Temporal and Spatial Changes of Land Use Research in Shenmu City, China

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ABSTRACT

Land use change is a very complex system, which is manifested in the functional complexity of different land use types. And it is also for the structural complexity between the various types, both of which need to be analyzed from the spatial pattern and time process. The land use model includes characteristics of simulating complex changes with advantages study on the trends, quantity and spatial changes of land use change. Land use modeling can effectively reflect the change of land class, especially for dynamic simulation of intricate geographic space system. It shows some advantages in simulating of spatial phenomena with time and space dynamic changes. Therefore, the use of modeling for land use change simulation research has its inherent practicality and rationality and it also can help to solve inappropriate land use.

With the development of social economy, the arable land is gradually reducing, and the construction land is infinitely expanding, which leads to the contradiction between land use and limited land resources. Therefore, making reasonable use of the limited land has become a key issue in land use. One aspect of land use change research is based on the historical data to predict in order to understand the future trend of land use for the rational use of land to provide the basis and reference

In the face of China's social and economic development of the excellent situation. Chinese land administration is always in a dilemma. On the one hand, China has a large population, which should be protected for the national food security to serve the 1.3 billion population and the survival and development of future generations as a top priority. "Protection of arable land is to protect our lifeline", which is China's land administration motto for dealing with the priority. On the other hand, "development is the most important", industrialization, urbanization is the only way of modernization. The land is the material carrier of industrialization and urbanization. The construction will be inevitably part of the land, including arable land, protecting the resources and the development. It is a dilemma that needs to be studied and solved in China for a long time. This means that good control of land use change has significance that can make efficient use of land to satisfy different land use.

In summary, in a multi-level and multi-factor complex geographic system, land use change process that is extremely complex. It is necessary to build a model for its simplify. Thus, the spatial model is irreplaceable for understanding the dynamic change process and predicting its future trend. The complex process and mechanism of understanding the change of land use can be realized by constructing the model. And then we can find out the corresponding countermeasures and solutions based on the analysis results. The combination of land use change and land use model, which can analyze and investigate change to put forward reasonable and efficient recommendations for optimization land use.

Key words: Land use change, Shenmu city, Land use model, Optimization land use

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1. INTRODUCTION

This chapter introduces the background and justification of this research, which focus on principle of land use and land use change to address the research problem. It aims to find out land use cannot be controlled appropriately by government. Then focus on analyzing the relationship between these land use and land use model to figure out the law between them.

1.1. Background

Land use is the total of arrangements, activities, and inputs that people undertake in a certain land cover type (Sleeter et al., 2012). According to Jansen and Gregorio (2002), land is used in human activities, such as agriculture, industry, transportation, residential etc., which are based on the natural, the needs of social and economic development, the long-term transformation, development and utilization of land resources.

Land use change is a very complex system, which is manifested in the functional complexity of different land use types, but also for the structural complexity between the various types, both of which need to be analyzed from the spatial pattern and time process (Q. Yang, Li, & Shi, 2008). At the same time, the change of land use system is the result of the interaction between natural geography environment system, humanities and social economic system (Foley et al., 2005).

The complexity of land use change determines that the land use research must adopt the theoretical method of complex system, especially the establishment or application of spatial model based on complex system thought, which is one of the important fields of land use process research (Santé, García, Miranda, & Crecente, 2010). Therefore, the combination of the characteristics of land use change, the use of complex system research methods and application of land use change scientific model is the key to the study of land change complexity.

So far, the direct and clear models for the theory and mechanism of land use change are a lot, but the combination of land use change and its spatial distribution as well quantity change is rare (Milad, Ming, Firuz, & Hanan, 2017). Therefore, this research combines cellular model and Markov model for land use change research. Spatial modeling is an analytical process conducted in conjunction with a geographical information system to describe basic processes and properties for a given set of spatial features (Han, Hayashi, Cao, & Imura, 2009). Spatial modeling can simulate complex systems, which can be used to study land use change processes, which can be done to protect limited land development planning, optimize the process of urbanization control and to effectively control the process of urbanization and spatial layout, through the development of policies and planning to control (Pérez-Molina, 2014).

In summary, the aim of this study is to understand the law of land use change by establishing the model, so as to provide a basis for alleviating the contradiction between land and human resources and putting up with optimization land use in Shenmu city.

1.2. Justification

With the development of social economy, the arable land is gradually reducing and the construction land is infinitely expanding, which leads to the contradiction between land use and limited land

resources (Guo, Yu, He, Zhao, & Li, 2012). Therefore, to make reasonable use of the limited land has become a key issue in land use or management of land. One aspect of land use change research is based on the historical data to predict, in order to understand the future trend of land use changes for the rational use of land to provide the basis and reference (Yamagata & Seya, 2013).
As the basic resources of human, the use of land will also change with the development of demand. China is rich in land resources, vast territories, many types of land, but the per capita possession is limited due to tight supply and demand (Yamagata & Seya, 2013). Therefore, to ensure the full and effective use of land resources, the Government needs to make good decision and implementation on land use management and supply and demand control. With the development of social economy, China's various regions face different levels of population, resources and environmental problems, and the central region is particularly serious, so this research has important practical significance, but also for the effectiveness of land policy implementation, continuous and targeted.
The land use model has characteristics of simulating complex changes which has advantages study on the trends, quantity and spatial changes of land use change. Research on driving forces of land use change can figure out which social or economic factors can influence land use changes and simulate the spatial changes of land use to make reasonable forecasts for the future. Therefore, put up reasonable land use and spatial modeling can help to solve inappropriate land use and land contradiction.

1.3. Research Problem

In the face of China's social and economic development of the excellent situation, China's land administration is always in a dilemma. On the one hand, China has a large population, should be to protect the national food security, to serve the 1.3 billion population and the survival and development of future generations as a top priority. "Protection of arable land is to protect our lifeline", which is China's land administration motto to deal with the priority (Jin et al., 2017). On the other hand, "development is the most important", industrialization, urbanization is the only way of modernization. The land is the material carrier of industrialization and urbanization. The construction will be inevitably part of the land, including arable land, protect the resources and protect the development. It is a dilemma that needs to be studied and solved in China for a long time. This means that good control of land use change has significance that can make efficient use of land to satisfy different land use.
Land use modeling can effectively reflect the change of land class, especially for dynamic simulation of intricate geographic space system. Spatial modeling shows some advantages in simulating of spatial phenomena with time and space dynamic changes (Q. Yang et al., 2008). Therefore, the use of land use model for land use change simulation research has its inherent practicality and rationality.
In summary, in a multi-level and multi-factor complex geographic system, land use cover change process is extremely complex. It is necessary to build a model make it simpler. Thus, the geographical model is irreplaceable for understanding the dynamic change process and predicting its future trend. The complex process and mechanism of understanding the change of land use can be realized by constructing the model. And then, we can find out the corresponding solutions based on the analysis results. Combination of land administration, land use change and spatial modeling, which can analyze and investigate change to put up reasonable and efficient

recommendations for land administration.

1.4. Concept Framework

Figure 1-1 shows the concept framework of this research is that process satellite image to generate land use maps in 2005, 2010 and 2015. Comparing different land use model to choose land use index model and CA-Markov. Then, using CA-Markov model to simulate land use change in 2020 with two development mode. Then using land use index and land use maps to analyze land use changes in Shenmu city. Finally, combining the situation in Shenmu to put forward optimization land use.

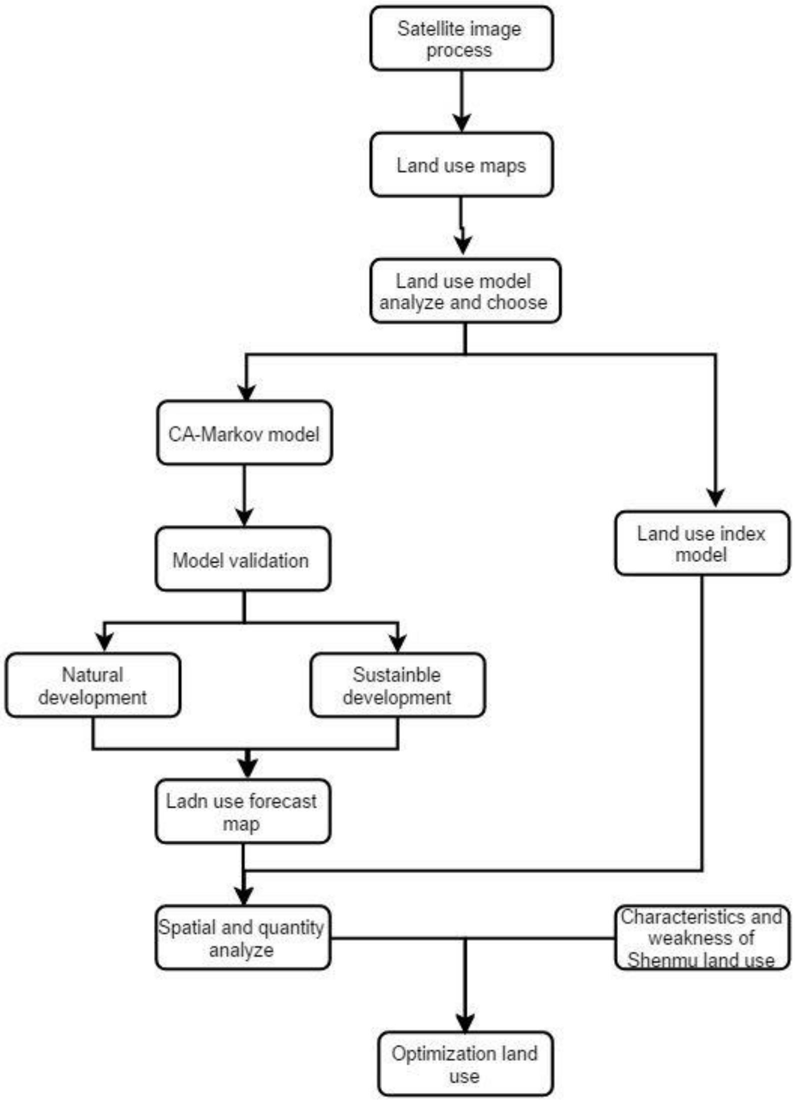

Figure 1 Conceptual framework

1.5. Overall Objectives

Using model to analyze and predict the land use change in Shenmu city for optimization land use.

1.6. Sub-objective

Objective 1: To choose the model and simulate land use change.

a) What are the criteria of spatial and quantity model to simulate land use change?

b) What are CA-Markov model and land use index model? Why CA-Markov model being most suitable for simulating land use change?

c) How to use the CA-Markov model to simulate land use change?

Objective 2: To analyze the land use change, combining with the situation of Shenmu to put forward optimization land use.

a) What quantity and spatial changes have been taken place in Shenmu city?

b) What are the situation in Shenmu city? Which factors will have significant impact on trends in land use change?

c) How to achieve optimization land use?

1.7. Research Design matrix

Table 1 Research design matrix

Using spatial modeling to analyze and predict the land use in Shenmu city for optimization land use.				
Sub-objective	Research question	Methods	Required data and tool	Anticipated result
To choose the model and simulate land use change.	a) What are the criteria of spatial and quantity model to simulate land use change? b) What are CA-Markov model and land use index model? Why CA-Markov model being most suitable for simulating land use change? c) How to use the CA-Markov model to simulate land use change?	-Literature review -Interview	--Satellite image in 2005, 2010, 2015 - County boundary of China --ArcGIS -ENVI5.3 -IDRISI	-Post satellite image -Components of CA and Markov model --Maps of trends prediction
To analyze the land use change, combining with the situation of Shenmu to put forward optimization land use.	a) What quantity and spatial changes have been taken place in Shenmu city? b) What are the situation in Shenmu city? Which factors will have significant impact on trends in land use change? c) How to achieve optimization land use?	-Interview -Spatial analysis and quantity analysis	-Post land use maps -Excel -ArcGIS -Situation of Shenmu city	-Factors which have significant impact on land use change. -Optimization land use

1.8. Thesis structure

Chapter 1: Introduction

This chapter introduce the information of research background and justification to address research problem. It generally illustrates relationship between land use change and land use model, as well as why this research uses spatial modelling to solve problem. Overall objective, sub-objectives and research question are mentioned to divide research to part to solve one by one. Moreover, the conceptual framework, methodology and research design are mentioned to answer research question.

Chapter 2: Literature review

In this chapter, it reviews the literature which introduce main basis of this research and define the concepts, as well as spatial models and quantity model which are used for simulating land use change. This chapter aims at clarifying relationship between land use model and land use change, it also compares different methods to explain the selection of cellular automata model.

Chapter 3: Research design and methodology

The approach for collecting data is explained in this chapter which presents why select specific study area for this research. different data collection methods will be introduced in this chapter for various kinds of data. Meanwhile, the process of satellite image also be presented in this chapter

Chapter 4: Land use model

This chapter present the principle and process of the model, and the reasons for simulating land use change. The elements and characteristic of cellular automata will be illustrated in this chapter, which also presents why this research choose specific elements.

Chapter 5: Results and Discussion

After satellite image process, I put post-image into the CA-Markov model to investigate the trends in land use change. This research has two different development models: natural development model and constraint development model. Then I do the quantity analysis and spatial analysis according to the results.

Chapter 6: Optimization land use

As the situation of inappropriate land use in Shenmu city and the result of model. We find the requirement for land use under the new situation and try to make some advice for optimization land use. Then we find out the proper way to achieve the optimization land use in different direction such as protect arable land, land use functioning zoning etc.

Chapter 7: Conclusion

This chapter includes the conclusion of the study. For conclusion, it will be proposed the suitable approaches for achieving objectives and sub-objective. And make some recommendation for this research.

2. LITERATURE REVIEW

This research will focus on the main concepts as follows: land use, land use change and land use model. This chapter also introduce land use current situation and land use change in China. It aims at analyzing relationship between land use and land use model. It also illustrates why cellular automata is chosen for this research. A complete process of the spatial modeling would be presented in chapter 3 and 4.

2.1. Land use

Land use involves the management and modification of nature or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. It also has been defined as "the total of arrangements, activities, and inputs that people undertake in a certain land cover type (IPCC, 2000).

According to Comber, Fisher, & Wadsworth (2005) land use is the naturally occurring or man-made coverage of the Earth's surface. Human activities on the land, causing land use, the intensity of change, and ultimately lead to changes in land use, land use changes in turn will affect the ultimate purpose of land use. Research on how to make reasonable use of limited land resources, improve land use efficiency and land productivity, and realize the sustainable use of land resources has become an increasingly important research topic.

2.1.1 Land use classification and type

Land use classification is used for measuring land and its impact on ecosystem that land use classification is required (FAO, 1976), to meet needs of different users and to monitor the environment a detailed classification of land use is required and to meet this need Economic Commission for Europe (ECE) released a Standard Statistical Classification of land use mixing some categories of land cover and taking into account additional economic activities like mining, industrial land, land used for public services, etc. (Gong, Marklund, & Tsuji, 2009). The System Of National Accounts (SNA) asset classification distinguishes four types of land for collection of data on land in physical unit and in monetary value according to the services it is providing: land underlying buildings and structures, land under cultivation, recreational land or associated surface river and other land and associated surface river (United Nations, European Commission, International Monetary Funds, Organisation for Economic Co-operation and Development, & Bank, 2008). There is the framework for integrated land use classification. The classification should cover the total area of land that needs to be classified irrespective of the fact if it is being used for any economic activity. For this purpose, we need to define land 1. The categories of the classification should not overlap 2. The classification should cover all activities 3. The classification systems should not be confused with legends 4. In segments having multiple activities, each activity should be included 5. Very often land use data base need to be linked with policy relevant information (Foody, 2002).

