UNIVERSITY OF BERGEN

The Impact of Tourist Behavior Intention on Panda Ecotourism Based on System Dynamics

A case study of panda eco-tourism project in China

Master thesis Submitted by

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Acknowledgements

May 25, 2019

The thesis that is in front of you is the achievement of a year of learning, developing, and researching life. I am grateful for having the privilege to live in good health, with so many kind people and excellent facilities around me. They provided me with all the needs and opportunities to accomplish my thesis. These assistants enabled me to present you this thesis after months of hard work.

I owe gratitude to those professors and teachers in System Dynamics in University of Bergen and for those who used their time and experience to teach me to become a systems' thinker. They accompanied with me to study from beginning It was an enlightening and informative experience for both my academic career and my life. In addition, I also owe thanks to those who supported me in applying for this Master program.

The most important is that I am so grateful for my professor, Dr. Birgit Kopainsky, who helped me a lot to improve my model and always encourage me to work hard and with whom I had many inspiring conversations over Email. Her comments were not only subtle enough to keep me enthusiastic about my paper, but also direct enough to steer me into the right direction.

Last but not least, I am especially grateful for all my friends and my family, who supported me in various ways, they gave me many supports and encouragement during this year.

To all, I hope you will enjoy reading this thesis.

Li Su

Abstract

In recent years, tourism is becoming more and more popular, government has put forward an ecological tourism on giant pandas in Sichuan Province, aiming at promoting local tourism and promoting economic development. At the same time, ecological tourism has certain educational significance, especially for giant pandas, a kind of endangered animal. Developing eco-tourism, more people can get a deeper understanding of the living status and current environment of giant pandas, thus appealing to more people to participate in the protection of giant pandas over a long period of time. However, there are some doubts about the project of vigorously developing panda ecotourism. The expansion of tourist reception sites will cut down forests and turn more forest land into roads, reception sites and scenic spots, which seriously affects the living space of wildlife and makes the habitat of giant pandas smaller and smaller. Moreover, for domestic short-distance travel, the public prefers to choose private cars or tourist buses. The emission of automobile exhaust will also pollute the local air, thus indirectly affecting the life span of giant pandas. The factors mentioned above are all related to the tourists behavioral intention on this project. Under this circumstance, this paper takes system dynamics as the main research method, adopts some data collection methods, establishes the basic data and makes a concrete research through the concept of behavioral intention. A series of solutions, replacing with new energy vehicles and planting more trees to return farmland to forest, are also put forward and evaluated the effect of the implementation of the scheme. After the implementation of the policy, it indicates that the number of giant pandas increases, the capacity of tourism reception increases and tourism income increases correspondingly. The urgent problem of sustainable development of ecological tourism of giant pandas has been solved. In the end of this article, some limitations and restrictions of implementation are also put forward together with some considerations of stakeholders.

Keywords: system dynamics; tourist behavioral intention; panda ecotourism; air pollution; panda habitat; local community.

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PART I : Problem

1. Research Setting

1.1 Problem Description and Problem Definition

With the development of the economy and people's living standards in the past 40 years from China's Reform and Opening-up, Chinese have more sufficient leisure time and abundant disposable income, which are the objective conditions of motivating tourists to go out.(Xin Zhou, 2009) Data from China Tourism Research Institution and National Tourism Statistic Center issued that the tourists at home and abroad were over 5.1 billion in the year of 2017 and the total income exceeded RMB 5.3 trillion, which occupied over 10% for the contribution to national economy and social employment. (Statistic Center, 2017) Therefore, tourism is not limited to a small fraction of the population anymore. Instead it shows a trend of popularization. However, tourism not only brings positive effects to the local population and the local economy, but also accelerates the pollution of the local environment and destroys natural resources. To foster strengths and circumvent weaknesses, in recent years, ecotourism has arisen as a potential alternative form of tourism that balances economic effects and ecosystem protection. Eco-tourism in this study refers to a tourism model based on the effective protection natural resources, natural ecosystems and indigenous cultures, and on the basis of regional socio-economic science and sustainable development, with natural eco-landscape such as biodiversity and indigenous culture as the main attraction. (Xuyu Yang & Rujia Li & Li Cheng & Shengjian Liu & Yuewu Xiong, 2006) Under the premise of environmental protection and ecological balance, letting the economy get the maximum benefit is the main purpose of eco-tourism.

