

Technological Innovation of Desertification Control in the Kubuqi Desert

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Abstract. This paper introduces the technological innovation of desertification control in the Kubuqi Desert that is the seventh largest desert in China. After 30 years of comprehensive treatment, Kubuqi Desert has become the first desert in the world to be largely treated. By means of physics, chemistry and biology methods, scientists and technicians have created a lot of effective desertification control methods for Kubuqi. These methods not only improve the efficiency of Kubuqi desertification control, but also have important reference and promotion significance to other desertified areas in the world.

Introduction

Kubuqi Desert is located on the northern edge of the Ordos Plateau on the south of Hetao Plain in the middle reaches of the Yellow River in China. Its administrative region belongs to Hangjin Banner and Dalate Banner in Erdos, Inner Mongolia. “Kubuqi” in Mongolian means “string of victory in the grip”. The Yellow River on its northern side is like bow. Kubuqi desert is 365 km long, and its narrow width from north to south is about 30 km, and the widest position reaches 65 km, covering an area of 18,600 square kilometers. The 200 mm annual precipitation contour cuts Kubuqi from north to south. In the natural belt, except for a small part of steppe zone in the eastern part, most of the central and western parts are desert steppe areas. Kubuqi is a transitional zone between the desert and the sand land, and the overall landscape of it is desert landscape.

The moving dune distribution of Kubuqi accounts for the most parts. Moving dunes make up about 80% of its total area. Crescent dune chains and grid dunes, which are generally 10-15 meters high, or 50-60 meters in singles are the main dune types. The fixed and semi-fixed shrubs dunes only distribute in the edge of the desert, especially in the southern edge, where *Artemisia*, *Caragana*, *Shami* and sand bamboo, etc. grow. They are not high, and most of them are less than 5 meters. In addition, there are white sand thorn dunes, which are less than 3 meters high. There are also some fragment crescent-shaped crescent sand dunes and dune chains on the Yellow River alluvial plain with height of less than 3 meters. They move forward faster, roughly from northwest to southeast direction, burying grazing, farmland and roads, directly endangering the production and life. Before 2012, the Hangjin Banner where the sand area is located is a national-level poverty-stricken county.

The north of the Kubuqi Desert covers the lacustrine sediments and river alluvial deposits on the south bank of the Great Bend in the middle reaches of the Yellow River Loop. The southern base is interbedded with the older red sandstone and mudstone. The basement terrain is terrace and river terraces, and the west is the terrace with more complete state. In the east, a few seasonal rivers flowing from north to south are cut into strips. The interior of the desert is sparsely populated, and most of the people live within fixed, semi-fixed dune areas and larger valleys at the edge of the desert.

The massive treatment of Kubuqi Desert began in 1988. As an enterprise developed in the hinterland of the desert due to the salt field, in order to survive, Yili Resources Group, with the support of governments at all levels, mobilized local people and started the desertification treatment. But in the early days, there was no technology or experience to learn from, and some mistakes were made. Technological innovation has always been the primary task of desertification treatment in Kubuqi. In particular, technological innovation has mainly focused on the overall planning of desertification control, technical system, germplasm resources, planting techniques and the comprehensive utilization of sandy plants.

The General Strategy of Kubuqi desert Desertification Control

The desert is a complete ecosystem with huge area, complex water environment and atmospheric environment, and so there must be a systematic solution. Otherwise, in facing the vast desert, there is no way to start and nothing to do. Some scholars have pointed out: “To control the quicksand hazards of the Kubuqi Desert, it is advisable to adopt partial remediation, such as bio-enclosure and cut-off engineering measures. The enclosure method is to create the edge-locked forest belt with joists, shrubs and grass at the edge of the desert and prevent the sands from continuing to invade southward and expand northward; cut-off is to create a channel protection forest on both sides of roads, railways at the edge of 10 mountain torrents trenches to prevent the eastward move of sand resources. In the treatment, enclosure and cut-off method should be combined together to complement each other, showing the individual advantages. Enclosure should be the emphasis and cut-off is the breakthrough for progress.”^[1] Based on the natural environment differentiation of the Khuzqi Desert, some scholars also point out that “the treatment of the Kubuqi Desert should follow the principle of local conditions, implementing the pattern of windbreak and sand fixation with non-irrigated plants in the eastern part of the desert, planting edge-locking forest in the middle part for cut-off treatment, as well as constructing integrated sand fixation mode with ‘four in one’.”^[2] The overall strategy of the desertification control of Kubuqi is “locking all around, infiltrating the hinterland, dividing areas with roads for individual treatment, technical support, industry-driven”. “Locking all around and infiltrating the hinterland” means that in a certain area of the desert, a shelterbelt system is established and it not only prevents the desert expanding to the periphery, but also forms a encircling circle and gradually penetrates into the hinterland of the desert and gradually completes the ecological restoration in the entire area. “Dividing areas with roads for individual treatment” refers to taking use of the rational planning roads as an infrastructure for large-scale desertification control and the basic means of dividing desertification control areas. For areas with fragile ecological environment or important ecological protection value, they can be divided into conservation areas and given proper ecological restoration, and no industrial activities are allowed to enter such conservation areas. For areas with good ecological environment, mature soil conditions and complete ecosystem, they are set as economic zones. Then low-carbon and environmental protection industries can be arranged reasonably to promote the sustainable development of desert economy. For a vast area of the desert that has certain water environment, atmospheric environment and infrastructure, it is set as a repair area, which is the main battlefield for desertification control and carried out vegetation restoration and soil rebuilding.

