

Land use/cover change and ITS eco-environment effect in Shiyang River Basin

X Q Hu¹, Y Z Jin¹, L H Ji², J J Zeng^{3,5}, Y Q Cui⁴, Z F Song¹, D Y Sun¹ and Y F Cheng¹

¹Gansu Research Institute for Water Conservancy, Lanzhou 730000, China

²Coalfield Geology Bureau, Gansu Province Lanzhou 730000, China

³Key Laboratory of Western China's Environmental Systems (Ministry of Education), College of Earth Environmental Sciences, Lanzhou University, Lanzhou, Gansu 730000, China

⁴College of Teacher's Education, Honghe University, Honghe 654400, China

E-mail: zengjj15@lzu.edu.cn

Abstract. Based on the origin data of Landsat TM images in 1980, 1995, 2000, 2006, 2012, this paper recurred to geoscience information spectrogram theory and utilized RS / GIS technologies, land use dynamic degree, land use transition matrixes and CA-Markov model to analyze the land use pattern change in Shiyang River Basin in the past 33 years, which was for the sake of discussing the spatial-temporal evolution rules and driving mechanism of land use in Shiyang River Basin. The results showed that: (1) There were apparent changes in the land use of Shiyang River Basin from 1980 to 2013. (2) in the past 33 years, the dynamic degrees of forest land, urban and rural resident construction land had relative large increase degree on the whole. (3) The main transition direction of land use types were arable land to grass land, grass land to unused land and unused land to arable land and forest land. (4) The CA-Markov model forecasting results indicated that there was no obvious change in land use construction in 2020. (5) The change of land use/cover brought desertification, mountainous runoff variation, the loss of water environment, vegetation coverage, water and soil, and a series of ecological environment problems.

1. Introduction

Land use and land cover change directly reflects the way to make use of land resources in a region [1,2]. Regional land use and land cover change has become one of the world's research hot spots [3,4]. The accelerating global climate change and human activities have led to the changes in land use and land cover, leading to the changes of regional society, economy and environment, and thus producing more complex land use patterns and functions of the evolution process [5], triggering more natural phenomena and changes in ecological processes, such as human activities, waters environment, desertification, vegetation coverage, ecological and environmental effects [6,7]. Therefore, based on the analysis of regional land use change, the land use pattern can be predicted by the dynamic simulation of land use pattern, which can provide scientific reference for the rational utilization of regional land resources, for the protection and improvement of ecological environment and the sustainable development [8-10]. At present, there are few studies on the spatial evolution of land use in the arid inland river basins, especially the arid inland river basin in the Hexi Corridor belonging to



“One Belt and One Road”, where the process of drainage is rapid. The study, combined with land use change and spatial evolution, on the pattern of land use in the arid inland river basin is relative less.

In order to make the combination of the two organically, this study, on the basis of obtaining the land use change and the spatial analysis function of GIS, took the Shiyang River Basin as an example and based on the remote sensing image data of different periods by using the geo-information map theory, land use dynamic index and transfer matrix, which can research the land use change in the process of river basinization in different periods, and reveal its pattern and process of evolution [11-13]. We can study At the same time, CA-Markov model was used to predict the land future spatial changes, to forecast the ultimate land use pattern, to study its spatial distribution pattern and the eco-environmental effects of land use and land cover change in Shiyang River Basin, and to prevent unreasonable development and utilization activities, which can minimize the risk of land use in the process of urbanization, can scientifically and effectively manage and utilize the land resources so as to provide the basis for rational planning of land use, ecological restoration and regional economic development [14-16].

2. Introduction of the study area

Shiyang River Basin is one of the three biggest Hexi inland river basins of Gansu Province. Its latitude is between $36^{\circ}29' \sim 39^{\circ}27' \text{ N}$ and $101^{\circ}41' \sim 104^{\circ}16' \text{ E}$, and covers an area of 41,600 square kilometers [17]. This area is linked with Baiyin City and Lanzhou City in the southeast, and adjoins Zhangye City in the northwest. In the southwest it closely lies beside Qinghai Province and in the northeast it lies in the Nei Monggol Autonomous Region.

The terrain of the south is higher than that of the north, which presents an inclination from the southwest to the northeast. Located in the interior mainland, the area is categorized as arid continental monsoon climate of the north temperate zone. The soil of the basin is in a zonal distribution. There are 4 cities and 9 counties in this basin, including Gulang County of Wuwei City, Liangzhou District, Minqin County, part of Tianzhu County, Yongchang County of Jinchang City, Jinchuan District, Sunan Yugur Autonomous County of Zhangye City, part of Shandan County, and little part of Jingtai County of Baiyin City. The polulation of the Shiyang Basin is 2.2733 million by the end of 2014. (figure 1 Location Map of Shiyang River Basin).

