

# Sustainable Development of Economic Circle in Tourist Destinations Based on System Dynamics

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Received: May 12, 2011; Revised Dec. 24, 2011; Accepted Feb. 13, 2012

**Abstract:** In the constraints of tourism resources and environment, how to develop regional economy, improve the capability of tourist reception, and stimulate both tourism and surrounding industries to grow collaboratively is gradually becoming a key point to keep the development of tourist destinations sustainable. Due to sustainable development in relation to the long-term planning, the research on the mutual relationships among economy, environment and other systems of tourist destinations, and the mechanism of long-term effects has proved to be the focus of managers of scenic areas and scholars. This paper discussed dynamic mechanism of sustainable development of economic circle in tourist destinations, of which tourism is pillar industry, built system dynamics model of subsystems of economic circle and then simulated. Finally, system inherently dynamic mechanism of developmental, mature and recessionary periods from this economic circle was analyzed, to provide a basis for prolonging the duration of mature period, slowing decline velocity of recession, and promoting sustainable development of economic circle in tourist destinations.

**Keywords:** sustainable development, tourist destinations, economic circle, system dynamics.

## 1. Introduction

The endowment of resources and conditions of a tourist destination promotes the origin of tourism, giving a swift boost to the development of tourism economy and stimulating the related industries to appear, such as railway, road and air transport, lodging and catering industry, banking and real estate industry, etc. Then an economic cycle with tourism pillared and other industries auxiliary is formed, consisted of the nature, society, economy, culture and ecology, etc, which makes the region conducive to absorb employed population, prosper the economy, construct the urbanization and develop the culture.

Tourism revenue is one of the main sources of income in 46 of the 50 world's most countries according to the World Tourism Organization [1]. So the development of tourist destinations' economic cycle has an irreplaceable role in promoting the region; particularly in western regions where tourism is regarded as a major industry.

Domestic and foreign scholars researched the sustainable development of tourism mainly through the perspectives of tourism environmental capacity, indicators and policies of sustainable development, tourist destinations' life

cycle, as well as community participation [2, 3]. It's worth noting that Tosun (1999), Logar (2010) researched the sustainable development of tourism industry from the policy aspect [4, 5]; Cevat Tosun (2001), Briassoulis (2002), Northcote and Macbeth (2006), Jeremy Northcote (2006), Castellani and Sala (2010), Castellani (2010) researched the evaluation index of the sustainable development in tourism from different aspects and did empirical research [6–9]; Briassoulis (2002) examined the factors which threatening the sustainable development of tourism, and pointed out that the economic recession, the deterioration of the environment, social contradictions and the degree of tourists' satisfaction decrease had been constraining the tourism sustainable development [10]; Miller (2010) researched the sustainable development of tourism industry from aspects of the public's understanding and the influence of the visitors behavior and pointed out that it was necessary to change the visitors behavior [11], Hilal (2010) put forward setting up collaborative network organization and environment management to promote tourism sustainable development based on the system theory [12], with the development of the sustainable development, the research in

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tourism products' life cycle theory has been brought into studying the tourist destination, the life cycle changes of tourist destinations and characteristics analysis of every life cycle's stages could be conducive to understand the possible problems appeared in different life cycle's stages and make effective control and adjustment to resolve the problem, finally to prolong the life cycle and realize the sustainable development of tourism.

Through analyzing the researches, it can be found that the methods for sustainable development of tourism are mainly qualitative analysis, but quantitative studies are relatively rare, primarily expressed in ecological footprint, environmental capacity, PSR method, system simulation and so on. And quantitative researches generally concentrate on sustainable development of tourist destinations [13–16].

However, when a tourist destination develops into a certain stage, manufacturing and other peripheral industries also will inevitably develop to provide the related materials for scenic spots. The speed of economic development of the tourist destination is getting faster in the developing period, while the rate of resources' consumption of the tourist destination also speeds up. In the later period of maturity and the process of recession, the speed of recession is much faster.

