MODELLING THE FUTURE VARIATIONS OF LAND USE AND LAND COVER IN THE MIDDLE REACHES OF HEIHE RIVER, NORTHWESTERN CHINA

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1. INTRODUCTION

The impact of Human activities on environmental change appears to be more important in global change research. Land use and land cover change (LUCC) are closely related to sustainable development of social and environment. So LUCC is a significant aspect of global change research. The future change of land use is a key scientific problem in current land use change research. As important tools for analyze the reason and result of LUCC, LUCC models can help to better understand mechanism of land use system, and to explore future LUCC in different scenarios.

CLUE-S (the Conversion of Land Use and its Effects at Small Region Extent) Model was used in the study. Zhangye City in the middle reaches of Heihe River, northwestern China (as a representative of arid areas) was selected to study its temporal and spatial evolution of LUCC between 2001-2020. The study especially highlighted the impact of water resource on LUCC. We hope to provide land use suggestions for the ecologically fragile areas through modeling results of LUCC changes under different water resource scenarios.

2. MATERIALS AND METHODS

2.1. Study area

Zhangye City is located between 97°20′-102°12′E and 37°28′-39°57′N, coverage 4.1064×10^6 hm^2. It is situated in the middle reaches of Heihe River, northwestern China. There are many types of land use in the study area such as grassland, wasteland, and woodland. Grassland accounts for more than half of the total land area, mainly natural grazing-based grassland, woodland is dominated by shrubbery; Farmland is less than7%.

2.2. Data collection

Land use data of Zhangye City was interpretated from TM image of 2000. The land use types included farmland, woodland, grassland, water cover, urban land and wasteland. We then converted Land use data from vector to grid with 1.0 km×1.0 km resolution.

2.3. Methods

CLUE-S Model was developed by scientists in Wageningen University of Netherlands and has had many successful study cases [1-4]. The model is sub-divided into two distinct modules, namely a non-spatial demand module and a spatially explicit allocation procedure. The non-spatial module calculates the area change for all land use types at the aggregate level. Within the spatially explicit allocation procedure these demands are translated into land use changes at different locations within the study region using a raster-based system.

For the non-spatial demand module includes different alternative model specifications ranging from simple trend extrapolations to complex economic models. The choice of a specific model is very much dependent on the nature of the most important land use conversions and the scenarios considered. The results from the demand module need to specify, on a yearly basis, the area covered by the different land use types, which is a direct input for the allocation module. The paper focuses on the procedure to allocate these demands to land use conversions at specific locations within the study area [5].

First, we used linear programming to calculate the requirement area of six land use types from 2001 to 2020 under three water resources scenarios. Constraint conditions include water quantity, total areas of the study domain, total population, macro-scheme of regional development and ecological balance. Second, 10 driving factors were chosen such as urban area, distance to river, distance to road, population density, elevation, slope, aspect, temperature, precipitation, evaporation. They represented the important contribution to LUCC changes in study area. Third, correlation coefficients between land use type and driving factors were obtained using logistic regression. We then constructed regression model using above coefficients, which served as input parameter of spatially explicit allocation procedure. Finally we got modeling results by CLUE-S model.

2.4. Water Resources Scenarios

According to water amount from the upper reaches of Heihe River, three scenarios of available water amount used to Zhangye city were supposed. They are 18.0 ×108 m3, 26.5 ×108 m3 and 35.0×108 m3, respectively, related to 68%, 100%, and 132% of water utilization ratio. Circulation and repeat utilization between surface water and groundwater was taken into account within study area.

3. RESULTS

The modeling results showed that: 1) The area of farmland decreases under the 3 scenarios. 2) The decreased farmland was negatively correlated with available water resources. 3) Woodland and grassland increase in three scenarios, which positively relates to available water resource. 4) The change of water area was not obvious in three scenarios. 5) The urban area does not change in scenario 1, but increases 19.5 % in Scenario 2 and 59.19 % in scenario 3, so urban areas also positively correlated to available water resources, 6) The wasteland greatly decreases (table1 and figure1-3)

Table 1 Land use area change modeled in three scenarios (Unit:km^2)

Land use type			Farmland	Woodland	Grassland	Water cover	Urban area	Wasteland
Initial stage(2001a)		area	3690	3555	11425	767	370	15499
		%	10.45	10.07	32.36	2.17	1.05	43.90
Final stage (2020 a)	Scenario 1	area	2283	5543	11817	767	370	14526
		%	5.05	15.00	34.60	2.17	1.05	41.61
	Scenario 2	area	2870	8183	12724	1164	442	9923
		%	7.44	24.58	36.10	3.30	1.25	28.14
	Scenario 3	area	3378	11953	12967	785	589	5634
		%	9.83	35.00	36.85	2.22	1.67	14.59

