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A class of differential dynamic system model for low carbon tourism and its application to LSD*

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Abstract. After the Climate Conference in Copenhage, low carbon economy becomes a hot issue worldwide. China, as the biggest developing country, is playing a significant role in the development of low-carbon economy. Low carbon tour is a crucial part of low carbon economy. Therefore, realizing the low carbonization of the development of tourism contributes to the economic system in developing low carbonization. This paper takes LSD as our case, analyzes several important indicators in its tourism to identify equations using GMDH. Also, this paper build differential dynamic system model regarding modern tourism in low carbon economy and simulates how the tourism in LSD develops in the future by MATLAB. We analyze the simulation results deeply hoping this can provide useful suggestions for other areas where tourism resoures are rich.

Keywords: low carbon tourism, differential dynamic system, computer simulation

1 Introduction

Global warming is a common problem of mankind. According to IPPC inference, in the period of 1850-1899 and the period of 2001-2005, global average temperature has increased by 0.67 degrees, which is likely (greater than 90% chance) caused by human activities, greenhouse gas emissions. If human beings still keep the existing level of greenhouse gas emissions, the trend of future global warming will accelerate. To the end of this century the average global temperature will likely continue to rise by 1.8 degrees to 4 degrees[1]. In order to reduce global warming, to achieve the sustainable development of human society to control human activities, greenhouse gas emissions is the general consensus of mankind.

Low carbon economy is an effective way of controlling greenhouse gas emissions. Since the United Kingdom Government in "our energy future: creating a low carbon economy" in 2003, the first time a low carbon energy white paper after the Economic Development Strategy, Low carbon economy, as a development strategy to reduce global warming, is gradually accepted by all countries, and evolved into a new development direction, which guides the human production and consumption patterns change[13]. Low carbon economy is intended to control greenhouse gas emissions and achieve human sustainable development. It advocates an economic development model that is "low consumption, low pollution, low emissions and high performance, high efficiency, high efficiency (3 low 3 high)". The core concept of low-carbon economy is "less consumption of natural resources and lower greenhouse gas emissions to economic output[19]". The nature of low-carbon economy is energy efficiency and clean energy structure, Core energy technology innovation and system innovation; the goal is to mitigate climate change and promote sustainable human development, which relies on technological innovation and policy measures, implementation of an energy revolution, the establishment of a less greenhouse gas emissions model of economic development.

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Tourism as a sunrise industry, after decades of rapid development, has become one of the society's most important industry. As tourism plays an important role in today's international trade and development, many countries, particularly developing countries and underdeveloped countries are striving to develop this industry. According to the World Tourism Organization, it's said among 50 of the world's most backward countries, Tourism revenue is one of the the main source in 46 countries[18]. Therefore, giving that low carbon economy is developing rapidly, tourism should become an important area of low-carbon economy. In fact from the tourism attributes of its own industry, tourism is the most suitable area in the development of low carbon economy. This research will select tourism industry in Shizhong District of Leshan city (LSD) as an example, study low-carbon system, hoping to explore the rules in low carbon development path of tourism areas which are applied to most of the tourism areas with rich resources.

With city tourism developing rapidly recent years, tourists and self-guided tourists increase by over 20% to 30%. Room occupancy rate of hotels in the center city has improved greatly, on the "Labours' Day" in 2007, the room occupancy rate increased 7% to 92% compared with that of last year at the same period. In 2008, the LSD saw 3.5595 million tourists traveling there, with revenues reached 3.374 billion yuan. It is stated that A-level scenic spots in LSD and municipal rural tourist sites attracted tourists has become development and tourism for the host team of both local tourists and self-driving tourist. Energy consumption caused by tourism development issues in the context of contemporary low-carbon economy has been greatly concerned. This article on LSD Tourism's quest for future research is hoped to provide a method.

Differential dynamic system is used in many research areas such as chemical systems, biological systems, economy, and other disciplines. Hale[4] has done much effort on time-delay systems over the decades. Then some scholars found that time-delay differential dynamic system can reflect the system's development better. So more attention is focused on the stability analysis and stabilization problem of neutral delay-differential systems, which are the general form of delay systems and contain delay on the derivatives of some system variables[3, 5, 11, 14, 15, 17, 20, 21, 23]. These literature are restricted to the static state feedback control schemes for stabilization of unstable neutral systems.

In LSD's situation, there is a strong need to construct dynamic input control instead of static control in order to obtain better performance neutral systems and differential dynamical behavior of state response. This article will use a class of differential dynamic system asymptotically to stable neutral system in low carbon which application to LSD.

Another efficient modeling technique in the paper is the group method of data handling (GMDH)-type algorithm. The GMDH algorithm[6] introduced by Ivakhnenko in the early 1970's is an analysis technique for identifying the nonlinear relationships between the inputs and outputs of a given system. There are other scholars have made some corresponding researches on the GMDH-type algorithm, such as [9, 10, 12, 22]; have become an important branch of GMDH-type algorithms, which called for better forecasting to ensure the accuracy of the premise, the establishment of complicated nonlinear relation between the relevant variables.