Therefore, the development trends of surrounding industries and their impacts on the regional economy cannot be ignored in the research of sustainable development of the tourist destination's economy. Studying the economic cycle system (ECS) of the tourist destination to understand its inherent impact factors and its mutual influence is the basis for how to coordinate the collaborative development of the leading tourism, other industries, regional economy, resources and environment, etc. And a system dynamics model to describe subsystems' intrinsically dynamic mechanism of this economic circle from the perspective of the combination with qualitative and quantitative analysis is built to research the characteristics and development trends, intending to provide a reference for promoting its sustainable development and a new perspective to explore the law of the evolution of tourist destinations.

This paper is organized logically as follows: in Section 2, with the description of the economic cycle system in the tourist destination, the tourism system for ECS development is introduced and then a dynamical system model for studying ECS of the tourist destination is proposed. In Section 3, on the basis of dynamic system with the six subsystems, the system dynamics equations of sustainable development of ECS are created to make a quantitative study and systematic analysis. Then through running the system dynamics model of sustainable development of ECS in the tourist destination by simulating it, we can get its simulation results, finally we do the resources sensitivity analysis. In Section 4, we make a conclusion about development situation and characteristics of ECS in a tourist destination and discuss necessary further researches.

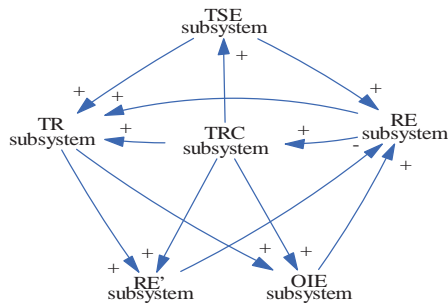
## 2. Modeling

### 2.1. System description

The sustainable development of ECS in the tourist destination should include at least six kinds of subsystem [16], such as region economy (RE), tourist reception capacity (TRC), tourism services economy (TSE), tourism region (TR), other industries economy (OIE), resources and environment (RE'). RE subsystem mainly indicates the external environment of ECS, the development of which will be to promote infrastructure constructing, visitors increasing, and provide supporting function for tourism services and other industries, instill the power into enhancing the capacity of tourist reception. TRC subsystem is the core of ECS, including the capacity of services reception corresponding to food, accommodation, transportation, travelling, shopping and entertainment, etc, particularly when tourism will develop to a certain scale, sustainable development of lodging industry, catering services, transportation business, retail trade and other industries will be more dependent on tourist reception capacity to ascend. TSE subsystem focuses on its economic output value through the action of TRC subsystem in tourism of ECS. TR subsystem is the carrier of cultural and natural landscapes, and also human resources gathering area that offers employed population for ECS developing. OIE subsystem contains other industries related to TSE and RE subsystem. When ECS develops to a certain stage, it can provide prerequisite resources for manufacturing, real estate industry and so on. RE' subsystem gives expression to resources endowment of ECS, including tourism resources, land resources, natural environment and interactive influence between men and environment, etc.

### 2.2. Dynamic mechanism

Sustainable development of ECS exerts dynamic, interactive and variant mechanism among the various subsystems in the space-time evolution process of ECS lying in tourist destinations, which are the basis of establishing a dynamics model for sustainable development of economic system [16, 17]. As shown in Figure 1, dynamic mechanism mainly displays in relationships between TRC and TSE subsystem, RE and TRC subsystem, TRC and RE' subsystem, TRC and OIE subsystem, TRC and TR subsystem, etc, especially the effect of mechanism is more apparent in the early development of ECS. Interactive mechanism primarily embodies in the mature period of ECS development, which is the function of the organization mode and the capability of ECS, divided into the positive and negative interactive mode, and through the function of each subsystem transformation and their synergy, ECS achieves evolution process, providing the necessary conditions for it to keep a sustainable, stable and orderly state. Variant



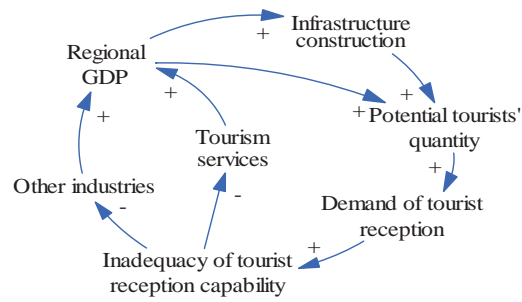
**Figure 1** Dynamic mechanism of sustainable development of ECS in tourist destinations.

mechanism principally reflects the life cycle characteristics of ECS development experiencing successively developmental period, stable period, mature period, degenerating period and so on, and each period has a certain threshold value range, once exceeding the threshold of a certain stage, ECS will undergo mutation process, from quantitative change to qualitative change, leaping toward next hierarchy stage of its life cycle by the help of the dynamic mechanism.