From the previous data, wild giant panda (ailuropoda melanoleuca) and their surroundings are one of the most distinctive tourism products in Sichuan Province. In 2009, the number of inbound tourists in Chengdu Giant Panda Breeding Research Base, with giant pandas as its main attraction, increased to 250,000, accounting for 70% of the total number of visitors received annually, making it the only scenic spot in Sichuan where the number of inbound tourists exceeds the number of domestic tourists. (Rujia Li, 2010) The international impact of giant panda tourism is evident. In 2017, Sichuan Ecotourism Institution launched a Panda Ecotourism Project, which aims at an Eco-tour about the wild Giant Pandas. There are 4

routes for 3 different core themes for this project: the journey to the source of giant panda, the journey to popularize science of giant panda and the journey to find giant panda. These 4 routes are all starting from Chengdu, capital city of Sichuan Province, and going north, west or southwest, respectively. From the data published by the Eco-tourism society in Sichuan Province, there are around 2000 wild giant pandas left all around China. Wild giant pandas are used to live in mountainous areas. These areas are among the poorest areas in China. To launch this Panda, the original intention is to promote local economic development by the government. Therefore, the core point of this project is to promote the tourism development of the impoverished areas where giant pandas live, so as to promote the local economic development and alleviate poverty. However, when the project was announced, there were two voices. On one hand, citizens support this project because of the economic effect. For a long term, the only way to sustainable tourism development is by reducing the poverty rate in the tourist destination. (Wen Keat & Musa, 2014) That is also the main purpose for government to carry out the Panda Theme Eco-tourism Project. As panda is an endangered protected animal in the world, most people in this world have never seen panda before. To some extent, panda is regarded as a rare natural resource. If the panda theme project is implemented, it's predictably attractive to those people who never saw pandas. As the data from Lijun P and Jian Y (Lijun Peng & Jian Yang, 2008), 99.7% of target respondents never went to Wo Long and 100% of them are showing extremely great interest in giant pandas. So the potential of this market is great. In 2010, the service value of the giant panda ecosystem and its protected areas ranged from $2.6 billion to $6.9 billion; in the same year, the total investment cost of giant panda protection was about $255 million. Even with conservative algorithms, the rate of return for panda conservation is still more than 10 times. This indicates that the ecosystem service value of giant pandas and their habitats is much higher than their conservation investment. (Wei, F., 2018) From the perspective of sustainability, protecting the panda eco-system could bring more numerous economical effects. Therefore, locals could also get some returns from this project. On the other hand, the vigorous development of tourism industry will inevitably destroy the local ecological environment to a certain extent, so there are some opponents as well. Forty years of satellite data show that habitats suitable for giant pandas have declined dramatically. Ouyang Zhiyun and his colleagues then studied the reasons for the decline. They found that natural and man-made factors are the main causes

of habitat loss, including earthquakes, human occupation, agriculture, road construction and logging, which lead to the growing fragmentation of giant panda habitats into smaller and smaller areas, a process known as “fragmentation". (Weihua Xu, Andrés Viña, Lingqiao Kong, Stuart L. Pimm, Jingjing Zhang, Wu Yang, Yi Xiao, Lu Zhang, Xiaodong Chen, Jianguo Liu, Zhiyun Ouyang, 2017) In the face of tourism disturbance, animals are also responded by changing their behavioral activities to change the utilization intensity of habitats affected by tourism in order to cope with the impact of disturbance pressure on population fitness, such as direct and indirect reactions such as escaping during the peak period of daytime tourism, increasing vigilance behavior, foraging at the end of night tourism and so on. (Roe et al. 1997, Dyck et al. 2004) A study in Nature, Ecology and Evolution finds that the habitat of giant pandas has not only shrunk but also become more fragmented over the past 40 years. From 1976 to 2001, the overall habitat shrank by 4.9%, while the panda habitat per area has shrunk by an average of 24%. Although relevant protection efforts have led to a slight increase in such data between 2001 and 2013, they are still insufficient to compensate for the reduction. Pandas are facing serious threats from fragmented habitats, population isolation, infrastructure development, tourism and climate change. (Viola， 2017) Besides, as more tourists is coming to travel, more vehicles will come in, which results in more exhausted gas emission. Emission of those exhausted gas may cause the change of climate. That affects the wild animals as well. Despite the important role of understory plants in forest ecosystems, climate impact assessments on understory plants and their role in supporting wildlife habitat are scarce in the literature. (Gilliam, F. S.,2007) Aimed to protecting wild giant pandas and enhancing the local economy, this research would find ways to balance these two factors.