In the process of determining the relationship between increasing rate and its influential factors of tourist system, GMDH is introduced to make sure the differential equations rigorous and scientific.

2 Modeling of low carbon tourism

In this paper, the main method is differential dynamic, which combined with economics and related disciplines. Then, MATLAB toolbox is used to establish the corresponding simulation model which simulate tourism in the city's low carbon development trend. According to the future diagnosis of low carbon tourism development, find the problems may be appearance, and correspond countermeasures.

2.1 Model description

Energy consumption caused by development of tourism is the main factor affecting the development of tourism. The number of tourists, tourism revenues and tourist reception facilities have different effects on the development of the energy industry: tourist trips, and tourist facilities need to consume energy Revenue of tourism is the foundation of funds to maintain tourist attractions. Therefore, energy (energy subsystem), number of tourists (demand subsystem), tourism revenue (demand subsystem), the number of tourist reception facilities (supply subsystem) including the number of tourist attractions, travel agents,and the number of hotels.The 6 parts (state variables) constitute the low-carbon travel system.

Therefore, the main methods of this research is that: firstly, simplify the impact factors of low carbon tourism system to the 6 state variables above, and then find the impact factors of this 6 variables factors. These factors will be classified as the endogenous variable (tourists per capita energy consumption, facility energy consumption, consumption per capita consumption, facilities, supply and demand ratio, ratio of tourism income facilities) and the exogenous variables (the number of variables in reception, annual tourism revenues of variables, variables in tourism facilities and tourism development in energy variable). Use dynamics differential system, describing the interdependence and the causality interaction among these variables. Eventually establish the analysis of the corresponding simulation model to predict the development of low-carbon tourism trends and obtain recommendations accordingly.

2.2 Index system

This model is targeted at trends of tourism energy consumption. The main variables and the impact factor of the model are identified on the base which refer to the relevant information of China and abroad, as well as the analysis on the other related factors.

2.2.1 Variable factor

The model is to explore the relationship of the 6 variables (development of energy consumption of tourism, number of tourists, tourism revenue and the number of attractions, the number of travel agents, and the number of hotels) and their changes in future. In this model, climatic conditions and geographic environmental factors are omitted. Draw cause-effect diagram of low-carbon Municipal Tourism System under the differential system dynamics, (see Fig. 1 and Fig. 2).

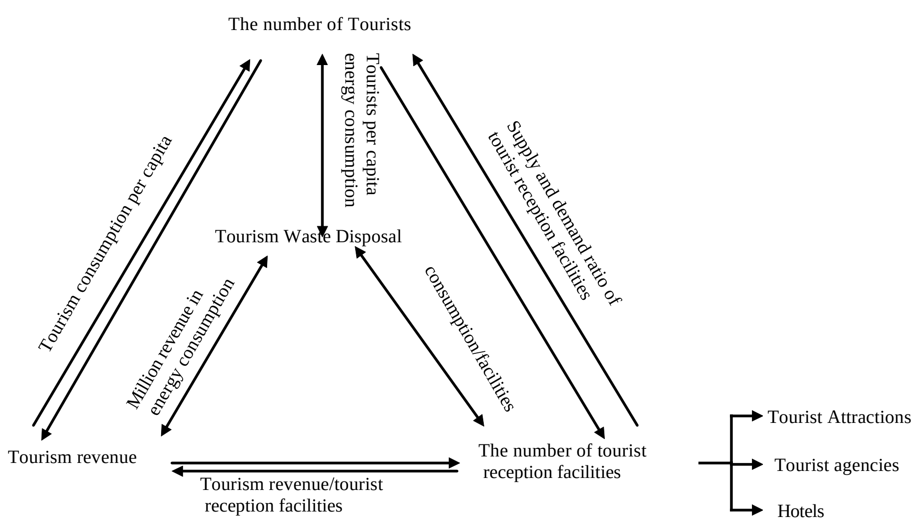

Fig. 1. Elements of low carbon tourism

As shown in Fig. 1: tourism population has an impact on tourism income; tourism income is crucial for the construction and maintenance of tourism facilities (including, tourism attractions, travel agencies and hotels). The renew of facilities can attract more tourists. Tourists' consumption and the operation of facilities cause energy consumption in the development of tourism industry.

As shown in Fig. 2: GDP, disposable income of residents and fixed assets etc. influence the increasing rate of population of tourism, tourism income and the number of agencies providing tourism service (including tourism attractions, travel agencies, and number of hotels), which affects energy consumption generated during the process of tourism development.