2.1.2. Land use quantity structure

Land use quantity structure, which means proportion of various types of land use and the relationship between the ownership in the country or region (Salvati & Carlucci, 2015). In different historical periods, social and economic conditions, human work on the development and use of land resources, the depth of different land use structure is constantly changing (Lauber, Strickland, Bradford, & Fierer, 2008). For instance, the expansion and development of the city reduce agricultural land, while the reduction of agricultural land and promote the intensive use of land. In different natural economic conditions, land use structure is also different. The land use structure directly reflects the land use status in a certain period and can be used to analyze the extent of the land economy, the regional economy and the various sectors of the enterprise economy. Because of the needs and the development of economy, land use structure can also be used to forecast and plan the utilization of land resources and its trend in the future (E F Lambin & Meyfroidt, 2011).

2.1.3 Land use spatial distribution

Lu & Liu (2013)indicated that Land use spatial distribution refers to the spatial relationship of different land use types in the region. Different areas require different spatial distribution of land. For example, in urban area, construction land or commercial land is generally distribution in the center of the city or in a convenient transportation area. Reasonable land use spatial distribution can allocate limited land resources in the region and make best use of different land use types. Due to the scarcity of land supply and the irrationality of land use, the optimization land use is to rationally protect land resources and scientific use of land. Distribution aims at finding a certain way of land use and land suitability, social and economic fit to match and so on (Berry & Minser, 1997).

2.1.4 Land use research

Land use have been researched on the southern part of Germany's, Thunen studied on "The Thünen rings" land use model since the early of the 19th century (Fujita, 2012). Land use research was mainly aimed at land use surveys in the early 20th century. Stamp set up the British Land Use Survey on the land use of the United Kingdom conducted a survey, which made a comprehensive report, including the national report, the various parts of the report and land use thematic map, and published the " The Land of Britain " from 1931 to 1939 (Stamp, 1931). From then on, the land use survey has been launched on a global range. In 1946, Australia completed a large-size as well as medium-sized land use survey (Terrain, 2009). Subsequently, many countries have carried out land resources research and other research, including the United Kingdom, Canada, Netherlands and some Eastern European countries, Japan, India etc. After World War II, due to the growing demand of land resources, lots of countries have gradually started planning the land use research work, and the requests of the using of aerial photography for regional scope of land survey to map a more extensive and systematic research (Gutman et al., 2008). In the early of 20th century, the study of land use mainly focused on the land use classification description, mapping and the preliminary mechanism of land use change. Land use was only a traditional blueprint planning and land use structure research had not been paid enough attention yet.

Since the 1970s, with the issue of population, resources, environment and development, there is a rapidly growing demand of land use and the sustainable use of land resources has increased a lot. Land use structure and its optimization research have been paid attention to land use planning. At this point, the beginning of the use of remote sensing, computer technology and mathematical methods is a great improvement in land use research. These methods have been widely used in analyzing and monitoring of land use change, land use mapping and classification, spatial pattern and pattern of land use and land use planning and mapping, etc., which solved many specific problems in land use research. At the same time, due to the needs of land use planning, both the land inventory and land evaluation research work have been carried out (Meyer & Turner, 1994). In 1976, the FAO promulgated the "A Framework for Land Evaluation", while FAO launched a study on the agro-ecological zone project, proceeding from the analysis of climate and soil production potential, and applied in Africa, Southeast Asia and West Asia(FAO, 1976). Since the 1980s, GIS began to be widely used in land resources and evaluation, land use planning, land use change and other fields. The promulgation of Agenda 21 at the World Conference on Environment and Development in 1992 has greatly promoted the ideas and concepts of sustainable development and the sustainable use and management of land resources. It has also become a common concern of all countries (UN, 1992).

2.2 Land use change

Land use change is a major driver of global change, through its interaction with climate, ecosystem processes, biogeochemical cycles, biodiversity and even more importantly - human activities (Eric F Lambin et al., 1999). Land use change includes land use quantity change and spatial change.

In the early days, people only discussed the mechanism of land use change and the landscape pattern and process of land cover from the angle of economics and landscape ecology. In 1931, River et al. (1931)in the study of the American Great Plains agricultural society, the influencing factors of the local agricultural land use types were studied, and the local land use types were determined by the local drought level. In the 1995, International Geosphere–Biosphere Programme (IGBP) and International Human Dimensions of global environmental change Programme (IHDP) actively planned a global integrated research program with the continued growth of population and industrialization, the rapid development of urbanization, the shortage of land resources and the occupation of agricultural land. Land use change research became global environmental change research frontier and hot areas(Turner et al., 1995). In the same year, the International Institute for Applied Systems Analysis (IIASA) launched a series of "land and land use change simulation projects in Europe and North Asia" jointly conducted by scientists from different countries and different backgrounds. The land use land cover in Europe and North Asia from 1900 to 1990 was analyzed change the temporal and spatial characteristics and environmental effects of the changes in the global environment, population, economic, technical, social and political factors such as changes in the context of the region over the next 50 years the trend of land use change. And it stressed that research must be associated with regional land degradation, river Resources and poverty and other sustainable development issues linked (Turner, Meyer, & Skole, 1994). In 1999, IGBP and IHDP also proposed a "research implementation strategy" to continue to promote land use change research (Eric F Lambin et al., 1999)

2.2.1 Land use quantity change

The change of land use quantity has range of change and rate of change. The range of change is mainly reflected in the change of the area of different land use type, and the change of area is mainly reflected in the change of total land amounts and the change of structure (Salvati & Carlucci, 2015). By analyzing the change of the amount of land use types and the change of the proportion of the land in the study area, it is possible to understand the trend of land use change and land use structure change.

The rate of change is measured using the land use dynamics model, including the single land use dynamics and the comprehensive land use dynamics. The single land use dynamic model can reflect the change of the number of land in a certain time range in the study area. Single land use dynamic model, also known as the rate of land use type change. It not only reflects the dramatic extent of regional land use change but also has a positive effect on predicting future of land use change and regional differences. The change of comprehensive land use quantity can express and describe the overall rate of land use change in the study area during a certain study period. The dynamic change reflects the degree of human disturbance to land use (Eric F Lambin, Geist, & Lepers, 2003).

2.2.2 Land use spatial change

Land use spatial change means the movement or change of space in different land types during a period of time. In the urban area research, the area where human activities take place more frequent is construction land. It is also the area where people are involved in the development and utilization of land. The urbanization is more developed, the more demand for urban construction land so that land is more occupied by construction land. The land is a material system with dissipative structure and ordinal characteristics. And it is constantly exchanging material and energy with the outside, changing in structure and form. Land use change is a dynamic process that can be described by entropy.

2.2.3 Land use research in China

With the development of social economy and the acceleration of urbanization process, the quantity of urban land is growing. The expansion of the size of the city is the result of economic growth, and consequences of extensive expansion and consumption of resource-intensive extensive land use. The number of cities in China has grown from 130 to 663 since 1949. The city area has been expanded from 3053 square kilometers in 1949 to 35010 square kilometers in 2007 (Jim & Chen, 2009). In addition, the individual city, the scale of urban land to expand the speed is also very alarming. Through the satellite remote sensing monitoring, China's major cities area have expanded 60 percent (Ding & Lichtenberg, 2011).

As the urbanization land is mostly transferred from arable land, and the rapid expansion of urban land is accompanied by a large number of arable land loss. At the same time, these expanded sites have not been fully utilized. From the per capita construction land point of view, China is far beyond the developed countries per capita construction land. In 2012, the developed countries urban construction land per capita 82.4 square meters, developing countries per capita close to 83.3 square meters, the data on China's mega-cities show that per capita construction land has been close to 100 square meters. China's urban per capita urban construction land has reached more than 130 square meters, the average has exceeded the national quota of more than 50 percent(Wei & Zhang, 2012), indicating that the waste of land use is very serious.

Urban land use direction is out of control, mainly in the real estate development as well as high-level hotels, shopping malls, golf courses and other facilities, so that urban residents in urgent need of affordable housing and construction, with the green space, sports venues, parking lots and other public facilities is more inadequate(Wu, 2009), resulting in a new unbalanced land use structure.

In recent years, China's commercial housing vacancy area are in rising trend. Commercial housing vacant area in 2016 close to 100 million square meters. The existing various types of development zones, vacant land I more than 40,000 square kilometers, the huge amount of backlog of funds(Yin et al., 2011). In the case of many vacant commercial housing prices remain high, ordinary wage earners can hardly afford a house. And these development zones are mainly in the edge of the city or a good location, taking up a lot of resources and occupation of a large number of high-quality farmland around the city.

2.3 Land use model

Spatial models is a subset of models admitting spatial dependence among modelled objects/observations, which can create relationships between observed data and hypothesized data generation processes (Bivand, 2002). This part describes the characteristic of each models and their relevance to land-use change.

2.3.1 Cellular automata

CA (Cellular automata), originally used to simulate the unique self-replicating phenomenon of the life system, was later extended and applied to many fields, becoming an important tool for simulating complex phenomena (Santé et al., 2010). CA can do both meticulous mathematical analysis and simulate a series of complex phenomena, so it can be used as a modeling method for complex dynamic systems, and it has advantages for geographically complex systems with time and space evolution.

Firstly, the spatial and temporal dynamic simulation of CA can express the complex temporal and spatial dynamic characteristics of the geographic system. Secondly, the cellular space of the cellular automata can be regarded as the discrete division of the real geospatial space, the geospatial data rasterization after each grid that is equivalent to the cell, the grid properties have become the state of the cell (Arsanjani, Helbich, Kainz, & Boloorani, 2012). In recent years, more and more scholars have used cellular automata to simulate land use change to achieve meaningful results.

2.3.2 Markov model

The Markov forecast method is a prediction method created by the former Soviet mathematician Markov and named by his own name. It applies the Markov chain theory and method research in probability theory to analyze the variation of random events and to predict future trends, involving the following basic concept categories and operational principles: In the event of an event development, such a process is a Markov process if the state transition process is ineffective, or that each state transition is associated with only the previous state. In the event of the development process, from a certain state to the next moment of the possibility of other states, known as the state transition probability, recorded as Pij (Arsanjani et al., 2012). In the land use structure prediction, usually refers to the state refers to the land type, such as arable land, forest and so on. In the study of land use dynamic change, the land use type corresponds to the "possible state" in the Markov process, and the number or proportion of the land transition type is the state transition probability (Muller & Middleton, 1994).

CA model and CA-Markov model, both of which have extensive application in land use change research. The former focuses on the prediction of land use change through the driving force analysis of all types of transition, which emphasizes the use of land transfer probability dynamic simulation and prediction of land use spatial pattern (Muller & Middleton, 1994). CA- Markov model includes regression model, CA model and Markov model, among which CA model and Markov model are combined into CA-Markov model, which combines CA model to simulate the advantages of spatial variation of complex system and M model to accurately predict land use type transformation ability (X. Yang, Zheng, & Chen, 2014).

2.3.3 Spatial Logistic Regression model

Logistic regression model refers to the regression analysis of the dependent variable as a binary classification variable or a multi-valued categorical variable. It is a multiple regression relationship between a strain and multiple independent variables to predict the probability of occurrence of an event in a certain region (Yamagata & Seya, 2013). The advantage of Logistic regression lies in the statistical analysis, the independent variables do not need to meet the normal distribution, either continuous, it can be discrete.

2.4 Land use model research

Land use models can be divided into two types: quantitative model and spatial model. Quantitative models have lots of model such as grey model, regression model, system dynamics model, Markov model and artificial neural network model. The grey model is a prediction method based on time and grey function. This model is applicable to the prediction of land use change with more data on time series, but other data are fuzzier. Liping Wang and others took Foshan as the study area and used the grey model to predict the land situation pattern in Foshan(Liping, Xiaobin, & Xindong, 2015). Xiaojuan Zhang, analyzed the land carrying capacity of the Three Gorges area by using the grey model combined with entropy weight TOPSIS, and predicted the bearing capacity in the next five years(X. Zhang, 2017). The defect of the grey model is that it cannot be analyzed by multiple factors, so it can only be applied to short-term forecasting. The regression model improves the shortage of grey model in this area. It is mostly used for the driving force analysis of land use. It combines the social, economic, natural and other factors to establish a regression model and forecast the land use in the future. For example, Jiaxing Xu, taking the Jiawang mining area in Xuzhou as the study area, uses multiple regression model to explore the driving force factors of the region(Jiaxing & Gang, 2012). The results have a guiding role for the ecological protection and sustainable utilization. The system dynamics model is based on the system theory and information theory to study the function, structure and dynamic behavior of the system. It can reflect the complex behavior of land use change from the macro level, and it is a tool for the simulation of land use change system. Yunpeng Zhang and others took the Xinbei District of Changzhou as the research area. The system dynamics method was used to simulate the land use change in the study area and achieved good results(Y. Zhang, 2012). Artificial neural network method is a mathematical model that simulates the activity of the neuron in the human brain. It has the ability of self-learning, self-organization and strong nonlinear mapping. It is suitable for the identification of different geographic patterns, simulation and prediction of geographical change process and operation of complex geographic system. For example, Yiying Ling uses the Kohonen neural network model to simulate the urban development of the Yangtze River Delta, and in the study points out the advantages, shortcomings and improvement methods of artificial neural network(Ling, 2003).

The spatial model have lots of types such as cellular automata model, CENTURY model, CLUE and CLUE-S and GEOMOD models. The CENTURY model is established by Parton. This model can not only simulate the change of the specified elements in the ecosystem, but also can be used in the study of land use change. However, the parameters of the CENTURY model need to be different, which need to be determined according to the different ecosystem conditions, and the representative parameters need to be input to get better simulation results, so there are some limitations. Weijun Shen and other sub-tropical carbon and nitrogen in Heshan as the designated elements, the CENTURY model is used to obtain better simulation results(Shen, 2003). The CLUE-S model was first developed by Feinberg and other scholars from the University of Wageningen. It was developed on the basis of the CLUE model. The earliest model was applied to the macro land-use cover change, and the applicability was not strong. It was mainly applied to the simulation on the national scale or intercontinental scale, while CLUE-S was a small range of soil. The study of land use change is more practical and has been widely used. For example, Xiaolong Zhu used CLUE-S as the model, taking the Wanzhou District of Chongqing as the research area to simulate the land use situation in the research area and forecast the land use for the next ten years(Zhu, 2011). The CLUE-S model needs to use other mathematical methods to obtain quantitative changes before the change of spatial distribution patterns of land use change. Therefore, there are some defects in the model. The GEOMOD model is developed jointly by two universities in the United States. It is a land-use change model based on the geographical concept. The model has been revised and perfected, and two versions have appeared. The model assumes that the purpose of human activities changes land use, and changes follow a number of principles. The model can simulate not only the changes of various land types, but also the change between the developed land and the undeveloped land.

2.5 Related theoretical basis

2.5.1 Sustainable development

Since the industrial revolution, the productivity of mankind has been greatly increased, and the driving force of industrialization on social and economic development has been increasing. However, the negative effects brought by industrialization are affecting us. Environmental pollution has a profound impact on China. Human respiratory diseases caused by the air pollution, river and soil pollution is a strong threat to our food and environmental safety.

Since the 1970s, human beings have gradually realized the negative effects of industrialization and the theory of sustainable development was born. For the definition of sustainable theory, many scholars have their own thinking, among which the most recognized by the industry is Brent's definition in our common future, that is, "to meet the needs of the contemporary people and will not put a threat to the needs of the future generations"(WCED, 1987). What is emphasized is that we cannot blindly plunder natural resources and exceed the capacity of the environment for our consumption. At the same time, we must provide good environment and sufficient resources for future generations.

The following five requirements for sustainable development of land use optimization were made by the FAO in the outline of sustainable utilization management evaluation published in 2014. Land use needs to maintain the productivity of land, including agricultural and non-agricultural productivity, as well as environmental benefits. It is demanded that in the process of land use, human beings should not to cause the decline of land use function because of the short-term interests. To reduce the risk of land destruction in the process of land use, not only to protect the function of land, but also to protect the other resources around the land, including river resources, biodiversity and so on; the optimization of land use should be scientific, reasonable and feasible; land use optimization should be accepted by local residents and society(FAO, 2014).

Sustainable development calls for the establishment of three-dimensional land in the process of developing and using land. The use of land is not only limited to the use of plane, but also needs the three-dimensional utilization, which includes the surface, underground and underground space resources. In the process of land use, the economic benefits should not only be considered, but also the social and ecological benefits should be paid more attention to.