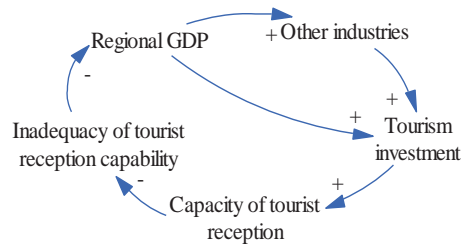
### 2.3. System dynamics model

The key to build system dynamics model lies in the analysis of the feedback structure based on cause-effect relationships of system variables [18]. According to expounding dynamic evolution mechanism of ECS development, causal relationships are expressed to show their chains combined with each subsystem as follows:

In RE subsystem, with the increase of regional GDP, to invest infrastructure construction could be promoted, strengthening the capability of tourism services, so as to intensify its tourists attraction, along with the number of tourists rising, tourism demand highlighted, so it will lead to the inadequacy of tourist reception capability and hinder tourism and other industries' development, limiting their contribution to output of regional GDP. And the chains of causation shown in Figure 2 are as follows: Regional GDP → Infrastructure construction → Potential tourists' quantity → Demand of tourist reception → Inadequacy of tourist reception capability → Tourism services → Regional GDP, Regional GDP → Infrastructure construction → Potential tourists' quantity → Demand of tourist reception → Inadequacy of tourist reception capability → Other industries → Regional GDP, Regional GDP → Potential tourists' quantity → Demand of tourist reception → Inadequacy of tourist reception capability → Tourism services → Regional GDP, Regional GDP → Potential tourists' quantity → Demand of tourist reception → Inadequacy of tourist reception capability → Other industries → Regional GDP.



**Figure 2** Chains of causation in RE subsystem.

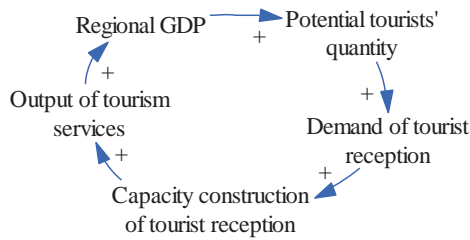


**Figure 3** Chains of causation in TRC subsystem.

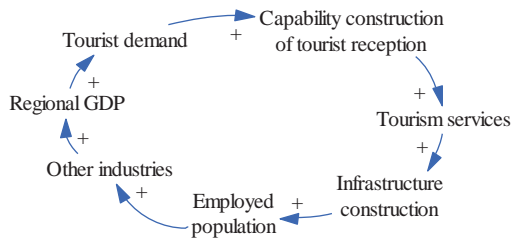
In TRC subsystem, upgrading the capacity of tourist reception would eliminate the shortages of tourism services, meet tourist demand, and expedite the increase of regional GDP, motivating the development of other industries, prompting the increase of tourism capital investment for providing financial foundation used to reinforce the capacity of tourist reception once again. And the chains of causation shown in Figure 3 are as follows: Capacity of tourist reception → Inadequacy of tourist reception capability → Regional GDP → Other industries → Tourism investment → Capacity of tourist reception, Capacity of tourist reception → Inadequacy of tourist reception capability → Regional GDP → Tourism investment → Capacity of tourist reception.

In TSE subsystem, tourism contribution to regional GDP would cause the regional economic development, consequently enhance the gravitational effects of the tourist destination on tourists, and potential tourists' quantity could generate more demand of tourist reception, so to construct the reception capacity, develop the tourism and improve its positive influence on regional GDP. And the chains of causation shown in Figure 4 are as follows: Output of tourism services → Regional GDP → Potential tourists' quantity → Demand of tourist reception → Capacity construction of tourist reception → Output of tourism services.