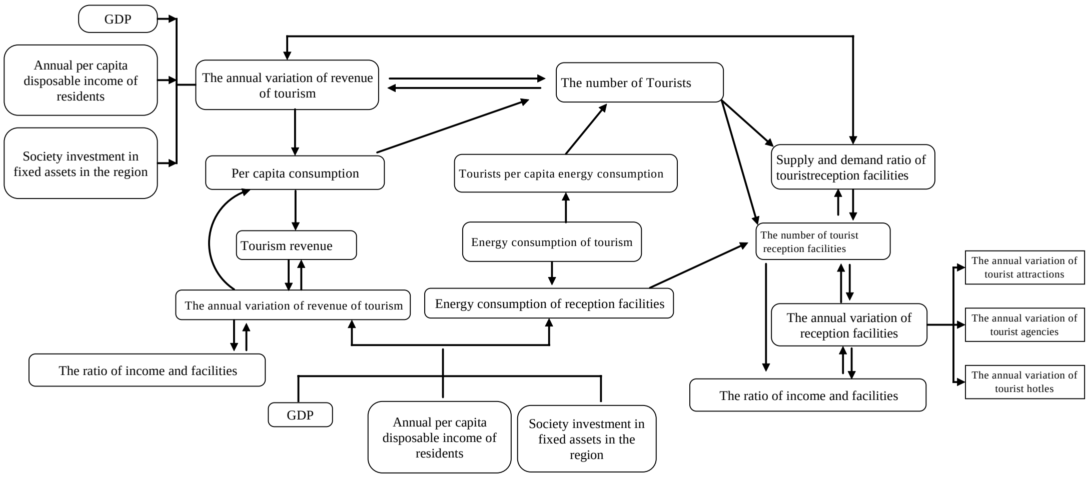

Fig. 2. Differential dynamic causality graph

2.2.2 Variable definitions

In order to study the development situation of low carbon tourism, we need define and classify the following variables. To provide preparation for the establishment of mathematical model, we divide them into endogenous variables and exogenous variables (Tab. 1 and Tab. 2). Then get the evidences for thinking on low carbon tourism development.

2.3 Mathematical model

Through analyzing the relationship between the variables and the impact factors, we construct a equation system and obtain the mathematical model of low carbon tourism.

2.3.1 Variable description

We define the mathematical relationship equation of differential dynamic system for low carbon tourism as below (note: see variables in Tab. 1 and Tab. 2).

$$z = z_1 + z_2 + z_3;\ E = e_1 \times x + e_2 \times z - e_3 \times z;\ r_1 = \frac{y}{x};\ r_2 = \frac{y}{z};\ r_3 = \frac{z_1}{x};\ r_4 = \frac{z_2}{x};\ r_5 = \frac{z_3}{x};$$
$$e_1 = 0.175;\ e_2 = 765.31;\ e_3 = 20\% = 0.2;$$

are got from the calculating the relevant data ([7]) published by China's national tourism administration and table [8] of some kinds of fuel Tce conversion published by the national development and reform commission.

2.3.2 Equation system

If the changes of the reception number of tourists tourism revenue and tourist reception facilities do not affect each other and are free from any external conditions, the variations of energy consumption generated by tourism is affected by the tourist reception facilities, and variations can be expressed as:

$$\begin{cases} \frac{\mathrm{d}x}{\mathrm{d}t} = ax; \\ \frac{\mathrm{d}y}{\mathrm{d}t} = by; \\ \frac{\mathrm{d}z_1}{\mathrm{d}t} = c_1 z_1; \\ \frac{\mathrm{d}z_2}{\mathrm{d}t} = c_2 z_2 - \frac{z_2}{40}; \\ \frac{\mathrm{d}z_3}{\mathrm{d}t} = c_3 z_3 - \frac{z_3}{40}; \\ \frac{\mathrm{d}E}{\mathrm{d}t} = e_1 \frac{\mathrm{d}x}{\mathrm{d}t} + e_2(1 - e_3)\left(\frac{\mathrm{d}z_1}{\mathrm{d}t} + \frac{\mathrm{d}z_2}{\mathrm{d}t} + \frac{\mathrm{d}z_3}{\mathrm{d}t}\right). \end{cases} \tag{1}$$

The system of equations is the mathematical model of the tourism industry. The various equations in Eq. (1) represents tourists subsystem, tourism revenue subsystem, attractions subsystem; travel agencies subsystem, hotels subsystem and travel energy consumption subsystem respectively. Where a denotes the annual growth rate (relative) of the number of visitors, b denotes the annual growth rate of the tourism revenue, c_1, c_2, c_3 denote the annual growth rate of the number of attractions, the annual growth rate of the number of travel agencies, the annual growth rate of the number of hotels, respectively.

Table 1. Endogenous variables of low carbon tourism

Notation	Variable name	Unit
x	number of tourists	10^4 persons
y	tourism revenue	10^4 yuan
z	number of tourist facilities	A
z_1	number of attractions	A
z_2	number of travel agencies	A
z_3	number of hotels	A
E	energy consumption of tourism	T
r_1	tourism per capita consumption	
r_2	income to the investment of facilities	
r_3	attractions of supply to demand	
r_4	travel agency of supply to demand	
r_5	hotels of supply to demand	
e_1	tourists per capita energy consumption	Kce
e_2	the average energy consumption of tourist reception facilities	Tce
e_3	the average energy saving rate of tourist facilities	
P_{GDP}	gross domestic product	10^4 yuan
t_z	Society investment in fixed assets in the region	10^4 yuan
s_r	annual per capita disposable income of residents	10^4 yuan
Q	government subsidies for energy consumption of tourism	10^4 yuan

