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RECENT PROGRESS OF RESEARCH ON OASIS IN CHINA

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ABSTRACT: Oasis is a kind of special ecological landscape of arid land. In the past two decades, certain progress has been made in research on Chinese oases and a series of achievements have been attained on system of oasis, evolution of oasis, maintenance and construction of oasis, regulation and control of oasis, sustainable development of oasis. To establish the science of Chinese Oasis is pressingly necessary for the development of arid land on a large scale and the opportunity is coming. We should specify the object of study and the nature of this science, and push forward it to more advanced level so that we could occupy the international leading position in this field.

KEY WORDS: oasis system, oasisfication, Chinese oasis science, research progress

In China, oasis of arid land and semi-aridland is widely distributed, and artificial oasis (oasis for short) appeared several thousand years ago. oasis had been paid little attention to However for a long time. Not until late the 20th century has the research on oasis become popular, which has created a new situation on research of aridland.

1 THE BACKGROUND AND HISTORY OF RESEARCH ON OASIS IN CHINA

It is since the 1990's that the research on oasis become popular. Its prevailing has profound social and historic background.

1) The scale of oasis has been expanded and the status has been promoted evidently. Oasis has been expanded by a big range in the northwestern aridland in China by several decades' development and construction since the people's Republic of China was founded. The area of oasis in Xinjiang at present is three times more than that of 1949. Oasis becomes the main place in which people live and produce and is the base area in which people exploit desert and mountain area further. About 95% of population and 90% of wealth are concentrated on the oasis which only account for 4% of the territory area in China.

2) Investigations and explorations on oasis have been frequently carried out and basic work has been accumulated. The main achievements are as follows: construction of ecological experiment center and observation, survey on agricultural resources of oasis, overall soil examination of oasis, thorough survey and planing of land use, population census of oasis, exploration of agriculture area of oasis, investigation on agricultural economy and so on. For example, the Chinese Academy of Sciences organized Xinjiang, Gansu, Ningxia comprehensive survey on a large scale. This kind of basic work accumulated plentiful fundamental information of oasis.

3) The ecological and environmental problems of aridland (including oasis) become more and more prominent and draw much attention of people. The eco-environment of aridland in China is in the condition of "part improvement and general deterioration". The opposite contradiction of oasisfication and desertification has been intensified. Oasis is generally confronted with draught, sand storm, saline-alkali,

soil impoverishment, pollution aggravation and etc., which have brought out great concern of government, industrial trade and scientific circles.

4) Reform and opening has instilled vitality and vigor into oasis research. Activated by the strategies of "Invigorating China by Science and Technology" & "Sustainable Development", the researchers of geography, biology, environment, ecology, meteorology and economy take up the research on aridland from different angles and different fields one after another, so oasis becomes one of the focus and hot spots.

5) Research on Chinese oasis has theoretical and practical significance. It is universally recognized by the scientific and technological circles that it is a piece of innovating work to establish oasis science with Chinese features and to occupy a dominating point in the world, which will forcefully promote the development of oasis economy and the construction of oasisfication in China and precipitate oasis to launch into the sustainable development track.

2 THE EMPHASIS AND PROGRESS OF RECENT RESEARCH ON OASIS

2.1 Oasis and Oasis System

2.1.1 The concept of "oasis"

With the advance of the society and the development of productivity, the connotation of oasis landscape has been successively extended and researchers are not satisfied for the explanation in lexicographical works.