2.5.2 Multiple Plans Integration

The concept of Multiple Plans Integration was developed based on the actual situation in China. There are many kinds of domestic planning and they can be implemented by different functional departments. Moreover, the planning does not have strong legal guarantees before. It will mainly change according to the awareness of different leaders, which will lead to the implementation of planning and Insufficient continuity(Tzou, Shu, & Lidan, 2017). For example, the environmental protection department pays more attention to the sustainability of planning for the environment, and the housing and construction department pays more attention to providing adequate housing, which leads to the differences of focus and goals of the two plans. In the absence of top-level design, China has also carried out multiple pilot projects in many different regions, designed different plans on a single platform and reduced disagreements in different plans due to different goals and different backgrounds. At the People's Congress and the Political Consultative Conference held in 2018, important decisions on institutional reforms were made, in which the Bureau of Land and Natural Resources, the Department of Housing and Construction, and several other departments were reorganized into the Natural Resources Bureau. It benefits for the establishment of a multi-institutional in the country.

Multiple Plans Integration are divided into several development steps. The first step is the integration of land use planning, including urban and rural planning; the second step is the combination of urban and rural planning, land regulations and socio-economic development planning; The third one is the integration of environmental protection planning and urban functions on the basis of the integration of the three regulations. Sex planning, transportation planning, etc. are integrated with the three regulations to become a multi-disciplinary one(Song, Zhou, & Zhang, 2011). At present, China's Multiple Plans Integration implementation has the following new priorities. The first point is to promote the legitimacy of multiple laws and regulations, protecting the implementation of the plan through legislative regulations. Second, emphasizing the importance to the supervision and management work after the formulation of plans and strengthening the supervision of post-planning construction approvals; The third one is applying information technology to provide planning efficiency. By combining the establishment of information systems, sharing of planning information is strengthened. Simplify the approval process for construction projects and improve the government's work governance capacity. The fourth point is to explore the flexible space and adjustment mechanism for planning. The plan needs to be adjusted and adapted to the development of social economy. Under the condition of stable main body, exploring the flexible space of planning.

2.5.3 Location theory

Location itself refers to the place where an object is occupied. Location is mainly studied by the space chosen by human activities or the combination of human activities within a certain space. It can be seen from the concept that the development and change of location will be influenced by human activities. From the agricultural society to the industrial society and urban development, human beings had pay a lot attention to the location. The first is the agricultural location theory of Thunen 's study, which mainly studies the impact of land rent on agricultural land in an ideal situation, due to the distance from the distance between the central city and other factors(Thisse, 2008). The second is Webb's industrial location theory. The core of this research is to establish a systematic industrial location theory system by hypothetical deduction. The minimum cost principle is built which is the best location with minimum charge for a certain location in industrial selection is the best location. Webb's theory does not only give a guide to the location selection of industry, it also provides a basis for the layout of other industries(Gorter & Nijkamp, 2015). After World War II, great changes have taken place in human life and production. The central ground theory was built that is based on the hypothesis based on the ideal way, but it reacts the layout of the city in order to master the larger market area and it reacts the distribution. The theory of inter configuration provides the basis for the best location of the city or the land. Because of the geographical conditions and development needs of different regions, it is necessary to allocate the different land in a certain range(Rousseau & Fried, 2001). Therefore, the research on the distribution of land and the spatial distribution of the land is required. The spatial and temporal research of land use must be systematically guided by location theory.

2.5.4 Land intensification and conservation

The land conservation use refers to the control process of land use to reduce the use of land due to its own production or life(Phelps, Carrasco, Webb, Koh, & Pascual, 2013). Land conservation is mainly reflected in the following aspects: the use of the original stock and the unused land cannot be added to the land; the land that is not occupied by the State shall not be occupied; the land use under the requirements of use control or the planning requirements should be appropriately improved, and the low level of land use can be used as much as possible. It does not occupy high-quality land; it does not occupy agricultural land. In a word, in the process of land use, it is necessary to take up the land as little as possible and calculate carefully, strictly implement the regulations of the state, and reduce the waste of land(Fischer et al., 2011).

Land intensification means that the land users add manpower, material and financial resources in order to obtain higher profit in the land of a unit area(Petersen & Snapp, 2015). Intensive use of land mainly refers to the intensive use of construction land, that is to increase the intensity of investment in the construction land of each unit area to improve the intensive degree of land, optimize the space layout and structure of the construction land, and increase the output of the high unit construction land by increasing the investment technology, capital and so on(Franks, 2014). Land intensive and intensive land use can be classified into agricultural land and construction land intensive and economical. The core of saving and intensification lies in the preferential protection of agricultural land resources and the control of the development and construction of non-agricultural land. Both land use and intensive land use belong to the way of land use. The difference is that intensive land use emphasizes the improvement of land efficiency and output, while saving land is mainly the savings of land use. The ultimate goal of the two is to balance the relationship between man and land and promote sustainable development.

3. RESEARCH DESIGN AND METHODOLOGY

The overall design of this research will combine qualitative and quantitative approach which will take three methodologies for achieving the objective of this research. Firstly, desktop research is applied to identify specific spatial modeling for land use change to find which is the most suitable model for this research. This method is also used for analyzing relationship between land use model and land use change Secondly, interview is used for collecting more information about current phenomenon of land use change during the field work. Thirdly, satellite image process is applied to deal with the satellite image for modeling.

3.1. Study area

Shenmu City belongs to Shaanxi Province, located in the northern part of Shaanxi Province. Shenmu city located in the middle of Yulin City. It is the political economy and culture center of the whole city. The total land area of about 410 square kilometers, 87000 acres of arable land, the total population of 14.53 million people, of which non-agricultural population of 9.351 million people, the temporary population of 26000 people.

Shenmu city is the largest city in Shaanxi Province, administer 15 townships, rank 21 in the economic comprehensive competitiveness of the top 100 counties, best in the northwest. Baomao Expressway, Yu Shang high-speed, Bao West Railway passing through Shenmu City. Shenmu City is China's largest coal-producing county, China's largest blue carbon base, China's largest PVC base, the largest thermal power base in the west, the largest float glass base in the west, the largest calcium carbide base in the west, Security system occupies an important position. In December 2016, as the third batch of national new urbanization comprehensive pilot area. In 10th April 2017, the revocation of Shenmu County, the establishment of county-level Shenmu City, directly under the jurisdiction of Shaanxi Province, Yulin City hosted.

The northwest of the city is low, the northwest is the wind sand beach area, the terrain is relatively flat. The southeast is the loess hilly gully region, the terrain is broken, the ravines are crisscross, the soil erosion is serious. The types of landforms in Shenmu can be divided into loess hilly gully region, wind-sand bank area and river valley. The city is rich in river resources. The Yellow River, the grotto, the bald river crossing. Shenmu is a vast area with rich mineral resources. Mainly coal, quartz sand, bentonite, rock salt, iron ore, limestone, natural gas, etc., which has abundant coal, wide scope of layout, preliminary proven reserves of more than 4500 square kilometers, accounting for 60.21% of the total reserves of 50 billion tons.

The model will be based on Shenmu City, where is an important part of Southwest Region. In last ten years, on the one hand, rapid economic and urban development has led to great land use change that most north and south areas of Shenmu have transferred from agricultural land to construction land. On the other hand, changes in urban planning are also one of the reasons for land-use change. Shenmu had been defined as international city which draws businessmen and industries attention to build a lot commercial and residential land. Therefore, Shenmu is the appropriate place for this research due to a lot of land use changes.

3.2. Data source and data collection

3.2.1. Desktop research

Desktop research is a qualitative method to get secondary data. This method can be used to review the previous research, scientist papers, published journals and books (Church, 2002) that scholars did in land use change based on spatial modelling, to provide some background information for this research. The main contribution of this method is to provide the advantages and disadvantages of different spatial models in simulating the land use change, and the relationship between land use model and land use change. In this step, the model is determined by comparing and combining with purpose of this research. The relationship between land use model and land use change can also be analysed through reviewing literature.

3.2.2. Interview

Interview is a qualitative research method that conducts interviews with respondents to explore their perspective on a specific program, situation and project (Guion, 2006). In this research, interview is a primary data collection method. By interviewing local land management agency, historical land use maps were obtained as well as to collect some information about the current phenomenon.

3.3. Data analysis

After obtaining the spatial data, this research analyses spatial analysis and then use land use change to model and then calibrate the model to predict.

3.3.1 Qualitative and quantitative combination

In the quantitative study, the land use of Shenmu city is classified by processing remote sensing image and the land use index model is used to analyse the land use quantity and spatial change of Shenmu City. Then the land use of Shenmu city is simulated by CA-Markov model to predict land use map in 2015. Then, verifying the results of the Kappa coefficient by comparing the status map and the prediction map in 2015. Then, according to the Shenmu city basic farmland protection area and the construction land control area to predict map of the sustainable development model in 2020. The research method of qualitative analysis is applied, the characteristics and weakness of land use in Shenmu City combine with the results of the analysis on the change of land use to put forward the ways as well Countermeasures for the optimization of land use.

3.3.2 Spatial and quantity analysis

Spatial analysis is a set of techniques for analyzing spatial data. The results of spatial analysis are dependent on the locations of the objects being analyzed (Wagner & Fortin, 2005). Software that implements spatial analysis techniques requires access to both the locations of objects and their attributes (Anselin, Syabri, & Kho, 2006). In this research, spatial analysis is applied to investigate location of land use change, which use ArcGIS for operating CA model to simulate land use change. First, the raster data for land use in different years were imported into ArcGIS. Secondly, the grid data of the CA model is used to deal with the raster data. The model predicts the future land distribution based on historical data and spatial model.Finally,using land use index model to analyze the degree of spatial change.Quantitative analysis was used to study the land use quantity change in Shenmu city and to analyze the trend of land use change in 2020.

3.3.2 Modeling use CA-Markov

The lattice in the cell lattice of the cellular automata has a large similarity to the structure in the raster data of the GIS. In this study, the grid of the raster data is the cell. In this research, the size of the cell is 30m * 30m because I tried four size of cells that the result of this size is the best. The cellular state of the cellular automata is defined as the land use type, with agricultural land, construction land, unused land and river area.
The prediction of this study is based on the land use change in 2005, 2010 and 2015, and then the prediction of the land use is based on the data in 2015. So, the interval between the years should be equal, so the study of land use in 2015 as the starting time to predict the status of land use in 2020.

3.4 Research flow

This section introduces the research flow of this study, which is divided into three phases i.e. data preparation, field work and data analysis.

3.4.1 Data preparation phase

This phase aims to collect secondary data by reviewing literature, which focuses on analysing relationship between land use model and land use change, as well as comparing different models and investigate criteria for modelling. After that, the criteria have been determined for designing preliminary model. Download satellite image form USGS and processes the image to make basis land use maps.

3.4.2 Field phase

In this phase, primary data and secondary data are collected during field work in study area. The main contribution for this phase is interviewing to get land use maps and knowledge of local expert for land use change.

3.4.3 Data analysis phase

After obtaining all data, this phase begins with spatial analysis. Then, analysing result of quantity and spatial modelling to find factors which have significant impact on land use change. Finally, some conclusions and recommendations are drawn for optimization land use.

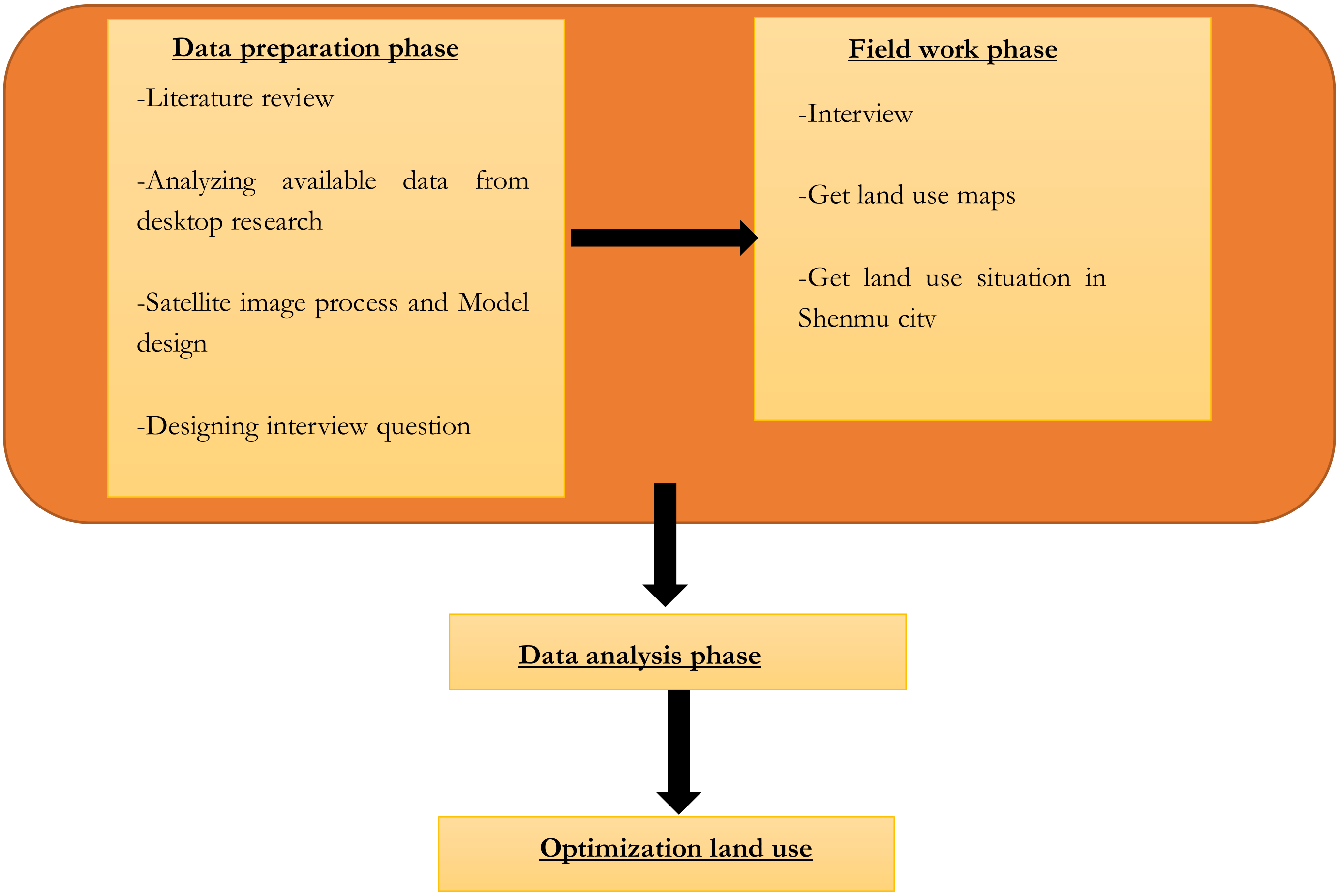

Figure 2 Research flow

3.5. Satellite image preprocessing

3.5.1. Data source and Software requirement

1. Satellite image

Data set: Landsat 5 TM C1 level-1(2005 and 2010) and Landsat 8 TIRS C1 level-1 (2015)
Sensor Type: Landsat TIR
Projection: UTM, Zone 49 N
Datum: WGS-84
Pixel: 30 Meters
Land cloud cover: less than 10%
Scene cloud cover: less than 10%
Date: 15/10/2015; 12/10/2010; 15/09/2005
Provided by USGS (https://earthexplorer.usgs.gov/);

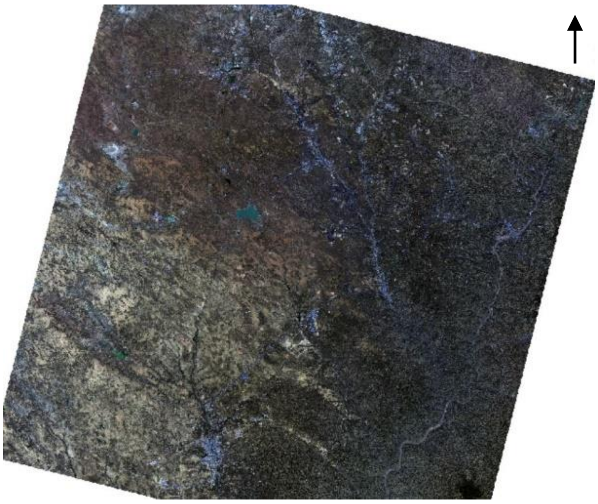

Figure 3 Satellite image

2. Boundary of Study area

Date name: County boundary of China

Date type: Shape;

