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CHANGES IN THE AGRICULTURAL STRUCTURE OF THE QIRA OASIS

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1 INTRODUCTION

Little is known about the recent development of oases in the Taklimakan Desert of NW China, and records of their structure prior to the major agricultural reforms undertaken in the 1980s are scarce. The availability of high-resolution b/w photographs taken in the 1950s allows for the first time to analyze space-related landscape patterns within and outside the oasis farmland and to compare them to their status quo. An analysis of time-related changes in the cropping pattern or in soil fertility management practices within the oasis was not possible, given insufficient resolution of both the aerial and the satellite image data.

2 MATERIAL AND METHODS

An aerial photograph from 1956 (series K-7-18X56) and a SPOT satellite image from 1998 (No. 209-276 26/09/98) of the Qira Oasis were used to quantify changes of the agricultural landscape in the oasis itself, as in the 1980s it underwent a complete restructuring of its farmland and canal system (Zhang et al. 2001). The aerial photographs and the satellite image were transferred into a Geographic Information System (GIS) using ArcView 3.1 and were geo-referenced according to a main road crossing the oasis, which was the only feature clearly visible in both the 1956 and 1998 images. Three areas of 108 ha each were selected along a gradient intersecting the oasis from north-west to south-east (Fig. 1). The first area was located at the north-western margin of the oasis, the second area in the oasis center approximately 5 km north of the village center, and the third area 3 km south-east of the village center following the main road. Visible features such as field margins, tree vegetation and irrigation canals were delineated in the GIS map. These delineated features were used as a basis to calculate field sizes, vegetation cover and the length of the canal system.