In TR subsystem, the increasing number of employed population accumulated to a certain degree, other industries would appear that is standing for tourism development entering into the mature period, thus other industries'



**Figure 4** Chains of causation in TSE subsystem.

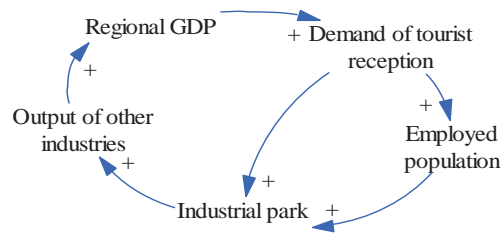


**Figure 5** Chains of causation in TR subsystem.

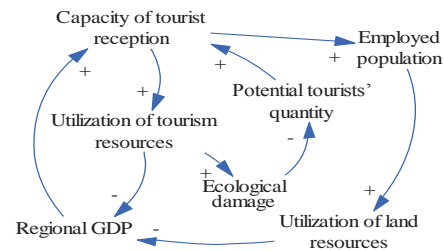
growth could bring the increase of regional GDP, further spurring the tourist demand, upgrading the capacity construction of tourist reception, and speeding up the infrastructure construction. Development of the tourist destination and its infrastructure would attract lots of employed population again. And the chains of causation shown in Figure 5 are as follows: Employed population → Other industries → Regional GDP → Tourist demand → Capability construction of tourist reception → Tourism services → Infrastructure construction → Employed population.

In OIE subsystem, when tourism develops entering into the mature period, other industries would began to emerge and develop with certain conditions, to reinforce the strength of regional economy, and drive the increasing tourists' quantity, so the demand enhancing tourist reception becomes more, resulting in employed population expanding in the tourist destination to promote the creation of the industrial park where tourism are the core, and make other industries further develop. And the chains of causation shown in Figure 6 are as follows: Output of other industries → Regional GDP → Demand of tourist reception → Employed population → Industrial park → Output of other industries, Output of other industries → Regional GDP → Demand of tourist reception → Industrial park → Output of other industries.

In RE' subsystem, with the utilization of tourism resources increasing, tourism resources and land resources could be less and less, giving rise to limit the development of regional economy, especially regional development would be affected negatively when the capacity of ecological environment might be surpassed. And the chains



**Figure 6** Chains of causation in OIE subsystem.



**Figure 7** Chains of causation in RE' subsystem.

of causation shown in Figure 7 are as follows: Utilization of tourism resources → Regional GDP → Capacity of tourist reception → Utilization of tourism resources, Utilization of tourism resources → Ecological damage → Potential tourists' quantity → Capacity of tourist reception → Regional GDP → Utilization of tourism resources, Utilization of land resources → Regional GDP → Capacity of tourist reception → Employed population → Utilization of land resources, Utilization of land resources → Ecological damage → Potential tourists' quantity → Capacity of tourist reception → Employed population → Utilization of land resources.

According to the cause-effect relationships among six subsystems, mainly researched level variables of each subsystem are as follows: RE subsystem: regional GDP; TRC subsystem: capacity of tourist reception; TSR subsystem: output of tourism services; TR subsystem: employed population; IOE subsystem: output of other industries; RE' subsystem: utilization of tourism resources, utilization of land resources, and the rate variables, auxiliary variables and constants proposed specifically can be seen in the system flow diagram, as shown in Figure 8. So the relationships between the variables takes on the complex and dynamic features, and with the help of the clarify of the cause-effect relationships between the variables or key elements, simulating the system and creating system equations are provided for the prerequisite and the foundation to make a quantitative analysis of this system.

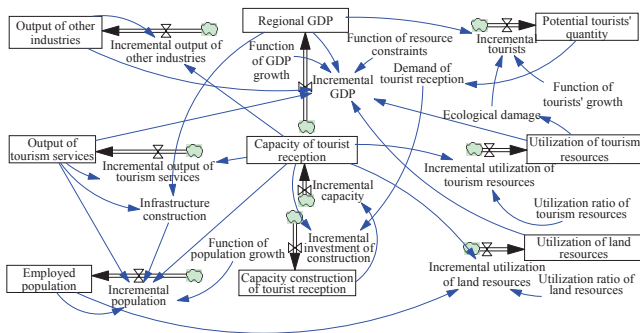


Figure 8 System flow diagram.