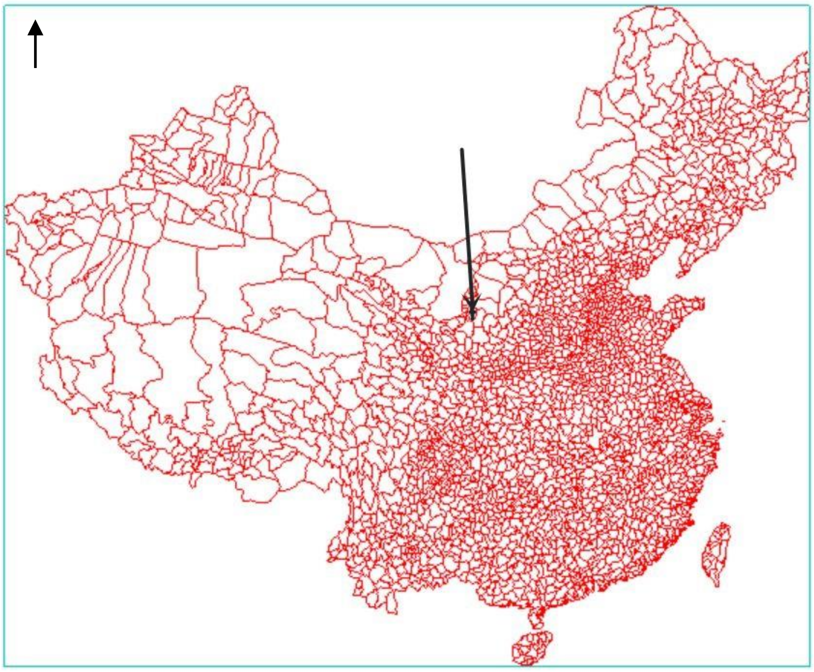

Figure 4 County Boundary of China

3.5.2 Software requirement

Satellite images are analyzed and processed by ENVI 5.3 to make work base map for predicting land use change. It is a powerful remote sensing image processing system developed by IDL based on interactive data language. It can easily read, display and analyze various types of remote sensing data and extract information from image preprocessing, to the integration of geographic information systems with the various tools needed. ENVI's excellent spectrum analysis tool can quickly and accurately extract the various information needed by the user from the remote sensing images(ENVI, 2013).

3.5.3 Band combination

The remote sensing image has a large number of data information such as spectral resolution, positioning accuracy and so on. Each band has different spectral features and the information reflected is different(Ramli & Petley, 2006). Therefore, combination of different bands can effectively reflect the land use information needed in this research. The resolution of remote sensing images can also be effectively improved by band combination. Different band of Landsat synthesis has different effect on terrain enhancement. The 4, 3, 2 band combination of Landsat5 is rich, bright, and good level. It can be used for the extraction of arable land, forest or grass information and river body recognition. Because this research needs to fuse two kinds of satellite remote sensing images of Landsat5 and Landsat8. The 5, 4, 3 band of Landsat8 The range is closer to the 4, 3, 2 band of Landsat5, so the 5, 4 and 3 standard false color band combinations are selected.

3.5.4 Radiometric Calibration

Radiometric calibration means to eliminate or correct the distortion caused by radiation errors. The distortion was caused during the process of random distortion or distortion of the system due to external factors, data acquisition and transmission systems. The causes of radiation errors can be divided into sensor response characteristics, solar radiation, and atmospheric transmission conditions, etc. The aim of radiometric calibration is to eliminate the sensor due to their own conditions such as mist and other atmospheric conditions such as the sun position and angle conditions and some unavoidable noise caused by the measured value of the sensor as far as possible (Gusson & Duarte, 2016); It also wants to restore the true colors of the image, for remote sensing image recognition, classification, interpretation, and other follow-up work.

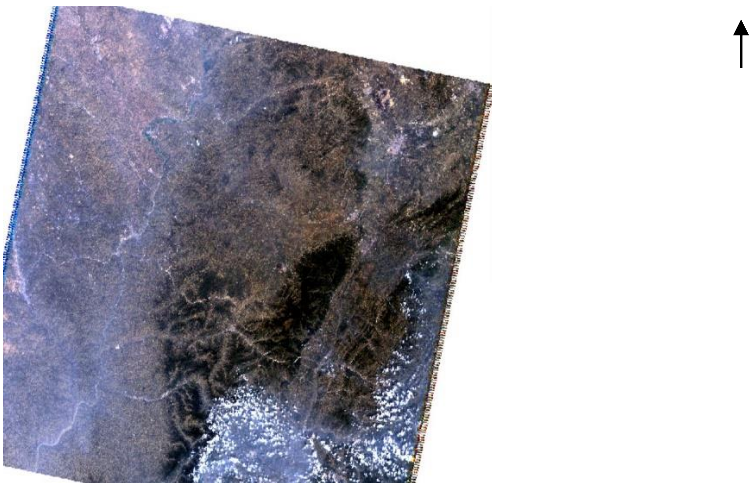

Figure 5 Radiometric calibration

3.5.5. Geometric correction

In the case of remote sensing imaging, due to the attitude, height or speed of the aircraft and the rotation of the earth and other factors, resulting in geometric distortion, the distortion of the pixel relative to the actual position of the ground object extrusion, etc. Geometric correction is the error correction for geometric distortion(Shimada, Isoguchi, Tadono, & Isono, 2009).

In this study, geometric corrections were made to the remote sensing images using the location and coordinates of the control points provided by the land use map and the coordinates obtained from field observations. In the remote sensing image, select 6-10 uniformly distribution control points. Select the control points which are obvious such as government center or transportation center, and add the control points at the edge of the image. Then control the error of the correction results to compare with the land use map.

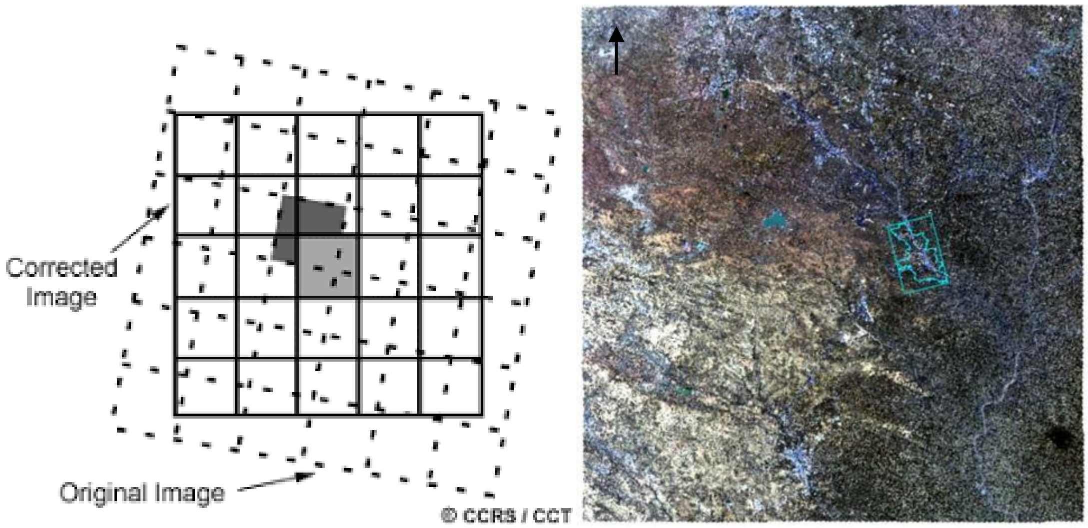

Figure 6 Geometric correction

3.5.6 Atmospheric correction

The purpose of atmospheric correction is to eliminate the effects of atmospheric and light factor on the reflection of the objects, including the effects of oxygen, carbon dioxide, river vapor, methane and ozone on the reflection of the objects, as well as the scattering of aerosols and atmospheric molecules. So as to obtain the physical reflectivity, emissivity, surface temperature and other physical model parameters to achieve the image correction(Gao, Montes, Davis, & Goetz, 2009). The ENVI software contains a number of atmospheric correction tools, including MORTRAN based on the radiation transmission model, the dark pixel method, and the reflectivity inversion based on the statistical model(Meng et al., 2008). This paper uses a FLAASH atmospheric correction tool based on the MORTRAN transport tool.

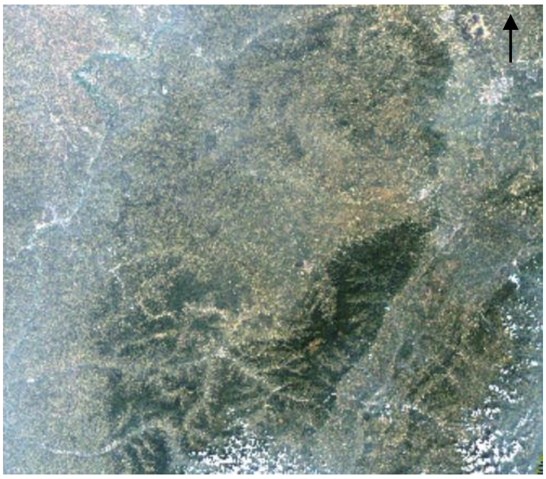

Figure 7 Flaash Atmospheric correction in 2010

3.5.7 Subset the region of study area

The study area cutting is a method of cutting the research area on remote sensing images. The study area needs to be cut after the adjacent images are merged into one. The study area boundary is obtained by studying the administrative boundary of the region. The study used Chinese county boundary data as a basis to collect the study area.

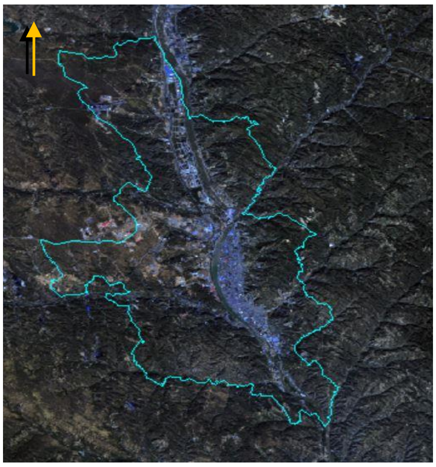

Figure 8 Boundary of study area

4 LAND USE MODEL

4.1 Justification of CA-Markov model

The transfer probability matrix derived from the Markov chain in the Markov model can describe the flow and transformation of each land use type in the process of land use change in digital form. Therefore, it can be used to predict the future trend of land use quantity in the study area.
Markov model is mainly used to predict the change of land use type quantity, which does not contain spatial content. It cannot predict the distribution of land use types in the study area. Therefore, it is necessary to combine other spatial models to realize the forecast of land use quantity and space.
CA model has good ability to simulate the complex spatial system and Markov model has the advantage of predict quantity. In the CA model, the core is the transition rule, and the land use transition probability matrix generated by the Markov model determines the transition rule.
Markov model has advantages of predicting the quantity change of land use, while the spatial parameter is weak and cannot know the spatial variation degree of each land use type. CA model has strangeness of spatial analysis and good at simulate complex space system. The CA-MARKOV model, which incorporates the theory of Markov and CA and other related advantages of time series and space prediction, can be used to simulate the spatial and temporal changes of land use in both quantity and space. Besides, some research focuses on land cover or land use change mainly use the CA-Markov model or combine with MCE or logistic, which consider some natural and economic factors such as population, DEM etc(Paegelow, Camacho Olmedo, Mas, & Houet, 2015)(Li, Jin, Wei, Jiang, & Wang, 2015).

4.1. Cellular Automata components

The cellular automata are mainly composed of five components: lattice, cell states, neighborhood, transition rules and time.

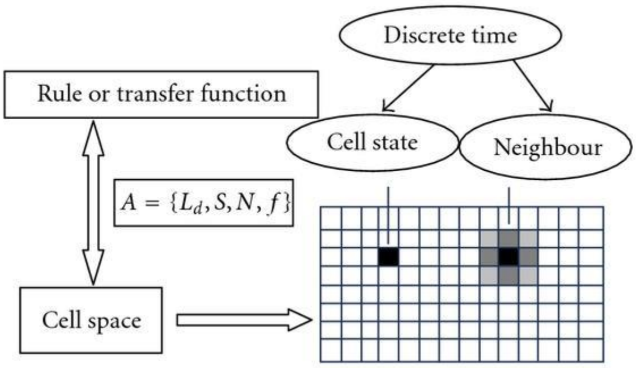

Figure 9 Relationship between CA components

4.1.1. Lattice

The lattice is the most basic component, with a discrete, finite state. The land use simulation prediction is carried out in two-dimensional cellular space, that is, the land use space is divided into a unified rule grid, each grid can be regarded as a cell.

4.1.2. States

The cell state can only have one, and the state can be either 0 or 1, or a discrete set of integers. A discrete set of integers is used in this research. Land use types CA cells have discrete set of integers reflects agricultural land, residential land, road, unused land etc.

4.1.3. Neighborhood

Neighborhood refers to a local cellular space centered on a cell. The two-dimensional cellular automata neighbor application is more Von Neumann type and Moore type, as shown in the figure, black cell is the central cell, the gray cell is its neighbor, the neighborhood determines the central unit state of the next moment.

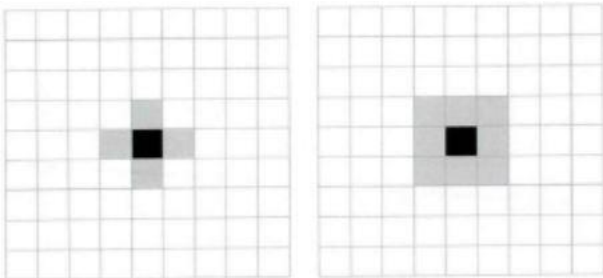

Figure 10 Cellular automata used neighbor type (X.-S. Yang & Yang, 2010)

4.1.4. Transition rules

The transition rule is the core of the cellular automata model, which is the dynamic function of the cell transition. The transition function can construct a spatial and temporal discrete local cell space that determines the entire simulation process. There are many ways to get the rule, such as MCE, Logistic regression method, SLEUTH model method based on five factors, principal component analysis method and neural network method. CA transition rules have two parts: transition potential rules and confliction resolving rules

Transition potential rules

As urban CA modes aim to simulate different urban development, so some development influence factors should be included in transition rules. And possible sub-rule classed in transition potential rules should be identified (Junfeng, 2003) such as neighborhood effect, accessibility effect, suitability effect etc. In this study, it mainly focuses on neighborhood effect, which study on different land use types influence in neighbor. Generally, the neighborhood effect means the interaction between neighborhood cells. These interactions can be divided into two categories. One of it is positive influence that reflects the attraction effect between cells. The other one is negative influence that the repulsion effect among cells (Junfeng, 2003). For example, the location of new construction land is not only affected by the existing construction land, but also influenced by the other land use type such as transportation land, agricultural land etc. It id generally believed that nearer land use type, the stronger will be the influence, whether positive or negative.

Confliction resolving rules

In case a confliction resolving rules are required is one parcels has transition potential rules to different land use types. This would be happened in real urban development process, such as the agricultural land can be transferred to residential land and commercial land, which can make confliction between different investors.

4.1.5. Time

The cellular automaton is a discrete system at time, and the change in time t is a continuous equal spacing value. For example, when the time interval is set to 1 and t=0 is the initial time, then t=1 is the next moment. In the process of system change, the state of a cell and its neighbor cell determines the cell at t+1 moment. In different CA models, time gap is different. In this research, it reflects five-year time.

