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ENVIRONMENTAL DEGRADATION IN THE MINQIN OASIS IN NORTHWEST CHINA DURING RECENT 50 YEARS*

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ABSTRACT

Minqin Oasis lies at the lower reaches of Shiyang River, which is one of the three inland rivers in northwest China. Due to sand dune encroachment and unconstrained activities of local people in recent years, the ecological and environment problems of Minqin Oasis are being taken seriously. The aims of this study is to analyze the factors driving environmental degradation in the Minqin Oasis during the past 50 years, to reveal the relationships among sandstorms, water resources, and human activities, and to present some reasonable practicable measures for ameliorating conditions in this region.

STUDY AREA

Minqin Oasis (102°45'~103°55'E, 38°20'~39°10'N), is at the lower reaches of Shiyang River, Hexi Corridor, Gansu Province, Northwest China (see Figure 1). It is surrounded by the Badain Jaran Desert and the Tengger Desert, and about 91% of the total area is covered by desert, Govi, salina and deflation basin. The

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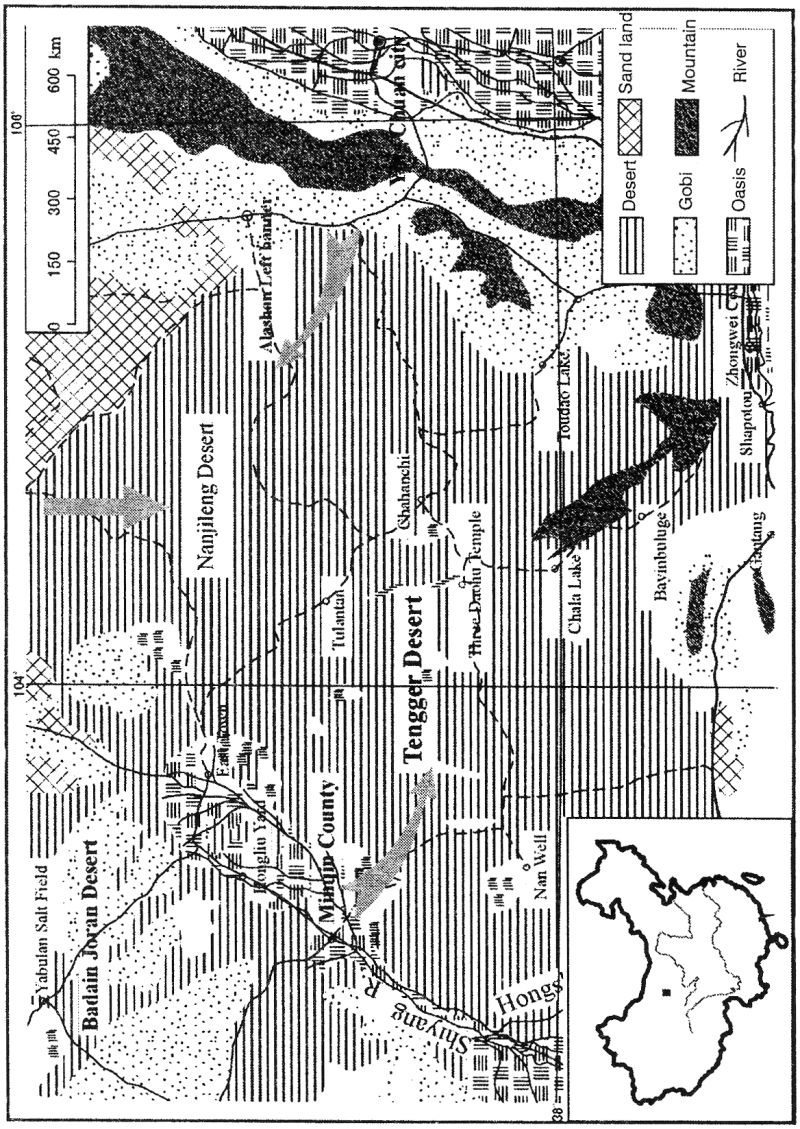

Figure 1. Location of the Minqin Oasis in Northwest China.

