Team Control Number

59496

Problem Chosen

E

For office use only

T1 _____

T2 _____

T3 _____

T4 _____

For office use only

F1 _____

F2 _____

F3 _____

F4 _____

---

2017

MCM/ICM

Summary Sheet

(Your team's summary should be included as the first page of your electronic submission.)

Type a summary of your results on this page. Do not include the name of your school, advisor, or team members on this page.


In this paper, on the basis of three goals and ten principles,we define Urban Sustainability Index (USI) to measure the success rate of urban "smart growth".We construct a comprehensive evaluation model to make a reliable and effective evaluation of USI and put forward reasonable suggestions.

In Problem 1, we define USI as a measure of the success rate of smart cities, and propose three-dimensional model and sixteen indicators of evaluation system. Then, the computational model is established, and the model is supplemented by the normalization method of index data, the discrete treatment method and the balanced weight method. Finally, the neutralization evaluation model of urban sustainable development ability is constructed.

In question 2, Shangri-La in China and Colorado Springs in the US were selected as representative cities were studied and evaluated according to the ten principles of "smart growth". We deal with various indicators according to the comprehensive evaluation model that we established in first question. According to the results of the treatment, Colorado Springs' "Urban Sustainability" value is slightly higher than it of Shangri-La, so Colorado Springs "śmart growth" obtain a higher degree of success.

In Question 3, based on the geographic location of the sample cities, expected growth rates and economic opportunities and combine with own development strategies, we make the future "smart growth" plan for two cities and the expected success rate of the program will be re-evaluated by using the indicator system.

In Question4,we use the improved principal component analysis to analyze the development potential.

In Question 5, the ecological environment, the economic level and the quality of life are discussed from the planned sub-items according to conclusion in Question 3. In addition,we compare the expected population growth rate of the city with the assumed growth rate in Question 5 and consider that in which way that the promotion of social effects support the growth of such a development.



Key words: Smart Growth Gray Prediction Normalization Processing

# Content

# Introduction

There are many problems exist in the process of urban planning and management in many countries. It is clear that the world urbanization trend is accelerated. The emerging economic globalization has made cities in all countries develop at an unprecedented speed. The followings are the basic form of urban sprawl:

a) Urban land growth outstrips population growth.
b) Dwellings, shops and workplaces are strictly separate.
c) The lack of high-density economic center and it is difficult to walk.
d) A road network characterized by large blocks.

Rapid urbanization of population leads to the disorderly spread and expansion of urban space, which causestremendous pressure on resources and environment, and makes the relationship between people and land tighter.

As Theodore Parker said that:The city“has always been a civilized fireplace, emitting light and heat in the dark. ”Smart growth theory was firstly proposed by American scholars in the 90s of last century. This was because of the continued expansion of city public space, the loss caused by the spread of serious road congestion, environmental deterioration, and the scarcity of natural resources and a series of problems that existed in city growth plans. The scholars and the government hoped to establish a new plan and managementwas pretty fine, and the ultimate goal is to achieve coordinated economic social ecological development. It is defined as a planned and resource-saving urban development model. The development of our city requires promoting the city economy to run well and improving the urban livability and quality of life. As the city itself is the collection of nature, society and economic, as well as human and many other attributes, the content of smart growth research will be in a multi-disciplinary cross.

# General Assumptions and Variable Description

## General Assumptions

? Our dataare derived from the websites of international organizations and the city's official website, and it is reasonable to assume the high quality of their data. So the data we collect from online databases are accurate, reliable and mutually consistent.

?Based on three E goals and ten principles, we select three secondary indicators and sixteen tertiary indicators as the city ’s “ smart growth" model. We assume that the unselected indicator data have no impact on the city's "Smart Growth "of comprehensive evaluation system of the weight and the results.

?We selected Shanghai in China, Colorado in the United States as the sample of middle-sized cities to validate our model, and we reasonably assume that the cities that were chosen were representative.

?Assuming that the selected sample cities have no more serious disasters in the next five years, this assumption implies that government decision-making, human behavior and natural activities have the least impact and the model we proposed is rational .

?Assuming that within one year, the development plan of the sample cities has not changed much. In this way, we can use the recent year's data to validate our model and obtain reasonable and accurate results.

## Definitions

In order to measure the successof smart growth of a city, we state the following variables and concept:

?Social harmony degree: our personal feeling about our physical condition, mental function ,social ability and personal comprehensive state on the basis of social economy, cultural background and value orientation

?Urban economy sustainability: a specific system in the specified objectives and the default stage, it can successfully constrain its degree of coordination and the degree of stability within the threshold of sustainable development rate, that is to say, the ability of a particular system to successfully extend to economy sustainable development goals.

?Policy-making degree: the proportion of urban residents who participate in policy-making accounts for of total population

?The soundness of Medical Security System: as for a sound medical security system, it 's main body is basic medical insurance, and it should be supplemented by other forms of supplementary insurance and commercial health insurance. And a sound medical insurance system is expected to meet the demand of diversified medical treatment and provide safe, effective, convenient and inexpensive medical and health services for the masses.

?Urbanization rate: the proportion of permanent resident population accounts for of the region total resident population

?Urban spatial compact ratio: the degree of spatial compact in the process of urbanization, and whether it can produce a relatively high density of residential and multi-purposed mixed land.

?Energy consumption per unit of output value: As for industrial enterprises, the industrial comprehensive energy consumption in ten thousand RMB divided by the total industrial output value in tons of standard coal.

?Urban green coverage ratio: The percentage of green land area out of the total area of the urban land, which is an important indicator of urban environment quality.