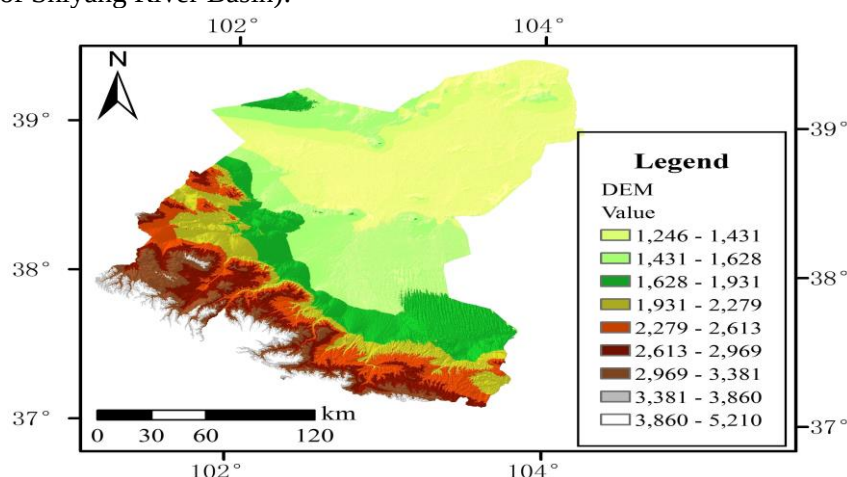


Figure 1. Location map of Shiyang River Basin.

3. Research methods

3.1. Remote sensing data processing

Land use data sources contain TM in 1980, TM in 1995, ETM+ in 2000, TM in 2006 and TM in 2010 image. With the support of ERDAS IMAGINE 9.2 software, the remote sensing data were processed by RGB false color synthesis and radiation correction. The geometric correction was carried out by

using the quadratic polynomial method with the reference geography of 1: 50000 topographic map. According to the classification system of land use in China [18], it is divided into six levels (arable land, forest land, grassland, waters, residential land and unused land) and 22 secondary land use types with the combination of the present situation and characteristics of land use in the study area. The method of supervised classification and human-computer interaction are used to complete the land use classification of remote sensing image interpretation. According to the sample points of field investigation, the accuracy of interpretation can be verified. With the support of ArcGIS9.2, the land use data of the 5 stage is finally formed and stored in GRID format, which is convenient for classification, spatial overlay and other computing operations [19,20]. Table 1 is the two classification system of land use / land cover of Shiyang River.

Table 1. The two classification system of land use/land cover of Shiyang River.

Class1 and classification codes	Class2 and classification codes
arable land 1	dry land 12
Woodland 2	woodland 21 shrub forest 22 forest land 23 other forest land 24
grass 3	high coverage grassland 31 coverage grassland 32 low coverage grassland 33
Waters 4	river canal 41 lake 42 reservoir pond 43 tidal flat 45 beach 46
residential land 5	urban land 51 rural settlements 52 other construction land 52
unused land 6	sand 61 Gobi 62 saline land 63 swamp 64 naked land 65 bare rock boulder 66

3.2. Analysis of land use change

3.2.1. Land use dynamic degree. A single type of land use dynamic degree represents the change rate of a land use type. According to the model of land use dynamic degree proposed by Wang Siyuan and Liu Jiyuan, it reflects the extent of regional land use change, the formula is [21]:

$$K = \frac{(U_b - U_a)}{U_a} \times \left(\frac{1}{T} \right) \times 100\% \quad (1)$$

In this formula, U_a is the number of land use types at the beginning of the study period, U_b represents at the end, and T is the length of the study period, K represents the dynamic degree of a land use type during the study period. When T represents the year, K is the annual change rate for some types of land use in the study area.

Land use degree and its change, can quantitatively express the comprehensive level and trend of land use in the area. According to Zhuang Dafang, Liu Jiyuan's calculation method [21]:

$$L = 100 \times \sum_{i=1}^n A \times C_i \quad L \in [100, 400] \quad (2)$$

$$R = \frac{(L_b - L_a)}{U_a} \quad (3)$$

In the formula: L represents comprehensive index of land use degree; R represents the degree of land use change; A represents the land use classification index; C_i represents the i -level land use

classification area percentage. The unused land grading index is 1; woodland, grassland and waters area classification index is 2; agricultural land (arable land, paddy field) classification index is 3; construction land classification index is 4; L_b and L_a represent the comprehensive index of land use at the end of the study period and the beginning of the study. $R > 0$ indicates that land use is in the development period. $R < 0$ indicates that land use is in recession.

