

# 赵松乔文集

Selected Works of Zhao Songqiao

科学出版社

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## 内 容 简 介

本文集精选了我国著名地理学家赵松乔先生生前180多篇(本)著作中的44篇代表作。内容涉及中国干旱区研究、自然区划与土地类型、农业地理、世界地理、环境资源等,其中英文著作占相当比例。可供国内外地理学者参阅。

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1946 年在美国克拉克大学。图为克拉克大学总办公所前的雪景(1946 年 12 月 29 日)



赵松乔、朱晓岫夫妇在一起

00920



1991 年在中关村 804 楼寓所书房



1989 年博士生蔡运龙论文答辩成功后合影。前排右起：孙惠南、赵松乔、林超、陈传康、赵济；后排右起：黄荣金、郭永芳、杨勤业、申元村、蔡运龙





1992年博士研究生论文答辩后的合影。前排右起：张百平、H.E. Dregne、赵松乔、陈传康、程鸿、黄荣金；后排右起：吕昌河、刘燕华、王爽、郑度、赵济、杜钟朴



1983年在柴达木盆地考察。图为冷湖东南40公里的荒漠



1993年与Cyrus M.Mckell  
教授在内蒙古国际会议上  
的考察合影

1993年9月与H.E.Dregne  
教授在贺兰山上考察



在祖国宝岛—台湾访问  
(1995年再次访问台湾时  
的留影)



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## 序

1938年日军进侵中国,战火日滋。浙江大学由江西再迁广西,我亦于该年到史地系任教。开学的时候,已秋尽冬来。我担任的课程中有一门是文理学院史地系的“自然地理”和师范学院史地系的“地学概论”,两个名目,内容相同,是当年两个史地系一年级的必修课。这一届史地系的人数特别多,优秀的也特别多。除松乔以外,施雅风、陈述彭、孙盘寿、杨利普、宋铭奎后来都曾与我同事。当时常来找我的约有十几位,松乔是其中之一。我口才特别差,还带有浓重的广东口音,登上讲台就感到紧张。对我来说,教书是苦事。但在当时,到浙大任教是翁文灏、竺可桢、张其昀等先生商定的结果,思想上没有别谋生路的打算,也没有改进口才的意图,唯一法宝是写讲义印发。班中同学经常有1/4左右到我寓所谈天说地,执疑问难,松乔是其中一位。他在入学考试中名列第一,获黄膺白奖学金,经常神采奕奕,而心仪富兰克林,既是伟大的科学家,又是外交家。我要他读马东《自然地理》英文简要本,十天后再书时能略述自然因素互相关联之涯要,并指出全书由气候开始之所以然。这对于方入学的学生来说,是难能可贵的。在浙大四年,松乔在我的印象中,是朝气蓬勃,力求上进,夙兴夜寐,勤奋异常的青年。以后我转至原资源委员会工作,很少见面。50年代初,他转入地理研究所工作,我亦于1953年由上海调来。自此以后,晤谈的时间很多。40多年中,世事如浮云苍狗,变幻无穷,时而日丽风和,时而狂飙暴雨。他所受的影响比我大得多,却始终保持着旺盛的进取精神,不懈地工作。他记忆力很强,对许多重要数据和年月日能不假思索,对答如流。他在野外考察,见到作物生长情况,即能较好地预估产量。在50年代,地理所人员中具有此经验的还很少。他写作很快,研究领域也特别广阔。在地理所工作期间,他最初研究外国地理(菲律宾和缅甸)。不久以后,多数时间从事地区考察,由东北、内蒙古逐渐扩及西北,中国干旱、半干旱区地理自然而然就成为他长期工作的重心。他不仅出版了许多著述,还受聘主编《Chinese Journal of Arid Land Research》。80年代初期,他又曾以较多时间从事中国地理及中国土地类型划分工作,先后出版了《中国自然地理·总论》和《Physical Geography of China》。他于1994年在美国出版的《Geography of China》,包括人口、资源、环境与发展。他告诉我,送我的一本不久可以运到。我相信这是以西文写成比较最完备的一本《中国地理》。正翘企以待,孰料书未到而他已长往不返,悲何可言!他给我印象最深的是:每次重大挫折以后,迅即恢复生机;在笔砚之间,勤勤不息。《赵松乔文集》行将付梓,要我写一序文,援管濡毫,潸然泪下,凄怆中难尽所怀。