## Model Definitions

## The Ability of Urban Sustainable Development

The concept of the main sources of the following three aspects: Firstly, economic growth requirements and the uncontrolled expansion of the city makes the investment of public service facilities increase, as a consequence, the government finance is difficult to support, thus causing the economic growth rate to slow down. Secondly, the formation of private cars and the promotion of the road network and suburbanization spread rapidly. The occupation of the city public open space brings a heavy burden on land. And there are many ecological environmental problems caused by excessive use of resources and serious environmental pollution. Thirdly, the needs of society, a series of factors caused by the rapid spread of city and the fast pace of urbanization residents directly lead to reduced quality of life, the city's social equality is heavily influenced by the city and the harmonious degree of decline.

After the implementation of "smart growth" plan in part of the city, good results are obtained in the city economic and social equality, as well as the environmental sustainability. In addition, sustainable development capacity of the city has been greatly improved, which, effectively curb the continued spread of city public space and the waste of resources. In order to measurethe success rate of a city's "smart growth" , we define the index of The Ability of Urban Sustainable Development as a measure.

## Indicator system

1. Sustainable Development of Urban Economy（SDUE）. Economic sustainable development is a reasonable form of economic development. Through the implementation of sustainable economic development strategy we can form a sustainable social economic development model. In order to reflect the sustainable development level of the sample city economy objectively and completely, the paper also requests that the evaluation index system should be simple and clear enough so that the government and other decision-making organs can understand and respond to it. The GDP per person of the sample cities can be used to reflect the overall economic development of the region, which is the evaluation index of urban economic growth. In addition, we suggest that the index system should include urban spatial compact ratio, urban traffic quality indicators, urban land use efficiency, energy consumption per unit of output value, population growth rate and other evaluation indicators. At the same time, we can also use the relational matrix or vector graphics to reflect the relationship between the indicators, so that we can ensure that the index system is more complete, reliable and effective, and ultimately obtain a series of more reasonable and accurate data.

| Secondary Indicators | Three Indicators | Abbreviation | Unit | Nature |
|---|---|---|---|---|
| Urban Economy Sustainability | Real GDP Per Capita | GDP | $/Per | Positive |
| | Urban Spatial Compact Ratio | USCR | — | Positive |
| | Traffic Quality Index | TQI | Meter/Per | Positive |
| | Urban Land - use Ratio | ULR | — | Positive |

| | | | | |
|---|---|---|---|---|
| | Energy Consumption Per Unit Of Output Value | ECPO | Ton / Million | Reverse |
| | Growth Rate Of Population | GROP | — | Reverse |

Table 1: Indicator System of Sustainable Development of Urban Economy

2. Social harmony. "Smart growth" plan not only focus on the improvement of the economic benefits and sustainable development, it should also include improving the livability and quality of life for the residents of the city, which is exactly on the basis of the theory of "people-oriented". We ought to ensure that all the city residents enjoy equal rights, and the city should also be civilized and harmonious as well as relatively fair. The objective of the smart growth plan is to truly encourage people to live and work in the city, and enjoy educational, social services and other facilities. Based on this goal, the first should be considered is the income gap between rich and poor, and urban crime rate and unemployment rate are also included in this evaluation system. Those three indicators can reflect the effective data from the opposite side, and conclude the harmonious degree of a city. As for the city residents, the opportunity to receive education resources deserves to be evaluated, since we can use the high school enrollment rate of the index data of the city residents to reflect the most intuitive analysis. The proportion of residents who participate in decision-making accounts for also serve as a good indicator of social fairness. At the same time, medical security and infrastructure spending of a city are also regarded as a measurement of the quality of life. And the life of city residents will be included in the index system of us. The sustainable development of population urbanization rate can also influence the harmony of society and city, whether the index data is too high or too low is not sure at present, since high rates may be positive influence in early stage, but shall be passive rates in later stage. So here it will be incorporated into our index system.

| Secondary Indicators | Three Indicators | Abbreviation | Unit | Nature |
|---|---|---|---|---|
| Social Harmony Degree | High School Enrollment Rate | HSLR | % | Positive |
| | Income Gap Between Rich And Poor(Times) | IRAP | times | Reverse |
| | Policy-making Degree | PD | % | Positive |
| | Average Crime Rate | ACR | Item/Per | Positive |
| | Unemployment Rate | UR | % | Reverse |
| | Expenditure On Infrastructure's Proportion | EOIP | % | Reverse |
| | THE Soundness Of Medical Security System | SMSS | % | Positive |
| | Urbanization Rate | UR | % | Bisexual |

Table 2: Index System of Social Harmony

(3) Urban Environmental Quality. The theory of “smart growth” is firstly proposed by American scholars in the 1990s. This is because the city continues to expand the urban green space due to the reduction of environmental pollution, land resources

shortage, and decline in the quality of life as well as a series of urban issues. The city's "smart growth" is proposed after the analysis of these so-called "urban diseases", and should be defined as a planned and resource-savingurban development model, the purpose of which is to keep the city sustainable development. Therefore, in order to measure the performance of the city's "smart growth" program, the quality of the environment must be integrated into this comprehensive evaluation model. At present, it is common and effective to measure the quality and sustainability of the urban environment by using the urban air quality in good and good ratio, it means that the proportion of the city's air quality days to the total number of days in a year. Therefore, we include this indicator data in our evaluation index system. In addition, in order to make the constructed model more accurate and complete, we also incorporate the urban greening coverage into the evaluation index system, which provides a strong data support for measuring the sustainable development of urban environment.

| Secondary Indicators | Three Indicators | Abbreviation | Unit | Nature |
|---|---|---|---|---|
| Urban Environmental Quality | Urban Greening Coverage | UGC | % | Positive |
| | The Rate Of Good Air Quality | ROGA | % | Positive |

Table 3: Index System of Urban Environmental Quality

## The Calculation Model of Urban "Smart Growth"

Through the above we build three-dimensional sixteen indicators of the evaluation index system, can be more comprehensive to the city's sustainable development capacity to make a reasonable calculation, get more accurate results.