4.2. Markov model

Using the Markov model to predict the land use change. First, determining the initial state of land use and the probability of state transition. The land use change can be predicted by using the following formula:

$$S_{(t+1)} = S_t * P_{ij}$$

Where S_t and $S_{(t+1)}$ are the system states at time t and t+1, respectively; P_{ij} is the state transition probability matrix.

4.2.1. Markov process

In the event of development, if the state transition process is ineffective, or that each state transition is associated with only the state of the previous time, we call it Markov process.

4.2.2 Markov chain

The Markov chain is a discrete process of both time and state. Assuming that the state of $X_{(n)}$random process is $X_{(t)}$, then t+1 time state $X_{(t+1)}$ is only related to t state, but not t-1, t-2. We call it Markov chain.

4.2.3 State transition probability

State transition probability refers to the possibility of a land use type moving from one state at the initial moment to another in the next moment during the change of the process(Telcs, 2000). In the land use change predict, the state is the land use type, this study involves 6 states includes arable land, grass or forest land, construction land, transportation land, river and unused lands.

4.2.4 State transition probability matrix.

Assuming that there are n possible states in the development of an event, which means E_1, E_2, ..., E_n, where P_{ij} is the state transition probability of state E_i to state E_j, the following matrix is called the state transition probability matrix:

$$P = (P_{ij}) = \begin{bmatrix} p_{11} & p_{12} & \dots & p_{1n} \\ p_{21} & p_{22} & \dots & p_{2n} \\ \dots & \dots & \dots & \dots \\ p_{n1} & p_{n2} & \dots & p_{nn} \end{bmatrix}$$

Figure 11 State transition probability matrix.

If an event is in a state E_i at a time, it may be converted from state E_i to any of the states of E_1, E_2, ..., E_n at the next moment.

In the study of land use change, the land use type corresponds to the possible state in the Markov process, and the number or proportion of the land transition type is the state transition probability. The land use change state can be predicted by the following formula.

$$S_{(t)}=S_{(t1)}*Pij$$

Where $S_{(t)}$, $S_{(t1)}$ represent the land use state at time t and t_1, P_{ij} is the state transition probability matrix.

4.3 Land use index model

4.3.1 Land use transfer matrix

The land use transfer matrix describes the system state of land transfer status in system analysis. The land transfer matrix is shown in table 2. In the table, D in T_1 and T_2 represents land use types in time T_1 and time T_2. Pij represents the percentage of the area of the land use type i transfered from the time T_1 to the time T_2 time to land use type j, and P_{ii} represents the percentage of land use type i kept unchanged from the T_1 to T_2 time period, and the P_{i+} represents the percentage of land use type i on the T_1. P_{+j} stands for the time T_2 class J, which accounts for the total area percentage. P_{j+}-P_{jj} represents the percentage of the increase in the area of the land use type j from T_1 to T_2 , and P_{i+}-P_{ii} is a percentage of the decrease in the land use type i in the T_1 to the T_2.

Table 2 Land use transfer matrix

(%)

		T2				P_{i+}	Decrease
		D_1	D_2	…	Dn		
T1	D_1	P_{11}	P_{12}	…	P_{1n}	P_{1+}	P_{1+}-P_{11}
	D_2	P_{21}	P_{22}	…	P_{2n}	P_{2+}	P_{2+}-P_{22}
	…	…	…	…	…	…	…
	D_n	P_{n1}	P_{n2}	…	P_{nn}	P_{n+}	P_{n+}-P_{nn}
P_{+j}		P_{+1}	P_{+2}	…	P_{+n}	100.00%	
Increase		P_{+1}-P_{11}	P_{+2}-P_{nn}	…	P_{+n}-P_{nn}		

4.3.2 Net change

In this paper, the land use index model is used to analyze the quantity change and spatial change of land use in Shenmu City, referring to the research results of Rui Liu et al(R. Liu, 2010). The model has three indexes to analyze land use change. The net change index of land use (Dj), which can reflect the absolute change of different land types, is the most commonly used index in land research, and can reflect the degree of change of land types in different periods of time. The calculation formula is as follows:

$$D_j = \mathrm{MAX}(P_{j+} - P_{jj}, P_{+j} - P_{jj}) - \mathrm{MIN}(P_{j+} - P_{jj}, P_{+j} - P_{jj}) = |P_{+j} - P_{j+}| \quad (2\text{-}3)$$

In the form, the net change of land is expressed by Dj..

4.3.3 exchange change

Because of the spatial characteristics of land, the net change cannot accurately reflect the dynamic process of land change. When the net change of land is 0, it does not mean that there is no change in the land use, and the land can still be changed in space. And this change cannot be reflected from the net change. For example, the development and construction land around the city occupies the arable land or forest and in other areas, and the land is converted to arable land because of the construction land renovation. Land changes similar to this are offset in the net change index. Therefore, only using net change will underestimate the degree of land use change to a certain extent. The exchange change quantity (Sj) is introduced to reflect this part of the land change which is counteracted. The exchange changes reflect the total value of the transition of different types of land, that is, the exchange change is reflected in the transition of one kind of land into another type of land in one region, and the other type of land in the other region is converted into a kind of land use change. The calculation formula is as follows:

$$S_j = 2 \times \mathrm{MIN}(P_{j+} - P_{jj}, P_{+j} - P_{jj}) \quad (2\text{-}4)$$

In the form, the net change of land is expressed by Sj..

4.3.4Total change

The last is the total change index (Cj), which is composed of net change and exchange change. The formula is as follows:

$$C_j = D_j + S_j \quad (2\text{-}5)$$

It can be seen from the formula (2-5) that the total change amount is equivalent to the increase of land use and plus the reduction amount, or the net change amount plus the exchange change quantity. In the formula (2-3) - (2-5), P_{j+} represents the percentage of land use type J on the total are at the T_1, and P_{+j} represents the percentage of land use type J on the total area at the T_2 time point, and the P_{jj} is the percentage of the land use type J remain unchanged for a period of time. When MAX (Pj+-Pjj, P+j-P_{jj}) is increased in the formula, then MIN (P_{j+}-P_{jj}, P_{+j}-P_{jj}) reflects the reduction, and on the other hand, when MAX (P_{j+}-P_{jj}, P_{+j}-P_{jj}) is reduced, MIN (P_{j+}-P_{jj}, P_{+j}-P_{jj}) reflects an increase.

In this paper, the study area is a closed system, and the increase and decrease of land is a mutual process. In the system, the addition of one kind of ground class inevitably leads to the reduction of another kind of land. In the study area, the total increase of the system is equal to the total reduction, and the total amount of change is equal to the sum of the first two. In this paper, the land use index model is used to analyze the quantity change and spatial change of land use in Shenmu city.

5 RESULTS AND DISCUSSION

5.1. Image information extraction

Remote sensing images show the different features by the brightness value, which is the physical basis for distinguishing different image features. Remote sensing image classification uses computers through analyzing the remote sensing images of various types of spectral information and spatial information analysis, select the characteristics of each pixel in the image according to a certain rule or algorithm which is divided into different categories (Kotsiantis, 2007). Then access to remote sensing images and the corresponding information of the actual objects, in order to classify different land use types.

5.1.1. Supervised Classification

The classification of features includes supervised classification and unsupervised classification. This study uses the supervised classification because of having the land use map of the study area and the visual interpretation of the field, it can make the accurate judgment for different land use types in remote sensing images (Valizadegan, Jin, & Jain, 2008). It also can train the model to complete the classification for different land use types.

This research uses the maximum likelihood classification that can make a more accurate judgement of different land use types in remote sensing images and it can also train models to complete the classification of different land use types. Maximum likelihood classification refers to the establishment of a nonlinear discriminant function set based on the maximum likelihood ratio Bayesian decision criterion in the two or multi class decision(Classifier, 2007). Assuming that the distribution functions are normal distribution and select the training area to calculate the attribution probability of each classified sample area, and a classification method for classification is made.

First, according to the type of empirical knowledge, determine the discriminant function and the corresponding criteria. Supervised training is the machine learning task of inferring a function from labeled training data. The training data consist of a set of training examples. In supervised learning, each example is a pair consisting of an input object and a desired output value. A supervised learning algorithm analyzes the training data and produces an inferred function, which can be used for mapping new examples(X. Liu, 2003). In this study, I use 20-30 samples for different land use types to train the classifier. And then determine the classification of the sample according to the criteria. In this study, I classify land to 6 land use types includes arable land, grass or forest land, transportation land, construction land, lake or river and unused land, which mainly according to Chinese land use type classification. Based on the classification of land use of other scholars and the classification standard of land use status, the remote sensing classification system suitable for Shenmu city is formulated. For example, the land use of Shenmu city is divided into 6 types of land use, including arable land, grass or forest, transportation land, construction land, river and unused land. Shenmu city land use classification system and the meaning of each type are shown in table 3.

Table 3 Classification and meaning of land use in Shenmu City

Land use types	Meaning
Arable land	Land used for planting crops, including Dryland and irrigated land.
Forest or grass	Land use for planting of trees or grasslands, including all kinds of woodlands and grasslands.
Construction land	Land use for residential buildings, including rural settlements, urban land and so on.
Transportation land	Land used for traffic functions, including railways, highways, etc.
River	Land used for natural or man-made rivers, lakes, tidal flats, ponds, etc.
Unused land	Land used for undeveloped land, including sandy land, bare land, etc.

5.1.2. Post Classification

It appears some small spots after classification that needed to be reclassified. Because of the small scale, it should make the whole map looks like clearly. So, in the process of classification, set the selection of the number of pixels in the map less than 625, put the small spot merge to the nearest largest class.

Figure 12 Image after classification aggregation

After satellite images processing, the images will be converted to vector data that includes colors, area etc. The vector data will be analyzed and processed in ArcGIS, which can calculate the area of different land use types and analyzed spatial distribution of land use.

5.1.3. Accuracy assessment

Input fieldwork sample point to ArcGIS. Symbolize the sampling points of different land use types that the color is obviously contrasted with the original polygon land use types color. And compare the sampling point data with the classified land data to assess accuracy. Due to the limited data that only the 2015 sample data is available, the accuracy of the 2005 and 2010 data needs to be evaluated in conjunction with the Google earth maps. First of all, importing the 2015 Google map into ArcGIS, manually adjust the size and position of the map and the classified map so that the two images overlap. Then, covering the sampling point with the Google map to obtain the grass or forest land and unused land, which is not easy to be interpreted from the Google earth maps. The 2015 land use map accuracy is 93.3%, the difference points are almost located in the boundary between difference land use types.

Figure 13 Google earth map in 2015 (Shenmu city)

5.2 CA-Markov model in study area

In this research, some parameters such as cell size needed to be set during the prediction process. The way I choose the certain parameters and validate the CA-Markov model is using Kappa coefficient.

5.2.1 Software requirement

IDRISI is a system of remote sensing and geographic information system. The system includes more than 300 practical and professional modules such as remote sensing image processing, geographic information system analysis, land use change analysis, cellular automata land dynamic trend predicting. Using IDRISI's newly developed land change model tool, it can simulate and predict changes in land cover and analyze the factors and mechanisms that contribute to these changes.

Based on the CA-Markov model within IDRISI software, this model uses Markov chain to predict the quantitative structure of land use. It is possible to predict the quantity and spatial distribution of land use change by strengthening the ability to simulate spatial pattern. Firstly, the transition probability matrix is used to model the land use space in the model, and the specific operation steps will be described later.

5.2.2 IDRISI data preprocessing

Based on the land use maps in 2005 and 2010, with the help of CA-Markov module in IDRISI software to simulate the land use change in 2015. Then comparing the simulation results with the actual data by Kappa coefficient. Then, verify the model. On the basis of meeting the application requirements, this research simulates and predicts the land use change in Shenmu City in 2020, and analyzes and discusses the results.

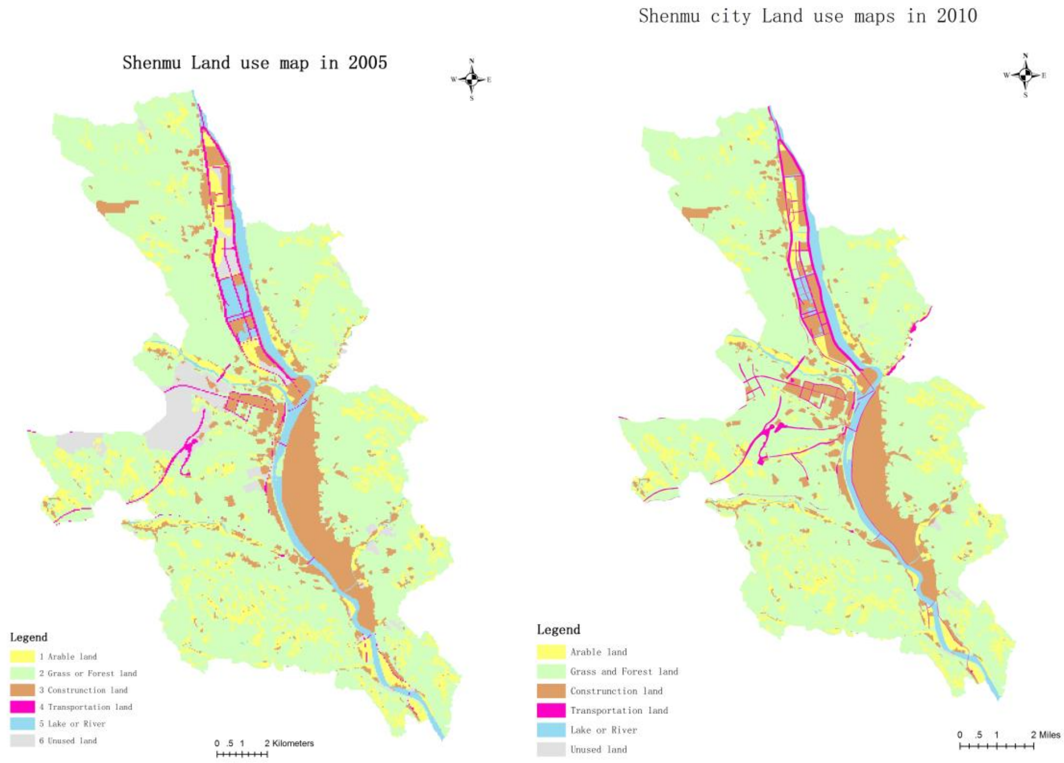

Figure 14 Land use maps in 2005 and 2010

5.1.2 CA components in study area

Each grid in the land use grid chart of the study area is a single cell. The attribute value of the grid is the land use type and represents the state of each cell. There are six states in total, namely arable land, forest or grass land, and construction land, transportation land, lake or river and unused land are replaced by numbers 1, 2, 3, 4, 5 and 6. In the figure 0 represents the background value.
Transition rules are the core of cellular automata and are the key factors that can effectively simulate geographic entities. The transition rules in IDRISI mainly include local space cellular state transition rules based on land use transfer matrix, which is transition probability matrix determined by Markov model.

Cell size chosen

In this paper, I choose the cell size includes 30m*30*, 50m * 50m, 100m*100m. Then the transition data will be processed and validated by Kappa coefficient. I will choose the cell size which Kappa coefficient is best., which means the forecast map is most similar to existing map. The results show 50m*50m cell size parameter is best. The area covered by the two-dimensional quadrilateral is the cell space, which contains 85,170 cells.

Neighbourhood or filter chosen

In the CA-Markov model, filters are used to define neighbours which means the defined neighbours can influence the central cell. The principle is to use the CA space filter to produce a significant spatial factor of weight, prompting the cellular state changes. In the IDRISI, two filters are normally chosen as filter, one is 5*5 filter, the other is 7*7 filter. In this thesis, a 5 * 5 filter is used because this filter has better Kappa result. This filter means that the rectangular space formed by 5 * 5 cells near one cell significantly affects the state of the cell. This filter is also the defined filter that is as below.

$$\begin{matrix} 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 \end{matrix}$$

Figure 15 5*5 Markov filter

5.1.3. Markov model

Using Markov module within IDRISI software, the model uses the maximum likelihood classification, the normal distribution ratio error is set to 0.15. The first and second land use maps are input to obtain the transition probability matrix and the transfer area matrix, which are used for predicting the next period of land use maps as parameters. Markov transfer area matrix shows the number of grids converted from one land use type to another. Markov transfer probability matrix is generated on the basis of the transfer area matrix, which reflects the probability of each type of land use transfer to other land use types.