1.2 Research Objectives and Research Questions

In this thesis, the tourist region is focused on Wo Long National Nature Reserve, which mainly protects the natural ecosystem and rare animals such as giant pandas in alpine forest areas of Southwest China. The Nature Reserve was established in 1963 with an area of 200,000 hectares (2 billion square meters). (Tourism Development Committee of Aba Qiang Autonomous Prefecture, 2018) In 1983, it joined the International Human and Biosphere Project. The main protected objects in this area are the giant panda and other rare animals in the forest ecosystems. On September 10, 2002, the State Forestry Administration officially

approved the "Wolong National Nature Reserve Eco-tourism Planning" to enable the sustainable development and utilization of closed natural reserves. (Lijun Peng & Jian Yang, 2008) As mentioned before, after the panda eco-tour project is introduced, the key problem is to find a way to solve the problem in order to balance the economy and environment in this region by using system dynamic method. The impact of ecotourism includes the continuous transformation of natural environment and direct or indirect contact with wildlife. (Morris et al. 2002, Manor et al. 2003) The number of tourists in tourism activities, tourist behavior, tourism routes and so on not only pose a serious threat to the survival of wildlife, but also the reproduction of them. (Knight et al. 1995, Mallord et al. 2007, Christiansen et al. 2010, 2013) Additionally, they are conducive to the sustainable development of ecotourism industry and local communities.(Guillemain et al. 2007) If including all the factors, the boundary will be very huge. Therefore, in this article, it focus on the tourist behavior and starting from this, it goes further to find the effect on panda eco-tourism by using the system dynamics, analyzes the way of trade-offs between economic development through ecotourism and ecosystem maintenance and tests different policies that help minimize these trade-offs. For reaching the research objectives, the research question to be addressed is:

Which processes drive the panda theme eco-tourism act in practice?

For answering this research question, answers to these sub-questions are to be found:

a. *Which causal factors are related to panda theme ecotourism?*
b. *Which factors is consist of tourist behavioral intention and how much each factor can influence it?*
c. *Which element in local community is casually related with the satisfaction of tourists when launching ecotourism?*
d. *Which component of land construction will have a causal relationship with giant panda Ecotourism?*
e. *Which factor brought by coming tourists is related to the increasing deaths of Panda?*

1.3 Research Approach

This article uses both qualitative and quantitative analysis. It has the root in the system dynamic model as it promotes to gain insights into the eco-tourism industry. Using a system dynamic model in the tourism industry, an approach including consideration of different

stakeholders during the process of decision making, assists to understand the structure and behavior of the eco-tourism system. (K. Stave, 2010) Data is collected by the literature research method, questionnaire survey, interview, personal observe action and case study, to name a few. The process is started with the literature research. Literature review of related case is helpful to not only understand the history and present status of pandas, but also could get plenty of basic data. For example, the wild giant panda population was originally distributed in southern and Eastern China, as well as Myanmar and Northern Vietnam. However, due to natural disasters and increased human activities, the existing wild giant panda population only distributes in six separate areas in the rugged mountains on the eastern side of the Qinghai-Tibet Plateau. Using data sets on panda occurrence (including footprints and foraging trails), the researchers calculated the MARs of five wild panda populations in mountainous areas of China, which accounted for more than 74% of the total number of wild pandas. (Qing J, Yang ZS, He K, Zhang ZJ, Gu XD, Yang XY, Zhang W, Yang B, Qi DW, Dai Q. 2016.) Also, the literatures can assist to build the core model structure of the whole tourism system. From many previous literatures, the causal relationship between some variables can be concluded, particularly many related studies about ecotourism or wild animals are based on system dynamics. Information gathering from websites, reports and articles is required to be screened out as valid reference values. Moreover, interview with local people is taken in Wo Long National Nature Reserve identically, which helps to understand the real life of the local people and their aspirations, which is one of the most important goals for this article to achieve. From the interview, it makes readers to have a deeper and more authentic understanding of the local residents. (Appendix 1) Besides, in order to get more credible essential data for this paper, questionnaire survey is sent to over 700 respondents aged from 10 to 60 and lived all around China. The content of questionnaire is about the basic information of the respondents, including income level, respondents' demand for tourism, respondents' views on ecotourism, respondents' attitudes towards environmental protection and government improvement measures. (Appendix 2) No matter which method it uses, the goal to collect the data via website, literature, survey and case study is to get a broader understanding of the research issues which are investigated.

1.4 Research Outline

In this thesis, there are four parts that indicates the processing of the research. Part I is the problem clarification. It introduces the main background and purpose of this paper. It gives not only the detailed description and definition of the problem, but also the objectives and approach of the research.

Part II is the hypothesis part. It describes the process of data collecting and the development and calibration of the base model. Firstly, it concludes from literature to get the theoretic framework of the model. It follows with specific observations from interviews and questionnaires combined with the case of eco-tourism in Wo Long National Nature Reserve. Last but not least, chapter 4 goes deeply into the certain case to build a conceptional base model for the research based on the findings from context.