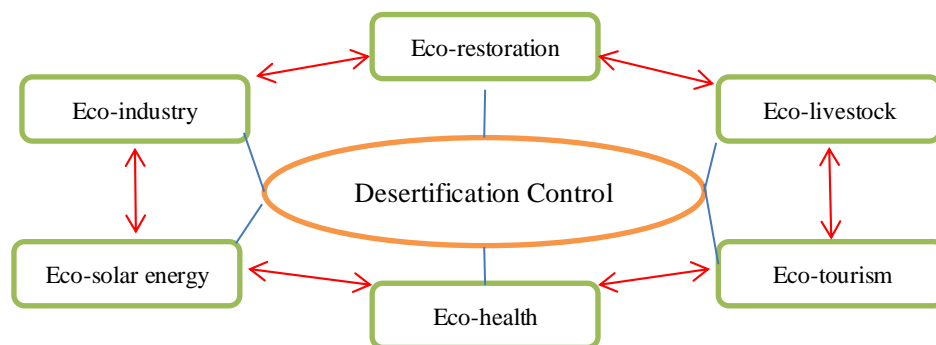


Figure 1. The industrial structure of Kubuqi^[3]

The Law of Natural Afforestation in Kubuqi Desert

Afforestation on the windward slope is an afforestation method that is highly efficient, highly technical and of high level and explored in practice in the area of Kubuqi desertification control. “Wind is the driving force to form aeolian landform and also the direct participant in causing the sandstorm disaster.”^[4] On one-half or two-thirds position of the windward slope of moving dunes, technicians plant *salix mongolica*, *hedysarum scoparium* and the other shrubs with wind and sand

burial erosion and strong stabilization ability of sands for direct afforestation to reduce wind speed and fix sand dunes. In the lower part of the leeward to the dunes foot and low hill land, because the wind erosion is smaller, and water conditions are better, tall pole willow, poplar, *Pinus sylvestris* var. *mongolica* or mixed forest are planted to block the flow of sand dunes. This afforestation method takes use of wind erosion dynamics of moving dunes, fixing them, and gradually reducing the dune height. Relying on natural forces, it is generally possible to smooth out the desert land in four to five years and greatly reduce the cost of afforestation. Natural afforestation method is used extensively in Kubuqi desertification control, greening 6253 square kilometers of desert, reducing the amount of land leveling construction of about 12 billion cubic meters, with cost savings of 30 billion Yuan.