Table 2. Exogenous variables of low carbon tourism

Notation	Variable name	Unit
dx	annual variation in the number of reception	10^4 persons
dy	annual variation in tourism income	10^4 yuan
dz	annual variation in tourist reception facilities	A
dE	annual energy variation in the development of tourism	Tce

In the model of the reality of tourism development, the growth conditions described by Eq. (1) could not exist. From the Fig. 2, the annual variations of tourism revenue in and tourism facilities are influenced by tourism consumption per capita, the ratio of revenue and the number of facilities ,the ratio of supply and demand of tourism facilities, GDP, the annual disposable income of residents per capita, investment in fixed assets in the district. So we can get the functional relation of a, b, c and those impact factors (take the constant value) Differential equations transfers as:

$$\begin{cases} \frac{\mathrm{d}x}{\mathrm{d}t} = a(r_1, r_2, r_3, t_z, s_r, g)x; \\ \frac{\mathrm{d}y}{\mathrm{d}t} = b(r_1, \xi_2, r_3, t_z, s_r, g)y; \\ \frac{\mathrm{d}z}{\mathrm{d}t} = c_1(r_1, r_2, r_3, t_z, s_r, g)z; \\ \frac{\mathrm{d}z}{\mathrm{d}t} = c_2(r_1, r_2, r_3, t_z, s_r, g)z - \frac{z}{40}; \\ \frac{\mathrm{d}z}{\mathrm{d}t} = c_3(r_1, r_2, r_3, t_z, s_r, g)z - \frac{z}{40}; \\ \frac{\mathrm{d}E}{\mathrm{d}t} = e_1 ax + e_2(1-e_3)(c_1 z_1 + c_2 z_2 + c_3 z_3 - \frac{z_2+z_3}{40}); \end{cases} \quad (2)$$

In Eq. (2), as we kown that the operational life of commercial house is 40 years, the removal rate of z_2 and z_3 is. As the removal rate of attractions is 0, we can ignore its impact on c_1, meanwhile, we may ignore the impact factors of the removal rate which come from its internal system and made it be a constant value influenced by external system only.

3 System simulation for LSD

On the base of constructing mathematica model and simulation model, use the Simulink tool box of MATLAB to establish the corresponding simulation model for LSD.

3.1 Data sources

Present study primary data are collected in the district of LSD statistical yearbook from 1999-2008, some individual data are provided from the Tourism Bureau. In the sample data, we use current prices to calculate. A very few years on the volatile value, if we find non-economic factors to explain, we will analyze the simulation diagram. such as tourism income, subjected to market conditions at that time or the impact of natural disasters. It can be explained in a reasonable non-economic factors (policy adjustment and environmental consciousness, etc.) to make the model reflect the general trends of tourism industry in the development of low carbon conditions. In this paper, we sorted out Tab. 3 and Tab. 4 after data processing.

3.2 Solving model of LSD

To a, b, c_1, c_2 and c_3, this 5 a growth rate of functions in expressions, we will introduce GMDH for sure. The following calculation of a will be a case.

Table 3. The original database tables

Years	x (10^4 persons)	y (10^4 yuan)	z_1 (A)	z_2 (A)	z_3 (A)	P_{GDP} (10^4 yuan)	t_z (10^4 yuan)	s_r (yuan)
1999	227.87	20.1	6	31	16	300879	103694	4947
2000	232.76	21.3	6	27	16	319883	155341	5217
2001	236.93	23.7	3	30	15	349074	145023	5610
2002	262.52	25.1	3	26	14	389800	165903	6076
2003	292.76	27.92	3	24	14	453700	206573	6489
2004	383.93	16.65	3	22	14	548742	238987	7161
2005	357.4	21.98	3	19	13	636986	283646	7520
2006	381.98	35.74	3	18	12	756564	401423	8399
2007	413.9	36.47	3	16	12	925282	476667	10853
2008	355.95	33.74	3	15	11	1135137	581622	12714

Since $a = \frac{x_i - x_{i-1}}{x_{i-1}}, (i = 2, 3, \cdots, 10)$ represents the number of years (relative) growth rate, so we have:

$$\begin{cases} a = \frac{x_i - x_{i-1}}{x_{i-1}}, (i = 2, 3, \cdots, 10); \\ \frac{\mathrm{d}x}{\mathrm{d}t} = a(r_1, r_2, t_z, s_r, g)x. \end{cases} \tag{3}$$

The use of GMDH calculated on data in Tab. 4, we get the following results:

The software set a variable to be solved a as X_1 and get three a and its affecting factors of the nonlinear relationship model. We select a model with a good fitness result which is shown in Fig. 3: the blue curve represents the nonlinear relationship between and its influential factors from real world data, while the red one is fitting results of software. The fitness degree is quite high.