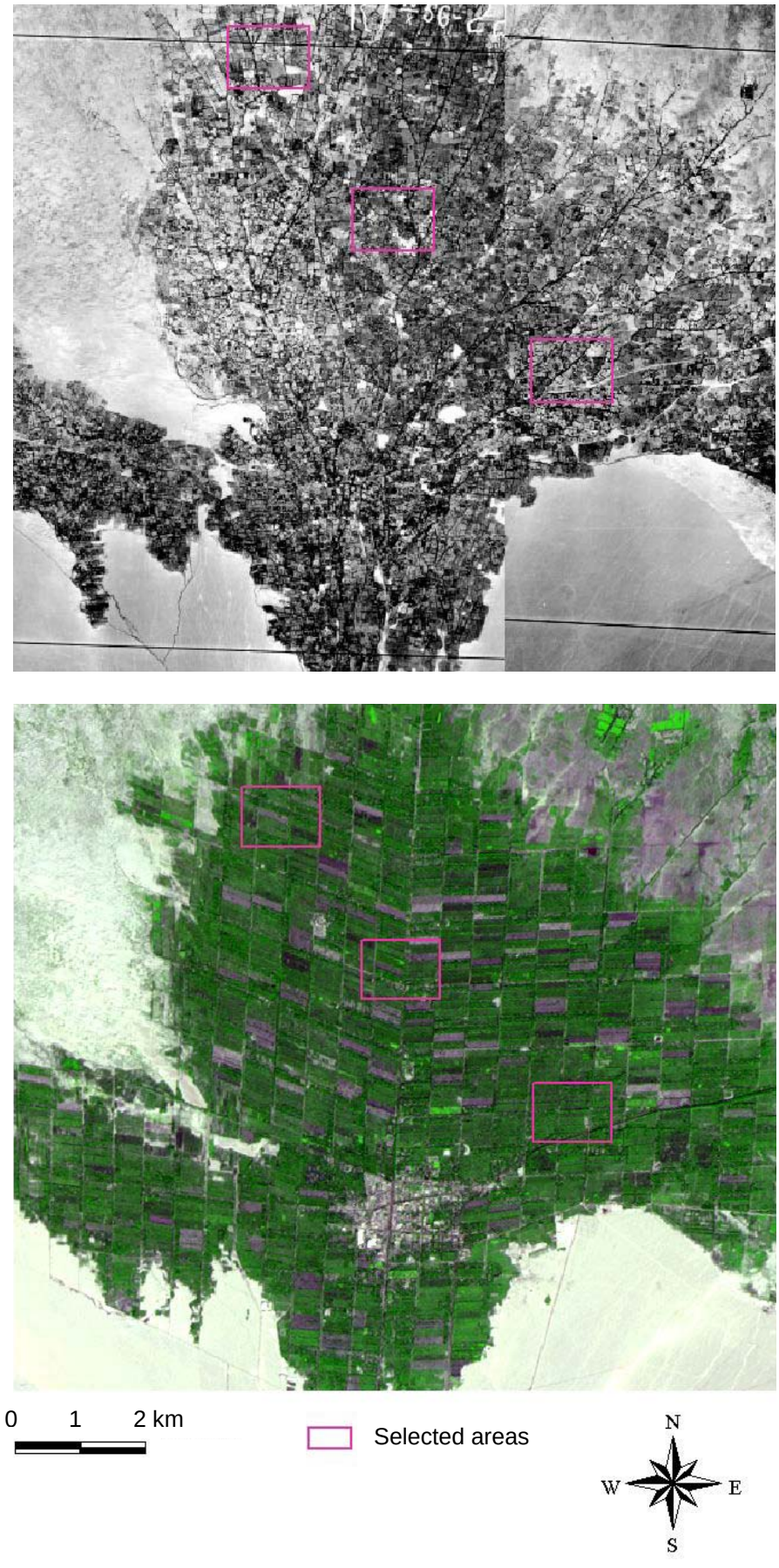

Fig. 1: Aerial photograph from 1956 (top) and SPOT satellite image from 1998 (bottom) of the Qira Oasis with selected areas for the image analysis.

3 RESULTS

The oasis of 1956 was characterized by a highly diverse agricultural landscape with fields of different size and shape, vegetation patches not used as arable land and an extensive canal system (Fig. 2). However, field sizes varied considerably dependent on the location within the oasis. The average field size of the north-western area at the oasis margin was twice as large as of the two areas at the oasis center (Table 1). This is illustrated by the distribution of the field sizes as percentage of total area (Fig. 3). Around two thirds of the fields in the central and south-eastern area of the oasis had a size of less than 0.5 ha. In contrast, in the north-western area the proportion of fields with less than 0.25 ha was very low; around one third of the fields were > 1 ha.

Table 1: Analyzed parameters in three areas of the Qira Oasis in 1956 and 1998 (all values are based on three observation areas of 108 ha size each).

Area	North-western area		Central area		South-eastern area	
Year	1956	1998	1956	1998	1956	1998
Number of fields	101	16	214	17	197	20
Average field size [ha]	1.1	6.7	0.5	6.4	0.5	5.4
Number of vegetation patches	323	0	919	0	1.173	0
Area covered by trees [%]	27.6	0	33.1	0	28.7	0
Total canal length [km]	20.2	10.8	23.7	10.7	17.1	11.8
Average canal length [m]	128	338	134	315	117	295

In 1956 a considerable part of the agricultural area was covered by tree vegetation in all three analyzed areas. The vegetation cover showed the highest density along the irrigation canals or in small patches in the fields (Fig. 2), and it might have partly consisted of *Populus euphratica* Oliv., at least in the peripheral areas (see Bruelheide et al., this volume). While the total area covered by tree vegetation was nearly equal along the analyzed gradient (Table 1), the size distribution of the vegetation patches showed differences according to the location within the oasis. Compared to the central and south-eastern area, the north-western area had twice as much vegetation patches with a size of more than 100 m² (Fig. 3), and the total amount of vegetation patches was much lower than in the previously mentioned areas (Table 1). In the oasis center, on the other hand, the share of vegetation patches with an area of less than 10 m² was considerably higher than elsewhere (Fig. 3).

The satellite image analysis of 1998 (Fig. 4) illustrates the complete transformation of the agricultural landscape. The only remaining feature seemed to be the road intersecting the south-eastern area. Dependent on the area the average field size increased six- to twelve-fold. On the satellite image no remaining vegetation could be identified in the fields (Table 1); whereas on the ground it was observed that *Populus alba*, *P. nigra* and *Juglans regia* plantations existed along all main canals. The new farmland was constructed fishbone-like from a main canal running across the oasis from north to south, which corresponded to the main canal intersecting Figure 2B in 1956, but it had no longer curvatures or bends.

Fig. 2: Delineated features of the Qira Oasis in 1956. **A**: north-western area; **B**: central area; **C**: south-eastern area.