## Establish the weight of each index

Ratio, analytic hierarchy process and principal component analysis can be used to determine the index weight. However, both graded and analytic hierarchy processes involve subjective judgments, which are not objectivity to the data that we are evaluating. In order to avoid the interference of subjective factors and to meet the comparability of indicators, this paper chooses the arithmetic average weighting method as the basic synthesis method of urban sustainable development ability, which represents each of the main components of the method and indicator weight. It should be noted that the use of the method is not the ultimate goal, but just used in the indicators of the merger, and thus facilitate the research of results for further analysis, which in order to arrive at the target weight.

| Dimension Index | | Two Level Index | | Abbreviation | Unit | |
|---|---|---|---|---|---|---|
| Name | Weight | Name | Weight | Abbreviation | Unit | Nature |

| | | | | | | |
|---|---|---|---|---|---|---|
| Urban Environmental Quality | 1/3 | Urban Greening Coverage | 1/2 | UGC | % | Positive |
| | | The Rate Of Good Air Quality | 1/2 | ROGA | % | Positive |
| Social Harmony Degree | 1/3 | High School Enrollment Rate | 1/8 | HSLR | % | Positive |
| | | Income Gap Between Rich And Poor(Times) | 1/8 | IRAP | times | Reverse |
| | | Policy-making Degree | 1/8 | PD | % | Positive |
| | | Average Crime Rate | 1/8 | ACR | Item/Per | Positive |
| | | Unemployment Rate | 1/8 | UR | % | Reverse |
| | | Expenditure On Infrastructure's Proportion | 1/8 | EOIP | % | Reverse |
| | | THE Soundness Of Medical Security System | 1/8 | SMSS | % | Positive |
| | | Urbanization Rate | 1/8 | UR | % | Duality |
| Urban Economy Sustainability | 1/3 | Real GDP Per Capita | 1/6 | GDP | $/Per | Positive |
| | | Urban Spatial Compact Ratio | 1/6 | USCR | — | Positive |
| | | Traffic Quality Index | 1/6 | TQI | Meter/Per | Positive |
| | | Urban Land - use Ratio | 1/6 | ULR | — | Positive |
| | | Energy Consumption Per Unit Of Output Value | 1/6 | ECPO | Ton / Million | Reverse |
| | | Growth Rate | 1/6 | GROP | — | Reverse |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Of Population | | | | |

Table 4: Index Data Weight Assignment

## Discrete Data Processing

According to Table 3 we can know that a city's urbanization rate of the impact of the degree of harmony is two-sided. On the one hand, urbanization will be able to drive the economic growth, promote social harmony and improve the quality of life of residents. However, the high urbanization rate will cause over-exploitation of resources and increase the burden on the ecological environment. Based on these factors, we will do discrete data processing. We find that the best urbanization rate is 45%, or 45% of the discrete threshold (BSUR). According to this assumption, we can get the discrete treatment formula of the urbanization rate:

$$UR^* = |UR - BSUR|$$

Where ER * is the discrete value of the population urbanization rate.

## Data Normalization Processing

In order to eliminate the dimensional effect between the indexes, we need to standardize the data (normalization processing) to solve the problem that the data are not consistent with each other. The comparability of indicators among these data . After the data are standardized, the indexes are in the same order of magnitude, which is suitable for comprehensive comparison and evaluation. There are two commonly used methods of normalization:

1. min-max normalization （Min-Max Normalization ）

Also known as dispersion normalization, is a linear transformation of the original data, the result value is mapped to [0 - 1] between. The conversion functions are as follows:

$$X^* \quad \frac{Max \quad X}{Max \quad Min} \qquad (1)$$

Max is the maximum value of the sample data and min is the minimum value of the sample data.

However, the use of this method will produce a flaw. When new data are added, it may lead to changes in max and min, need to be redefined.

2. The second method normalizes the data by giving the mean and standard deviation of the original data. The processed data are in accordance with the standard normal distribution, and the mean is 0 and the standard deviation is 1. The transformation function is:

$$X^* \quad \frac{X}{\qquad} \qquad (2)$$

Where $\mu$ is the mean of all sample data and $\sigma$ is the standard deviation of all sample data.

According to the nature of data and data results, we use the extreme value method to normalize the data, because the extreme value of the number of indicators and the

distribution of data requirements are lower, the transformed data are in an area asked, After transformation, the relative number of data is more obvious, at the same time to avoid the emergence of negative numbers, easy to do further data processing. Therefore, the entire index system processing, will use the extreme value method. The formula is as follows:

$$\text{Positive indexes：} \quad Xi \quad \frac{xi \quad min}{max \quad min} \quad (3)$$

$$\text{Negative indexes：} \quad Xi \quad \frac{max \quad xi}{max \quad min} \quad (4)$$

## Establish the comprehensive evaluation model

Assess the success rate of a city's "smart growth" program, which is to calculate the capacity of the city's sustainable development. After collecting and normalizing each index, we can synthesize 16 secondary indexes into three dimensions according to the weight of each indicator. Then we can get the success rate of the city's "smart growth" plan. In order to ensure that the influence which each index factor act on a more reasonabletarget in a model can adapt to more cities, which is more inclusive, we define a Ti variable and the mean weight, so that the results are more reasonable, more inclusive. Specific methods:

$$F= \sum_{i\ 1}^{n} W_i X_i \qquad (5)$$

Where F is the total index of the sample urban element index, and $W_i$ is the weight of the i-th index, $X_i$ is the value of the i-th objective index of the sample city.

.

