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SHORT COMMUNICATION

Environmental hazards from population pressure in the Jinta Oasis, arid northwestern China

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Abstract Oasis is not only the most concentrated area of human activities in arid region but also the largest area where artificial disturbances occur at the regional scale. The Jinta Oasis is a very typical artificial oasis in arid region of China and is set as one of the national land resource developing and representative areas in China. With the continuous increase in population and livestock number in Jinta Oasis, such severe problems of environmental degradation as serious land pollution and desertification, water environmental degradation, and vegetation degeneracy occur within the whole oasis.

Keywords Population pressure · Land use change · Environmental hazard · Jinta Oasis of northwestern China

1 Introduction

Oases exist with deserts in arid and semi-arid regions of the world and are the specific and unique intrazonal landscapes. In China, oases are mainly distributed in temperate and warm temperate desert areas between the west of the Helan Mountain and the north of Qinghai–Tibet Plateau, which are connected westward with those of the Middle Asian region (Zhang et al. 2003; Jia et al. 2004). Although oases take up only 4–5 % of the total area of the region, over 90 % of population and over 95 % of social wealth are concentrated within the oases (Han 2001). Oasis is not only the most concentrated area of human activities in arid region but also the largest area where artificial disturbances occur at the regional scale.

The Jinta Oasis, located in the northeast of Jiuquan District, north side of middle of Hexi Corridor, is a very typical artificial oasis in arid region of China and is set as one of the national land resource developing and representative areas in China. With the rapid

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growth of human population, environmental hazards have been induced in the overall Jinta Oasis.

2 Background of Jinta Oasis

The Jinta Oasis is located in the lower reaches of Heihe River Basin of arid China and between 39°56′–40°17′N and 98°39′–99°08′E. Its total area is 1,652.2 km^2 (Fig. 1). The total annual average precipitation is about 59.5 mm, and annual potential evapotranspiration is about 2,567 mm. This oasis is a very typical artificial and agricultural oasis in arid region of China, which is set as one of the national land resource developing and representative areas in China owing to the continuous and easy reclamation of oasis soil (Chen 2000).

3 Land use change from 1988 to 2003 and environmental hazards induced by population pressure in Jinta Oasis

A land use map was acquired from Landsat images of the study area in 1988 and 2003 and it indicated that the total area of cropland, urban/built-up land, water, and barren land increased and forestland and grassland decreased from 1988 to 2003, respectively (Fig. 2). The relative increase in urban/built-up land was up from 7.67 to 21.03 km^2. However, the

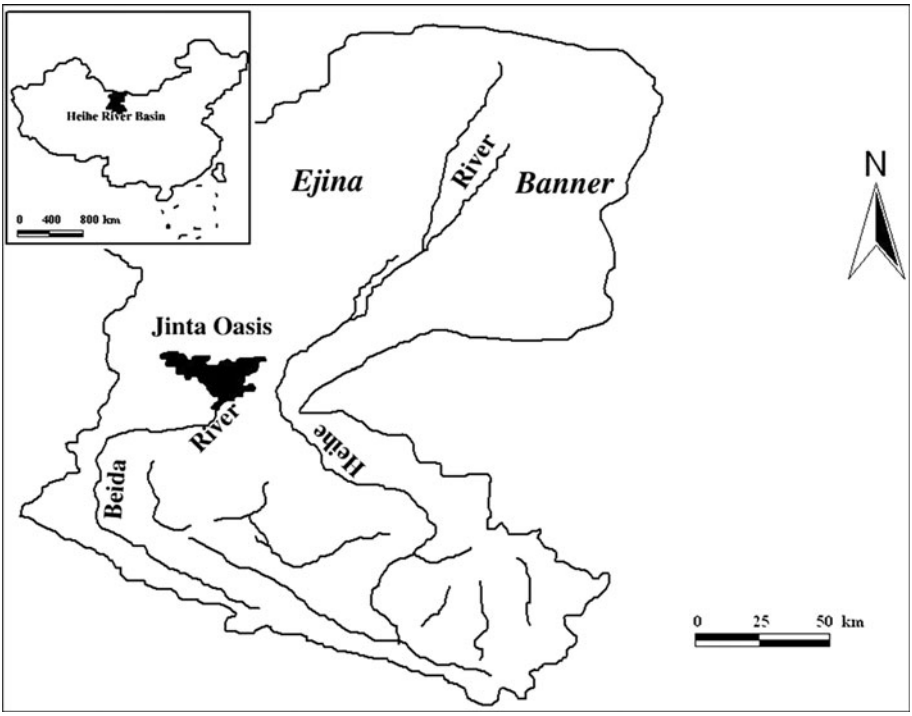

Fig. 1 Location map of Jinta Oasis (after Qi et al. 2007)

relative decrease in grassland was down from 206.61 to 148.55 km^2 (Fig. 2). Cropland (324.90 km^2 in 1988 and 354.93 km^2 in 2003), grassland (206.61 km^2 in 1988 and 148.55 km^2 in 2003), and barren land (1,576.47 km^2 in 1988 and 1,591.99 km^2 in 2003) were the main land use/cover types in Jinta Oasis, which accounted for more than 15, 7, and 73 %, respectively.

These changes in cropland, urban/built-up land, and grassland have the following reasons. Both natural conditions and human activities are responsible for the land use/cover changes in Jinta Oasis. The direct driving force for increases in cropland and urban/built-up land mainly was population growth in the oasis (Table 1).