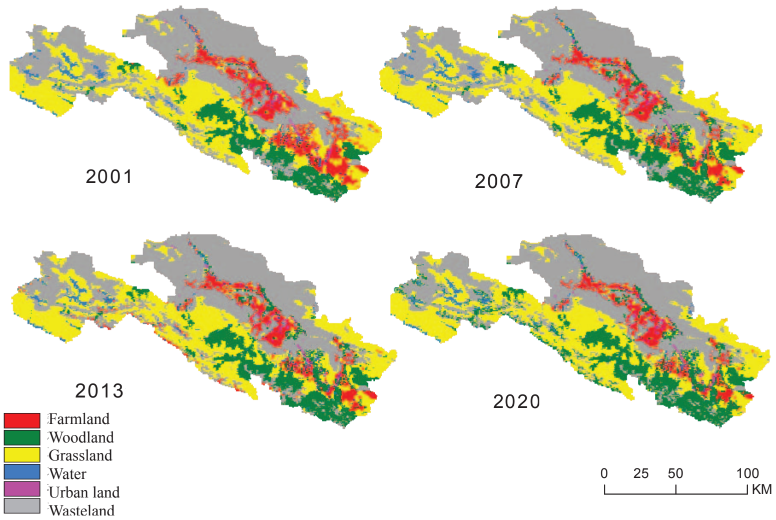

Fig.1 Land use change modeled in scenario 1 in the study area

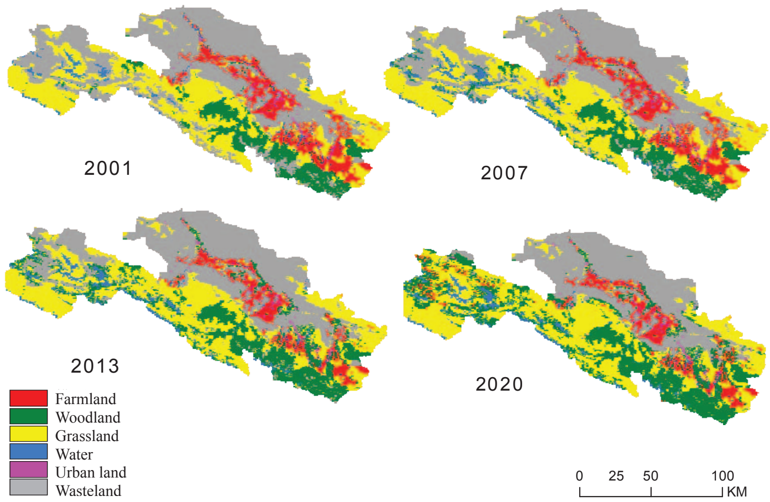

Fig.2 Land use change modeled in scenario 2 in the study area

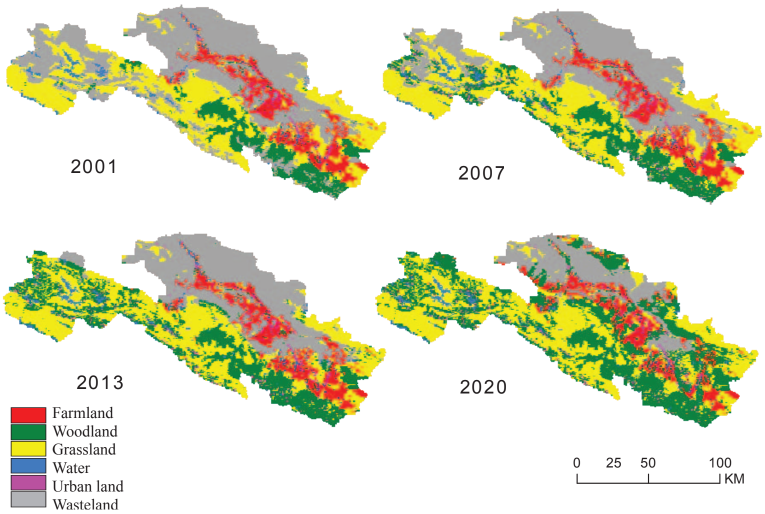

Fig.3 Land use change modeled in scenario 3 in the study area

4. CONCLUSIONS

LUCC in arid area is strongly restricted by water resources, especially for woodland. At different scenarios of available water resources, big changes about land use and cover can be detected. From the study, some conclusions can be draw that when the amount of available water resources is 35.0×108 m3, wood land and grass land coverage may rise to 35% and 36.85% respectively. The ecological environment would be significantly improved. The model can easily be applied to a wide range of study areas and land-use change situations.

The model is suitable for scenario analysis and the simulation of trajectories of land-use change. The model can identify critical areas of land-use change (hot spots) in different scenarios. Scenarios can be either macro-level conditions, such as price developments of agricultural products and/or changes in demographic characteristics or consumption patterns, or local level conditions, such as nature reserve protection, on the surrounding region. The possibility to simulate different scenarios makes the models be a powerful tool for natural resource management [5].

5. REFERENCES

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