黄集伟

1997年8月

# Developing the Arid Regions of China: A Tribute to Zhao Songqiao

*by H. E. Dregne*

As a world-famous physical geographer, Professor Zhao Songqiao was intimately acquainted with the opportunities and the problems of living in the arid regions. His extensive travels in, especially, Gansu Province, Inner Mongolia Autonomous Region, Ningxia Hui Autonomous Region and Xinjiang Uygur Autonomous Region exposed him to the fascinating character of the drylands. He saw forbidding deserts exist next to prosperous oases, where the only difference was water. And he also saw those forbidding deserts yield vast amounts of petroleum for the nation's industries, as well as minerals and precious ores. Perhaps Professor Zhao's most exhilarating experience was to participate in and describe the responses that people made to the challenges posed by deserts. He marvelled at the successful and sustained development of the Turpan oasis and its network of kanats that brought life-giving water to a furnace-hot depression sitting below sea level in view of snow-covered mountains. He followed the route of endless streams of merchant caravans along the Silk Road, connecting the Middle Kingdom with Central Asia, Europe, India, Persia, and the Ottoman Empire. He participated in and guided the adaptive responses of farmers to new irrigated lands of the Hexi Corridor. And he took pride in the role he had played in stabilizing the moving sand dunes that had plagued travel on the Baotou-Lanzhou railway at Shapotou. Out of that pioneering effort came the "checkerboard" pattern of fixing sand dunes in place using intersecting lines of dead vegetation at 1 meter intervals. Checkerboarding has been employed in recent years to protect the first highway to cross the Taklimakan Desert as well as communication routes in China and other countries.

## Desertification

Desertification is a term that has come into wide use since the 1977 Conference on Desertification in Nairobi, Kenya. Several definitions of the term have been proposed. At the 1992 United Nations Conference on Environment and Development in Rio de

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Janeiro, Brazil, delegates adopted the following definition (Darkoh, 1994):

Desertification is land degradation in arid, semi-arid, and subhumid areas resulting from various factors including climatic variations and human activities.

Desertification is the general name for several land degradation processes that affect arid lands. These processes include vegetation degradation on rangelands and water erosion, wind erosion, salinization, waterlogging, and soil compaction.

In China, most land degradation control has consisted of efforts to control wind erosion (Zhao, 1985). Virtually all of the research conducted at the Institute of Desert Research of the Chinese Academy of Sciences in Lanzhou has been wind erosion research. The Institute has become famous for the field methods it has devised to stabilize sand dunes in hyperarid, arid, and semiarid regions of China. Much of the field research has been done in southern and eastern Inner Mongolia, northern Shaanxi, western Ningxia, and in the Hexi Corridor of Gansu Province. The Institute operates a large wind tunnel at its laboratories in Lanzhou.

More recently, at the urging of Professor Zhao Songqiao, the Institute has begun to look at other desertification processes of importance to China's environment. Vegetation degradation of rangelands apparently is prevalent in most grazing lands (National Academy of Sciences, 1992) and so is salinization of irrigated lands (Dregne *et al.*, 1996). Zhao (1993) has described a large number of natural hazards (wind erosion, salinity, drought, earthquakes, etc.) that are present in northwest China. Some of the hazards are aggravated by human activities, and these are the ones that can be changed.

Over-development of scarce water supplies for irrigation has caused extensive problems of water shortages and salinization in the lower sections of several river irrigation systems in Xinjiang, especially on the edges of the Tarim Basin, and in the Hexi Corridor. Expansion of irrigation to higher points along the rivers has led to there being not enough water left to adequately irrigate the lower (and older) irrigated lands (Zhao, 1993).

Little has been published on water erosion as a part of the desertification process in northwest China. Water erosion is extensive and severe in the northern part of the Loess Plateau in Shaanxi Province, where the climate is semiarid and dry subhumid. Water erosion also damages lands in the wheat-growing areas of central Inner Mongolia, the hilly croplands of eastern Gansu and Qinghai provinces, and along the over-grazed foothills of the mountains throughout northwestern China. Even less is known about the importance of soil compaction, which may reduce soil productivity in irrigated lands, especially.

Evidence exists that another form of desertification occurs in the northwest. Open-pit coal mines in the "Golden Triangle" where the provinces of Shanxi and Shaanxi and

the Inner Mongolia Autonomous Region meet, are numerous and the residues of the mining process pollute the soil in and around the pits (Zhao, 1993). Heavy metals in liquid wastes and smoke are polluting air and soil around the industrial areas such as Baotou, Lanzhou, the middle Hexi Corridor, and Urumqi (Zhao, 1989). The land area affected directly by these deadly pollutants is small but the off-site impacts on water quality and human health probably are significant.

## De-desertification

Professor Zhao coined his own term for the process of economic development of the arid regions; de-desertification. By this, he meant both the reversal of desertification and the establishment of "oases" of sustainable development that are appropriate for the dry conditions of deserts. Optimally, the oases would be a combination of agricultural, industrial, and commercial land uses. Environmental resource conservation must be a major consideration in the development process. Businesses that degrade the air, land, and water resources are unacceptable. The arid environment is a fragile environment in that it is easy to destroy desert ecosystems but difficult to restore them.