Part III is the analysis and policy section. It starts with the validation of the base model in chapter 5. The validation goes with the extreme condition, behavior reproduction and the sensitivity analysis and so on. According to the outcome, chapter 6 raises the policy that is aimed to solve the problems in different sections. Furthermore, it also presents the result after launching combined policies. Also, some validation test is conducted in the last section of Part III.

In part IV, it gives some reflects on the implementation process of this research. It acknowledges the limitations of the study and suggests next steps to be considered by stakeholders, as well as the conclusion and recommendation of the whole thesis.
The road map is summarized in Figure 1 as described above.

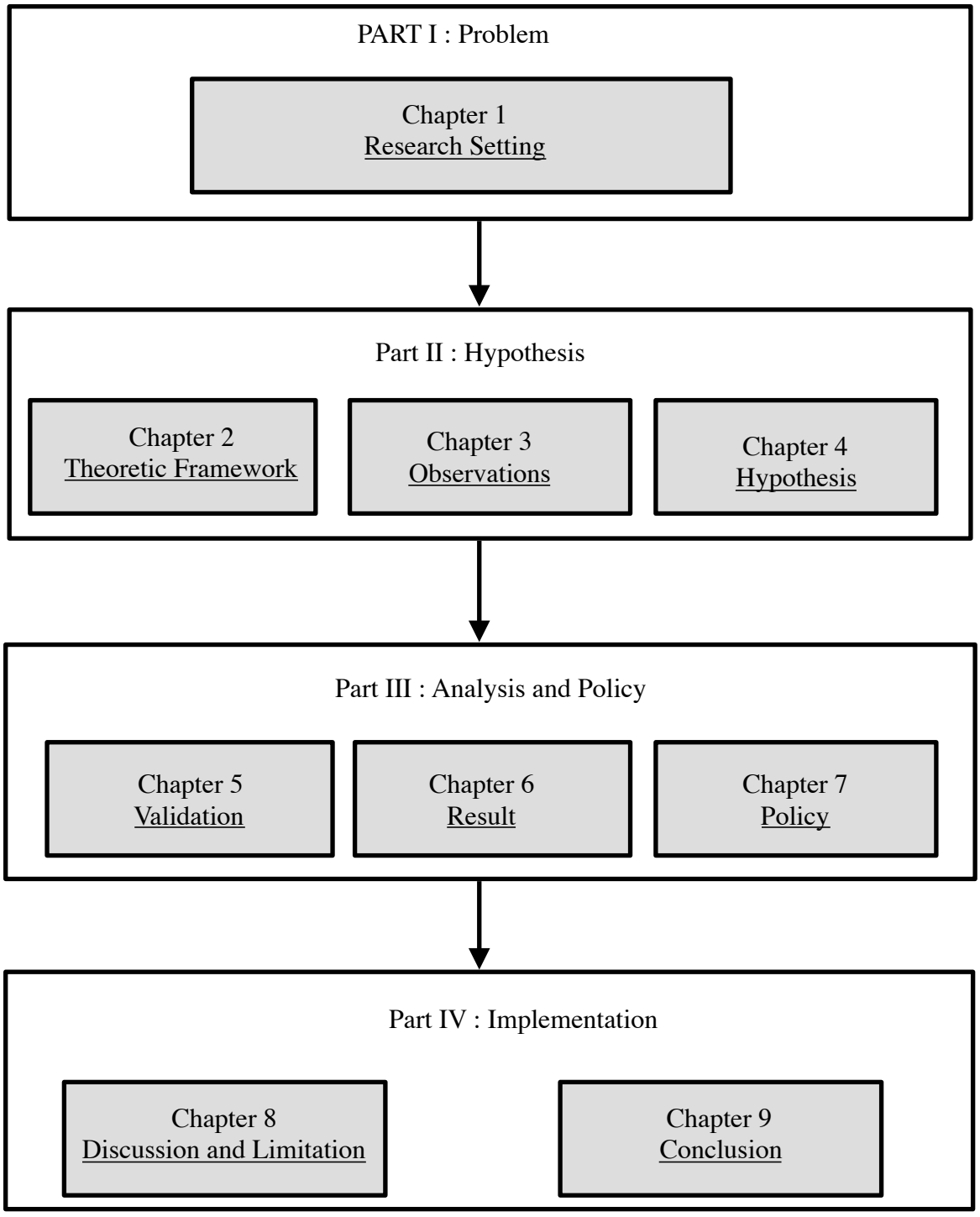


Figure 1. Research Outline

Part II : Hypothesis

2. Theoretic Framework

2.1 Theoretic CLD

IUCN definite the ecotourism as tourism activities with the dual responsibility of protecting the natural environment and maintaining local people's lives. From the definition, it refers that the ecotourism should be done without interfering with natural areas, protecting the ecological environment, reducing the negative impact of tourism and providing beneficial social and economic activities to the local population. (Yongde Yang & Jun Lu, 2004) Tourism is not simply defined as an “industry” but also as a “system” (Gunn, 1994; Leiper, 1990; Mill & Morrison, 1998). Generally, a system has a structure and the environments (Bertalanffy, 1971). The structure of the tourism system has been conceptualized from different perspectives.(Van Mai, Thanh and Bosch, O. J. H, 2010)