3.2.2. Land use transfer matrix. The land use transfer matrix is a general method of revealing the direction of land use and land cover type at home and abroad. It can reflect the structural characteristics of the change and the direction of the transfer between the various types. Based on the analysis of land use change, the land use data of the Shiyang River Basin during 5 periods were analyzed by Arc-GIS, and the land use change graph database and the land use transfer matrix in the Shiyang River Basin from 1980 to 2013 were established.

3.3. CA-Markov model

The CA-Markov model is composed of Markov chain, multi-criteria evaluation (MCE) and CA [22-24]. Markov chain is used to generate the probability of land use type transfer. MCE creates land use transfer possibilities by using socioeconomic data and terrain data to. Image sets, transfer probabilities and transfer possibilities Atlas use CA filters to achieve future land use simulation [25]. Based on CA-Markov model in IDRISI 15 software, the change of land use pattern in the study area was simulated. The specific process is as follows:

- The determination of the conversion rules. Through the GIS overlay analysis, the transfer area matrix and the transfer probability matrix of the land use type in the 1980-2013 study area are obtained, and the transition probability matrix is used as the conversion rule to participate in the simulation operation.
- The set of suitability atlas. The multi-criteria evaluation model (MCE) provided by IDRISI software is used to create the land use suitability atlas, to select the natural factors (digital elevation model, soil organic matter content, rainfall, accumulated temperature, waters resources, etc.), to distance factors and socioeconomic factors (population density, GDP, etc.). According to the needs of the MCE model, the appropriate range of 0 ~ 255 is standardized, and five categories are divided including the most appropriate, appropriate, generally appropriate, unsuitable and most unsuitable, and it to be a parameter for CA transformation rules;
- The construction of the CA filter. The CA5 standard 5×5 adjacent filter is defined as the neighborhood, that is, the matrix space composed of 5×5 cells around each central cell has a significant effect on the change of the cell state.
- The determination of the starting time and the number of CA iterations. Taking the 2012 as the starting time of prediction, and the number of iterations of CA is 8, which means to simulate the spatial pattern of land use in the study area in 2020.

4. Results and analysis

4.1. Characteristics of land use and land cover change in Shiyang River Basin

Based on the analysis of the change rules of land use and its structure, we can see the land use area and the structure of Shiyang River basin in 1980, 1995, 2000, 2006, 2012 (Refer to table 2). During the period from 1980 to 2012, the land use and land cover in the Shiyang River basin had significant changes. The area of arable land, forest land, waters, urban and rural residents and construction land increased by 281.57 hm^2 , 128 hm^2 , 40.57 hm^2 and 177.19 hm^2 respectively, and the area of grassland and unused land decreased by 212.21 hm^2 and 415.12 hm^2 respectively. The proportion of unused land is 48.47%, 47.62%, 47.89%, 48.85% and 47.19% respectively. It is the dominant position of land use pattern, followed by grassland and arable land. In addition to that the forest land, residential land and waters accounted for a smaller share, indicating that the region is dominated by unused land,

consistent with the characteristics of arid inland river basin (figure 2).

Table 2. Land use area and structure of Shiyang River basin in 1980, 1995, 2000, 2006, 2012.

type	1980		1995		2000		2006		2012	
	Area (km ²)	Percentage (%)	Area (km ²)	Percentage (%)	Area (km ²)	Percentage (%)	Area (km ²)	Percentage (%)	Area (km ²)	percentage (%)
arable land	6663.63	16.42	6439.61	15.87	6796.81	16.75	7044.22	17.36	6945.20	17.87
woodland	2628.06	6.48	2653.87	6.54	2630.56	6.48	2545.17	6.27	2756.06	6.79
waters	149.69	0.37	278.36	0.69	149.83	0.37	192.45	0.47	190.26	0.47
Grassland	11121.16	27.41	11547.00	28.46	11183.05	27.56	10525.89	25.94	10908.95	26.40
Residential land	349.24	0.86	337.22	0.83	386.84	0.95	447.82	1.10	526.43	1.29
Unused land	19667.04	48.47	19322.76	47.62	19431.75	47.89	19823.29	48.85	19251.92	47.19
total	40578.83	100.00	40578.83	100.00	40578.83	100.00	40578.83	100.00	40578.83	100.00

However, nearly 33 years, the residential land showed a sustained growth trend, mainly due to population growth, economic development and the acceleration of urbanization process. But its extent of area growth varies, and the increase in area from 2006 to 2012 is particularly significant. The unused land presents a decreasing trend, and the decrease in the area from 1980 to 1995 was 227.09 km² less than that of 2006 to 2012. The trend of arable land change was the same as that of residential land, which showed a continuous increase trend, mainly due to the “method of closing well”, “grain for green” and other accelerating urbanization policies. Forest and waters changes in the same trend. Woodland in 2006-2012 increased the largest area from 2545.17 km² to 2756.06 km². The waters in 1980-1995 increased the largest area from 149.69 km² to 278.36 km², but the trend is increasing on the whole 33 years mainly due to the national policy of “grain for green”, ecological natural recovery, and “method of closing well”. Reasons affecting the change of waters were largely attributed to the natural environment, the increased waters area.