Table 4 2005-2010 Transition probability

Land use types	Arable land	Forest or grass	Construction land	Transportation land	River	Unused land
Arable land	92.87%	0.00%	2.88%	2.14%	2.11%	0.00%
Forest or grass	0.98%	92.48%	3.18%	3.36%	0.00%	0.00%
Construction land	0.00%	2.00%	88.58%	4.00%	0.88%	4.54%
Transportation land	4.13%	0.00%	3.51%	92.36%	0.00%	0.00%
River	0.00%	5.00%	1.66%	2.09%	85.01%	6.24%
Unused land	0.02%	14.09%	3.19%	1.92%	3.00%	47.78%

5.1.4. Set the number of cycles

The number of model cycles depends on the time interval between the base year and the forecast year, which is usually a multiple of the study period. For example, if the two study periods are separated by 5 years, the number of cycles set is a multiple of 5 and the cycle is equally spaced. If the set number of cycles is 5, the model runs at intervals of 1 year. If it is set to 10, the model runs at 6-month intervals. The study period of this paper is 2005, 2010, 2015 and 2020, the time interval is 5 years and the number of cycles is set as 5, which means the model is run at the 1-year interval.

5.1.5. Kappa

In this research, the effectiveness and validation of the model are evaluated by Kappa coefficient, which comparing land use prediction map in 2015 and land use map in 2015. Kappa coefficients are generally used to evaluate the classification accuracy of remote sensing data and the similarity of two images(McHugh, 2012), the formula is as follows:

$$Kappa=(P_o-P_c)/(1-P_c)$$

Where Po means the actual similarity rate, Pc means the theoretical similarity rate. When Kappa $\in$ [0,0.4], which shows that the consistency between the two land use maps is poor and the model simulation is not effective. When Kappa $\in$ [0.4,0.75], which indicates the similarity between the images is general. When Kappa $\in$ [0.75,1], which shows that the consistency of the two images is high, the model simulation effect is good, and results can be trusted.

5.1.6. Validation process

First, input the land use map in 2005 and 2010 into the Markov model to calculate the transition probability matrix of the land use. Then, set the number of cycles to 5, select 5 * 5 filter, run the model predicting land use map in 2015 based on the map in 2010.

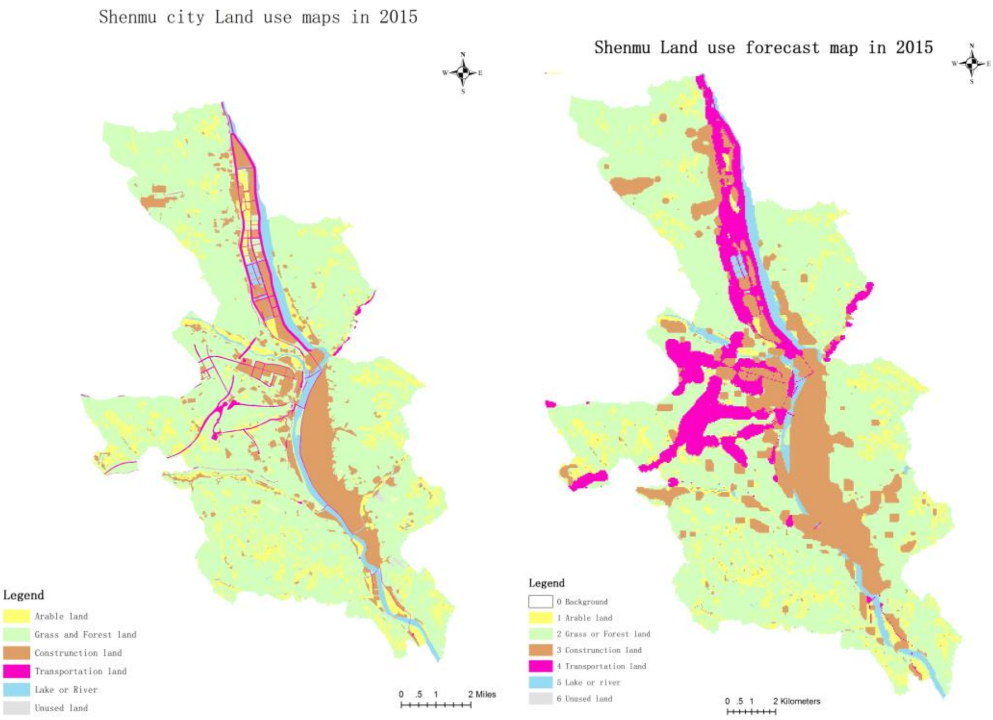

Figure 16 Land use exiting and forecast map in 2015

Use Kappa validation tool in IDRISI to verify the result. The Validate module in IDRISI offers one comprehensive statistical analysis that answers simultaneously two important questions. How well do a pair of maps agree in terms of the quantity of cells in each category? How well do a pair of maps agree in terms of the location of cells in each category (J. R. Eastman, 2012)? It means Kappa validation can verify the quantity and distribution of different images. The validation result is shown below.

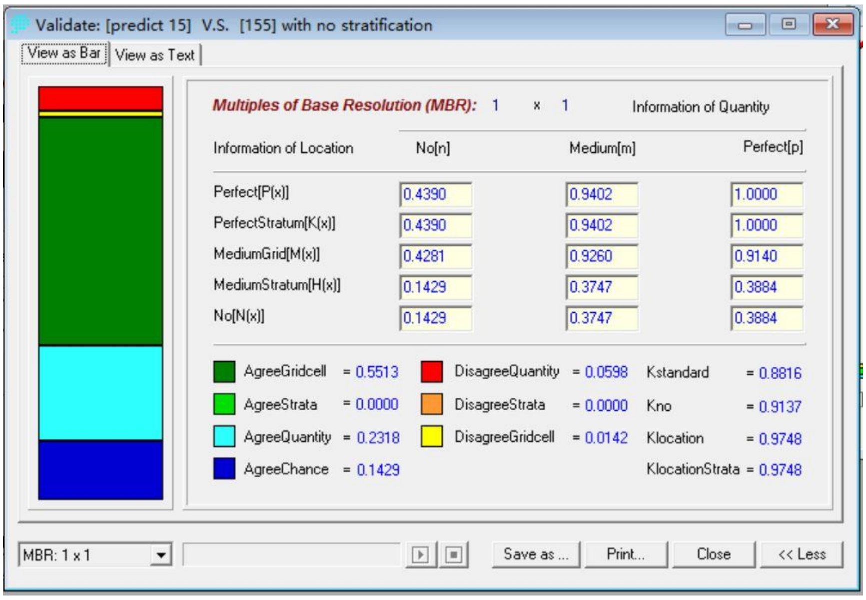

Figure 17 Kappa result

Which shows the Kappa coefficient is 0.8816 that means the model and parameters are well. According to the figures, we can see the transportation and construction land change a lot, but the others type of land just change a little. The integrated CA-Markov model in this study has performed well in comparison to other research which also used with different types of models. Nahar & Pradhan (2016)applied the CA model with Markov Chain statistics to monitor future urban sprawl in Tripoli, Libya. Their model reached 85% accuracy. Meanwhile, White, Engelen, & Uljee (1997)used only the CA model to simulate urban land-use dynamics, where the accuracy of the model was found to be 69%. However, there are some studies that have achieved far better CA model accuracies, such as (Santé et al., 2010), in which they combined the CA model with AHP, and achieved 88% accuracy. The CA-Markov model used in this study has performance well and accuracy compared to the many studies that have been done in this field.

5.2.1 Normal development model

Shenmu land use forecast map is exported based on land use map in 2015. Set the parameters as above and run the model to predict land use forecast map in 2020. Then, export result to ArcGIS to symbol and mapping. The result is as below. This model in this research I named it to 2020Ⅰ.

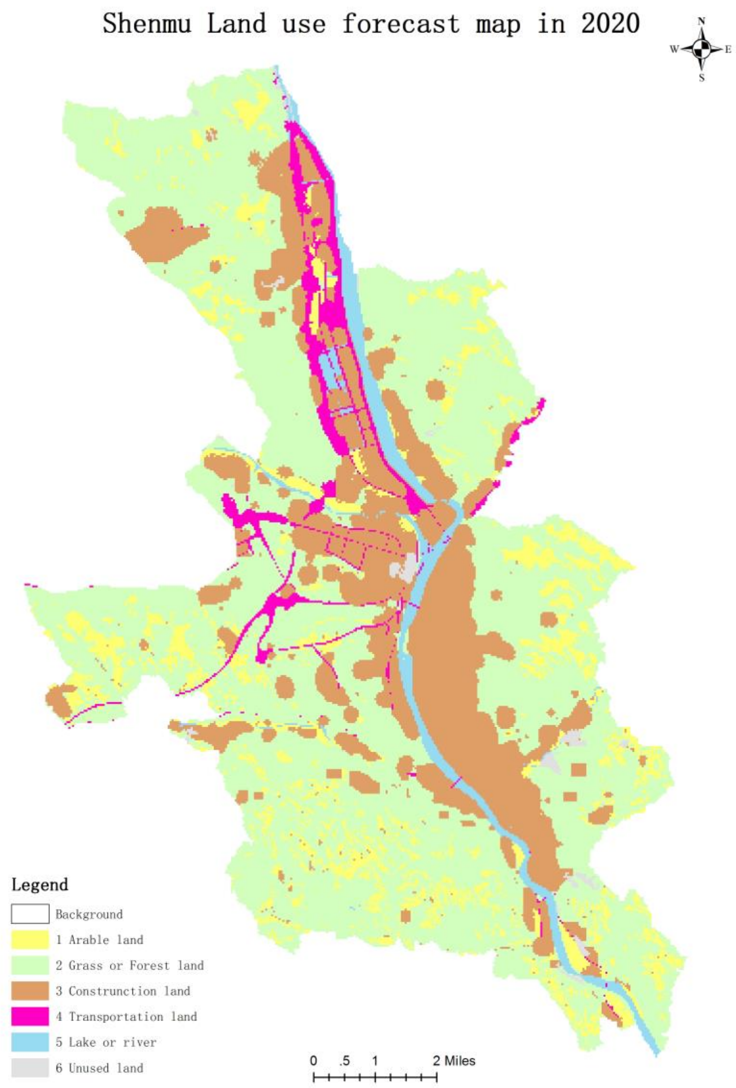

Figure 18 Land use forecast maps in 2020

Comparing forecast map between 2015 and 2020, the transportation land is totally difference.

Because the basic maps is not the same, land use forecast map in 2020 is predicted based on land use map in 2015 and the transition matrix is produced by 2010 and 2015. It means government control the expansion of transportation and protect arable, grass and forest land after 2010.

5.2.2 Multi-criteria evaluation

Multi-Criteria Evaluation is used in IDRISI to make the transition suitability image of each land use type. MCE is a common method and decision support tool for evaluating and centralizing multi-criteria, and the criteria used can be divided into two kinds of constraints and factors, among which the constraints the condition is to Boolean to divide the region, that is, meet the conditional or non-conditional assignment and the factor is to define the region with continuous suitability. There are three options to combine the standard used, namely Boolean method, weighted linear method and ordered weighted average method. The boolean method and weighted linear combination method used in this research are described below.

Boolean method

Boolean method is the most common method to solve the problem, but also the most common method of multi-standard evaluation. The method first standardizes all the criteria (including the limiting factor and the constraint factor) into Boolean values or uses a Boolean intersection method to obtain a binary suitability image (J. Eastman, 1999). The Boolean method is used in this study because the two constraints in this study are basic farmland protection areas and restricted construction areas. In these two factors, they control the land strictly which means if factors do not allow the land to change, it cannot be changed. Basic Farmland Protected Area refers to the special protection of basic farmland, according to the overall land use planning and in accordance with legal procedures, no matter what kind of construction land cannot be occupied this land.

Weighted linear combination

The WLC method is more complex than the Boolean method. It reclassifies the factors as 0 or 1, the WLC method normalizes the factors to 0 (most inappropriate) 255 (most suitable) continuous suitability values based on some functions, thus avoiding to define some location directly considered as appropriate or inappropriate. On this basis, each factor is given different relative weights in order to compromise or compensate for each other. Then, each normalized factor is multiplied by its corresponding weight, and the result is added. Then, divided by the number of factors to obtain the weighted the average result image and the final result image are multiplied by the constraint image to obtain the final suitability image (Munda, 2004). This method is suitable for generating images of suitability with factors such as river, DEM, distance from the road.

5.2.3 Constraint development model

The contradiction between the irreversible trend of urbanization and industrialization and limited land resources has become an important factor that restricts the sustainable development of the economy and society in the region. Increasing construction land occupation, occupying a large amount of arable land, resulting in the contradiction between the protection of arable land and economic development. However, the drastic reduction of arable land will seriously shake the basis of sustainable development in the region. Therefore, the issue of sustainable development focuses on the protection of arable land and restrict the expansion of construction land. In view of this, the planning of special provisions for basic farmland protection zones and construction land control zones has strengthened the control of land use. This model in this research I named it to 2020 II .

Constraint factors

In this study, the constraint factors are basic farmland protection area and constraint construction area. Both of these restrictions are land that cannot be occupied by construction land and are not to be taken up unless there are large projects that the country has been approved by the National Development and Reform Commission (NDRC). In this study, the construction land control area constraint factor is used in this method, allowing construction area is set to be 255, that is, the construction area is suitable for construction. The forbidden construction zone is to be 0, that is, the construction area is not suitable. The condition construction area is 150, and the restricted construction area is 75.

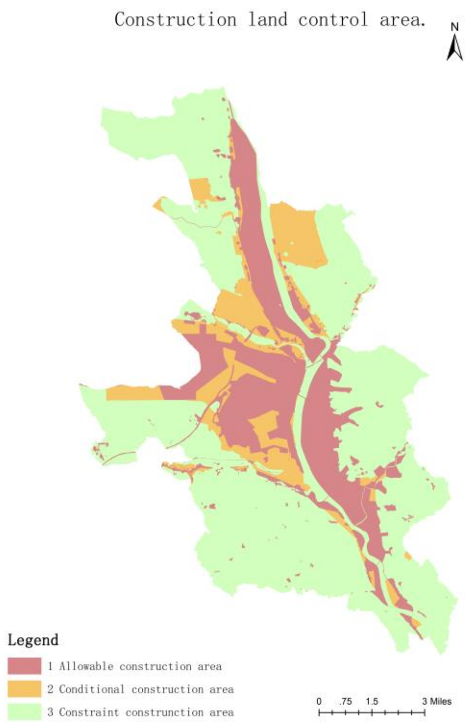

Figure 19 Basis farmland protection map **Figure 20 Construction land control map**

Combining the constraint factors with the original land transition suitability map using the MCE approach to export constrained transition suitability map, which is used for predicting using the CA-Markov model.