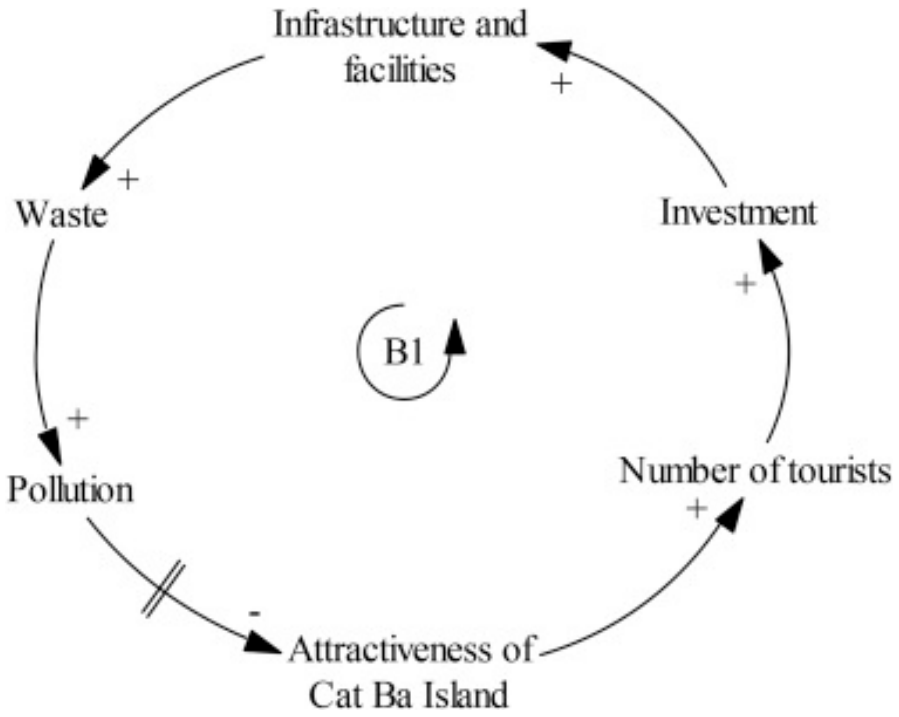


Figure 2. CLD of Tourism System in Cat Ba Island in Vietnam

In Mai and Smith (2015), a causal loop diagram (CLD) in figure 2 above was used to describe feedback loops which affects tourism system in Cat Ba Island in Vietnam. It is described as the conceptual framework of the tourism system this article studied. This CLD

indicates that as the number of tourists grows, it will enhance the tourist revenue. Moreover, investment in infrastructure and facilities stems from tourist revenue, so if income increases, investment will also increase. More funds put into constructions to hotel, restaurant, transportation and so on, which is able to carry more tourists. Understandably, if there are more travelers to visit, human activities will bring more waste material, such as packaging of goods or disposable tableware for food, melon skin, paper scraps, plastic boxes or bags of goods brought by tourists, and even paper tickets for scenic spots. What's more, waste is currently not treated fully, pollution will also increase from time to time. After a delay, the increase in pollution acts to decrease the attractiveness of the tourist site to tourists, slowing the growth in tourist numbers. Visitors have the behavioral intention, they have the willingness to choose different tourist spot. It is definitely that no one will prefer the site where has more pollution. From the paper, this CLD is cited for a certain tourist site, it describes the balancing loop in almost every tourism site. In this article, it also use the logic of this balancing loop to create a related system for a certain eco-tourism destination.