Owing to the increase in cropland under population pressure in Jinta Oasis (Table 1), the gross yield of grain crops is continuously increasing. However, the amount of fertilizer application is also obviously increasing at the same time (Fig. 3, the curve of fertilizer application rates). For example, the yield of grain crops in the Jinta Oasis increased from 32.2 millions kg in 1988 to 111.3 millions kg in 2003. Accordingly, the amount of fertilizer application increased from 12.8 millions kg in 1988 to 36.4 millions kg in 2003 (Fig. 3). The increasing amount of fertilizer application caused severe land pollution and therefore limited sustainable development of the Jinta Oasis.

With the continuous increase in population and livestock number (Table 1), the area of cropland and built-up land has risen, but the grassland area has decreased significantly during the study period. These changes have caused land desertification development exhibiting spatial and temporal differentiation and the changes in regional groundwater resources in the study area (Lu et al. 2002; Li and Zhao 2003). Owing to the increase in cropland in Jinta Oasis and overuses of surface water resources in the upper and middle reaches of Heihe River Basin (Qi and Luo 2005), widespread extraction of groundwater resources is inevitable. For example, the area of cropland increased from 324.90 km^2 (1988) to 354.93 km^2 (2003) (Fig. 2), and the number of water-supplying wells in Jinta Oasis increased from 1,053 in 1988 to 1,570 in 2003 (Fig. 3).

Water being a limiting factor in plant growth, decreases in the water resources and decreasing grassland in the oasis have resulted in concomitant decreases in the number of plant species, as well as their density, coverage, and yield or biomass, thus resulting in the degradation of natural vegetation and oasis desertification in Jinta Oasis. Based on the collected data, the area of degraded grassland, sandy grassland, and grassland suffering

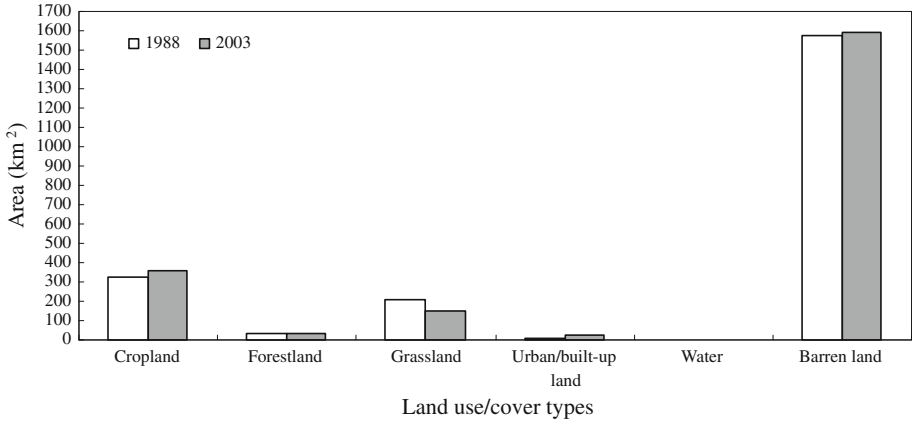

Fig. 2 Area of different land use/cover types of Jinta Oasis from 1988 to 2003

Table 1 Changes in cropland area, population growth, and livestock number in Jinta Oasis from 1988 to 2003

Years	Area of cropland (km^2)	Population ($\times 10^4$)	Livestock number ($\times 10^4$)
1988	324.9	11.85	2.602
1989	325.3	11.98	2.636
1990	329.7	12.53	2.646
1991	331.9	12.83	2.681
1992	334.4	13.04	2.746
1993	338.9	13.01	2.777
1994	341.5	13.13	2.869
1995	345.9	13.2	2.888
1996	348.5	13.39	3.036
1997	349.4	13.5	3.051
1998	350.7	13.62	3.332
1999	352.1	13.78	3.447
2000	352.8	13.76	3.645
2001	353	13.94	3.691
2002	354	14	3.852
2003	354.9	14.17	3.864

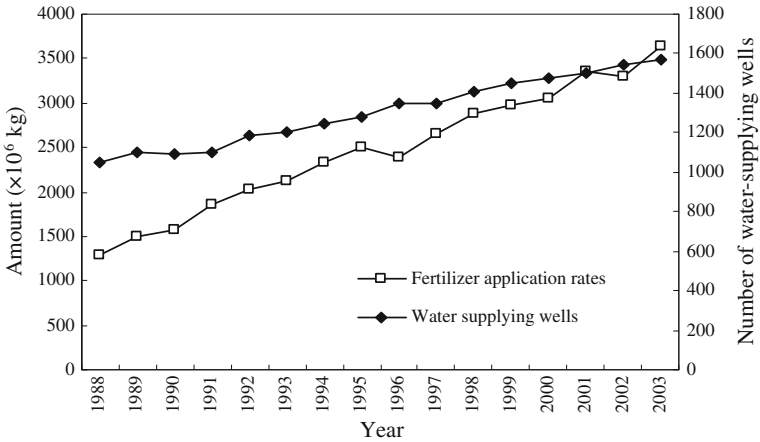

Fig. 3 Changes in fertilizer application rates and number of water-supplying wells in Jinta Oasis from 1988 to 2003

from wind-blown sand accounts for 52.0, 28.0, and 29.0 % of the area of available grassland in Jinta Oasis, respectively (Editorial Committee of Jiuquan Yearbook 2000).

4 Conclusions

With the population growth of Jinta oasis, the agricultural landscape and environment have obviously changed. The effects on oasis environment under population pressure mainly are

land pollution and desertification, water environmental degradation, and vegetation degeneracy.

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