## The current smart growth of Colorado Springs （2014）

In order to study the model, we find some information about the current situation in two cities today on sustainable development and smart growth plan, and we state those information as follows:

1. The Government has come up with a new concept: Scorecard. The scorecard is a community self-assessmenttool that can help spur discussion and action on our community ’s approach to growth and development issues. We can use it in a number of different ways. Such as:

?As a concerned community member.

You can use the scorecard to as an educational tool to better understand your community ’ **s**trengths and weaknesses in promoting smart growth. Individually answering the questions in the scorecard could also be the starting point for discussions with other members of your community.

?In small group discussions or workshops.

You can use the scorecard in small group discussion on your community ’s approach

growth and development to check your own and other people 's assumptions about what your community is and is not doing and what policies it may or may not have concerning growth and development (and even how effective the policies might be). Given the results of your small group discussion, you might be able to use the scorecard as part of more formal evaluation update of your community comprehensive master plan.

2. Urban sprawl is an important reason for our intelligent growth, and the government emphasize the integrated use of land, and residential, office, commercial, kindergarten and some entertainment facilities are arranged in the community, and the government aims at community constructions. People can live in and work in communities, as well as run business and participate in entertainment activities, we look forward to form compact, suitable communities for walking, and mixed use. In this way, this plan can exactly meet the demand of taking advantage of compact building design.

3. Take the City Lifestyle Apartment to Downtown Colorado Springs When developers work together on a pair of apartment buildings in the heart of Colorado Springs, the goal is to design projects that fit the city lifestyle rather than being suburban to the heart of the city. The result is that two buildings will have facilities that may be found in suburban buildings, but will have other features specifically designed to attract urban tenants, many of whom are young professionals. This exactly reflects the principle that creating a range of housing opportunities and choices.

4. The related departments cooperate with each other to lower a major barrier, which is about the construction of affordable housing by passing a construction defects ordinance.

## The current smart growth of Shangri-La (2014)

To enhance the urban functions, the city focuses on green development, the Sangria-La try to build a fine ecological environment, beautiful environment, livable city for people, the following are their future plans:

1. Improve the basic conditions for the development of tourism in the traffic construction, speed up the construction of external roads, adjust the level of industrial structure, improve land utilization, Urban transport should establish the concept of pedestrian priority, improve the residents travel environment, protect the safety of travel, advocate green travel, which caters to the first principle of intelligent growth.

2.Sangria-La population density is relatively low, and the government aims at promoting the urbanization process to some extend. The government is expected to strengthen urban construction and improve the urban system. In addition, we ought to take the path of sustainable urbanization, the road of intelligent urbanization, and the

road of harmonious urbanization.

3.Increase public infrastructure Of the financial input ， optimize the layout of urban infrastructure, insist the overall plan, improve the city open space, rational planning of urban space compactness. It is suggested that the city should build urban walkway and bicycle "green way", strengthen pedestrian crossing facilities, bicycle parking facilities, road greening, lighting and other facilities to effectively change the over-reliance on car travel traffic development model, and meet the needs of a variety of transportation choices.

4.Improve the participation of citizens in government decision-making to participate in current affairs of the initiative. Promote the process of political modernization, improve the transparency of government management, and innovate the government management mechanism, which, is beneficial to encourage community and stakeholder collaboration in development decisions.

The growth of urban population plays a significant role in assessing the viability of the programs that are being developed in the cities over the next few decades. Therefore, we analyze the population development trends of the selected cities by using the gray prediction model based on available data.

## Application of the Refined Model to the sample cities

In order to understand the reliability and accuracy of our comprehensive evaluation model, we made the following applicability assessment for two sample cities. Because our model is based on data for the year 2014, we looked at multiple literatures and produced a series of data. Parts of the data that need to be dealt with are normalized or discrete processed. The corresponding values for each indicator data for the two sample cities are shown in Table 5:

| Variable | Unit | Nature | Shangri-La | Colorado Springs |
|---|---|---|---|---|
| UGC | % | Positive | 30% | 45% |
| ROGA | % | Positive | 100% | 100% |
| HSLR | % | Positive | 57.92% | 92.60% |
| IRAP | times | Reverse | 4.2 | 9.7 |
| PD | % | Positive | 17.60% | 80.50% |
| ACR | Item/Per | Reverse | 0.40% | 4.10% |
| UR | % | Reverse | 3.87% | 4.80% |
| EOIP | % | Positive | 1.60% | 9.90% |
| SMSS | % | Positive | 23% | 84.6% |
| UR | % | Bisexual | 43.30% | 76.80% |
| GDP | $/Per | Positive | 8306$ | 29030$ |
| USCR | — | Positive | 0.2 | 0.4 |
| TQI | Meter/Per | Positive | 13.16 | 25.27 |
| ULR | — | Positive | 33.30% | 52% |

| | | | | |
|---|---|---|---|---|
| ECPO | Ton / Million | Reverse | 0.0644 | 0.1539 |
| GROP | — | Reverse | 5.73% | 1.50% |

Table 5: The Results of All Indexes

When processing the selected sample cities, we define the Ti values according to the characteristics of the selected cities as follows: When the two dimensional indicators are combined to obtain the corresponding dimensional indicators, the factors considered are very comprehensive, and each index And the degree of influence on the upper-level indicators is approximately the same, Ti = 1 (i = 1, 2, ...) can be assumed at this time. According to the characteristics of the two sample cities and the policy of urban sustainable development (urban success rate), the paper analyzes the characteristics of urban sustainable development (the success rate of urban "smart growth") from the three dimensions of urban economy sustainable development, urban harmony and urban environmental quality. The impact of environmental quality on the model is the largest, and it should be defined as the Ti 1/2. The other two indicators of the degree of impact similar data, it is defined as 1/4.