Table 4. The unit of the table after computing a

Years	x_i	a_i	$\mathrm{d}x/\mathrm{d}t$	r_1	r_2	r_3	r_4	r_5	t_z	s_r	g
1999	0.5505	0.0212	0.4917	0.9240	1	1	0.8719	0.1783	0.3891	0.2651	
2000	0.5624	0.0210	0.0178	0.4739	0.8997	0.8600	0.7490	0.7498	0.2671	0.4103	0.2818
2001	0.5724	0.0176	0.1025	0.4336	0.9498	0.4659	0.9018	0.8125	0.2493	0.4413	0.3075
2002	0.6343	0.0975	0.1089	0.4536	0.9807	0.4980	0.8353	0.8115	0.2852	0.4779	0.3434
2003	0.7073	0.1033	0.2695	0.4547	0.9486	0.4636	0.7178	0.7073	0.3552	0.5104	0.3997
2004	0.9276	0.2375	−0.0716	1	0.5421	0.6079	0.8629	0.9276	0.4109	0.5632	0.4834
2005	0.8635	−0.0742	0.0742	0.7052	0.6871	0.6780	0.8310	0.8866	0.4877	0.5915	0.5612
2006	0.9229	0.0644	0.0802	0.4635	0.9800	0.7512	0.8723	0.9824	0.6902	0.6606	0.6665
2007	1	0.0771	−0.1506	0.4922	1	0.7646	0.7893	1	0.8196	0.8536	0.8151
2008	0.8600	−0.1628		0.4575	0.86448	0.7810	0.7558	0.9363	1	1	1

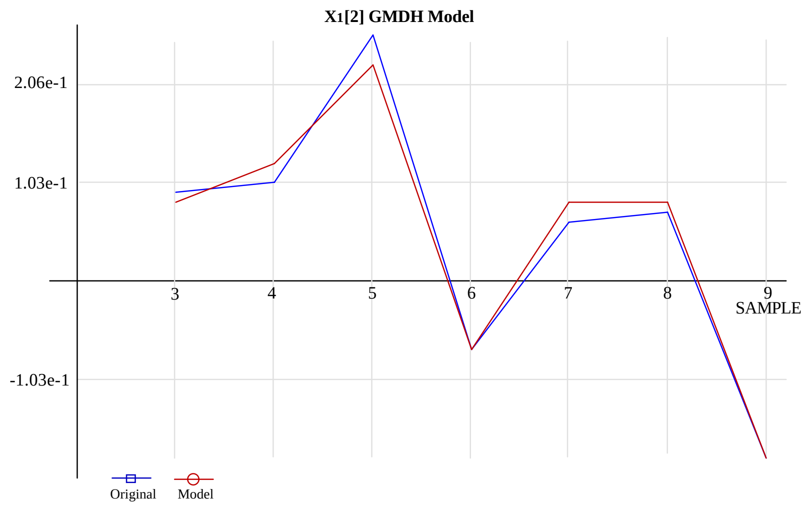

Fig. 3. fitting chart of a by applicating GMDH

Then the results after fitting the data of software indicates: the Mean Absolute Percentage Error: 6.5%, Approximation Error Variance: 0.0065, and Coefficient Of Determination (R-squared): 0.9935, so we know that

$$a = -302.7r_5 - 201.2r_3 + 3665r_5^2 + 5748r_{3(t-1)}^2 + 7.554$$

is effective. b, c_1, c_2 and c_3 will not go into the calculation, only presented the results.

$$\begin{cases} a = -302.7r_5 - 201.2r_3 + 3665r_5^2 + 5748r_{3,(t-1)}^2 + 7.554; \\ b = 3255.1792r_4 + 871.0547r_{4,(t-2)} - 11404.617r_4r_{4,(t-2)} - 13433.161r_4^2 \\ \qquad + 18.1103r_{2,(t-1)} - 384.9083r_4r_{2,(t-1)} + 6.4422r_{2,(t-1)}^2 + 105.5881; \\ c_1 = -1.4248c_{1,(t-1)} + 2.0519s_r^2 - 2.0571; \\ c_2 = -1.356c_{2,(t-1)} + 1.0024t_{z,(t-1)} + 1.3158t_{z,(t-1)}^2 + 0.0645; \\ c_3 = -5.7756r_1 - 9.8632c_{3,(t-2)} + 7.2859r_1c_{3,(t-2)} + 1.9044r_1^2 \\ \qquad + 14.2505c_{3,(t-2)}^2 + 3.2163r_5g - 0.1426g^2 + 3.8496 \end{cases} \tag{4}$$

Bring $r_1 = \frac{y}{x} r_2 = \frac{y}{z} r_3 = \frac{z_1}{x} r_4 = \frac{z_2}{x} r_5 = \frac{z_3}{x}$ into Eq. (2) and Eq. (4), we can obtain Eq. (5):