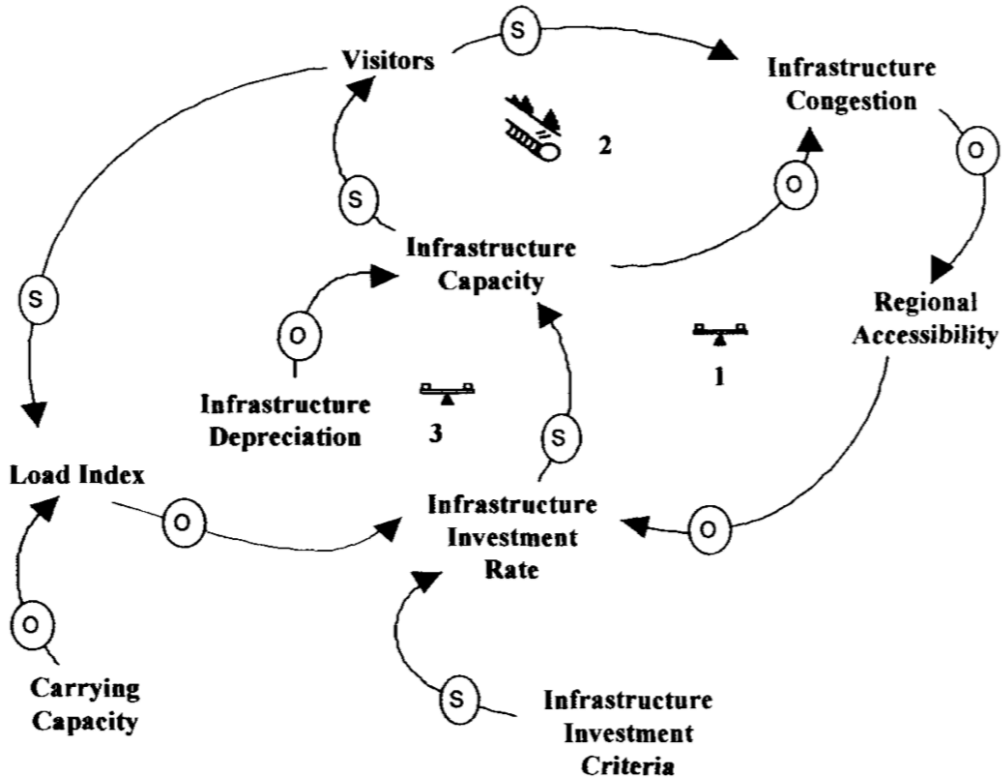


Figure 3. CLD of Infrastructure and Investment Loop

For detailed, the tourist capacity and the investment also have some relations. In figure 3, it is easy to see that when infrastructure enhances, there are more travelers coming which leads

to higher congestion on one hand. Infrastructure congestion goes up, so does infrastructure rate. On the other hand, more visitors results in higher road index, which reduces infrastructure investment rate. It is complicated for infrastructure and investment, but they complement each other and cannot be separated. More in-depth speaking, more investment must come from the rich tourism resources. Tourist destinations can attract more tourists, which is doomed to need more capacity for infrastructure. This can also be used for reference in this paper.

2.2 Theoretic SFD

In order to build a simulation model for research purposes, some of the reviewed literatures have been extracted from the similar research direction as this paper and the models that have been built before in the conceptual scope. These theoretic models should be adjusted and optimized so as to obtain specific SFD for this paper.