Definitions of oasis are explained virtually the same in "*Great Lexicon*", "*Geographical Dictionary*", "*Environment Science Dictionary*" and "*Concise Britain Encydopedia*". Oasis is also called "fertile land", "fertile wilderness", "water and grass field", "bostan" (in Uighur), which refer to places that situate in desert, have rich sources of water and fertile soil, have luxuriant trees and grass, have thriving agricultural and husbandry industry and have dense population. Since the late 1980's, some geographers have given oasis new definitions and the discussion is still under the way. Through the discussion, academic circles get to some common views: (1) It is necessary to observe and study oasis from dynamic and developmental view. (2) Oasis exists in arid land or semi-arid land, so only desert areas have real oasis. (3) That there is guarantee or steady supply of water resource is basic condition under which oasis exists. (4) Oasis is suitable for plants (especially mesophyte) to thrive and fit for human beings to inhabit and reproduce. Biological process and social economic activity thrive. (5) The water, soil, climate, landform are optimized in oasis, but it is a kind of non-zonal ecological geographic landscape. The author define oasis as a "non-zonal, high effective, ecological geographic landscape (or region) that exists in desert, has steady water supply, fit for plants to thrive and fit for human beings to live and to reproduce".

Oasis is classified commonly by intervention extent of human activity, time sequence, terrain location, economic function or usage direction. Oasis can be classified into "natural oasis" and "artificial oasis", and some point out there exist "semi artificial oasis" or "quasi oasis". Natural oasis is classified into valley oasis, alluvial plain oasis, alluvial fan fringe-lowland oasis and lakeside wetland oasis according to terrain types. Artificial oasis can be classified into agricultural (rural) oasis, urban oasis, industrial and mineral oasis.

2.1.2 Oasis system

To study oasis people should probe into from system view. Oasis system exists objectively and is a complicated dissipative structure. Each oasis constitutes a unique ecological geographic system, but artificial oasis is complicated ecological-economic system (Chen *et al.*, 1992). In oasis, light-heat, water-soil and biological resources are optimized, and energy and biology transformation rate is high.

Some researchers put forward the four features of oasis by analysis (Chen *et al.*, 1993): geo-determining, water-relying, fragility and high efficiency. Other researchers put forward six features of oasis: zonality, dynamic variability, diversity, fragility,

dominance and moderation. Oasis system is generally composed of nature, society and economy subsystem. The essential attributes can be summarized as complicacy, high efficiency, water-relying, opening, fragility(Han, 1995a). The basic feature of oasis system is "having higher energy-transformation productivity (Mei, 1995)". All in all, the four features of regionalism, water-relying, fragility and high efficiency are comparatively identical opinion. In addition, the structure of oasis system determines its function (productivity and self-organization). It is necessary to set up optimum model to realize optimizing structure.

The oasis ecological-economic system, especially oasis agricultural ecological system, is given exceptional concern. Researchers have analyzed the structure, function, formation mechanism and evolution of oasis agriculture ecological and ecological economy system of the southern fringe of Takilamakan Desert, the northwestern part of the Ulan Buh desert(Li *et al.*, 1995; Li, 1992).

2.2 Formation and Evolution of Oasis

In Xinjiang, the formation of natural oasis can be tracked back to the late Tertiary and the early Quaternary. Artificial oasis formed during the transitional time from hunting society to farming society.

The factors that influence the formation of oasis can be classified as natural factors and human factors. Hydrologic condition, which determines the scale of oasis, is the most important among natural factors. Landform condition determines the shape of oasis. In addition, soil and vegetation are also necessary conditions for the formation of initial economic structure of oasis. Human factors include population scale, production condition, scientific and technologic level, social development etc. The formation mechanism of oasis can be primarily analyzed from the angle of matter flow, energy flow, information flow (Liu, 1995a).

To study the formation and evolution of the Tarim Basin Oasis has special representative meaning. Professor Fan Zili revealed three phases of development of Tarim oasis: the period of downstream simple drawing water (ancient oasis founded by ancestors), the period of drawing water to piedmont (hydrotechnics developed greatly, production tools improved greatly, artificial oasis expanded), the period of plain reservoir regulation (opening up new oasis). He also analyzed the causes of the decline of the ancient oasis: natural factors such as river's changing course, land storm damage, aggravation of saline-alkali, factors created by men such as social turbulence, irrigation activity(Fan, 1993). Some researchers studied in detail the formation and evolution of primitive oasis, ancient oasis, new oasis of the Keriya River along the southern fringe of the Tarim Basin(Zhou *et al.*, 1995). The evolution of ancient oasis of the Hexi Corridor is representative. Ancient oases such as Camel Town and Juyan Town were abandoned and decayed due to imbalance and impropriety of water resource usage(Qu *et al.*, 1995).