The best arid land development for agriculture is to select the most favorable local areas with excellent land and water resources and turn them into well-managed irrigated oases. China has many well-managed oases in the arid northwest but it also has many that are badly affected by salinity. A second, but more hazardous type of land development is rainfed farming. This type of land use has spread from the humid zones into the subhumid and semiarid zones of northwest China, particularly in southern and eastern Inner Mongolia and in northern Shaanxi province. Rainfed cropland in the 250 to 400 mm precipitation zone is a risky enterprise because of low and unreliable rains as well as frequent droughts. Pastoralism has the potential to be reasonably stable and profitable if the grazing lands are productive and population density is low. Pastoralism is an extensive activity of low economic value on a unit area basis, compared to either irrigated or rainfed agriculture.

Stable and prosperous communities (oases) generally are those where there is a variety of economic enterprises that offer support to agriculture or provide non-farm work opportunities. In the arid regions, off-farm businesses include primary industries (steel-making factories, mining) and secondary industries (auto assembly plants, electronic factories, tourism, commercial trade, government offices). The most desirable and sustainable industries are so-called "clean" industries (assembly plants, electronic works) that produce little waste material. Disposal of wastes (heavy metals, toxic chemicals, organic material, dust and smoke) is an important problem in arid regions because permanent rivers to dilute and safely carry away wastes are rare, soils are dry, and decomposition of organic materials is slow.

Communities relying solely on agricultural production frequently have unstable economies because production and commodity prices can fluctuate widely from year to year. A protracted drought, for example, can devastate affected communities. Population increases commonly cause subdivision of land holdings and greater food demand from what usually is a finite resource. Excess farm labor, if any, may not be able to find jobs locally. Migration, either temporarily or permanently, then occurs as people must seek employment elsewhere. Agricultural industries such as food processing and equipment manufacture can contribute much to the local employment opportunities and to a stabilization of the economy.

### **Irrigated Agriculture**

China, as one of the world's oldest civilizations, has many examples of irrigated oases which have been sustained for at least 2,000 years. Some of them, such as the Ningxia Plain and the Back Elbow Plain on the Yellow River in Ningxia and Inner Mongolia, have serious salinity problems. Nevertheless, they continue to be productive. The oasis of Turpan in Xinjiang has thrived for perhaps 3,000 years, depending for water on one small river flowing out of the Flaming Mountains and a large number of underground canals called *kanats* (*karez*). Turpan was a major trading station on the middle branch of The Silk Road. Today it remains important for the trading and tourism which supplements its production of raisins and other irrigated crops as well as industrial salts.

Many oases have been established over the centuries in the Hexi Corridor of Gansu Province. Similar to Turpan, the string of oases from Wuwei on the east to Anxi on the west was part of the Silk Road. It was at Anxi where the Road split into a southern and northern branch across the Xinjiang Uygur Autonomous Region, heading toward southwest Asia and Europe. Irrigation agriculture is the principal economic activity in the Corridor, using water from the several rivers that originate in the Qilian Mountains. Some of the rivers are overexploited, causing water shortages in the lower section of the streams, such as in Minqin. Industrial development is centered on mineral mining and refining and on steel-making in the middle part of the Corridor.

Southern Xinjiang is the site of dozens of old oases on the north, south, and west sides of the Tarim Basin, many of them bordering on the Taklimakan Desert. In northern Xinjiang there are both old (Hami) and new (Shihezi) oases. Shihezi is the focus of the extensive Manas Valley irrigation project on the north slope of the Tianshan. It is one of a number of new cities between Urumqi and Bole that utilize irrigation water from rivers beginning in the Tianshan. Petroleum production in Xinjiang is sure to stimulate the economy of many oases in an ever-increasing amount since Xinjiang has most of the known oil reserves in China Mainland.

The most important long-range threat to irrigation agriculture, globally, is salin-



ization and waterlogging of soils. That is also true for China. Wind erosion and sand dune movement are comparatively minor although there are some oases in China that are, or could be, threatened by mobile sand dunes.

### **Rainfed Agriculture**

De-desertification of rainfed cropland in arid China requires, mainly, control of wind erosion. There are two ways to bring about that control. One is to stop cultivating the land and changing it back to grazing land. The other choice is to continue cropping but institute adequate control methods, such as planting windbreaks, strip-cropping, minimum tillage, or using emergency tillage methods, that will hold wind erosion to a minimum. On very sandy soils in semiarid climatic zones, it may be impossible to hold erosion to a tolerable level by any presently-known method that is economic to employ. In dry or drought years, there simply is not enough crop growth to control wind erosion on such sandy soils.