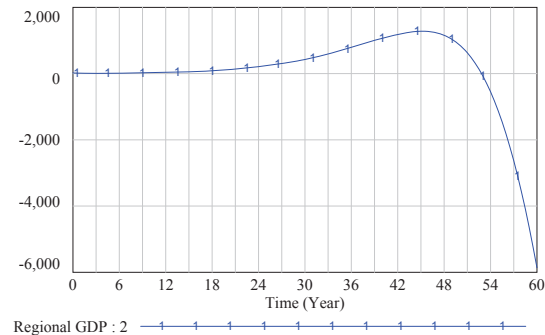


Figure 9 Changes of regional GDP.

### 3. System Simulation

#### 3.1. System Dynamics Equations

Specific performances of the system dynamics model are a series of mathematical equations, which can be created by using the formula editor that VENSIM provides [20–22]. Combined with the system flow diagram and operation way of the tourist destination, the system dynamics equations of sustainable development of ECS can be created.

RE subsystem:  $Regional\ GDP.K = Regional\ GDP.J + Incremental\ GDP.JK, Incremental\ GDP.KL = Output\ of\ tourism\ services.K + Output\ of\ other\ industries.K - (Utilization\ of\ land\ resources.K + Utilization\ of\ tourism\ resources.K) \times Resource\ limit\ rate.$

TRC subsystem:  $Capacity\ of\ tourist\ reception.K = Capacity\ of\ tourist\ reception.J + Incremental\ capacity.JK, Incremental\ capacity.KL = (Demand\ of\ tourist\ reception.K - Capacity\ of\ tourist\ reception.K) \times Growth\ rate.$  TSE subsystem:  $Output\ of\ tourism\ services.K = Output\ of\ tourism\ services.J + Incremental\ output\ of\ tourism\ services.JK, Incremental\ output\ of\ tourism\ services.KL = Capacity\ of\ tourist\ reception.K \times Growth\ rate.$

TR subsystem:  $Employed\ population.K = Employed\ population.J + Incremental\ population.JK, Incremental\ population.KL = Output\ of\ tourism\ services.K \times Rate1 + Infrastructure\ construction.K \times Rate2 + Capacity\ of\ tourist\ reception.K \times Rate3.$

OIE subsystem:  $Output\ of\ other\ industries.K = Output\ of\ other\ industries.J + Incremental\ output\ of\ other\ industries.JK, Incremental\ output\ of\ other\ industries.KL = Employed\ population.K \times Rate4 + Capacity\ of\ tourist\ reception.K \times Rate5.$

RE' subsystem:  $Utilization\ of\ tourism\ resources.K = Utilization\ of\ tourism\ resources.J + Incremental\ utilization\ of\ tourism\ resources.JK; Utilization\ of\ land\ resources.K = Utilization\ of\ land\ resources.J + Incremental\ utilization\ of\ land\ resources.JK; Incremental\ utilization\ of\ land\ resources.KL = Capacity\ of\ tourist\ reception.K \times Utilization\ ratio\ of\ tourism\ resources.K; Incremental\ utilization$

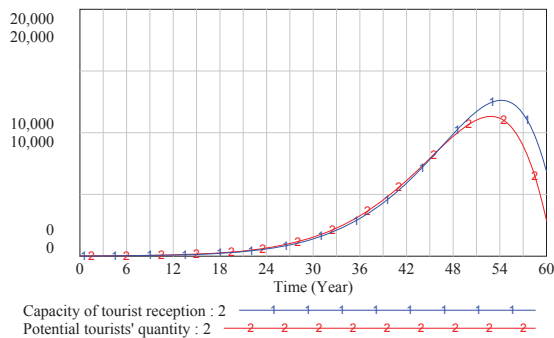
of land resources. $KL = (Employed\ population.K + Capacity\ of\ tourist\ reception.K) \times Utilization\ ratio\ of\ land\ resources.K.$

#### 3.2. Simulation Results

Running the system dynamics model of sustainable development of ECS [20, 23] in the tourist destination by simulating, it can be found in Figure 9 that from the beginning to the 35th year, regional GDP has maintained a fast growing trend driven by the radiation of tourism development, however, as the increasing damage to resources and environment gradually hinders the economic development of ECS, the growth trend of regional GDP slows down from the 35th year to the 44th year. After 44 years, the impediment that the damage of resources and environment could bring to economic development would be increasingly obvious, then regional economy would begin to sharply decline. So the related management department should take protection measures of local resources and environment to cope with the future problems in advance.