The general law of oasis spatial evolution can be indicated: from intermountain basin (valley) → the fringe of pluvial fan, downstream (delta) → upstream pluvial plain → the surrounding of river(Wang *et al.*, 1999). The law has been verified by disuse of some reclamation areas along the downstream of the Tarim River and the desertification of the Minqin Oasis in the Shiyang River valley.

2.3 Stability and Sustainable Development of Oasis

Oasisfication and desertification are basic geographic process of arid land. It is a fundamental target for the surviving and development of arid land people to strive for stability, order and sustainable development of oasis system. However, owing to superimposed influence of natural and social dynamic factors, oasis system is always in active and dynamic state. The stability of oasis system, mainly referring to the stability of oasis ecological system, is an oasisfied state that assure energy flow, matter flow, information flow of oasis ecological system to be in benign cycle, living environment of oasis life to be successively optimized and oasis system functions to develop

steadily and constantly.

It is a complex system engineering to realize stability and sustainable development of oasis. Currently, the main problems that are paid much attention to by most researchers are as follows: the rational usage and development of water and soil resource of oasis, appropriate oasis scale and bearing capacity, oasis ecological economy and agriculture, oasis-desert transitional zone and shelterbelt networks, oasis arrangement and oasis geography construction, oasis regional system, regulation and control of (Population, Resource, Environment, Development).

2.3.1 Rational exploitation and usage of oasis climate, water and soil resource

Climate and water are the most basic and important renewable resources on which oasis relies to develop. Oasis climate has some features, such as aburdant light, adequate heat, stable water yield, special local climate (oasis cold island effect), great latent capacity of heat. Organization of water resource and soil resource is prerequisite for formation of oasis, and water is the first restrictive factor to oasis. In the 1980's, it was precisely presented to "protect oasis ecological water" (Xu *et al.*, 1990). After that, someone put forward further "to establish policy and system of ecological environment water usage" (Tang, 1995) and promoted techniques to economize on water and advanced irrigation method. Someone established model of economizing on water and regulating and controlling system for oasis (Chen *et al.*, 1995a). The main countermeasures to use oasis water resource rationally are to irrigate scientifically, to assure drainage, to recover and use groundwater, to do well in analysis of balance of water supply and demand, to allocate water rationally and etc. As to appropriate usage of oasis land, the measures are to study the formation, characters of oasis soil, such as anthropogenic-alluvial soil, to improve deteriorated soil like secondary saline-alkali soil, to plan oasis land use and etc.

2.3.2 Appropriate oasis scale and oasis bearing capacity

Studies indicate that oasis scale is determined by water resource rate and use level. The volume of surface water and groundwater confines the scale of oasis and spatial change of drawing surface water restricts distribution pattern of oasis. In the middle 1980's, some researchers in Xinjiang calculated bearing capacity of oasis water resource, land and population. In arid land, it is complex to define the relation between water yield and oasis bearing capacity, because it is closely related to climate, oasis closure and distribution extent, irrigation pattern, technological equipment, productivity development level and management level. Somebody calculated appropriate oasis area by water volume of each valley and oasis water demand, analyzed stability of oasis, and calculated appropriate oasis cultivated land area. Afterwards, somebody calculated irrigation area that can be supported by traditional irrigation pattern and the corresponding appropriate oasis area to judge oasis stability. "appropriate oasis area" cited above refers to oasis scale that basically keeps the regional natural ecological balance.