Kubuqi Desert Tree Planting Technology

“Water vapor method” is the main technique of tree planting in Kubuqi, and its device is similar to a long water gun. This planting technology integrates planting and watering into one, suitable for planting cuttings species. It is a revolutionary change in desert treatment technology. The planting speed is greatly increased. One sapling can be planted per 30 seconds. The afforestation area per person can be more than 8 mu per day, so it is 14 times higher than traditional digging and planting. The survival rate is increased from 20% to 80%. The key technologies include water preparation, seed preparation, program control and so on. The cost saving of this planting technology is 30 yuan per mu. *Salix psammophila* is the main tree species of water-vapor method afforestation in Kubuqi Desert. The results of Kubuqi desertification control indicate that the survival rate of *Salix psammophila*, the height of branches, the length of branches and the diameter of branches have a decreasing trend with the decreasing of planting density. The planting density of 1m×1m is the most suitable *Salix* planting density in Kubuqi Desert.^[5] “Stubble Rejuvenation” is the maintenance technology applied to the desert shrubs that have survived many years. Desert shrubs, including *Caragana korshinskii*, *Salix*, Yang cai, *hedysarum scoparium*, etc., with the requirements and characteristics of stubble rejuvenation, need to be cut from the collar after growing a few years later to make it grow straight and sturdy trunk. The seedlings after “stubble” are not only straight, but sturdy. At the rhizosphere, there are rarely sprouted root tillers competing for nutrients. Due to vigorous growth, less pest damage, the seedling quality is greatly improved. The practice shows that “stubble” work must be in the dormant period of nursery stock, that is, after falling leaves until the first 2 years of germination. If it’s premature, once the upper adventitious buds germinate, they are vulnerable to frost damage; if it’s too late, due to nutrient up transport, the growth potential will be greatly reduced. At present, the common afforestation species in the desert include: *caragana microphylla*, *hedysarum mongolicum*, *hedysarum scoparium*, sea-buckthorn, *salix mongolica*, *salix gordejewii*, poplar, willow and elm^[6] It is a very important key technology to give full play to the native trees in the selection of wind prevention and sand fixation plant species. These native tree species need to have the biological characteristics of drought resistance, barren tolerance, wind erosion resistance, sand cutting resistance and sand burial erosion. They are the rare fine plants in the harnessing and ecological construction of the Kubuqi Desert.^[7]

Kubuqi Desert Soil Improvement Technology

Licorice is a valuable medicinal herb and grows well in the desert. Licorice is mycorrhizal plants, which can secrete a variety of enzymes, increasing soil activity, improving soil physical and chemical properties, to improve soil fertility^[8]. In practice, it has been found that licorice absorbs, transfers and fixes nitrogen in the air into the soil and forms rich rhizobia in the desert with excellent soil improvement. After planting licorice, soil nitrogen content of cultivated soil is increased obviously, increasing by 38%, 76%, 110% and 148% in the first year to the fourth year respectively. It can be said that a licorice is a “nitrogen-fixing factory” that has obvious improvement on sandy land and can turn the desert into a fertile land and is an effective plant for controlling desertified land. In addition, licorice has strong anti-salinity characteristics. It can

significantly reduce the surface soil soluble salt content of more than 80% by planting licorice in the saline-alkali soil. Yili Innovation researches and develops new technology of planting licorice. Licorice desertification control technology refers to the use of “transplanting method”, so that licorice can grow horizontally, becoming “sleeping” growth. The greening area of a licorice is expanded from 0.1 square meters to 1 square meter. The new technology will expand the effectiveness of greening for ten times. For the licorice using translation method, excavation can also avoid large-scale destruction of the soil. Using this new technology, we have achieved four goals: greening the desert, establishing a liquorice industry chain, repairing the land and driving the poor out of poverty. At present, Yili Resources Group has planted more than 220 million mu o in all major deserts in China.

In addition, in scientific research and practice, Yili Resources Group, with the support of the government, establishes the germplasm resources database of desert shrubs and rare and endangered plants in northwestern China and systematically collects, preserves and protects germplasm resources. The seed samples reaches 1000 , and a desert plant breeding technology system is established.

“The Khuzizi model has great influence both at home and abroad and has achieved a win-win result of desertification control and ecological economy.”^[9] At the thirteenth conference of contracting parties of the UN Convention to Combat Desertification on September 11 this year, UNEP released *China Kubuqi Ecological Wealth Assessment Report*. This is the first report released by the United Nations on the ecological wealth. The assessment of the Kubuqi desert treatment shows that a total of 6,253 square kilometers of green desert have been restored, 15.4 million tons of carbon have been fixed, 24.476 billion cubic meters of water have been conserved, 18.3 million tons of oxygen have been released and biodiversity protection has generated a value of 349 million yuan, creating more than 500 billion yuan of ecological wealth, where 80% is ecological and social benefits, led 100,000 local people out of poverty, providing more than 100 million jobs (times). In 2014, the Yili Ecological Management District in the Kubuqi Desert was recognized by the United Nations as the “Global Ecological Economic Demonstration Zone.” Yili Resources Group has also been awarded as the “global leader in desertification control” by the Secretariat of United Nations Convention to Combat Desertification. Solheim, UN Under-Secretary General and UNEP Executive Director, said: “I have been fortunate to see the Elion Group’s Kubuqi Model first hand. I believe it proves how effectively innovative public-private partnership can boost both profits and sustainable development. Now I hope that it will inspire many more such initiatives in other areas fighting back against the desert”^[10]

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