2.2.1 Tourism System

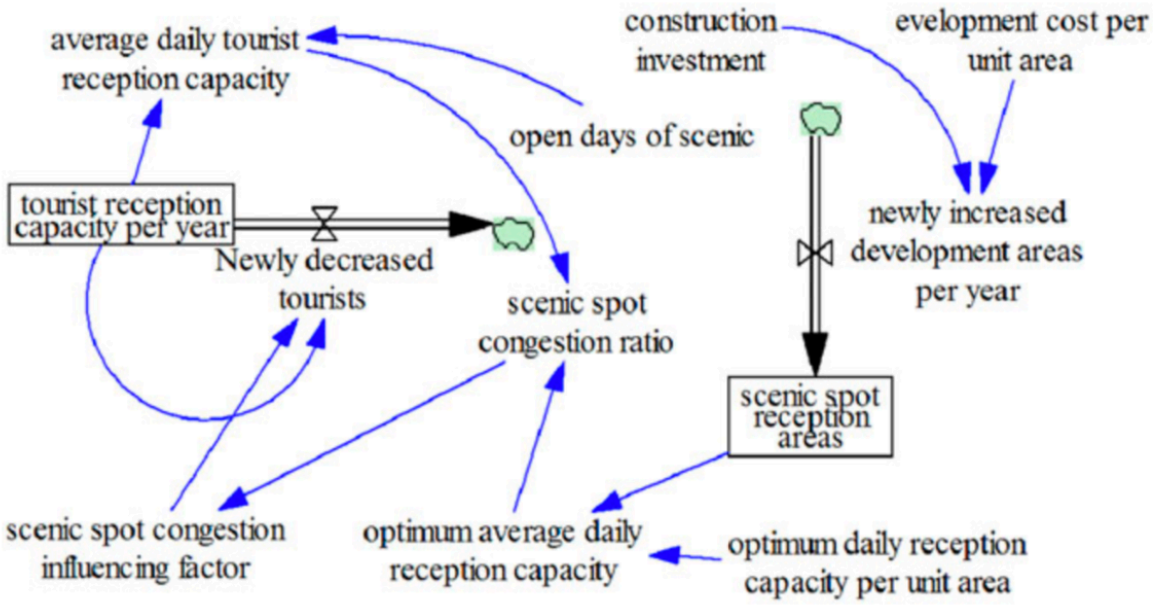


Figure 4. Flow diagram of scenic spot space-use subsystem.

A similar tourism sub-system is constructed in others' paper before. All the tourists are regarded as the tourist reception capacity as the following figure, which is declined by newly decreased tourists. This tourist reception could be regarded as the infrastructure capacity as mentioned in the previous part in figure 3. For the outflow of newly decreased tourists, it is determined by tourist reception capacity per year and scenic spot congestion influencing

factor, which is another element that has impact on newly decreased tourists. It is induced that if scenic spot is more crowding, it will increase rate of the loss of tourists, because people do not prefer to those more crowding places. Furthermore, the tourists reception capacity also affects the average daily tourist reception capacity. To get this number, it is useful for the administration department of the tourist site to control the tourist flow every day. That is the open days of scenic. In addition, the scenic spot congestion ratio, influenced by average daily tourist reception capacity and optimum average daily reception capacity from scenic spot reception areas, affects the scenic spot congestion influencing factor as well. It says that if tourist reception capacity is increasing, there are more average reception capacity per day, leading to higher congestion ratio in this tourist site. The higher congestion ratio, the impact on tourists decreasing is greater.

Additionally, the tourist reception capacity per year is also related to the scenic spot reception ares. As for the natural scenic spots, featuring in unique terrain, have mostly gone through a long geologic age, so its eco-environment is rather closed and vulnerable, so during the process of scenic spot development, the areas developed for tourist activities are usually controlled strictly. In the space-use subsystem, the parameters is connected to different flows. In the figure 4 below, there are state variable includes scenic spot reception areas, rate variable includes newly increased development areas per year and auxiliary variables include average daily tourist reception capacity, scenic spot congestion ratio, influencing factors of scenic spot congestion and construction investment. (Zhixue Liao, Peiyu Ren, Maozhu Jin & Zhenzhong Zhang, 2017) Particularly, the stock of scenic spot reception areas is increased by the flow of newly increased development areas per year, which is influenced by construction investment and development cost per unit. The connection between tourist reception capacity and scenic spot reception areas is the scenic spot congestion ratio. The factors that affects congestion ratio are average daily tourist reception capacity and optimal average daily reception capacity, which results from scenic spot reception areas and optimal daily reception capacity per unit area.

2.2.2 Local Community System

For the local community part, what should be more considered is the population from farming to tourist industry, that is the off-farm labor. Previous literatures have some suggestions for this part as well. In H. Xu and S. Dai’s article for Xidi, the local population in

their research comprises two groups, one is local village residents and the other is off-farming labors. Changes in the local population have resulted not only from natural birth and death rates, but also from off-farming activities (Figure 5). (H. XU & S. Dai, 2012) Accordingly, off-farm activities are influenced deeply by job impact on off-farm, available house impact on off-farm and wage impact.