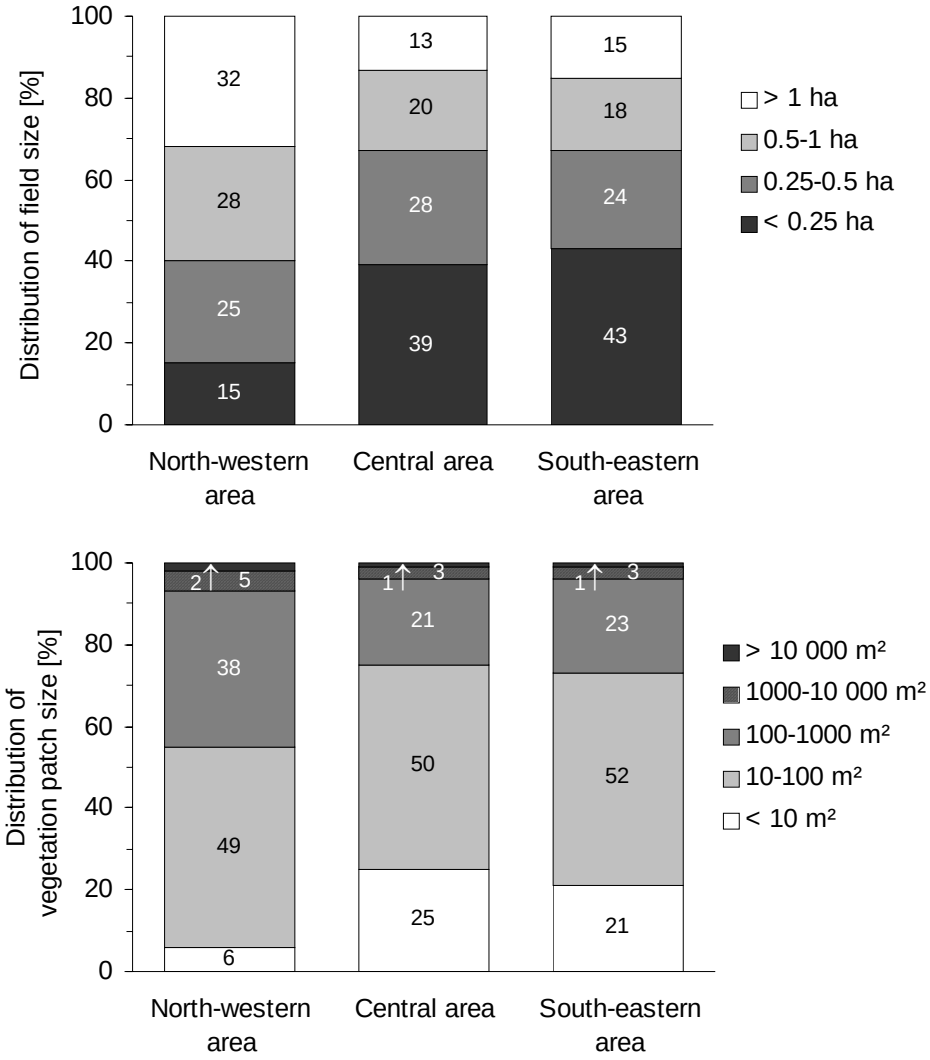

Fig. 3: Percental distribution of field size (top) and size of vegetation patches (bottom) at the Qira Oasis in 1956.

On the aerial photograph of 1956 straight lines covered by vegetation were identified as irrigation canals. Only in some cases was it possible to locate a canal as a single feature. Therefore the total canal length (Table 1) may be to some extent underestimated, and no relation to the field sizes could be established. In the satellite image of 1998 canal features could not be identified. However, it was assumed that the new canal system has been established along the field margins, and the field perimeter was taken to calculate the canal length. According to this calculation the total canal length per area was reduced by about 50% after the restructuring, meanwhile the average canal length increased by about 250% (Table 1), which mirrors a total abandonment of the individually constructed irrigation system of the old oasis. Due to the uniform design of the farmland no differences among the observation units were visible for the analyzed parameters in the oasis of 1998, but the fields closest to the village center were about one hectare smaller than the fields at the oasis margin, with a correspondingly lower average canal length (Table 1).