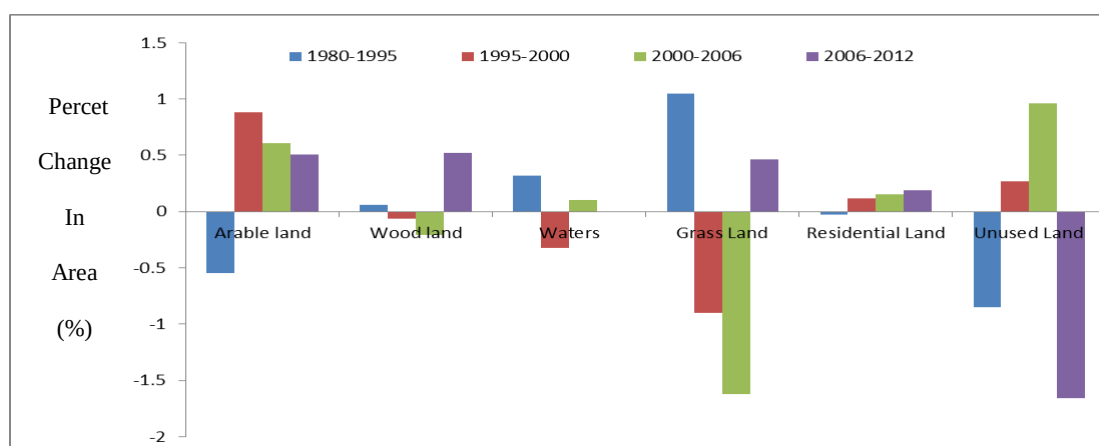


Figure 2. Land use change area of different periods in the Shiyang River Basin from 1980 to 2012.

4.2. Analysis on land use change degree in Shiyang River Basin

In the past 33 years, from the single dynamic degree of various land use types in the study area, the overall increases of forest land and residential land in the Shiyang River Basin were from 0.0655%

and -0.2295% respectively from 1980 to 1995 increase to 1.3810% and 2.9257% from 2006- to 2012. In addition, the forest land showed a significant increase after the process of continuous increase, and residential land showed a trend of decreasing first, increasing later and tended to be stable.

The results showed that waters and unused land decreased. The single land use degree respectively from 5.7305% and -0.1167% from 1980 to 1995 reduced to -0.1897% and -0.4804% from 2006 to 2012. Meanwhile, the waters showed “increase-decrease-increase-decrease” trend, the overall reduction of unused land was small and arable land was relatively stable. Figure 3 represents different periods of land use dynamic degree in Shiyang River Basin in 1980-2012.



Figure 3. Different periods of land use dynamic degree in Shiyang River Basin in 1980-2012.

According to the formula (2), the land use comprehensive index of the Shiyang River Basin in 1980, 1995, 2000, 2006 and 2012 was 16969, 16993, 17076, 17069 and 17328 respectively, which showed that the upward trend was first fast and then slow. According to the formula (3), the land use change values from 1980 to 1995, 1995 to 2000, 2000 to 2006 and 2006 to 2012 were 0.0014, 0.0049, -0.0004 and 0.0152 respectively. Moreover, the land use change values were greater than 0, which indicated that land use in the study area from 1980 to 1995, 1995 to 2000 and 2006 to 2012 were in the development stage. However, its value was less than 0, indicating that the land use in the study area during the period of 2000 to 2006 was in the slowing stage. From the comprehensive land use dynamics, the rate of land use change in the Shiyang River Basin had experienced a process of “significant change-significant change-slow change-rapid change” in the four periods. Figure 4 represents the comprehensive dynamic degree of land use type in Shiyang River Basin.

