of rapid and high quality economic and social development, especially to strengthen the prediction and prevention of serious soil erosion phenomena caused by typhoons and haze caused by strong winds, dust-raising weather, and sandstorms.

Soil and Water Conservation

Soil and water conservation refers to the use of certain measures and technologies to reduce the loss of soil and water to a certain goal, i.e., soil allowable loss, to make efficient use of soil and water resources in the process of water and soil loss and increase the ecological, economic, and social benefits of soil and water resources in the soil and water loss system to provide high quality products and services for social development and to maximize the safety of the life and property [14]. Soil and water conservation makes rational use of soil and water resources to achieve sustainable development. For example, introduction of flood irrigation with high sediment concentration to form high-quality farmland using water sources of rivers, lakes, and reservoirs in the sand area; drawing water by gravity or by machinery; washing sand dunes using hydraulic power, and carrying sand to positions to form high quality farmland, or using runoff and topography to promote eco-tourism, such as the Shapotou and Hukou tourist attractions in the Loess Plateau. Soil and water conservation measures can effectively conserve soil and water [17]. These measures include engineering measures, farming and biological measures for soil and water conservation. In the restoration of vegetation, natural forces can be used to restore vegetation in uninhabited areas; however, in areas where there is a population, artificial interference should be used to restore vegetation in order to create the vegetation ecosystem goods and services to meet the needs of human production and life. Over the past 100 years, with the unremitting efforts of the vast number of soil and water conservation workers, China has made great progress in its work on soil and water conservation. A large area of soil and water conservation vegetation has been established in water and soil loss areas, and a large number of reservoirs have been built; some water and soil conservation measures such as water and soil conservation projects including dams or levees have been set up along the tributaries of the Yellow River and other soil erosion areas, which have made great progress in controlling water and soil loss below the allowable amount and promoting regional economic development. However, due to the lag in theoretical research on soil and water conservation, the construction standard of soil and water conservation measures is low and imperfect, and the spatial allocation of soil and water conservation measures is not balanced. For example, silt storage dams for farmland buildings have played important roles in preventing floods, consolidating the return of farmland to forests or grassland, safeguarding ecological security and food security, and promoting the development of economy and social stability. However, in construction of silt storage dams, the problems of low-quality construction, serious disease-risk dam, and poor management of reconstruction, especially concerning the large number of small dams, have not received enough attention [18]. Therefore, it is urgent to strengthen the study of soil allowable loss on different underlying surfaces, formulate high quality and strict standards for soil and water conservation engineering and vegetation construction, and carry out spatial optimal allocation to obtain maximum soil and water conservation efficiency. The space optimal configuration is expressed by the spatial optimal configuration coefficient. Spatial optimal allocation coefficient indicates that, in a water and soil loss area or watershed, soil and water conservation funds or measures may have different allocation methods; these different allocation methods result in different soil and water conservation efficiency, i.e., different surface runoff and soil loss. The optimal allocation of space is the allocation that results in maximum soil and water conservation efficiency.

High-quality and Sustainable Management of Soil and Water Conservation

In order to achieve high-quality and sustainable development of soil and water conservation, it is necessary to implement high-quality and sustainable management of soil and water conservation measures, reduce or even eliminate unsafe traffic accidents and loss of life and money accidents caused by serious soil and water loss, reduce dam dyke damage and flood dam overturn caused by inadequate design, material fatigue, rodent damage and piping, and continue to achieve the maximum efficiency of soil and water conservation. The high-quality sustainable management approach for soil and water conservation includes: Based on the external forces of soil and water loss, the temporal and spatial changes of soil and water loss, and the requirements of residents, we should improve the anti-erosion standards of infrastructure such as homes, roads, Bridges, levees and DAMS, improve the design and construction standards of soil and water conservation measures, and optimize spatial allocation to avoid soil and water conservation from exacerbating ecological security. At the same time, the prediction of extreme weather such as sandstorm, tornado, heavy rainfall, earthquake and other geological disasters should be strengthened, and Beidou satellite, UAV and other monitoring equipment should be used to dynamically monitor key sites prone to geological disasters. The corresponding emergency plan for high-quality sustainable management of soil and water conservation should be formulated, and the emergency plan should be launched immediately in case of disasters. According to the theory of resource utilization limit and the theory of vegetation carrying capacity, the utilization limit of soil water resources and the vegetation carrying capacity of soil water in water shortage areas should be the limit of soil water resources utilization and the vegetation carrying capacity of soil water, and the high-quality sustainable management of soil and water conservation vegetation should be implemented to continuously obtain the maximum efficiency of soil and water conservation [14] to reduce loss of life and property.

Application Effect

Because of the large area of soil and water loss area, people's understanding level of soil and water conservation is uneven, and the development of soil and water conservation work is unbalanced. In the areas with early understanding and high level of soil and water conservation, the new theory of soil and water conservation is practiced consciously to achieve high-quality sustainable development of soil and water conservation, and satisfactory results have been achieved. For example, we have been engaged in innovative research on soil and water conservation for many years, and carried out high-quality sustainable management of soil and water conservation vegetation for Caragana (*Caragana Korshinskii*) shrubland in the Guyuan experimental Station the semi-arid loess Hilly , Guyuan, China according to the theory of utilization limit of soil water resources and the theory of soil water and vegetation carrying capacity. In order to reduce soil water consumption in the dry season, the vegetation cover of Caragana Korshinskii forest should be kept at least 60% to ensure that the canopy coverage is not lower than the construction standard of soil and water conservation forest in the region. In the growing season, when the soil water resources in the soil depth ranged from land surface (0 cm) to maximum infiltration depth (290cm) decreased to the soil water resources utilization limit by plants of 212.7 mm, the plant water relationship entered the critical period of plant water relationship regulation. The end time of plant water relationship regulation is when the plant water relationship regulation period fails.