2.3.3 Oasis-desert transitional zone and oasis shelterbelt works

The stability of oasis is mostly determined by its ambience. The periphery of oasis may be desert, prairie, Gobi, mountain or lake, but the main part is desert. There is always a transitional belt between desert and oasis, which is not only restrained by desert but also influenced by oasis. Under the disturbance of arid climate and the irrational intervention of human beings, the ecological system of the belt is apt to turn into imbalance and is difficult to recover, so far as to form "ecological graben" (Huang, 1990). For example, the Mosuo wan in the southern fringe of the Junggar Basin formed three distinguished landscapes: luxuriant oasis, decayed oasis surroundings and sacsaoul origin desert. The effective countermeasure is to close 0–4 km boundary strip and to facilitate vegetation. In the edge zone of the Fukang Oasis, by closing for 8–10 years, the coverage of desert vegetation such as sacsaoul increased from 2%–5% to 20%–30%.

To build shelterbelt works is a basic countermea-

sure to construct and protect oasis. The works demand trees' even distribution, rational allocation, sheltering ring by ring, combining trees, bush and grass. The general model is: to plant shrub and grass around oasis, to plant network of forest protecting crop land within oasis, to plant trees along "river edge, road edge, house edge, field edge", to build small stretch of economic forest and timber forest, big stretch of firewood(Liu *et al.*, 1994). The experiment and study on cultivated land of the Hetian Oasis indicates that agriculture protection forest has obvious effect on upkeep and equilibrium of oasis ecological system and it can abate wind speed, regulate temperature, decrease soil evaporation and crop transpiration, cut down strength of dry-hot wind and meliorate properties of oasis soil. In Hetian, people build several kinds of successful model of agriculture and forestry composite arrangement, such as long grape corridor, garden economy and so on. Someone set up multiple objective programming model for optimum structure of oasis shelterbelt works.

2.3.4 Oasis ecological economy, oasis ecological agriculture and oasis city

Oasis ecological economy is the result of which arid land people regulate and optimize regional system of oasis man-land relation by using principle and method of ecological economics and also is the task of oasisfication construction. The laws to regulate oasis ecological economy are integration, structure-function, optimum and compatibility. The countermeasures are to readjust agricultural economy orientation, to use rationally water resource, to coordinate the relation between agriculture, forestry and husbandry, to improve shelterbelt works. To get a clear understanding of oasis economy-ecology system, we can take up computer analog according to its basic feedback structure relation and set up dynamics model of oasis economic growth. We did some fruitful research when studying the Manas Oasis(Han *et al.*, 1994).

The optimum model and outlet for oasis agriculture is to develop oasis ecological agriculture. So it is necessary to understand well oasis ecological agriculture, especially its structure and function, its nutrient cycling and to study in detail matter flow, energy flow and information flow of oasis agriculture optimum model(Li *et al.*, 1998). In the meantime, we should recognize the features of farmland ecological system (having plentiful water resource, big matter and energy flow, high land output, strong natural power, high stability, strong power of product exchange and economic operation) to find a effective way to increase energy transformation efficiency (Mei, 1995). Many researchers particularly emphasize the important status of grass cultivating in oasis ecological agriculture and hold that to develop grass is an important requirement for sustained development of oasis agriculture and economy. Some researchers sum up the effective model of oasis solid ecological agriculture such as agriculture, forestry and grass compound planting, alternate planting, solid planting and breeding.

Oasis city is a kind of high-class, late-model artificial ecological system, researchers of which increase day by day. They have studied the formation and evolution of oasis city, environmental and geological problems for formation of oasis city, city and town system planing and development mechanism of oasis city, oasis urban environment and sustained development(Fang, 1991; Zhang, 1997).