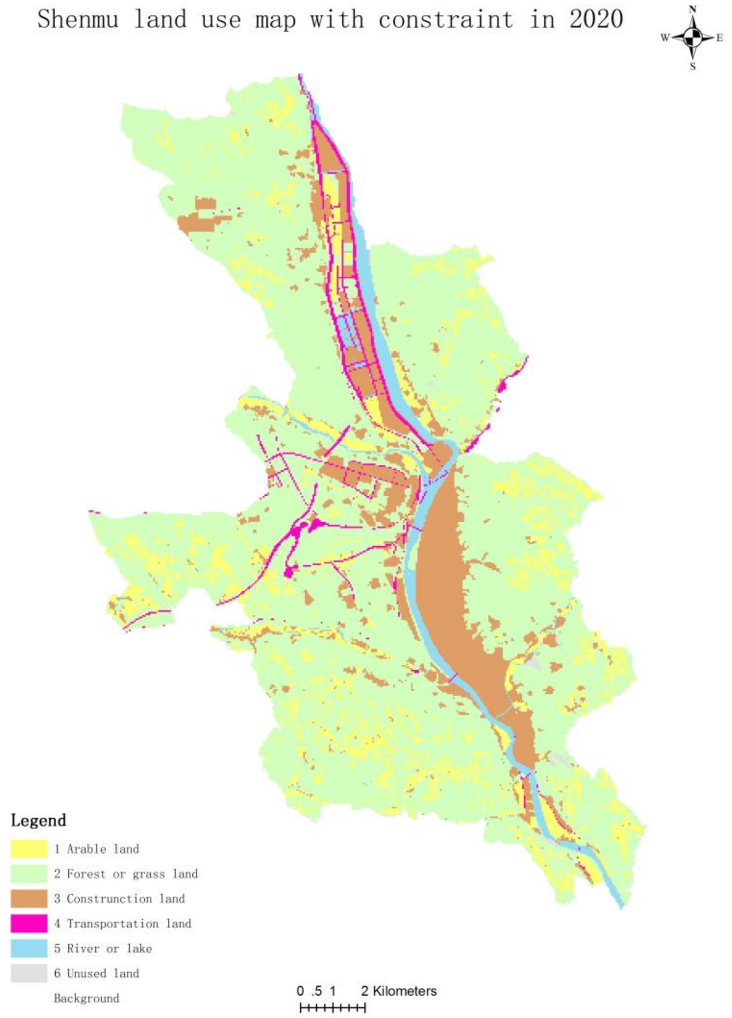

Figure 21 Shenmu forecast land use map in 2020

5.3. Characteristics of land use in Shenmu city.

1.High quantity but low quality of land resources.

Shenmu city land area is in the first place in Shaanxi province. The per capita land area of 24.4 mu and the arable land per capita 3.8 mu in 2016. However, the productivity of land is low and food production is also relatively small because of the limitation of topography and soil type.

2. Abundant mineral resources and large proportion of industrial land.

Shenmu covers coal area of 4500.00 square kilometers, accounting for 60.21% of the total area of the land and including 50 billion tons. The geological structure of coal bed is not only simple but also shallow so that it is easy mining. Furthermore, mining of mineral resources exploitation drives the usage of 21.97% of the total area for the urban and rural construction.

3. Obvious differences use in land.

In the northwest of the city, it is a sandy beach area, which is relatively flat. However, due to its rich mineral resources, land use is mainly used to construction land, and develop industry and business. The southeast is the loess hilly gully region, the land is broken, the land use is mainly agricultural land, the development of traditional agriculture.

Interview1: I am an official from basic farmland protection apartment in Land Agency. I have some ideas about land use in Shenmu City. With the progress and development of the economy and society, the change of land use in Shenmu city has been obviously changed since 2005. The concrete performance is that the number of arable land has been reduced, the construction land has increased rapidly, among which the urban industrial and mining land has the largest increase, and the newly built construction land mainly occupies the arable land.

Interview2: I am an official from land use planning apartment in Shenmu Land Agency. I have worked in this apartment for about ten years. I think the land use of Shenmu city has the following characteristics: abundant coal resources, fragile ecology, frequent natural disasters, serious soil erosion and rapid growth of construction land. The rich coal resources have played a great role in promoting the economic and social development of Shenmu City, which increases the demand for construction land.

Interview3: I am an official of the land use law department. I have the following opinions on the land use of Shenmu city. The following factors affect the land use change of Shenmu. First, the demand for the construction land is increasing, a large number of agricultural land is occupied and the structure of land use is not reasonable. Secondly, the local coal resources are rich. In order to develop the economy, we should make full use of the local resources. The local land use changes, and the state policy affects land use change, such as returning farmland to forest and grass, land renovation, and most importantly, the local people's awareness of land use also affects the land use change of Shenmu. The use of land to develop agriculture has little effect and slow returns, and the local topography is broken and the soil quality is low. Land use to develop the industry has a relatively high return on investment.

Interview4: I am the deputy director of the Land Agency. I have been working here for more than twenty years. I know a lot about the land use of Shenmu city. Now I want to talk about my views on the land use of Shenmu city. Shenmu city has been more intensive in construction land since 2005, the intensity of land use has been continuously improved. And the output value of unit land is increasing. The arable land is limited to natural conditions, grain yield is low, and some land renovation projects have been carried out. A perfect irrigation and drainage system and mechanical farming have been built. The land use of Shenmu city has the following characteristics. Shenmu city has a large area of land, mainly in the northern part of the region, and relatively flat in the north. The quality of arable land is low, mainly in dry land, and large per capita land for construction. The northern part of Shenmu city is mainly affected by water resources. The southern mountainous area is mainly restricted by terrain and is not easy to develop. If the land use pattern is continued, the soil fertility will be degraded and desertification will intensify in the future. The land use of Shenmu city is mainly restricted by the economy, the land development and consolidation fund is large, the recovery period is long, the market capital inflow will be low, mainly relying on the government investment, or the government guidance.

5.4. Land use weakness in Shenmu city

5.4.1. Ecological fragility, soil erosion and coal mined area are more serious

The county soil erosion area of 6,700 square kilometers, accounting for 87.5% of the total area. Land degradation and desertification area is increasing. Irrational farming, fertility decline, soil erosion intensified. Although the deterioration of ecology has been postponed with the implementation of returning farmland to forest land and grass land, the task of governing soil and river loss and desertification is still grave. Especially with the further development of coal resources, the area of the mined-out subsidence area has increased. The pollution caused by the industrial has become increasingly serious. The task of governance is arduous and the management is very difficult. At present, there is a 324-square-kilometer mined-out area, and the area of mining subsidence area is increasing year by year. The difficulty of remediation is high, and the pollution of land by industrial wastes is urgent.

5.4.2. Land-use quota is not enough seriously because of the rapid growth of construction land

With the rapid growth of industrialization, urbanization and the construction of the national energy and chemical industry, Shenmu City's economy has rapid growth and large projects have been built in recent years. The construction of transportation infrastructure and the integration of urban and rural areas continue to accelerate which need a substantial land. However, there is no more preferential policy on the index of land for construction purposes, which makes the contradiction between supply and demand of land and the quota of construction land is seriously insufficient, which affects the process of economic development.

5.4.3 The residential land in rural area is scattered, and the remediation task is heavy.

In 2015, the land for rural residential areas per capita up to 349 square meters, which is higher than the national standard (140 square meters per person). At the same time, there is a growing trend of hollow villages in the urban land industrialization. The waste of land resources is serious, lacking of reasonable arrangement. So, it needs to be regulated to improve the utilization efficiency.

5.4.4 The structure of land use is not reasonable

Although the forest and grass are the largest types of land, but efficiency is poor, low profit per unit. The layout of rural residential areas is scattered. Each household uses more than 300 square meters, which is not economical enough and a large number of hollow villages emerge. However, this provides a huge space for utilization in increasing. In coral land, the larger proportion of unused land, a large number of abandoned, unused land in urgent need of reclamation, restoration of cultivation.

Interview5: I am a director of mining apartment. I have the following views on Shenmu arable land and mining land. Land use in Shenmu city have some mining land close to town and residential area, which has a certain impact on people's lives. The proportion of newly occupied construction land occupied by part of arable land is too large, resulting in a decline in the number of arable land. The use of land is not intensive and economical. Shenmu's abundant exploitation of coal resources has a major impact on land use change in Shenmu city. The following factors restrict the land use of Shenmu City, first of all, the natural factors. Shenmu city is located in the Loess Plateau area, the precipitation is small, the land is poor, the ecological fragile, and the soil erosion is serious. This requires greater protection for local ecology. The second is the social and economic factors, the GDP growth of Shenmu city is positively related to the change rate of construction land. In order to pursue economic growth, the demand for construction land is also increasing, which leads to the rapid growth of construction land. Finally, policy factors.

Interview6: I am a deputy director of the land use apartment. I have been working in this department for nearly fifteen years. I have the following views on the defects of Shenmu's land use. The proportion of high-quality arable *land is small, and protection measures need to be strengthened. The quality of arable land is small and the proportion is small. With the acceleration of industrial development, construction occupies a lot of arable land. At the same time, the hollow villages appearing in the process of urbanization and industrialization are also increasing. Towns in the south, including towns and so on are all distributed. The waste of land resource utilization is rather serious. Lacking reasonable arrangement, it is necessary to improve the efficiency of utilization. Shenm cityu, as the core area of national energy and chemical industry, the economic construction of Shenmu city is changing with each passing day and a variety of large-scale projects are constantly emerging, which makes the demand for construction land increase rapidly. But the land use has not been given special support and the contradiction between supply and demand of construction land is becoming increasingly prominent. Due to the influence of drought and strong wind, the land degradation and desertification area is increasing, and the land fertility of the hilly and gully area has been greatly reduced by the fragmented landforms and unreasonable reclamation in the hilly and gully areas. In recent years, with the further development of coal resources, the land resources have been seriously damaged, and some even irreversible. The area of the goal subsidence area is increasing year by year, the difficulty of renovation is high, and the pollution of the industrial three wastes to the land, the treatment of the goal is imminent.*

Interview7: I am an official of the land use department of the Shenmu LandAgency, working in this department for a long time, according to my understanding of the land use of Shenmu City, there are still many constraints in the future development of Shenmu city. Local natural conditions restrict the land use in Shenmu city. Shenmu city is located in the Loess Plateau, with broken terrain, ravines, and serious soil erosion. The level of intensive use of arable land is low, the scale management is less and the degree of land use is not high. The expansion speed of the construction land is rapid, the agricultural land is great pressure and the ecological environment in the local area is not optimistic, the rocks around the mining area are bare and the grass is not living. The exploitation of mineral resources and the later processing cause land collapse. The adverse consequences such as water pollution and excessive dust seriously affect the land use in Shenmu city.

Interview8: I am the director of the Land Conservation Department of the Land Agency. I have the following opinions on the proportion and land use types in Shenmu city. The proportion of all kinds of land used in Shenmu city is unreasonable, the proportion of urban land use structure is maladjusted and the structure of land use mainly exists the following problems: the agricultural land area of Shenmu is too large, and the development of other types of land is limited to a large extent. This leads to the difference of landscape heterogeneity and diversity in Shenmu city. The low index will affect the anti-interference ability of the land structure, which leads to the poor stability of the land structure, the low proportion of urban and industrial and mining land in Shenmu city and the scattered distribution of villages and mining land. It will cause damage to the living environment of the residents to a certain extent, and thus affect the process of urbanization. Shenmu city is short of traffic land and the connectivity of traffic landscape is not high. Urban traffic landscape can play the function of traffic and the ecological function of road greening belt at the same time.

5.5. Result analysis

5.5.1 Land use quantity analysis

By interpreting the remote sensing data in 2005, 2010 and 2015, the area and quantity and extent of the three base periods of different land types can be obtained through statistics and summarization. According to Table 5, it is known that the main area of Shenmu city is forest or grass, the proportion of the occupied area is more than sixty percent, the area of forest or grass is declining every year. The second is arable land, accounting for about twelve percent, and the change range of arable land is small. In 2005, the lowest proportion was transportation land, but the development rate of transportation land was the fastest, from 1.77% in 2005 to 4.14% in 2015. The largest change is unused land, from 5.23% in 2005 to 1.43%, a decrease of about 3200 cells, from fourth to sixth in all places. The increment of construction land is the largest, rising from 9948 yuan in 2005 to 16661 cells, accounting for 19 from 11.68.4% to 56%. The amount of river change was minimal, and there was little change in ten years.

Table 5 2005-2015 Land use quantity

Land use types	2005	Occupation ratio	2010	Occupation ratio	2015	Occupation ratio
Arable land	10795	12.67%	10529	12.36%	10026	11.77%
Forest or grass	54765	64.30%	52906	62.12%	50419	59.20%
Construction land	9948	11.68%	13682	16.06%	16661	19.56%
Transportation land	1508	1.77%	2474	2.90%	3530	4.14%
River	3698	4.34%	3356	3.94%	3314	3.89%
Unused land	4456	5.23%	2223	2.61%	1220	1.43%

5.5.2 Land use net change, exchange change and total change

The land use transition probability matrix is generated by the Markov model and the land use index model to obtain the land use transfer probability of Shenmu city from 2005 to 2010 and 2010 to 2015 on the basis of the land use quantity. Then, the net change, exchange change and total change of land use change are calculated from the probability of land use transfer. The result can be seen in Table 6, 7, 8 and 9.

Table 6 2005-2010 Transition probity

		2010						Total	Decrease
		Arable land	Forest or grass	Construction land	Transportation land	River	Unused land		
2005	Arable land	11.77%	0.00%	0.37%	0.27%	0.27%	0.00%	12.67%	1.03%
	Forest or grass	0.63%	59.47%	2.04%	2.16%	0.00%	0.00%	64.30%	4.84%
	Construction land	0.00%	0.23%	10.35%	0.47%	0.10%	0.53%	11.68%	1.33%
	Transportation land	0.07%	0.00%	0.06%	1.64%	0.00%	0.00%	1.77%	0.14%
	River	0.00%	0.22%	0.07%	0.09%	3.69%	0.27%	4.34%	0.65%
	Unused land	0.00%	0.74%	0.17%	0.10%	0.16%	2.50%	5.23%	2.73%
Total		12.36%	62.12%	16.06%	2.90%	3.94%	2.61%	100.00%	
Increase		0.59%	2.65%	5.72%	1.27%	0.25%	0.11%		

Table 7 2005-2010 Land use change information

Land use types	Increase	Decrease	Total change	Exchange change	Net change
Arable land	0.59%	1.03%	1.62%	2.06%	0.44%
Forest or grass	2.65%	4.84%	7.49%	5.30%	2.18%
Construction land	5.72%	1.33%	7.05%	2.66%	4.38%
Transportation land	1.27%	0.14%	1.40%	0.28%	1.13%
River	0.25%	0.65%	0.90%	0.50%	0.40%
Unused land	0.11%	2.73%	2.84%	0.22%	2.62%

As can be seen from table 6 and 7, from 2005 to 2010, the total change, exchange change and reduction of forest or grass are the largest, which indicates that the number of forest or grass is not only greatly reduced, and the location changes are very large. The forest or grass mainly transfers to arable land, construction land and transportation land. But the situation of arable land is not the same, the net change amount is only 0.59%, but the exchange change amount is 2.66%, indicating that the total amount of arable land changes less, and the spatial position had changed significant. In the all kinds of land, the changes in the river area are relatively not obvious. The net change of the transportation land had changed a lot than exchange change. It shows that the Shenmu city has carried out the construction of a large scale of highway and railway network in the last five years. The net change of the construction land is the largest, which means the Shenmu had built a lot construction land, and the construction land is mainly converted from arable land, forest or grass.

Table 8 2010-2015 Transition probity

		2015						Total	Decrease
		Arable land	Forest or grass	Construction land	Transportation land	River	Unused land		
2010	Arable land	11.22%	0.40%	0.20%	0.55%	0.00%	0.00%	12.36%	1.14%
	Forest or grass	0.52%	56.52%	2.62%	2.45%	0.00%	0.00%	62.12%	5.60%
	Construction land	0.16%	0.64%	12.69%	1.93%	0.64%	0.00%	16.06%	3.37%
	Transportation land	0.00%	0.09%	0.00%	2.73%	0.00%	0.09%	2.90%	0.17%
	River	0.15%	0.00%	0.02%	0.08%	3.70%	0.00%	3.94%	0.24%
	Unused land	0.15%	0.55%	0.27%	0.26%	0.00%	1.38%	2.61%	1.23%
Total		11.77%	59.20%	19.56%	4.14%	3.89%	1.43%	100.00%	
Increase		0.55%	2.68%	6.87%	1.41%	0.19%	0.05%		

Table 9 2010-2015 Land use change information

Land use types	Increase	Decrease	Total change	Exchange change	Net change
Arable land	0.55%	1.14%	1.69%	1.10%	0.59%
Forest or grass	2.68%	5.60%	7.49%	5.36%	2.92%
Construction land	6.87%	3.37%	10.24%	6.74%	3.50%
Transportation land	1.14%	0.17%	1.33%	0.34%	0.97%
River	0.19%	0.24%	0.45%	0.38%	0.05%
Unused land	0.05%	1.23%	1.28%	0.10%	1.07%

From the table 8 and 9, we can see that the Shenmu city had more change than the first five years from 2010 to 2015. The exchange rate of arable land is 1.14%, and the net change is only 0.55%, which indicates that the change of the position of arable land is more obvious. The main reason for the reduction of arable land is the development of construction land and transportation land, and the increase is transferred from the forest or grass and unused reclamation. The amount of exchange change of forest or grass is the 5.36%, mainly transfer to arable land, construction land and transportation land. The net change of forest or grass is 2.92%, and the decrease is 5.6%. The largest net change is construction land, mainly from the development of arable land and forest or grass. The state of the rivers remained unchanged for the last five years. The net change and exchange change of unused land are in the middle reaches, mainly transfer into arable land, forest or grass.