## Results and Discussion

Our model shows that Colorado Springs has a sustainable urban capacity index of 52.47% and Shangri-La's urban sustainable development capacity of 46.38%.Finally, we can analyze the model test result is that the success rate of the current development plan in Colorado Springs is 52.74%, and Shangri-La current development plan success rate is 43.68%. Colorado Springs has been basically successful and achieved remarkable results. As for Shangri-La, due to the implementation of the plan for a short time, it has not shown significant performance.

## Future plans and strategies for Smart growth

Through our discussion on the principle of smart growth, we know that the principle mainly includes reducing travel distances, reducing travel times, avoiding single land uses, developing public transport, constructing pedestrian walkways, allocating public facilities and employment opportunities within walking distance, and increasing the number of industries that can promote economic growth Strength. As for a city, those industries are tourism and agriculture, forestry and so on.

### Colorado Springs

### Geographic location

Smart Water Plans:The city lies in a high desert with the Southern Rocky Mountains to the west, the Palmer Divide to the north, high plains further east, and high desert lands to the south when leaving Fountain and approaching Pueblo. Colorado Springs has a semi-arid climate, and its location just east of the Rocky

Mountains affords it the rapid warming influence from winds during winter but also subjects it to drastic day-to-day variability in weather conditions. Due to unusually low precipitation for several years, as such, protecting and enhancing and a community ' s natural infrastructure are critical components of achieving Smart Growth.

Intelligent Industry Plan

Due to high-tech industry will relatively develop in the next few decades, the city are expected to seize the opportunity to recruit more high-tech talent, for example, in the city to establish a experimental base for migratory immigrants to attract more investment. In addition, the city ought to increase the information technology and complex electronic equipment research, since even after the next few decades, science and technology is still the primary productive force.

## Economy opportunity

Investment: A large percentage of Colorado Springs' economy is based on manufacturing high tech and complex electronic equipment.Attract foreign investors, and make a plan of investment. In addition, related departments can draw up a contract that fulfills the requirements and initiates a bidding process by calling for tenders.

Increase employment: The city's location at the base of Pikes Peak and the Rocky Mountains makes it a popular tourism destination. Tourism is the third largest employer in the Pikes Peak region, accounting for more than 16,000 jobs. Nearly 5 million visitors come to the area annually, contributing $1.35 billion in revenue. Appropriate scale of the new tourism projects, the establishment of their own city characteristics of the ecological industry, science and technology into tourism.

## Shangri-La

## Geographic location

Ecological red line

Shangri-La is located in the northwest of Yunnan Province, the city is surrounded by many mountains, so there is no doubt that the forest area is very large, green coverage in urban areas is very high, and the specific develop management is to build a global tourism system, scientifically determine the development intensity, and delimit red-line areas of ecology, and turned to the rational distribution of production space, living space and ecological space, as well as the construction of sustainable, livable and beautiful town, so that can retain enough open space, farmland and natural.

Adjust the process of urbanization

Shangri-La City is located in Yunnan Province, and it is one of the largest and the most densely populated cities, and the personnel are relatively scattered. We are expected to considering the carrying capacity of cities and towns and the capacity of

population absorption, we should scientifically determine the scale of urbanization and reasonably grasp the pace and rhythm of urbanization

## Economy opportunity

Discover the great potential of tourism

Shangri-La is an important ecological function area in China. It is a multicultural and multicultural gathering place with broad development prospects. Its unique geographical advantages make the city's tourism and agriculture have great potential, so its future is very impressive.

## Expected growth rates

The growth of urban population plays a significant role in assessing the viability of the programs that are being developed in the cities over the next few decades. Therefore, we analyze the population development trends of the selected cities by using the gray prediction model based on available data. In this part, we use gray forecasting to infer the variation tendency of the population.

Gray forecasting is a method to predict the system with uncertain factors. The gray forecasting model can find out the regularity of the system variation by generating the correlation of the original data by differentiating the trend of development trend among the system factors, generating the data sequence with stronger regularity, and then establishing the corresponding differential Equation model, in order to predict the future trend of things the situation, which constructs a gray prediction model by using a series of quantitative values of the response prediction object characteristics observed at equal time intervals to predict the feature quantity at a certain time in the future or the time to reach a certain characteristic quantity.

| Number(k) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Year(t) | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Population( $10^5$ ) | 3.70729 | 3.75834 | 3.75189 | 3.78793 | 3.83071 | 3.91846 | 3.94858 | 4.01186 |

| Number(k) | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|
| Year(t) | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Population( $10^5$ ) | 4.07733 | 4.20529 | 4.26883 | 4.31710 | 4.37568 | 4.44482 | 4.57912 |

Table 6:Colorado Springs'Population

| Number(k) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Year(t) | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| Population( $10^5$ ) | 1.45190 | 1.52640 | 1.58310 | 1.69830 | 1.72980 | 1.74585 | 1.75149 | 1.75730 |

| Number(k) | 9 | 10 |
|---|---|---|
| Year(t) | 2014 | 2015 |
| Population( $10^5$ ) | 1.76490 | 1.79320 |

Table 7:Shangri-La’s Population

Firstly, we get the original time series of the population of Colorado Springs from the above data

$$X^{(0)} \quad (X^{(0)}_{(1)}, X^{(0)}_{(2)}, \cdots X^{(0)}_{(n)}) \quad (6)$$

Plugging (1) into the equation for v6, and we obtain

$$X^{(1)} \quad (X^{(1)}_{(1)}, X^{(1)}_{(2)}, \cdots X^{(1)}_{(n)}) \quad (7)$$

Therefore, from (1) (2),we have the corresponding differential equation of GM (1,1) model

$$\frac{dX^{(1)}}{dt} \quad aX^{(1)} \quad u \quad (8)$$

Where $a, u$ called the identification parameters, and can be solved by least squares