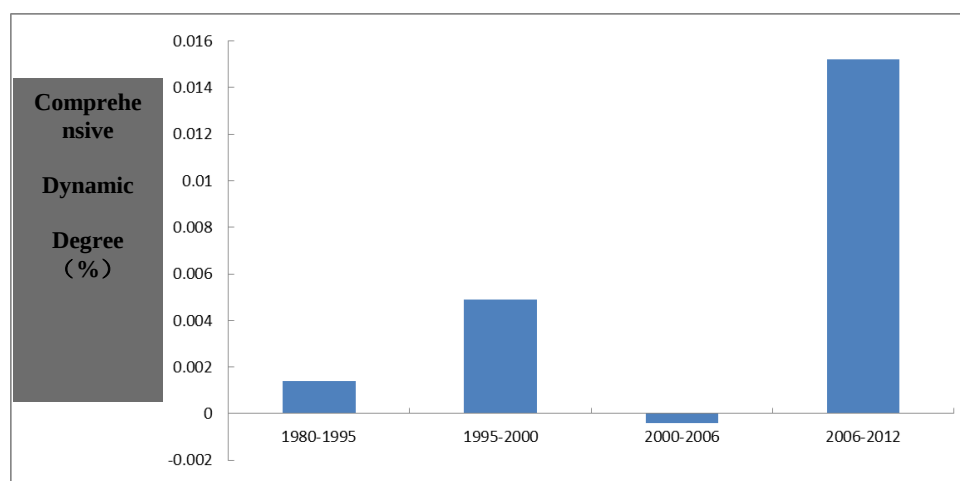


Figure 4. The comprehensive dynamic degree of land use type in Shiyang River Basin.

4.3. Analysis of land use and land cover change process in Shiyang River Basin

In order to explore the land change in the Shiyang River Basin, the land use dynamic transfer matrix of the Shiyang River Basin from 1980 to 1995, 1995 to 2000, 2000 to 2006 and 2006 to 2012 was calculated. The spatial dynamic shifts of various types of land in the study area are shown in table 3. It is not difficult to see that the main direction of land use was the conversion of arable land into grassland, the conversion of grassland into unused land and the conversion of unused land into Arable land and forest land. Among them, arable land was converted into grassland with value of 333.80 km², grassland was converted into unused land with value of 1780.25 km², and unused land was converted into arable land and woodland with values of 644.82 km², 376.61 km² respectively.

Table 3. Land use type conversion matrix for the Shiyang River Basin from 1980 to 2012 (10⁴ hm²).

1995								
	name	Grassland	Residential land	arable land	Wood land	waters	Unused land	total
1980	Grassland	10772.56	3.65	197.47	14.28	12.04	121.16	11121.16
	Residential land	9.25	306.03	29.14	0.36	0.14	4.31	349.24
	arable land	423.54	21.47	5885.59	59.96	2.64	270.42	6663.63
	woodland	36.05	0.12	26.46	2540.46	0.17	24.80	2628.06
	waters	1.26	0.36	8.07	0.00	139.86	0.15	149.69
	Unused land	304.34	5.58	292.88	38.81	123.51	18901.92	19667.04
	total	11547.00	337.22	6439.61	2653.87	278.36	19322.76	40578.81
2000								
	name	Grassland	Residential land	arable land	Wood land	waters	Unused land	total
1995	Grassland	10769.04	11.17	433.43	36.22	1.26	295.88	11547.00
	Residential land	3.65	306.30	23.50	0.11	0.36	3.29	337.22
	arable land	199.57	60.82	5993.40	28.57	9.63	147.62	6439.61
	woodland	14.32	0.64	69.56	2539.76	0.00	29.58	2653.87
	waters	13.35	0.14	2.72	0.24	138.43	123.47	278.36

	Unused land	183.10	7.77	274.19	25.64	0.15	18831.90	19322.76
	total	11183.04	386.84	6796.80	2630.55	149.83	19431.75	40578.82
2006								
	name	Grassland	Residential land	arable land	woodland	waters	Unused land	total
	Grassland	9368.05	14.38	293.68	62.70	13.29	1430.93	11183.05
	Residential land	1.09	359.66	23.51	0.57	0.02	1.99	386.84
	arable land	300.72	60.91	6221.29	26.20	2.55	185.14	6796.81
2000	woodland	168.57	2.39	49.45	2349.33	3.07	57.74	2630.55
	waters	2.73	0.00	5.03	0.04	139.89	2.14	149.83
	Unused land	684.72	10.47	451.26	106.34	33.62	18145.33	19431.75
	total	10525.89	447.82	7044.22	2545.17	192.45	19823.28	40578.83
2012								
	name	Grassland	Residential land	arable land	woodland	waters	Unused land	total
	Grassland	8669.05	12.68	270.81	276.04	17.66	1279.17	10525.42
	Residential land	9.19	328.81	84.47	5.30	1.02	19.02	447.82
	arable land	253.24	137.51	6326.15	78.37	3.95	244.87	7044.10
2006	woodland	333.91	2.48	44.57	2038.22	11.10	114.90	2545.17
	waters	14.65	0.08	6.39	5.11	139.10	27.13	192.45
	Unused land	1628.92	44.87	212.82	353.02	17.43	17566.22	19823.27
	total	10908.95	526.43	6945.20	2756.06	190.26	19251.31	40578.22