2.3.5 Oasis management and oasis geography construction

Oasis is the result of human beings' long-term exploitation and arrangement, during the course of which it is inevitably regulated and controlled by people. However, oasis is generally facing with many problems such as water shortage, ecological deterioration, energy deficiency, population growth, disaster happening frequently. So researcher advances that "harmony, stability, high efficiency and adjustability are orientation of oasis construction(Wang, 1995)". The main objectives of future geography construction are to set up oasis of order, high efficiency, multiple function, open type and exchange-earning. The content of oasis construction includes the development and arrangement of water and soil resources, the construction and administration of transportation and

communication, the prevention and control of disaster, and the construction of oasis geography database. Oasis construction should stress importance of environmental value and high investment, build up oasis economic centers, and form into an oasis economic region having comprehensive aggregation capability according to point-axle model. Some researchers analyze oasis as a system with high-grade structure by using AHP(Analytical Hierarchy Process) in order to make decision and work out proposal for oasis construction (Liu, 1995b).

Administration of oasis ecological system, this scientific frontal issue, is put on our work schedule. For instance, agricultural system of the oasis along the southern fringe of the Tarim Basin is in low stability, with weak interference-resistance and with poor self-recovering ability, consequently, to regulate it should begin with strengthening infrastructure construction, improving oasis capability to resist draught, sand flow and saline-alkali, keeping appropriate scale of oasis and improving oasis shelterbelt works and etc. (Li *et al.*, 1995).

2.3.6 Sustainable development of oasis and regulation of PRED system

All the work cited above is to realize sustainable development of oasis. The bi-pole orientation of oasis evolution is particularly obvious —either reversal evolution (desertification) or benign development (oasisfication) —it must be one or the other. It is critical to regulate well oasis natural factors and to adjust social economic structure and sequential structure of oasis coordinate development for human beings to control desertification and to deal well with oasis evolution regulation according to the law that structure confines function(Sheng, 1995).

The formulation of "oasis sustainable development" is widely accepted by people, and it has been put on our research schedule(Han, 1995b). More researchers make efforts in studying PRED system coordination and optimum regulation of oasis and in studying the composition and feedback structure of it (Chen *et al.*, 1995*b*). The connotation and essence of oasis sustained development is precisely to strive for PRED's harmony and optimum state. Taking the Turpan oasis as an example, some researchers have done some system study, set up successfully decision-making supporting system of oasis sustained development and put forward strategic choice and countermeasures for sustained development (Huang, 1998; Wang, 1998).

3 STRENGTHENING STUDY ON OASIS AND DEVELOPING OASIS SCIENCE WITH CHINESE FEATURES

In China, the area of the arid land is large, the resource is rich and the development potential is great. The west of China will have a prospect of being exploited in a large scale and rising abruptly as the west region of America in those years and the prologue has been pulled open. But many problems of oasis are exposed currently, and to strengthen regulation and management must be based on science. To construct oasis, to develop vigorously oasis and to arrange new-type oasis must rely on support of some new discipline such as oasis science, desert science and etc.

Since the late 1980's, Professor Huang Shengzhang, a famous history geographer in China, wrote books and papers to appeal to establish Chinese oasis science. After that, many researchers from geography, biology, meteorology, ecology, hydraulic engineering, range science, forestry, agriculture, economics and history have devoted themselves to oasis study, have gained gratifying science accumulation and obtained theory and method ripening day by day. The research forces are growing steadily.

Particularly, some academic societies held successfully symposiums on oasis. In September 1994, the six provincial societies including Xinjiang Ecological Society and Xinjiang Geography Society, jointly held "Xinjiang Oasis Ecology and Environment Symposium" in Wujiaqu Town. Then, in August 1995, Chinese Natural Resource Research Society, Arid land and Semi-Arid land Research Society and Chinese Sand Industry Foundation held "Oasis Theory

and Practice Symposium" in Hohhot. The Proceedings of the two meetings were published. The two symposiums have historic influence on formation and development of oasis science. Nowadays, many institutes and universities in arid land or semi-arid land take oasis as main research field. Xinjiang Institute of Ecology and Geography, the Chinese Academy of Sciences, especially takes oasis ecology as the main research target. With the great development and prosperity of the western arid region, research on oasis will be thriving. The day is not far off to establish international first-class "Chinese Oasis Science".

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