$$
\begin{cases}
\frac{\mathrm{d}x}{\mathrm{d}t} = -302.7z_3 - 201.2z_1 + 3665z_3^2x + 5748\frac{z_{[1,(t-1)]}^2 x}{x_{t-1}^2} + 7.554x; \\
\frac{\mathrm{d}y}{\mathrm{d}t} = 3255.1792\frac{z_2 y}{x} + 871.0547\frac{z_{[2,(t-2)]} y}{x_{t-2}} - 11404.617\frac{z_2 z_{[2,(t-2)]} y}{x x_{t-2}} \\
\quad - 13433.161\frac{z_2^2 y}{x^2} + 18.1103\frac{y y_{t-1}}{z_{[1,(t-1)]}+z_{[2,(t-1)]}+z_{[3,(t-1)]}} \\
\quad - 384.9083 r_4 \frac{y y_{t-1} z_2}{x(z_{[1,(t-1)]}+z_{[2,(t-1)]}+z_{[3,(t-1)]})} \\
\quad + 6.4422\frac{y y_{t-1}^2}{(z_{[1,(t-1)]}+z_{[2,(t-1)]}+z_{[3,(t-1)]})^2} y + 105.5881y; \\
\frac{\mathrm{d}z_1}{\mathrm{d}t} = -1.4248c_{[1,(t-1)]}z_1 + 2.0519s_r^2 z_1 - 2.0571z_1; \\
\frac{\mathrm{d}z_2}{\mathrm{d}t} = -1.356c_{[2,(t-1)]}z_2 + 1.0024t_{z,(t-1)}z_2 + 1.3158t_{z,(t-1)}^2 z_2 + 0.0645z_2 - \frac{z_2}{40}; \\
\frac{\mathrm{d}z_3}{\mathrm{d}t} = -5.7756y - 9.8632c_{[3,(t-2)]}z_3 + 7.2859\frac{y}{x}c_{[3,(t-2)]}z_3 + 1.9044\frac{y^2}{x^2}z_3 \\
\quad + 14.2505c_{[3,(t-2)]}^2 z_3 + 3.2163\frac{z_3^2 g}{x} - 0.1426g^2 z_3 + 3.8496z_3 - \frac{z_3}{40}; \\
\frac{\mathrm{d}E}{\mathrm{d}t} = e_1 a x + e_2(1-e_3)(c_1 z_1 + c_2 z_2 + c_3 z_3 - \frac{z_2+z_3}{40}).
\end{cases} \tag{5}
$$

The system of nonlinear equations is the mathematical model of the tourism industry in LSD.

3.3 Simulation model of LSD

Simulink can be applied to simulate linear or nonlinear, continuous or discrete, or the mix of both systems. In other words, it can be used in almost every possible dynamic system. Given the complexity of this model and the analysis in 2.1, six subsystems are constructed first, which are tourism population subsystem, tourism income subsystem, tourism attraction subsystem, travel agency subsystem, hotel subsystem and energy-consumption subsystem in tourism development respectively. Later, those six subsystems are reconstructed into one whole system (as the Fig. 4 below).

Mathematical models used in this simulation are simultaneous equations. The orders mainly used in this simulation are In, Out, Product, In2tegrator, Gain, Math function, Scope, etc. Before operating computer simulation model, M document is run. We put every parameter in the working space, which is simultaneously activated and used in the working space when operating simulation model.

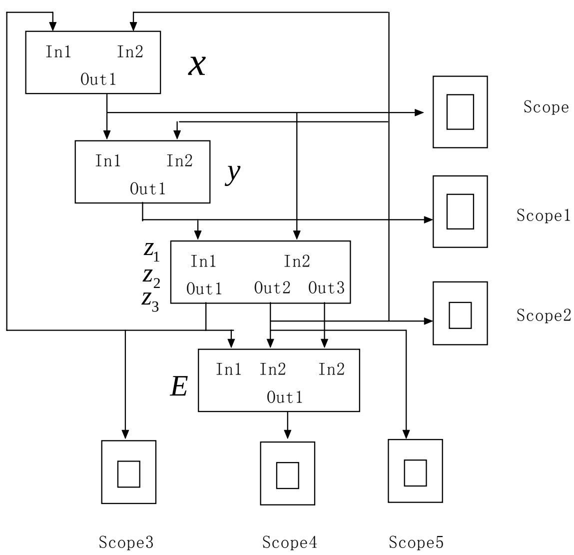

Fig. 4. Simulation of LSD low carbon travel

3.4 Simulation results

Theory analysis which is to check whether those relationships meet the requirements of theory of the system that is studied in the modeling process and whether the overall behavior of the models is consistent with theoretical reasoning and empirical judgments and historical situation observation which is to compare simulation results with actual behavior of the past of the system, we can obtain the simulation results as follows:

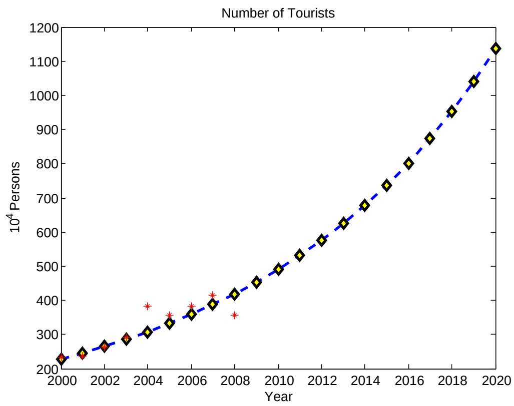

Fig. 5. Tourists simulation curve compared with the actual data

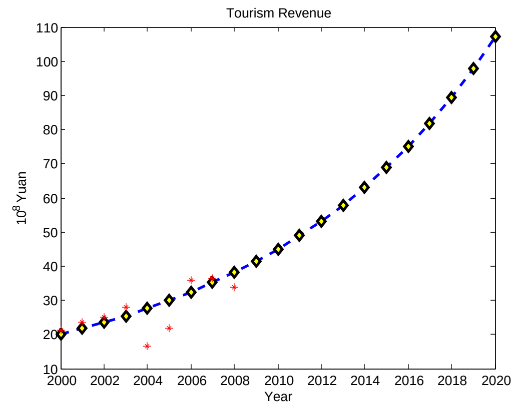

Fig. 6. Tourism revenues simulation curve compared with the actual data

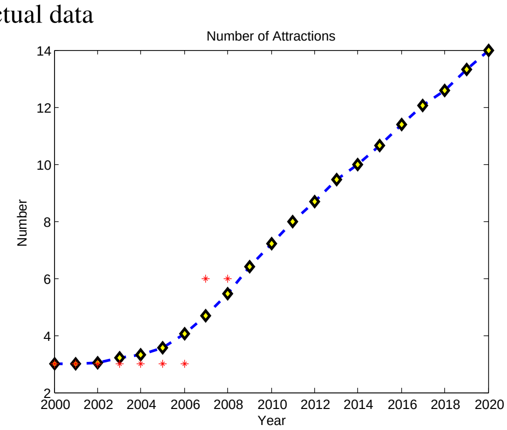

Fig. 7. The number of attraction, the simulation curve compared with the actual data

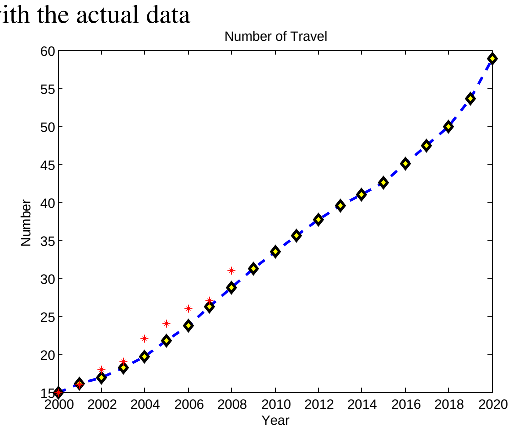

Fig. 8. The number of travel agency, the simulation curve compared with the actual data

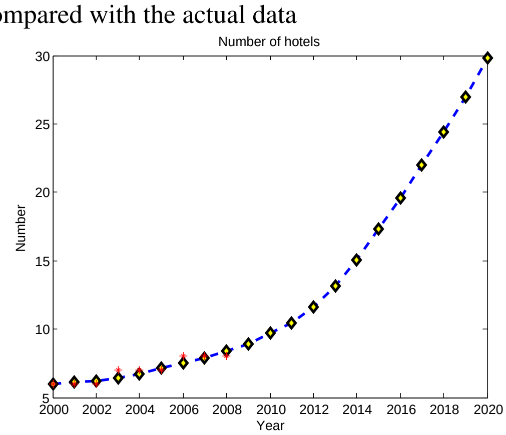

Fig. 9. The number of hotel, the simulation curve compared with the actual data

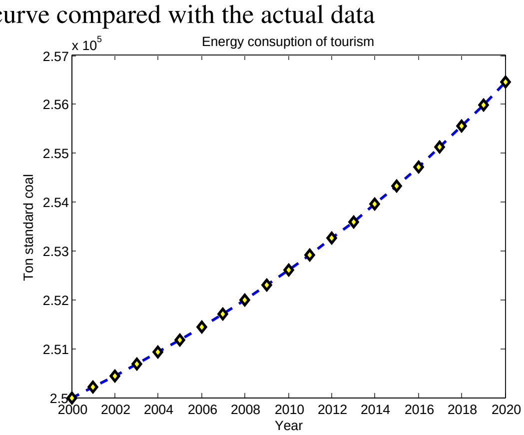

Fig. 10. Tourism consumption simulation curve compared with the actual data

Firstly, the simulation graphs show that: number of tourists has been relatively rapid development momentum, but tourism revenue and service facilities are subject to some restrictions which appears a slower linear growth momentum like letter J and the model's overall behavior is consistent with theoretical reasoning and empirical judgments.

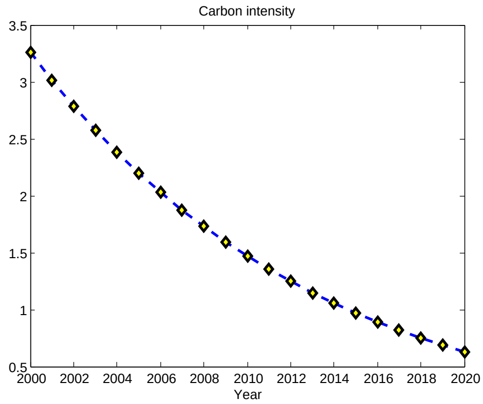

Fig. 11. Carbon intensity of tourism development in the simulation curve compared with the actual data

The Figs. 5 $\sim$ 11 shows the simulation curve fits with the actual curve, that indicated this model is valid. Now, on the base of verifying the validity of the model, do the qualitative analysis and quantitative analysis on the model established. According to computer simulation, after 2008, tourism revenue, tourist arrivals, tourism facilities and development energy consumption will increase year by year. Through the data comparison it shows that the growth rate of energy consumption in tourism increases less than that of income. In other words, tourism million/GDP energy consumption goes down; at the same time, carbon intensity will be further reduced, finally transform to a good situation of development of low carbon tourism.