From the development status of potential tourists' quantity shown in Figure 10, the change of tourists' quantity has a similar development trend with regional GDP. Compared to regional GDP, the amount of potential tourists has certain delay. When regional GDP reaches the peak in the 44th year, the potential tourists' quantity still shows a rising trend. But it appears with a sharp decline in about the 52th year, mainly resulting from the recession of regional GDP leading to reduce tourism promotion and the related service facilities construction that also have certain delayed effect, causing the reduction of potential visitors in about 8 years later after regional GDP having reached its peak. Therefore, regional GDP has a direct effect on the number of potential tourists.

With the increasing number of potential tourists, capacity of tourist reception shown in Figure 10 takes on a trend of rapid growth and reaches its peak in about the 56th year, then begins to decline. As the construction of tourist reception capacity is a long project, the peak of tourist re-



**Figure 10** Changes of capacity of tourist reception and potential tourists' quantity.

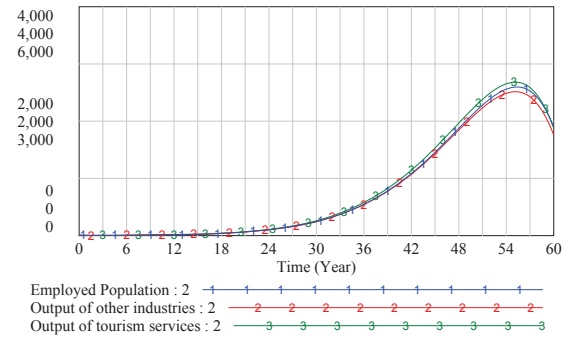
ception capacity delays for about 3 years more than potential tourists. The management department and the managers may take actions to stop the construction of tourist reception capacity in 52 years later, to avoid wasting resources, that is a way to lengthen the life cycle of ECS and keep regional economic sustainable development.

Driven by the development of tourist demand, tourism develops rapidly, promoting fast expansion of employed population. Employed population and other industries have the same trend with tourism services revealed in Figure 11 obviously inspiring local managers, meaning that tourism can be irreplaceable on aspects of taking in employed people and promoting the development of ECS. With the development of tourism and other industries, the use of tourism resources and land resources presents exponential growth displayed in Figure 12. Because resource is the decisive factor to limit economic development, hinders the growth rate of ECS in the early stage and speeds up the recessionary rate of regional GDP in the later stage. So how to reduce the use of resources and stimulate the environment protection plays a crucial role in extending economic cycle of the tourist destination' life cycle and achieving its sustainable development.

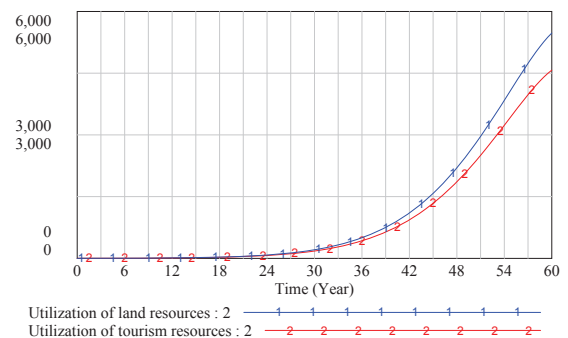
### 3.3. Sensitivity Analysis

From the analysis above, it can be found that resources could determine the length of ECS especially in the later of life cycle. Thus it is necessary to analyze the impact of resources utilization's changes on the length of the life cycle of ECS.