The change of grassland was caculated. First, the outflows of grassland were 348.6 km², 777.96 km², 1814.98 km² and 1856.36 km², and the inflow areas were 774.44 km², 413.99 km², 1157.83 km² and 2239.91 km² respectively from 1980 to 1995, 1995 to 2000, 2000 to 2006 and 2006 to 2012 respectively. It can be seen that in the past 33 years, the total turning out area of grassland was larger than that of transferred into area. In the past 33years, the largest outflow rate of grassland in 33 years was changed to unused land. The largest outflow from grassland in the period from 1980 to 1995, 1995 to 2000 was arable land, and it from 2000 to 2006, 2006 to 2012 was the unused land. This indicated that the two-way transfer of grassland was mainly arable land and unused land. Thus, the protection of grassland, arable land and unused land area development had mutual tourism effects.

Changes in the transfer of residential land showed that first, the land area of residents were 43.2 km², 30.91 km², 27.18 km² and 119 km², and the inflow areas were 31.18 km² and 80.54 km², 88.15 km² and 197.62 km² from 1980 to 1995, 1995 to 2000, 2000 to 2006 and 2006 to 2012 respectively. The total area of residential land into the area was greater than the transfer area. Secondly, during the 33 years, the largest land outflow rate for residents was shifted to arable land, and the largest source of land inflow was arable land. This showed that the two-way flow of residential land was mainly between residential land and arable land, followed by residential land expansion which had been taking up arable land resources. The results showed that urbanization was the progress of residential land, the backward of Arable land, and the transfer of residential land to Arable land. Meanwhile, the main area was suburb, which was mainly caused by land reclamation under the guidance of land use planning.

The conversion of Arable land showed that from 1980 to 1995, 1995 to 2000, 2000 to 2006 and

2006 to 2012, the outflow area of Arable land was 778.03 km², 446.21 km², 575.52 km² and 717.94 km² respectively, and the inflow areas were 554.02 km², 803.4 km², 822.93 km² and 619.06 km² respectively. In the past 33 years, the inflow area of Arable land was generally larger than the outflow area, showing a continuous increase trend. Second, nearly 33 years, the largest outflow of arable land was the transformation of grassland. Correspondingly, the most important source of arable land inflow was unused land, which showed that a large amount of unused land had been transformed into arable land in urbanization.

The change of forest land Indicated that from 1980 to 1955, 1995 to 2002, 2000 to 2006 and 2006 to 2012, the outflows of forest land were 87.6 km², 114.1 km², 281.22 km² and 506.96 km² respectively, and the inflow areas were 113.41 km², 90.78 km², 195.85 km² and 717.84 km² respectively. Nearly 33 years, the total area of forest land into the area was larger than the transfer area, showing a continuous increase in the trend. From 1980 to 1995, 1995 to 2002 and 2000 to 2006, the inflow and transfer areas were almost balanced, but the inflow area was much larger than that of the area transferred from 2006 to 2012, which mainly caused by the “method of closing well”, “grain for green” and other policies.

Changes in the transfer of waters reveled that from 1980 to 1955, 1995 to 2002, 2000 to 2006 and 2006 to 2012, the outflows of the waters were 9.84 km², 139.92 km², 9.94 km² and 53.36 km² respectively, and the inflow areas were 138.5 km², 11.4 km² and 52.55 km² and 51.16 km² respectively. From 1980 to 1995 and 1995 to 2000, the change of waters was obvious, but the overall transfer rate was not largeapparent. From 2006 to 2012, the waters had not changed greatly, and basically maintained at the same level.

Unused land transfer change. From 1980 to 1955, 1995 to 2000, 2000 to 2006 and 2006 to 2012, the outflow areas of the waters were 765.12 km², 490.85 km², 1286.41 km² and 2257.06 km² respectively, and the inflow areas were 420.84 km², 599.84 km², 1677.94 km² and 1685.09 km² respectively. The conversion of unused land into Arable land was the main change track, which reflected the regional population pressure under the trend of economic interests, and caused people to increase the utilization of sandy beach. Human factors leaded to increase food but accelerated the deterioration of regional ecological environment.

4.4. Prediction of land use change trend based on CA-Markov model

Based on the distribution of land use types in 2012, the input land use suitability atlas was established by input Basic MCE. The number of cycles of geocontrol automata was 8a, and the CA-Markov model was used to obtain the land use forecast map of the study area in 2020 (figure 5).