Besides establishing a data matrix B and

$$Y_N \bar{a} \quad (B^T B)^{-1} B^T Y_N \quad (9)$$

Putting (1)-(4) together, we can obtain

$$X^{(k)} \quad (X^{(0)}_{(1)} \quad \frac{u}{a}) e^{a(k-1)} \quad \frac{u}{a}, k \quad 0,1,2...,n \quad (10)$$

In order to facilitate the calculation we use mathematical tools to calculate, and get the results of the calculation

| Year(t) | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|
| Actual value | 3.7073 | 3.7583 | 3.7519 | 3.7879 | 3.8307 | 3.9185 | 3.9486 | 4.0119 |
| Predictive value | 3.7073 | 3.6797 | 3.7390 | 3.7992 | 3.8604 | 3.9226 | 3.9858 | 4.0500 |
| Relative error(%) | 0 | 0.021 | 0.003 | 0.003 | 0.008 | 0.001 | 0.009 | 0.010 |

| Year(t) | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| Actual value | 4.0773 | 4.2053 | 4.2688 | 4.3171 | 4.3757 | 4.4448 | 4.5791 |
| Predictive value | 4.1152 | 4.1815 | 4.2489 | 4.3173 | 4.3868 | 4.4575 | 4.5293 |
| Relative | 0.009 | 0.006 | 0.005 | 0.000 | 0.003 | 0.003 | 0.011 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| error(%) | | | | | | | |

Table8:Colorado Springs'Population Fit Result

From the above form , meanwhile, according to the above results, we can draw an image about the trend of urban population growth, as shown below

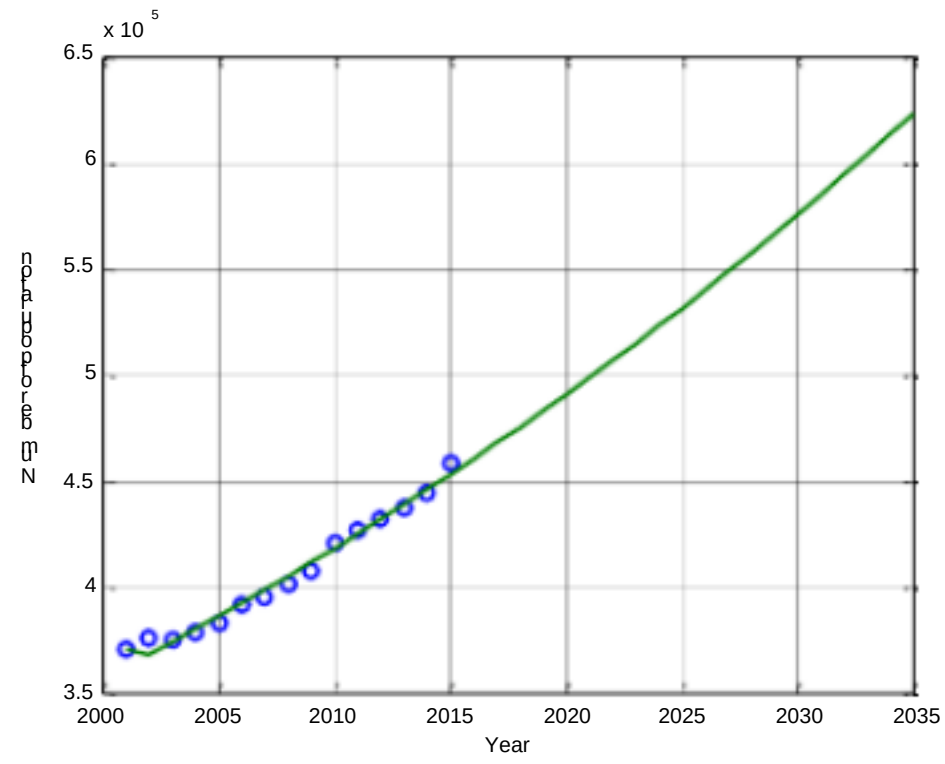


Figure 1: Colorado Springs'Population Development Trends

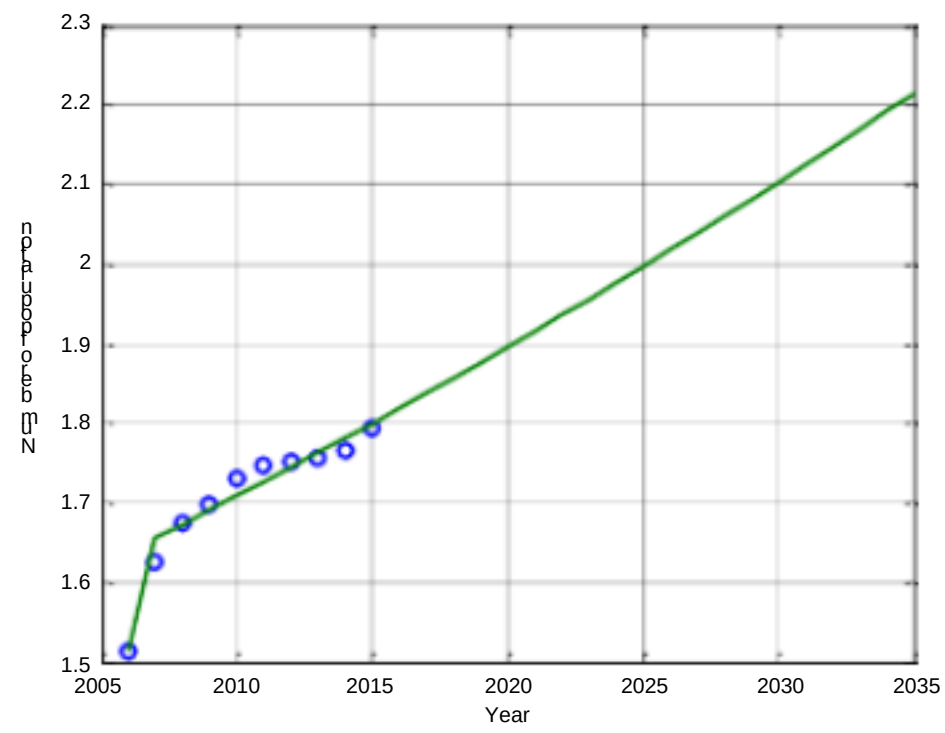


Figure 2: Shangri-La's Population Development Trends

## Colorado Springs

In order to rank the development potential of each plan comprehensively and accurately, we overlook the influence of the minor factors within redesigned smart growth plan. We use the improved principal component analysis to analyze the development potential. We define the development potential index for each development plan.