The development trends of regional GDP is shown in Figure 13 and Figure 14 supposing utilization ratios of resources are 8%, 6%, 4% and 2%. With the decrease of the utilization ratio from 8% to 2% by two percent each time, the range of the peak of Regional GDP increases larger and the downhill time lasts longer, that's to say with the decrease of utilization ratios of resources, the utilization of



**Figure 11** Changes of output of tourism services, output of other industries and employed population.



**Figure 12** Changes of utilization of tourism resources and land resources.

per unit of resources reduces, and the greater the amount of regional GDP increases, the longer the decline time delays, mainly because of the limited resources, the obstruct degree of per unit of resources to economy has a positive correlation to the amount of resources utilization, explaining that reducing resources utilization affects greatly in achieving sustainable development of ECS.

By comparatively analyzing the effects of the utilization ratio of tourism resources and land resources, it can be found that when other variables do not change, the sensitivity of changes in the utilization ratio of tourism resources to regional GDP is significantly higher than changes in the utilization ratio of land resources. As for the effect of changes in the utilization ratio of tourism resources on regional GDP, namely under the premise of the same initial utilization ratio, the increase of regional GDP caused by reducing the same utilization ratio of tourism resources is significantly higher than land resources. So in the development of tourism destinations, the reasonable control of tourism resources is the most important for the sustainable development of the tourism destination's economic circle.

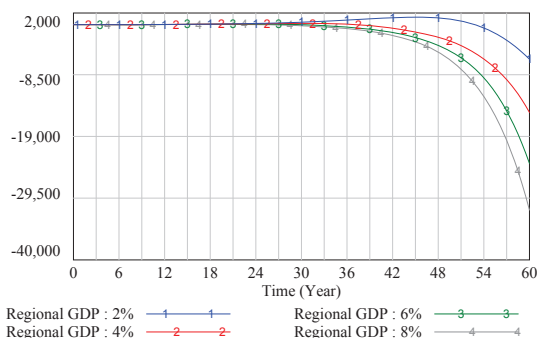


Figure 13 Changes of regional GDP with utilization ratios of tourism resources of 8%, 6%, 4% and 2%.

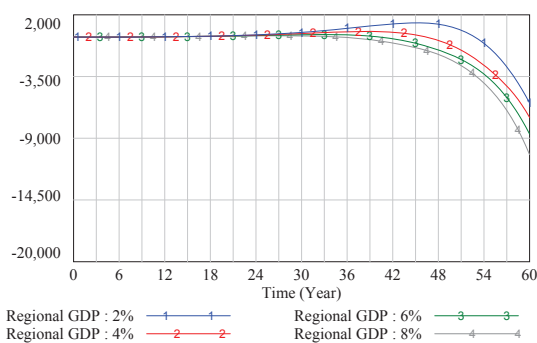


Figure 14 Changes of regional GDP with utilization ratios of land resources of 8%, 6%, 4% and 2%.

#### 4. Conclusions

This paper aims to use system dynamic model to reveal the development situation and characteristics of ECS in a tourist destination. Six subsystems proposed interacting with each other are integrated into a complex system of ECS. In order to realize its sustainable development, the system changes and behavioral tendency can be discussed in terms of scale and trend. By making use of system simulation, its sustainable development is found to be dependent on the radiation of tourism and the promotion of other related industries in the development of the early period. Along with the increase of the potential tourists, tourist reception capacity takes on the upward trend, further promoting the development of all the related industries, alleviating the pressure of employment. But according to current trend, economic development situation will change from a slow increase into a sharp decrease because limited resources are increasingly scarce in the development of the late period. In short, economic sustainable development of a tourist destination is a long-term project, so to grasp its inherent characteristics and interactive rules is full of strong theoretical and realistic significance for systemati-

cally managing or strategically planning of a tourist destination.

With time and length constraints, how to give the detail measures or plans to a certain scenic area by this system and its dynamic models is not well expressed and dynamic strategies formulation of specific tourist destinations with case studies will be studied in depth in future research.

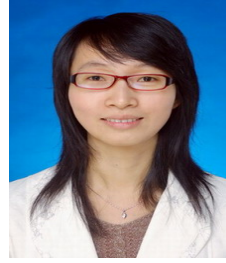
#### Acknowledgement

This work was supported by Major International Joint Research Program of the National Natural Science Foundation of China (71020107027), National High Technology Research and Development Major Program of China (Program 863) (2008AA04A107), Project 985 and 211 of Sichuan University, and Doctoral Fund of Ministry of Education of China (20110181110034).

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