With the support of ArcGIS, random samples were generated with create random points, and 498 samples were randomly selected finally. With the help of the function of spatial analyst, the data of the two types of landings respectively in 2013 and 2014 were extracted, and the accuracy of the prediction model was verified. The simulation results showed that the simulation data could express the trend of convergence among the classes, and it was a good idea that the model was able to predict future changes in land use types. According to the forecast, the area of arable land, forest land, waters, grassland, residential land and unused land in the study area in 2020 are 6136.83 km², 3186.73 km², 203.32 km², 11928.03 km², 669.30 km², 18462.39 km² respectively. Compared with 2012, although the land use structure did not change greatly in 2020, the land use pattern continued to maintain the trend of 1980 to 2012, and it was still dominated by unused land and grassland. Thus, land use was not dominated by land use pattern. The second was the grassland and the arable land. Compared with it, forest land, residential land and waters had smaller share and small reduction, those degrees of mutual conversion were relatively small and keep basically stable in a dynamic equilibrium state.

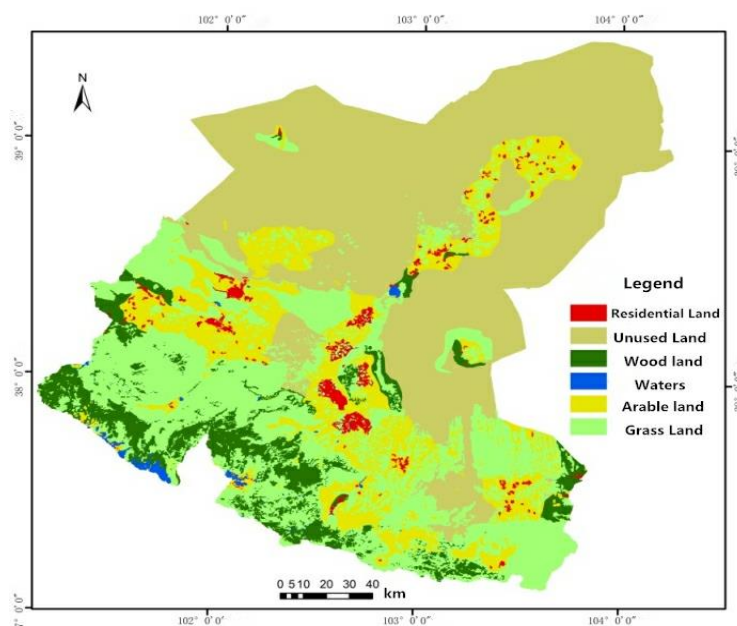


Figure 5. Land use of Shiyang River Basin in 2020.

The increase rate of predicted 8a grassland is was about 1019.082 km², and the increase rate was relatively obvious from 2006 to 2012. The trend of ecological restoration was still apparent. The area of arable land was reduced by 808.37 km², and its reduction rate was greater than that of 2006 to 2012, which showed the effective implementation of “grain for green” and the continuous expansion of urban land use scale. The unused land, arable land and grassland were the main transformation trajectories, which also showed that the future protection of arable land was still arduous. It could be seen that strengthening urban land use management, rational planning and ecological restoration was still very necessary. The increase of forest land in the forest area was also the arable land and unused land. Although the project of “method of closing well”, and “grain for green” had played a certain role, the momentum of regional ecological environment deterioration had been curbed to a certain extent. However, how to adjust the agricultural, animal husbandry industry structure and change the mode of production and management were still the current problems which must be solved. The ecological environment and economic development between the contradictions would exist for a long time. Compared with 2012, the type was basically in a dynamic equilibrium state.

5. Conclusion

With the technical support of RS and GIS, the remote sensing interpretation of land use in 1980, 1995, 2000, 2006 and 2012 was completed. The GIS spatial analysis function and the geo-information map theory were used to study the land use change and the spatial pattern of the urbanization process. The results showed that the land use and land cover change was significant in Shiyang River Basin, and the overall land use structure was 48.47%, 47.62%, 47.89%, 48.85% and 47.19% respectively, Which was the matrix of land use pattern with position of greater strength, followed by grassland and arable land. Compared with that the share of forest land, residential land and waters were smaller, which indicated that the area to the main land, consistent with the characteristics of arid inland river basin. As a whole, residential land, forest land and grassland were expanding, accompanied by a large decrease in arable land and unused land.

From the point of view of the single dynamic degree of various land use types in the study area, the single dynamic degree of the forest land and the residential land in Shiyang River Basin had increased greatly in the past 33 years. Meanwhile, the forest land firstly showed a stable declining tendency and then became a significant increase during the process. Residential land showed a trend of decreasing

first, increasing later and tended to be stable finally. The waters showed the trend of increasing-decreasing-increasing-decreasing. The overall reduction in land use was not significant, arable land was relatively stable, and the land use in the study area was in the developing stage in the study area from 1980 to 1995, 1995 to 2000 and 2006 to 2012, but from 2000 to 2006 it was in a slowing down stage. From the perspective of comprehensive land use, the rate of land use change in Shiyang River Basin experienced a process of “significant change-significant change-slow change-abrupt change” in four periods.