total area is 1.6 × 104 km2 for Minqin County, within which the desert area is 0.853 × 104 km2 and the oasis area is 0.144 × 104 km2 [1]. Minqin County consists of 23 towns. Its total population is 307,000. Many years ago, Minqin County was a beautiful oasis with many lakes, fertile land, plenteous water resources, and grassland. At that time, people could live on local rice and fish there [2]. Recently, due to sand dune encroachment and unregulated human activities, the ecological environment began to deteriorate. In addition, as one of the four major sources of sandstorms in China, Minqin Oasis directly affects the ecological health of Hexi Corridor and the weather conditions of the north region of China [3]. If Minqin Oasis vanished, it would lead to a larger-area connection between the Tengger and Badain Jaran deserts, and directly threaten environmental conditions in northern China. Premier Wen Jiabao has expressed great concern about environmental conditions in the Minqin Oasis. He made special note of the environment issues of the Minqin Oasis in his government work report and suggested that it is very crucial to protect this environment.

In this article, we take the Minqin Oasis as a typical case to illustrate the environmental degradation progress in the inland river basin of northwest China and present some reasonable methods to combat desertification and its attendant problems.

NATURAL STATE IN THE MINQIN OASIS

Minqin Oasis has low rainfall (115 mm average annual precipitation). The lowest recorded precipitation is only 45 mm, in 1964, while average annual evaporation is high at 2640 mm [4]. There are more than 30 days with sandstorms in an average year. Strong winds carrying much sand is a typical weather pattern in the oasis. On average, the days with strong winds of more than 17 m s^{-1} exceed 25 in a year. The dominant wind direction is northwest [5]. Due to the arid climate and scarce water resources, the ecosystem of Minqin Oasis is very fragile. The oasis plays a vital role in the ecological systems of northwest China, and even beyond. During the last 50 years, with the increase of water resource utilization at the upper reaches of Shiyang River, the water discharged into Minqin Oasis has decreased gradually. This has brought many adverse effects on the local environment, including soil salinization, vegetation degradation, and land desertification. Today, the oasis has become one of the driest regions in China. The large-scale exploitation of groundwater has added burying depth by as much as 0.5-1.0 meters annually. This has made Minqin Oasis a region of severe desertification, one of four major sandstorm sources in China [6]. Statistics show that there were 6.13×10^4 hm^2 of farmland before the 1950s—reduced to 4×10^4 hm^2 in recent years, due to wind-blown sand encroachment and shrinkage of the oasis's area [7].

ENVIRONMENTAL DEGRADATION IN THE MINQIN OASIS

As population increases and human activities extend their scope, the environment and climate in Minqin Oasis is simply unsuitable of residential use. Its climate is now a severely dry continental regime. Especially in recent decades, over-exploitation of groundwater, coupled with inadequate re-supply from surface waters, has led to dramatic deterioration in the quality of underground waters. Because water discharges into Minqin Oasis have been strictly restricted due to reservoir construction and utilization of surface water on the upper reaches of Shiyang River, environmental geological tragedy has been emerged, as shown by the following specifics.

Water Shortage

Water discharges into Minqin Oasis was continually decreased during the last 40 years by about 5.42×10^8 m^3 annually. Water quantities taken from Shiyang River also decreased from 4.03×10^8 m^3 in the 1960s to 1.52×10^8 m^3 in the 1990s (see Figure 2). It has been reduced 1.0×10^7 m^3 annually since 1950. The water capacity flowing into the Minqin Oasis was only 0.84×10^8 m^3 in 2002. Today, per-capita water resources in Shiyang River are about 700 m^3, one-third less than that in China overall. Water capacity of a unit of farmland is only 220 m^3, which is even less than that of the driest place in the world, Israel, by about 34 m^3. While the depth of underground water was about 2 m in the 1970s, now it has decreased to 28 m and in some places down to 40 m [8]. Approximately 11,000 wells are used to extract underground water since the 1970s. Of these, 260 have a depth of between 200 and 300 m. At present, about 6.0×10^8 m^3 of groundwater is pumped out in one year [9]. The rapid decline of the underground water level simultaneously greatly deteriorates its quality. A typical case is that water mineralization increased from 0.02 to 0.35 $g.l^{-1}.a^{-1}$ in the Minqin Oasis during the last 50 years.