Firstly, we analyz the future growth potential of Colorado Springs. Situated at the base of the Southern Rocky Mountains, Colorado Springs, Colorado, is a vibrant city with iconic mountain views, year-round tourism and a thriving economy –landing it fifth on US News & World Report's recent list of best places to live. For the more than 450,000 people who live there, the lifeblood of the community is the city's supply. However, strains on local water resources, unpredictable weather patterns and

uncertainty related to growth and climate change are threatening Colorado Springs ' water supply and the local ecosystem and economy that depend on it.Only trying to to identify and address the uncertainty that affects its water supply, both in the short and long term,can they ensure current and future generations could enjoy all that Colorado Springs has to offer, the city 's water steward, Colorado Springs Utilities (CSU).Besides, according to the relationship between supply and demand, we get the conclusion smart Water Plans in the next few decades is the most potential for development.

Secordly, it provides ideal experimental conditions for many large-scale scientific experiments because of its unique geographical environment.With the rapid development of Mars exploration program, It has appropriate chance to develop high-tech industry production. Colorado Springs is one of the most active lightning strikes in the United States. As a result, some researcherschose the location of Colorado Springs to build laboratories and study electricity. In addition,the city's high-tech industrial foundation is very stable.Therefore,hig-tech development plan development potential index ranked second.

Now, the development of urban tourism industry is stable.In the next period of time, it will be no dramatic changes. It can provide more jobs for urban residents, and enhance the city's employment rate through former plan. As a result, the employment potential has the lowest development potential.

Shangri-La

First of all, we can see that Shangri-La is a tourism-based city, a good ecological environment for its sustainable development plays a vital role by the above analysis. Therefore, delimiting ecological red line is most plan for the development of tourism resources is the most potential plan.

Secondly,Urbanization rate is too high, the urban population is seriously overloaded, the unemployment rate remains high, the urban disparity between the rich and the poor, environmental pollution, chaos and other issues, hinder the process of urban sustainable development, contrary to urbanization rate is too low to curb consumer demand growth, Thus hindering the improvement of social labor productivity and affecting environmental protection and governance. Therefore, the development potential of urbanization adjustment plan is second only to the delineation of ecological red line.

Thirdly, through the gray prediction model, the next 20 years of population growth is more gentle. The future of sustainable development of the city of Shangri-La, the process of urbanization has a profound impact on its population within a short time to promote urbanization, the development of the city to provide a lot of labor resources. Urbanization rate is too high, the urban population is seriously overloaded, the unemployment rate remains high, the urban disparity between the rich and the poor,

environmental pollution, chaos and other issues, hinder the process of urban sustainable development, contrary to urbanization rate is too low to curb consumer demand growth, Thus hindering the improvement of social labor productivity and affecting environmental protection and governance. Therefore, the development potential of urbanization adjustment plan is second only to the delineation of ecological red line.

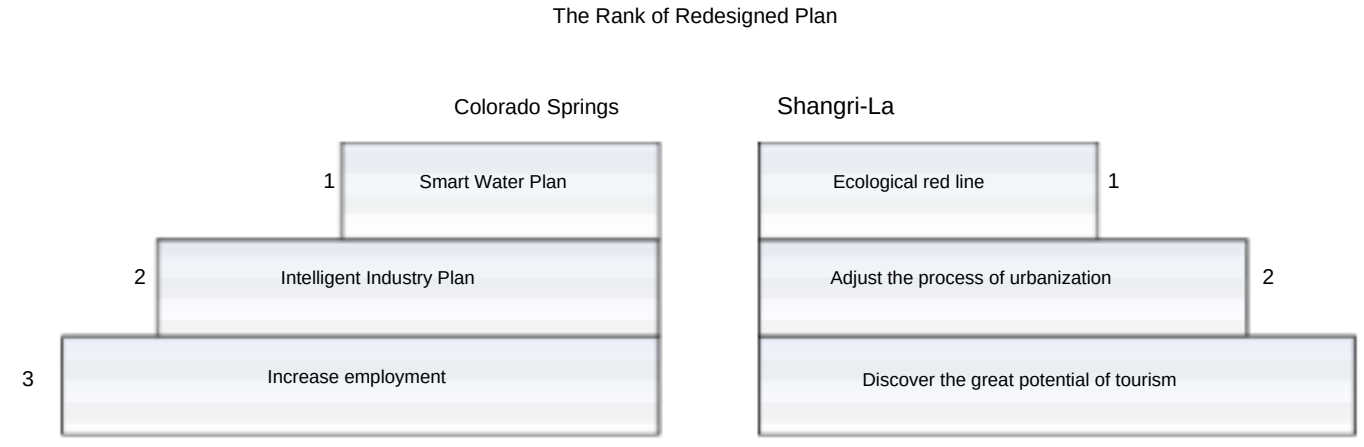


Figure 3:the Plan of Two Cities Development Potential Ranking

## Compared And Discussion

By comparing the potential growth of the two cities in the smart growth plan,although two cities have a big gap in implement time smart growth plan the next few decades of development, it will be the development and protection of ecological resources into the top position . As the Colorado Springs city of moderate urbanization, so the high-tech industry development potential is very large. In contrast, Shangri-La's high-tech industry is still in the early stages of development, due to geographical constraints, the future development potential is relatively low. Although the two cities geography, economic development and other aspects of the same, but in the future development trend there are still some degree of difference.