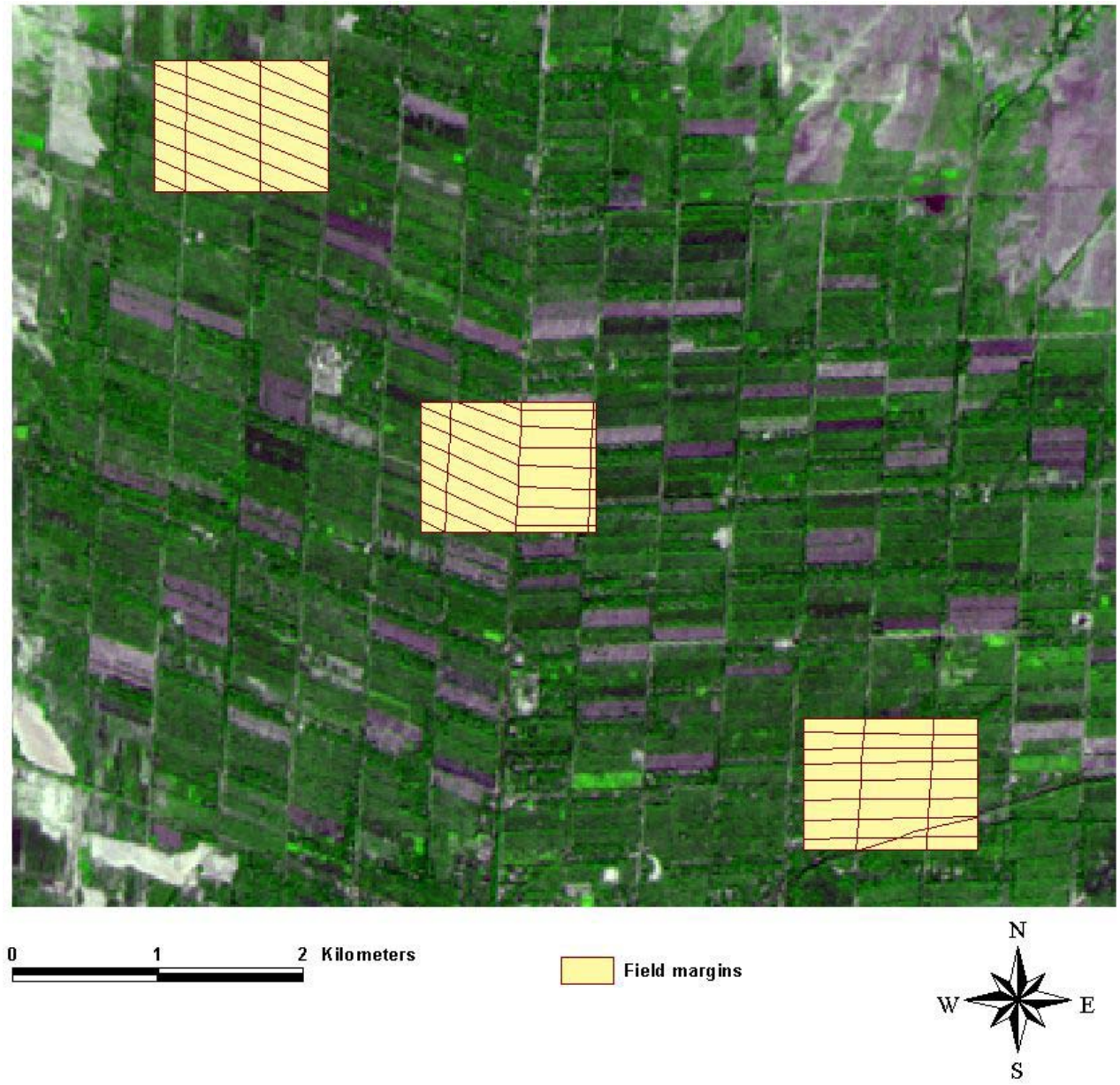

Fig. 8: Delineated features of the Qira Oasis in 1998.

4 DISCUSSION

The application of a GIS allowed to quantify differences in the farmland structure over space (within the 1956 oasis) and time (from 1956 to 1998). It showed that the size of fields and vegetation patches in the old oasis increased with an increasing distance from the oasis center. Being an obvious expression of the feudal land tenure system in pre-revolutionary times, the old oasis structure may have helped to protect the agricultural lands against sand drift from the surrounding desert; in this context the typical shelter belts around the fields should have effectively reduced wind-speeds. Zhang et al. (2001) mentioned that until 1957 the vegetation within the oasis was sufficient to cover the local fuel wood demand. The uniformity of the fields and the irrigation system in today's restructured oasis certainly favours an intensive, mechanized agriculture. There

are reports about considerable increases in the yield level and cropping area of crops such as cotton (Zhang et al. 2001). But the destruction of the small-structured farmland may have made the agricultural area more susceptible to severe sand drifts. This was confirmed by Xia et al. (1993) and Zhang et al. (2001), who stated that a considerable part of the farmland is at risk to be covered by drifting sand. However, the main causes for those sand drifts are likely to be found in the overused vegetation of the oasis foreland, following fuel wood exploitation, rather than in the changed structure of the oasis. Efforts undertaken to protect the oasis from sand encroachment and desertification should include both, protective measures within the oasis and in the foreland.

5 REFERENCES

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