Vegetation Extinction and Grassland Degradation

The decline of the underground water level limits the growth of natural vegetation and grassland in the Minqin Oasis. Statistics show that 9×10^3 hm^2 of artificial *Elaeagnus angustifolia,* 2.3×10^4 hm^2 of *Nitraria sibirica Pall,* and *Tamarix ramosissima* were withered and dead; about 3.3×10^4 hm^2 of woodland faced the problem of sandy desertification during recent 50 years [10]. In the Minqin Oasis, natural grassland covered over 40×10^4 hm^2 before the 1970s. Unfortunately, nearly 70% of that has degraded at present. The main reasons are the shortage of water resources, over-grazing over many years, and the attempts by local people to reclaim barren land largely in order to obtain temporal economics or practical benefits. These factors only accelerate natural plant losses

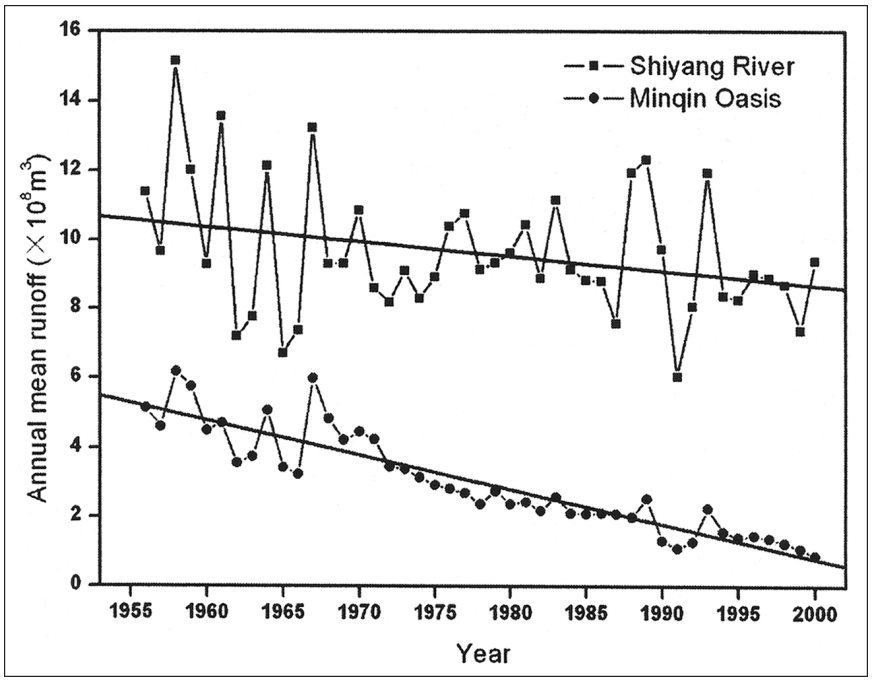

Figure 2. Surface runoff variation in the Minqin Oasis and Shiyang River during recent 50 years.

and bring on sandy desertification. The area of reclaimed barren land increased to 3.0×10^4 hm^2 from 1985 to 1995, while the area of vegetation extinction grew to about 8.0×10^3 hm^2. Many sand-protection forests on the periphery of the oasis have been destroyed. Sand shrub forestry dropped from 1.33×10^5 hm^2 in the 1950s to 7.3×10^4 hm^2 in 2000, of which 3.6×10^4 hm^2 was degradation, and 1.3×10^4 hm^2 was full sandy desertification.

Salinization

The Minqin Oasis also accumulates salt from the Shiyang River basin. Under conditions of deep underground water levels and high evaporation rates, soil salinity, water mineralization, and earth surface-drought will increase correspondingly (see Figure 3). Salina land was only 1.2×10^4 hm^2 in 1950s, rapidly enlarging to 1.2×10^4 hm^2 in 2002 [11]. Mineralization of underground water ranges from 4 to 10 g.l^{-1}, even up to 109.0 g.l^{-1} in some villages of the Minqin Oasis.