If plant density of soil and water conservation forest, expressed by goal tree species in the critical period of plant water relationship regulation is greater than soil water vegetation carrying capacity, timely plant water relationship regulation should be carried out according to the soil water vegetation carrying capacity, so as to ensure normal plant growth, prevent drought from leading to early deciduous leaves, dry shoot or death of caragana (*Caragana Korshinskii*) before the rainy season, resulting in forest canopy intercession and disappearance, so as to continuously obtain maximum soil and water conservation efficiency. For the economic forest, such as red plum and apricot, firstly enlarge the tree pit and improve the quality of terrace according to local conditions, realize all the precipitation in situ infiltration, and reduce the soil and water loss to the allowable soil loss. At the same time, according to the local weather forecast, green house and high smoking at 1 meter above land surface measures were taken to prevent the damage of low temperature frost during the flowering and young fruit period in the period from late March to early May, and high efficiency cyhalothrin was adopted around May 20 to prevent the harm of eating worms. If the conservation density in the critical period of plant water relationship regulation exceeds the soil water vegetation carrying capacity, the plant water relationship in the critical period of plant water relationship regulation should be regulated first according to the right amount of leaf when the plant density is equal to the soil water vegetation carrying capacity, and then the vegetative growth and reproductive growth relationship should be regulated according to the right leaf amount in the carrying capacity and the leaf amount and quality fruit relationship to obtain the maximum yield and economic benefits, the income of red plum and apricot mu can reach more than 10,000 yuan [14]. Since 2017, the national high-quality red plum apricot demonstration base has been established on hilly land to demonstrate and promote high-quality production methods of red plum and apricot (Figure 1).

After the founding of New China, Gao Zuyu, the secretary of Gaoxigou Village, Mizhi County, Yulin City, China, under the guidance of Mr. Tao Ke, carried out comprehensive management of soil and water conservation, such as silting dam, terraced fields and forest and grass vegetation construction. After years of continuous efforts, Gaoxigou Village has built a barren mountain gully with broken surface, serious soil and water loss into terraced mountain tops, pine and cypress contiguous pieces, soil loss is lower than the allowable soil loss, and efficient use of water and soil resources. Gaoxigou cultivated organic apples, e-commerce helps to develop ecological tourism, walk a variety of management. In 2020, the per capita income is 18,851 yuan, far exceeding the county's average level (5,834 yuan), becoming a typical example of high-quality sustainable development of soil and water conservation in the area. The government of Hangjin Qi built diversion sluices, diversion channels, ecological levees, and drainage sluices connected with the main trunk channel to divert water from

Figure 1: solar Power Plant (Dengkou, right photo).

the Yellow River into the Kubuqi Desert and back water into the Yellow River. More than 200 million cubic meters of water were diverted in total, reducing runoff, sediment and siltation in the middle and lower reaches of the Yellow River, and forming a surface area of nearly 20km^2 and an ecological wetland of nearly 60km^2 in the Kubuqi Desert. Plants grow well, some water birds come to roost here, let the desert into an oasis wonder, aroused the attention of all countries, the diversion of water and sand control law let the world imitate.

State Power Investment Group Beijing Electric Power Co., Ltd. innovatively put forward the concept of "photovoltaic sand control and ecological restoration". The Dengkou Industrial Park Management Committee of Bayannur City, Inner Mongolia cooperated with the State Power Investment to build the Dengkou photovoltaic sand control project. It not only reduces exposure to sunlight under photovoltaic solar panels and near-surface wind speed, promotes plant growth, and achieves good desertification control effect, but also obtains green and clean energy, which achieves good effect, as shown in the Figure. It is currently promoted in Gansu, Ningxia, Tibet, etc. Build wind power stations in tuyere areas to reduce wind and sand hazards [14]. The establishment of high-standard construction and water and soil conservation projects in soil erosion areas can not only avoid the harm of soil erosion, but also achieve good ecological, economic and social benefits, such as high-standard Hani terraces, e Guanyin Ge in Building in Yangzi river, Ezhou, Hubei Province, Dujiangyan and contemporary Three Gorges Dam, which have continuously given full play to the comprehensive benefits of flood control, irrigation, water transportation and social water use for two thousand years [14]. On the contrary, in the areas without the guidance of the new theory of soil and water conservation and the implementation of high-quality sustainable management, once encountered hurricanes, sandstorms and rainstorms, there will be serious dam collapse, dam collapse, flood destroyed houses, roads and farmland, and other serious events affecting high-quality development, resulting in the destruction of civil houses, roads, levees and storage DAMS. Car scrapping, human casualties and other serious events, such as in 2021 in many European countries, the United States and China's Henan, Shanxi and Shaanxi provinces serious flood disaster. In 2022, severe soil and water events occurred in many parts of China, such as shaanxi, Shanxi and Henan province and Pakistan in 2022.

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Competing Financial Interest Statement

There are no competing financial interests.

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