The main direction of land use type transfer was the conversion of arable land into grassland, the conversion of grassland into unused land, and the conversion of unused land into arable land and forest land.

The CA-Markov model is used to introduce the ultimate state transition matrix to predict the trend of land use pattern. The CA-Markov model predicts that the land use structure does not change greatly in 2020, but its land use pattern will continue to maintain the trend of that from 1980 to 2012, which is still dominated by unused land and grassland, being the land use pattern of the matrix landscape, followed by grassland and arable land. Compared that the share of woodland, residential land and waters were smaller, and its reduction were small.

The degree of mutual conversion was relatively small and basically stable in a dynamic balance state. The change of land use and land cover had caused a series of ecological and environmental problems including desertification, soil erosion, the change of vegetation coverage and waters environment, runoff loss and so on. This paper provides a basis for rational planning of land use, ecological restoration and regional economic development. The key management of the Shiyang River Basin has achieved initial results. On this basis, the planning should be further revised and perfected; the waters-saving society should be taken as the main line and be built; the ecological environmental protection should be regarded as the foundation; the rational allocation of waters resources, conservation and protection should be treated as the core; the economic and social sustainable development should be taken as the goal. In accordance with the general idea of the downstream rescue Minqin oasis, the middle reaches to restore the ecological environment and upstream protection of waters sources, the Shiyang River Basin has been carried out the key governance and achieved the goal of never allowing Minqin to be the second Lop Nor.

6. Discussion

The results of the above studies show that the land use and land cover change of Shiyang River in the past 33 years was significant, and on the whole, the overall land use structure of the region was dominated by unused land with area of 48.47%, 47.62%, 47.89% %, 48.85% and 47.19% respectively. Taking in the dominant position, and being the matrix of land use pattern, which indicated that the area was dominated by unused land and met the characteristics of arid inland river basin.

Followed by grassland and arable land, and compared with that the share of forest land, residential land and waters was smaller. As a whole, residential land, forest land and grassland showed expanding, accompanied by a large decrease in arable land and unused land. In the four periods of 1980 to 1995, 1995 to 2000, 2000 to 2006 and 2006 to 2012, land use change had a process of “significant change-significant change-slow change-rapid change”.

In the four periods, land use change had undergone a process of “significant change-significant change-slow change-rapid change”. This was basically the same as the historical development of the Shiyang River Basin. From the beginning of the founding of the early 20th century to the early 1980s, the population of this basin was stable, and the human activities had little effect. In addition, the arable land decreased significantly, and the area of forest land and grassland increased greatly. By the mid and late 90s, through the “grain as the key link” thought, grain production expanded in a large area, so that a large number of grassland was converted into arable land. Coupled with lower yields of various crops, the development of agricultural production mainly relied on the expansion of arable land, so the land area increased. The cultivation of economic crops caused a large number of forest grassland and forest land to be reclaimed as arable land, while some unused land such as saline-alkali land was

reclaimed as arable land, which resulted to a significant increase in arable land area. By the 21st century, with the implementation of the key management plan of Shiyang River Basin, the area of Arable land decreased, and the area of grassland and forest land increased continuously.

Over the past 30 years, the population of the Shiyang River Basin had continued to increase. As the population increased, food demand increased dramatically. At that time, the farmland was not enough to maintain life. In order to solve the problem of food and clothing, the area of arable land was expanded by cutting down forests and reclaiming grasslands and wetlands, which caused an increase in Arable land area and a decrease in grassland area. At the same time, population growth, urban expansion, road and other infrastructure construction intensity increased, resulting in a significant increase in residential area. The unused land increased first and then decreased, which reflected the ecological environment of the Shiyang River Basin. Under the combined action of nature and human activities, it experienced the process of deteriorating from the 1950s to the mid-1990s. At the end of 2010, with the implementation of the “grain for green” and the recent comprehensive treatment project in the Shiyang River Basin, the trend of continued use of unused land had been curbed to a certain extent, but the overall degradation trend still existed. It can be seen that population growth, economic development factors and national policies are the main drivers of land use and land cover change in the Shiyang River Basin.

Due to the special geographical conditions, the effects and capability of the ecological environment in Shiyang River Basin for human disturbance had a certain sensitivity and vulnerability. With the change of global climate and the aggravating of human activities on the disturbance of the environment, the change of land use and land cover has caused the sustainable destruction of waters environment, desertification, vegetation coverage, soil erosion, runoff and a series of other eco-environmental problems. Therefore, only reasonable planning and ecological restoration will restore the ecological environment of the Shiyang River Basin.

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