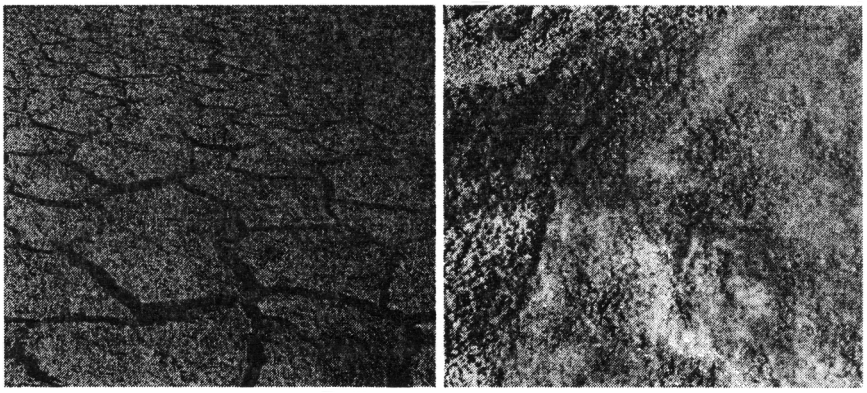

Figure 3. The appearance of the land surface due to the drought and mineralization.

Figure 4. A sign warning of sand dune encroachment.

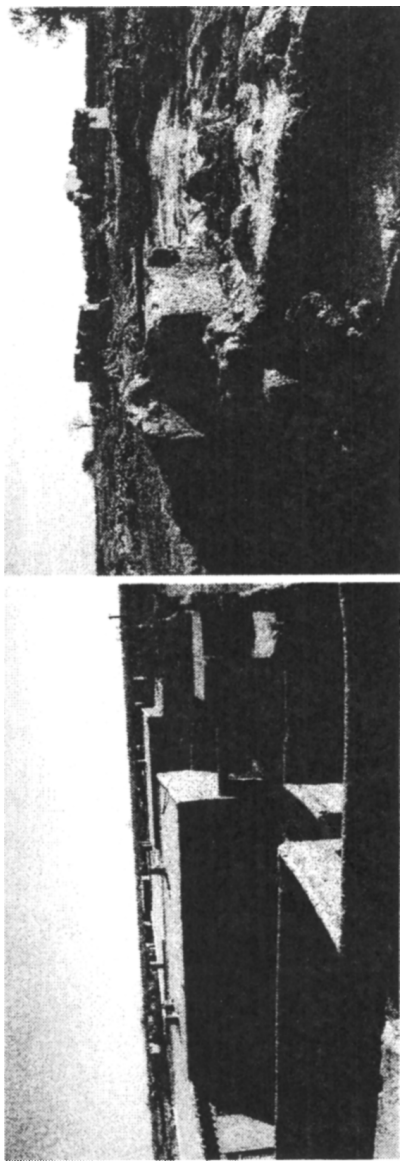

Figure 5. An example of habitations after the residents moved elsewhere.

Sandy Desertification and Poverty

Sandy desertification has expanded greatly in the Minqin Oasis since 1950s. At present, 6.67×10^3 hm^2 of crops are suffering sand encroachment and 2.0×10^4 hm^2 of farmland has been aborted in the Minqin Oasis. About 1.0×10^4 km^2 mobile sand lurks the periphery of the oasis. These moving sand dunes encroach toward farmland at a rate of 3-4 m every year. Especially in some severe zones of sand-activities, the rate exceeds 10 m per year (see Figure 4). Due to the deterioration of environmental conditions, the people there are very poor. Some people are even forced to move from one area to another again and again in order to search for a better place for living, and finally become the so-called "ecological refugee" (see Figure 5).

Therefore, in order to alleviate and remedy the poor situation in the Minqin Oasis, the current plans should be designed to change the current farming structure, use underground water resources carefully and innovatively, and establish a stable ecoagricultural system should be established.

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