In China, the large dryland rainfed cropland areas lie in Inner Mongolia and Shaanxi. Water erosion is severe in the loess soils of Shaanxi Province and is a hazard on other sloping lands but sandy wind-eroded soils are the main desertification hazard. The problem sandy soils are found mainly in eastern and southern Inner Mongolia (e.g., Mu Us, Horqin, and Hulun Buir sandy lands). Rainfed cropping in the Inner Mongolia sandy lands has expanded and contracted over the years as droughts came and went and as government policies changed. An important cropland in central Inner Mongolia where water erosion, rather than wind erosion, can be severe is on the northern foothills of the Yinshan. Professor Zhao (1990) has described the desertification process and defined the conditions under which de-desertification (sustainable development) can occur in Inner Mongolia.

Inner Mongolia croplands are subject to a number of constraints on production aside from erosion. Growing seasons are short, rainfall is erratic and low and droughts are common, salts accumulate in depressions, soil fertility is low, poverty is widespread, transportation and communication are limited, and population growth is rapid. The basic productivity of the cropland can never be high, largely because of a short growing season and unreliable rainfall. As a grassland, however, its basic productivity is high.

Expansion of sand dunes in the Mu Us sandy lands on the Ordos Plateau in the north part of the big bend in the Yellow River has been a matter of concern for centuries. Once a rich grassland, large patches of wind-eroded cropland have appeared as governments promote the transformation of what are viewed as low-value grasslands into productive farmlands. In the process, formerly stable sand dunes have become mobile. Shifting sands are deposited on adjoining grasslands, reducing their productivity and further increasing susceptibility to wind erosion. The story is similar in the Horqin and Hulun Buir sandy lands of eastern Inner Mongolia.

Great effort has been made in the last forty years to combat the desertification process in the sandy croplands. For the worst conditions, changing poor croplands into good grasslands is the only way to control wind erosion and desert expansion. For less severe conditions, shelter belts (windbreaks) of trees and shrubs can provide protection to the sandy croplands, as can irrigation and intensive management practices that keep a complete or partial vegetative cover on the land during the windy season.

Wind erosion control practices are similar throughout the Inner Mongolia sandy lands. Much desertification control has been done to help the de-desertification process and to use the land in accordance with its potential. Progress is threatened, however, by the increase in population and the consequent pressure to produce more food. Good grasslands are inviting targets of governments intent on expanding farmlands.

Growing conditions in the foothills of the Yin Mountains (Yinshan) are about the same as in the sandy lands. A major difference is that the medium textured foothill soils are on sloping land. Water erosion is the principal land degradation problem. Wind erosion is minor. The best solution there appears to be to restore the sloping lands to grass and to concentrate crop production on the flatter lowlands. Lowlands are more fertile and have better moisture relations than the uplands. Supplemental irrigation is possible in the lowlands, where groundwater supplies are better. In addition to more intensive land management, there is much opportunity to improve animal husbandry practices, modernize crop production, and introduce agricultural processing factories.

### **Pastoralism**

Land degradation in grazing lands is, first of all, vegetation degradation. Water and wind erosion become problems only after the vegetative cover has been reduced or destroyed. Many Chinese rangeland scientists believe that the national grazing lands, from eastern Inner Mongolia to western Xinjiang, are overgrazed (National Academy of Sciences, 1992) and that the degradation process is rapid, accelerating, and caused by human intervention. The principal culprits are the extension of cropping and the overgrazing by domesticated animals (livestock). The result of extending cultivation is that grazing lands become smaller but the livestock numbers remain high, leading to further degradation.

There are many ways to increase grazing land productivity. Chinese scientists have experimented with fencing, seeding, fertilizing, burning, desalinization, construction of windbreaks, and insect and pest control. Much improvement is possible, once vegetation degradation has been halted.

## **Conclusions**

Desertification, in the form of wind and water erosion of rainfed croplands, salin-

ization of irrigated land, and overgrazing of rangelands, are widespread in the drylands of China. The most affected province and autonomous regions are Gansu, Inner Mongolia, Ningxia, and Xinjiang. Wind erosion is a particularly acute human-induced problem in Inner Mongolia. Salinization of irrigated land is a long-standing hazard in Ningxia and Inner Mongolia and has become important in recent years in Xinjiang. Vegetation degradation is believed to be common on nearly all rangelands in the dry regions.

Dé-desertification is the opposite of desertification. It refers to the development, on a sustainable basis, of the natural resources of drylands. For sustainable development, desertification must be controlled and reversed, where possible, and economic activity in an area must be of a kind that provides financial stability. De-desertification, then, is a process that harmonizes agricultural, pastoral, and industrial activity and the socioeconomic environment. It is a long, difficult process requiring commitment by governments and an understanding of people's needs and how to meet them.

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