## Conclusions

Considering that 3E goals and ten principles of the city "smart growth" is still at the stage of promotion , according to our analysis, we get the following conclusions:

1. In the process of "smart growth", we must realize that economic prosperity, environmental sustainability and social harmony and fairness of the three are not independent existences, but are regarded as inter-constraint measures.Therefore, in the case of the economic development is developing rapidly, we should pay attention to protecting the ecological environment and curbing the spread of the urban sprawl to improve the economic, environmental and fair interaction, and the priority should be given to enhance the quality of life of urban residents.

2.In the process of analysis, we found that the success rate of the "smart growth" plan of the two selected sample cities is relatively low, which is the result of the combination of index system which was composed of many indicators data. Mainly reflected in three dimensions (the ability of sustainable development of urban economy, social harmony and the sustainability of ecological environment). Therefore,

we propose the future development plan of the city on the basis of 3 E: improving the carrying capacity of environmental quality and ecology, promoting the sustainable development of the economy and improving the social harmony and the quality of life of residents.

3. The future development of the city will pay more attention to "smart growth", so as to ensure the ability of sustainable development of the city improve steadily, and enable the urbanization rate of the city to tend to the level of high rationality.

## Strengths

(1) The model fully takes into account the three objectives of urban sustainable development and the ten principles of "smart growth", and the data obtained are of high reliability and accuracy.

(2) When the comprehensive evaluation model is used, the weights of two Ti variables are defined, considering that different cities have different emphaseson the three dimensions. So as to ensure that the model is of the higher inclusive, we can apply a lot of different sample cities.

(3) when we select the sample cities, we selected Shangri-la in China as the eastern city, and Colorado Springs in the United States as the representative city in the west. They are representative middle-sized countries.So the sample is representative and persuasive.

(4) We construct a comprehensive evaluation model of three-dimensional and sixteen indicators, which can provide a clear reference for decision-makers by making a comprehensive evaluation of the sustainable development ability of cities from multiple angles and levels.

(5) In the measurementmodel, we use the average weight method to simplify the model, and to ensure the rationality of the data. Thus, the whole model is relatively easy to implement.

## Weakness

(1) In this model, considering more indicators of data, when they are applied to more cities,we may find it difficult to collect part of the data , and thus have an impact on the calculation.

(2) The data for 2015 and 2016 are not available due to the updating of the city
We only consider the data before 2014, so there may be outdated data problems.

(3) Due to limited space, we only consider the more important three-dimensional and sixteen indicators, so there are some important indicators may not be considered. If a more accurate model is needed, a larger number of indicator data need to be considered to make the model more complete.

## Model Improvement

Assuming that we ignore the impact that local natural weather conditions and other factors act on the city's sustainable development ,this assumption is just be putted

forward to make it convenient to solve the problem.In addition,we are expected to pay attention to ideas more clearly. If it a series of data that may have an impact on the model assessment can be incorporated into the indicator system, and the data will not only be closer to the actual value, but also more convincing. In the modeling time, due to limited space and limited resources, each indicator of the reference data is small, and the data is not so representative. To improve the model, Governments data in previous years should be included in the test system.

## References

[1]"Geographic Identifiers: 2010 Demographic Profile Data (G001): Colorado Springs city, Colorado". American Factfinder. U.S. Census Bureau. Retrieved January 25, 2016.

[2]http://www.city-data.com/city/Colorado-Springs-Colorado.html

[3]Wikipedia,Retrievedfrom:https://en.wikipedia.org/wiki/Colorado_Springs,_Colorado

[4]Colorado Springs ’Government, City of Colorado Springs Annual Budget&Resource Allocation January 1,2015.

[5]Shangri - La People 's Government,Shangri-La Statistical Yearbook 2015, Yunnan Science and Technology Press,2016,1:30-34.

[6]DDN,China Statistical Yearbook For Regional Economy 2014, China Statistical Publishing House,2015,4, 1:30-77.

[7]Pei Yi-gao. General Rules of Urbanization in the World and China 's Urbanization [J]. Chinese Social Sciences, 2006, 9: 42-46.

[8]Wei-er. The Practice of New Socialist Countryside Planning Based on "3E" Principle [J]. Proceedings of China Urban Planning Annual Conference, 2007,23(3):3-5.

[9]Qiang-ma. To the "smart growth": from "car city" to "public transport" city [J]. China Building Industry Press,, 2007,41(2): 33-35.

[10]Long Xiang-tang. A Survey of "Smart Growth" [J]. Urban Issues, 2009, 28(8): 98-102.

[11]Jian Da-zhu.Study on smart growth theory and its enlightenment to China [J]. Journal of Tongji University: Social Science Edition, 2006,17 (4): 22-28.

[12]Bin-chong. Quantitative evaluation of environmental and economic development and its classification system [J]. Tropical Geography, 1999,27 (2): 171-177.

[13]Yan-zhagn. Study on the Coupling and Development of Regional Economic Growth and Environment in China [J]. Resources Science, 2008,30 (1): 25-30.

[14] Ning-li. An Empirical Analysis on the Coupling of Low Carbon Economic Development and Environmental Resource System in the Bohai Sea Economic Circle [J]. Resources and Industry, 2013,15 (2): 022.

[15]Xiaoshun Liu,Zhen Zhang,Yahui Long,:A Study on the Urban Smart Growth[J],Contemporary Economics,No.4,Feb.2016:115-117.