3.5 Sensitivity analysis

Analysis on the change on the tourism revenues

By the impact of SARS in 2003, the LSD Tourism revenues dropped sharply, and due to the great earthquake in 2008, there is a certain level of revenue decline. In addition, tourism revenues grows generally which reached 3.647 billion yuan in 2007. In 2006, in an environment of rapid economic growth of Sichuan, the LSD tourism fast forward to present tourism revenues and economic growth are related. After 2006, tourism revenues increased significantly deceleration which related with the large base of the tourism revenues. On the other hand, due to the life-cycle of tourism, the LSD tourism in the area after the development phase and the consolidation phase, entered a phase of stagnation or decline that slow down the growth rate of tourism revenue sign obviously.

Analysis on the change on the number of visitors

From the start time of simulation to 2008, the total number of tourists had remained relatively fast growth rate and showed a peak in 2004,that was because, with rapid economic growth in Sichuan Province and in the whole country, the number of domestic tourism and travel in the province stayed in a relatively stable rate of growth. With economic growth and productivity gains, people have more disposable income and leisure time, which laid the foundation for the number of tourists increasing. Accompanied reform and opening of up the depth, also is an injection of an inotropic to the number of tourists in increasing. But influenced by the earthquake in Wenchuan, the number of tourists decreased slightly in 2008.

Analysis of the change on the tourism facilities

Based on the overall analysis of the change of tourism attractions, travel agencies and hotels, from the simulation start time to 2006, in LSD, it was the growth period of tourist facilities. Since then, growth rate will slow down. From 1999 to 2006, with the number of tourists and tourism revenue in the volatile situation, the number of facilities maintain a certain rate of growth,that is a reflect of growth of energy consumption which is because the balance of supply and demand are neglect and facilities are payed few attentions on.in the next LSD Government should pay more attention to the number of facilities and needs to adapt to ensure that low-carbon tourism will develop in a healthy condition and coordinated in LSD.

Analysis of energy consumption on the development of tourism

From the simulation start time to 2006, the total energy consumption of LSD's tourism has been rising, but the growth is slow, and its growth rate was lower than that of the number of tourist and facilities, It shows that the growth rate of energy consumption is in the normal range while the carbon intensity of tourism development ($E * 2.66$ / million GDP) is declining. Till 2008, it falls down to 1.595 tons from 3.259 tons in 2000.

3.6 Policy recommendations

To achieve low carbon tourism, energy saving technology must be introduced to reduce carbon consumption of tourism development, and policy support is needed. City District need to implement practical, low-carbon tourism indicators and measures, and finally construct a chain of low-carbon development of tourism.

Establish the policy basis

Make the slogan "promote low carbon travel, promote the development of energy-saving environmental protection industry" included in the new round of LSD's tourism in the five year development program; Yellow line marked car will be limited provisions in order to build low-carbon transport system; Introduce low-carbon tourism in the scenic team award incentives; For the "green hotels" industry standards stated by the end of 2015, introduce relevant policies to encourage.

Enforcement incentives

By 2015, the region all the new hotels which are over the level of three-stars achieve "Green Hotel" assessment standards; Found energy saving special fund to award the hotels which have outstanding contributions on energy saving. Star hotels achieve that the average single-room water, electricity consumption decreased by 20% in the past 5 years. Reward the hotels which use environmentally friendly materials and energy-saving equipments and award the emissions-compliant hotels sewage fee waiver incentives.

Provide technical support

Enhance the intelligence development of tourism to improve operational efficiency, while introducing comprehensive energy saving technology in a timely manner reducing carbon consumption, and ultimately construct a model of recycling economy of the whole industry chain.

Establish a low carbon ideas

Strengthen the concept of low-carbon tourism promotion, to reverse the atmosphere of extravagance and wastefulness of some of the tourists travel to this region, and strengthen tourism facilities clean, convenient, comfortable and functional, enhance the brand of cultural tourism.

4 Conclusions

This paper intends to apply differential dynamics to construct a low-carbon tourism system, which is influenced by factors like z_1, z_2, z_3, s_r, t_z ,g, etc. By using GMDH method to calculate the parameters in each sub-system in low-carbon tourism differential dynamics, we find that this system is nonlinear, thus, we make theoretical and empirical analysis based on the theory of nonlinear differential dynamic system. Through empirical analysis of the development of low-carbon tourism in LSD in 1999-2000, we find that although the energy consumption of the tourism development tends to reduce in the future, the gap between LSD and other developed countries is still quite large. Currently, what LSD should do is to keep the balance between the supply and demand of tourist facilities and reduce the carbon fixed production under the premise of steady increase of tourist income. In future, we may do some research under the fuzzy state when forecasting the trend of low carbon tourism and add more complicated hypothesis. Therefore, more practical conclusions can be obtained by this analysis.

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