5.5.3. Spatial analysis of simulation results

As shown in the figure 18, construction land mainly expands to the periphery mainly from the original construction land. Shenmu city government also delineated a new construction land for development in the city surrounding areas. The construction land is mainly built based on river and distribution on both sides of the river. In scenario one, the construction land gradually changed from a point-like distribution to a planar distribution, occupying a large amount of surrounding forest land and arable land. In scenario 2, due to the influence of the constraint factor, the growth of construction land is controlled to a certain extent. The development of transportation land should be a trend of linear development. In scene one, it is a planar peripheral expansion. This is not common sense, but it is technically difficult to solve. Therefore, this research thinks that the amount of land for transportation growth, the result of changes in space will not be accepted. In both scenarios, the basic farmland has been expanded in a planar manner. Fragmented farmland has been annexed by other lands around it, which is also in line with the continual development of farmland. However, for arable land being occupied, to account for a complement to ensure the number of arable land. In general, in scenario one, all the land use types are dominated by land types with the largest area in the area, occupying other land and showing a planar growth. In scenario 2, due to the influence of two constraint factors, the development of various types of land is controlled.

5.5.4 Quantity analysis of simulation results

In this research, there are two situations of development. One of them is 2020 I, which is the natural development model with no constraint factors. And the other one is the sustainable model with two constraint factors. In the first situation, construction land is expected to increase sharply from 2015 to 2020 with the change of about 6000cells. The proportion of total area will change from 19.56% to 26.47%. However, arable land, grass land and forest land are decreasing rapidly. As the graph shown that, the grass land and forest land will drop from 59.2% to 54.21%. Then the transportation land will grow up sharply with the proportion of 49%.

Overall, this kind of change stands for that the contradiction between human and land use will be more and more sever because the plan of various land use is closely related to economy development and environment. Thus, we should take measures to deal with the problems to protect arable land and utilize other land properly.

In the second situation, the speed of deduction of arable land and grass or forest land decreases slowly. As the table 10 shows, arable land decreases about 200 cells but the construction land increases about 2000 cells. It shows that policies from government in protecting arable land are working perfectly. Furthermore, the utilization of land use is changing from traditional to intensive.

Table 10 Number of simulation results

Land use types	2015	Occupation ratio	2020 I	Occupation ratio	2020 II	Occupation ratio
Arable land	10026	11.77%	9451	11.10%	9800	11.51%
Forest or grass	50419	59.20%	46174	54.21%	48800	57.30%
Construction land	16661	19.56%	22541	26.47%	18691	21.95%
Transportation land	3530	4.14%	3220	3.78%	4235	4.97%
River	3314	3.89%	3189	3.74%	3246	3.81%
Unused land	1220	1.43%	595	0.70%	398	0.47%

6. LAND USE OPTMIZATION

The essence of land use optimization is to maximize the three comprehensive benefits of society, economy and ecology. In this study, the land quality is low, the mineral resources are rich, the land difference is obvious, the ecological environment is more fragile, the residential sites are more dispersed and the construction land is fast expanding, but still faces the quota shortage. The ways and Countermeasures for the optimization of land use are put forward. Combine with the analysis of the quantity and spatial change of land use change in Shenmu City, the ways for land use optimization in Shenmu city are put forward.

6.1 Strictly protects the arable land

According to the results of the land use analysis, we can see that although the arable land in Shenmu city is less occupied, it is still necessary to strictly strengthen the protection of arable land, especially the protection of basic farmland. Through the improvement of the basic farmland protection system and the supervision of the basic farmland, farmland protection should be carried out in a planned way.

From the land use maps, we can see that the concentration of arable land in Shenmu city is low, and there are few large areas of arable land, and the arable land is far away from the transportation land. So, it is necessary to strengthen the degree of continuous arable land and make full use of the traffic advantage for the basic farmland around the town or the surrounding roads.

From the characteristics of land use and the existing problems in Shenmu City, we can see that the quality of arable land is low in Shenmu city. In order to cope with the new situation of urban construction, it is necessary to improve the quality of arable land to deal with the relationship between economic development and arable land protection. It is necessary to establish a management system to monitor the quantity and quality of arable land dynamically to ensure that the productivity of the basic farmland is maintained at a certain level, and to increase the investment in the economic and other resources of high quality farmland, and to improve the quality of the farmland. Strengthen the investment of arable land, improve the quality of arable land to prevent more and less, dominant and inferior, ensure that the quantity of arable land is not reduced, the quality is improved, and the balance of arable land in this area is realized.

Interview9: I am the director of the Basic farmland protection Department of the Land Agency. I have the following opinions on the protection of the arable land in Shenmu city. The protection of arable land is mainly in the following ways: to increase the arrangement and reclamation of rural arable land, to reorganize and reuse the land abandoned because of the weakness or unwilling to cultivate. Reclaiming the land in time because of the environmental pollution. For farmland, we should cultivate the soil, improve the structure, and actively explore the methods of scientific farming. Farmers are the main factor to improve the utilization ratio of agricultural land. Let farmers voluntarily learn the methods of production, operation and management of modern agriculture. Strengthening farmers' agricultural marketization idea. To promote farmers from pure production to business type by training, take the initiative to go out of the land,; for protect agricultural land, we should rationally increase the investment in land to ensure the intensity of land use to a certain extent.

6.2 Strengthen the ecological civilization

From the results of land use analysis, we can see that forest or grass is the most occupied land, and the ecological environment is relatively fragile. Shenmu city belongs to the region with more serious soil erosion. It is necessary to strictly observe the bottom line of ecological protection and construct an ecological comprehensive protection model to improve the function of the ecosystem. The protection of ecosystem services and ecosystem maintenance in the region should be strengthened, including the protection of forest and grass.
From the result of the analysis, we can see that the transition level of the forest or grass in Shenmu city is low, so it is necessary to protect the ecological barrier of soil erosion and river source protection area. We should strengthen ecological environment management, environmental risk control and environmental quality improvement, maintain key ecological functional areas and stabilize eco-environment sensitive areas and vulnerable areas.
Interview10: I am deputy director of the Environmental Protection Agency. I have the following opinions on the protection of Shenmu city's ecological environment. The implementation of ecological construction and greening action will combine the conversion of cropland to forest with the construction of shelterbelt system and create a green ecological barrier. The construction of ecological landscape around urban area will promote the construction of green corridors along urban roads. We should promote pollution control in some ways. We should actively carry out environmental improvement work, strengthen environmental control of industrial distribution and join the concept of ecological governance and ecological industry in the industrial management system. We should actively carry out mine ecological rehabilitation and increase the comprehensive control of subsidence and subsidence areas. Efforts should be made to create an environmentally friendly land use pattern. The model of modern characteristic agriculture industry in Shenmu city is established. The industrial demonstration area featuring characteristic planting and leisure sightseeing will be built with the goal of achieving win-win ecological and economic benefits.

6.3 Promote intensive land use

In addition to the centralized construction of Shenmu city center, most other areas of the city are relatively scattered, so the intensive land use is needed. According to the principle of centralized rural land use, village and town construction should actively deal with empty village, speed up the construction of rural infrastructure and public facilities, guide farmers to centralization in the central village of town and transfer rural migrant workers in a reasonable way to the central villages or towns with stable living conditions. The farmers should be concentrated and guided to key towns and central villages with good basic conditions and well-developed facilities. Control the spread of natural villages, promote orderly space, enhance the leading role of aggregation and promote population aggregation and industrial agglomeration.
Shenmu City is the Coal Center in China where is rich in mineral resources. But because of the unordered and low efficiency expansion of the mining land, the coal mined area of Shenmu city has increased greatly. Therefore, it is necessary to control the new construction land scale and the regulation of land supply is of great importance to the fundamental transformation of the economic development. We should make full use of the unused land, excavate the inefficient land, effectively reactivate the land, increase the transformation and reclamation of the abandoned mining areas, and improve the efficiency of land use and the intensive utilization rate.

Interview11: I am the deputy director of the Land Agency. I have the following opinions on the intensive and economical utilization of Shenmu city. The protection of arable land is mainly in the following ways: to increase the arrangement and reclamation of rural cultivated land; to reorganize and reuse the land abandoned because of the weakness or unwilling to cultivate; to reclaim the land in time because of the environmental pollution. For the farmland, we should cultivate the soil, improve the structure, and actively explore the methods of scientific farming, planting and fertilization, and enhance the ability of grain production.

6.4 Land consolidation

In view of the collapse of mined out area, we need to improve the land management. We should consolidate the construction of rural construction land and rebuild rural residential areas with larger per capita construction land. In order to develop new arable land in a reasonable area and improve the quality of arable land, the new arable land should be consolidated and built, and the unused land is developed in a orderly way according to the regional demand. Measures for land regulation and protection. We need to further enhance the awareness of land use, strengthen planning and management, and improve relevant laws and regulations. In addition, we should strengthen institutional innovation, establish and improve the land management mechanism for economic operation to ensure the implementation of land reclamation projects.

6.5 Land function zoning

According to the obvious land difference in Shenmu City, it is necessary to delineate the functional area of the land with clear function. It can not only improve the degree of the cropland, but also solve the problem of the disorderly expansion of the residential land and the disorderly expansion of the construction land. The Central District of Shenmu is designated as the area of urban development. As the core area of Shenmu City, the main area is construction land combine with infrastracture. At the same time, the entrance threshold of the construction land should be controlled to avoid the introduction of projects with large pollution and low environmental benefits into the urban area. The industrial development of Shenmu area is driven by the urban development zone.

In the area of better traffic conditions, the area which is closer to the town or the area with higher concentration is classified as the concentrated area of agricultural development. It can use it to gain the advantage of other economic resources to improve the quality of arable land, promote the construction of farmland, improve the production conditions and improve the production efficiency.

The Shenmu forest or grass area is the biggest and interlaced with the arable land, but in the Loess Plateau. There should be set up to improve the fragile ecological environment of Shenmu. Proper agricultural activities and appropriate tourism construction should be carried out in these area, and the construction land must be strictly approved. The core of the area lies in the construction of ecological environment and the coordination of various resource relationships in the region.

Mining is the main industry of Shenmu City, should appropriately delineate mining production areas. In some areas where the goaf is serious, mining should be prohibited or restricted. And land reclamation and other means are adopted to improve the goaf environment should be carried out.

The examination and approval of strict mining land to improve the access threshold of mining land, from the simple mining behaviour to the mining process and other land types of small damage to the environment change.

7. Conclusion

This research aims at using spatial modeling to analyze the land use in Shenmu city for optimization land use in case of inappropriate control of land use. It was reached by two sub-objectives which would be summarized in following. This research was presented in 7 sections. The first chapter present the information of research background and justification to address research problem. Overall objective, sub-objectives and research question are mentioned to divide research to part to solve one by one. Moreover, the conceptual framework, methodology and research design are mentioned to answer research question. The second chapter reviews the literature which introduce main basis of this research and define the concepts, as well as land use model. The third chapter introduce the methods of collecting data and process of satellite image. The fourth chapter present the principle and process of the model and the elements and characteristic of cellular automata. The fifth chapter present the result of the model and analyse it. The sixth chapter present the optimization land use according to the result. This chapter present the conclusion and recommendation.

7.1. Conclusion

This research aims at using land use model to analyze the land use change in Shenmu city for optimization land use in case of inappropriate control of land use. The conclusion of the research sub-objective will be explained, follow by the final conclusion
Objective 1: To choose the model and simulate land use change.

This objective aims to process remote sensing image data technically and then process the data to finally obtain the types of data that can be manipulated in the model. Using the model to simulate the change of land use in Shenmu City to prepare for the next analysis. This objective is achieved in Chapter 3 and 4. The following steps are carried out to achieve this objective. Firstly, we can obtain basic land use data through downloads and interviews. Then, a series of processing should be performed on the acquired remote sensing image. The next stage is analysing the strengths and weaknesses of each model in a variety of spatial models. We have found the CA model has many advantages for the simulation of spatial distribution and the Markov model is relatively accurate for the quantity simulation. Therefore, combining these two models are chosen for analysis of land use change. Subsequently, we should focus on the accuracy of the CA-Markov model for land use simulation results. The accuracy reached the standard, the land use of 2020 can be predicted. Furthermore, two unused scenarios were used in this study. The first one is the natural growth model without any constraint factor. The second one is limiting the development model. And the model adds two factors, basic farmland protection and construction land restrictions.

Objective 2: To analyze the land use change, combining with the situation of Shenmu to put forward optimization land use.

This objective is to deal with the data after the spatial analysis and quantitative analysis since 2005 and put forward optimization land use based on the results of the analysis. This objective is achieved in Chapter 5 and 6. we should find out the influential factors in land management and then figure out how these factors affect land use change. Secondly, we also need examine the shortcomings of the land management methods based on the changes in land use in order to protect the arable land and ecological environment. Finally, putting forward optimization land use in Shenmu city.

The main object of the research was to investigate trends in land use change and put forward optimization land use. The research resulted in CA-Markov for simulating land use change in Shenmu city. The model has advantage of distribution and accuracy in simulating. It can also investigate the land use trends in 2020. Optimization land use is raised according to the result of model.

7.2. Recommendations

This research investigates trends in land use change and put up optimization land use. It proved the advantages of using CA-Markov as spatial model in support of simulating land use change. However, more research is needed to support the claims and further develop methods because some land use development cannot be explained by this model. Further research should develop the different models because different land use types have different changes. It should not be included in the same model.

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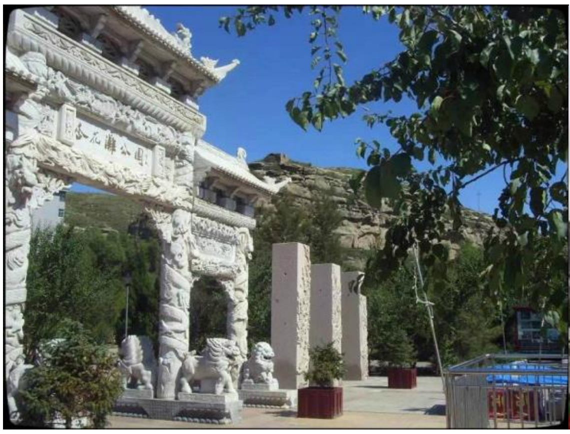
ANNEX

1. Place for data collection, accuracy assessment and interview.

Shenmu City Hospital

Children's activity centre

Xinghua Beach Park



Shenmu city Government

2. Interview question for Shenmu's Bureau of land and resources official

Dear Sir/Madam

I am Kun li, a student from Chang'an University and University of Twente, majoring in land administration. I am doing my interview about Shenmu city land use research and I'd like to learn from you. Your answers will give me a lot help.

1. Your name:______________________________
2. Your department: ______________________
3. Your major work: ______________________
4. Your position in this bureau:________________________
5. What land use change is happened in these years?
6. What are the characteristics of land use in Shenmu city?
7. What are the strengthen and weakness of land use in Shenmu city?
8. What factors have significant impact on land use change in your opinion?
9. Which land use type have the biggest impact on Shenmu city?

10. If you keep this land management, what land use change will be happened in the future in your opinion?

11. Which factors restrict land use change? And Which factors develop land use change

12. How these factors restrict and develop land use change?

13. In what way do you think you can optimize land use?

Thanks for your cooperation!!!