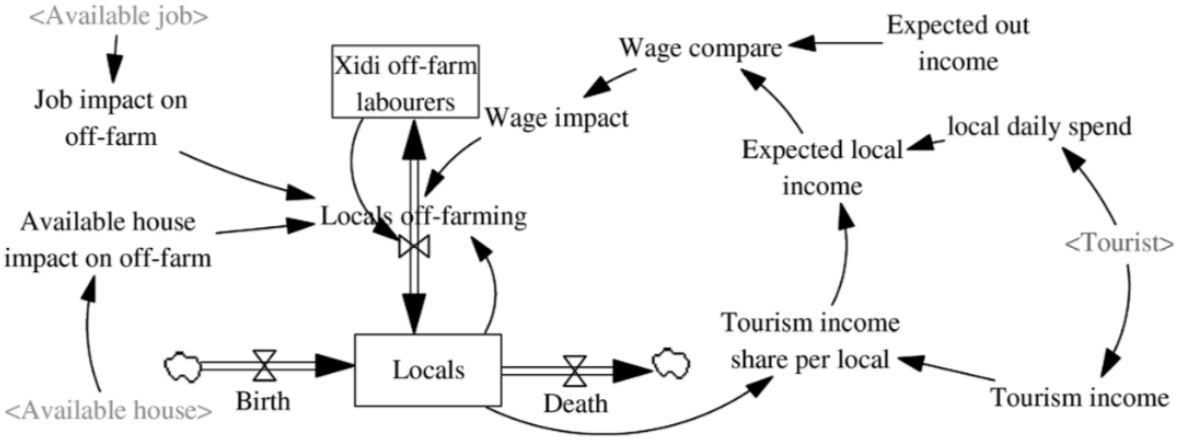


Figure 5. Structure of local resident sector.

Firstly, those local young people are predominantly motivated to leave due to the discrepancy between the expected income outside of county and the expected local income (Todaro, 1969). If local incomes and local job opportunities increase, the rising off-farm labor is going to return because of more availability of rural non-farm employment opportunities. It indicates that rural labors prefer to find local non-farm work than migrating unless they can earn much higher incomes by migrating (Zhao Y.H., 1999). Therefore, wage compare is very important in these factors that attracts local people to transfer to off-farm labors which could inflow into the tourism industry. Furthermore, the expected local income involves the local cost of living, the average wage of local people and the local tourism income allocated by government. The annual allocation has become quite significant in recent years and has attracted many off-farm labors to return (Zhang & Dong, 2006).

Secondly, local off-farming is also influenced by job impact on off-farm, which is determined by available jobs. It is supposed that if there are more available job for locals, people will have more job opportunities. Moreover, available house impact on off-farming, affected by available house, is the third element that results in differences numbers of local

off-farming. It is conceivable that some local people don't want to find job in other region, the main reason is no house outside their hometown. As all may know, house price in China, especially in some big city, like Beijing and Shanghai, even Chengdu, Capital city of Sichuan Province, is very expensive and rising continuously. Lots of people cannot afford the high house price in these cities, so they will prefer to stay in their hometown to work and live. Therefore, the variables that influence locals off-farming rate are impact of wage, job and available house as mentioned above.

2.2.3 Conclusion

According to the research object and purpose, some factors are screened out from the theoretical model. For tourism section, tourist reception capacity per year is influenced by the congestion rate of scenic spot, which comes from scenic spot reception area. However, within this part, more specific elements should be considered in this article, like the willingness of potential tourists who are coming to travel due to panda, the satisfaction affected by the congestion ratio, year to build and depreciate the tourism reception capacity. Additionally, the scenic spot reception area results from forest land, some of the developed forest land is used for local residents' living and farming and some for tourist attractions. As more and more tourists come to visit, more scenic spots need to be developed and more roads carrying more cars and buses need to be developed.

As for the local community section, the main factor that is discussed in this thesis is only the wage impact, but it is not only the factor for flows of locals off-farming, but also the determinant for people who are eager to immigrate to this area. The wage impact also comes from the wage compare, which is the relative parameter between average income outside and average local income.

From the purpose of this article, in addition to the tourism system and the local population, more factors need to be added to the whole system. Because this paper takes the wild panda as the carrier, the factors related to the wild panda, such as environmental pollution, giant panda habitat and so on, will affect the survival of the wild panda, thus further affecting the ecological tourism system.

3. Observations

3.1 Observations from Interview

In order to get to understand more about the local community, a face-to-face interview was conducted. There were 5 interviewees living in Gengda, where is the panda garden located. Four of them are born there, some of them have retired, some are giving up farming and works as tourist guide and some are still busy in farming. Besides, one of them is an immigrant, who runs a family house there. These interviewees are also stakeholders in panda eco-tourism project, so the interview helps to know more about the local living standards, the attitude to panda eco-tourism, the awareness of protecting wild giant pandas, to name a few. From interview, interviewees say that there were lots of wild giant pandas when they were young, they often saw pandas those years and sometimes this wild animal would climb down to their house to find food. However, they also mention that the number of panda is declining these years, because people focus mainly on economic development and destroy the environment in the last forty years due to more coming tourists. Damaging to the environment and mass road construction lead to the big loss of habitat of wild giant panda and the decreasing life expectancy of panda's live as the exhausted gas emission of vehicles and bus and more tourist reception area for rapidly rising tourists. This can be verified in the article of Ouyang Zhiyun and his team. They constructed a model based on remote sensing data of elevation, slope and forest coverage to comprehensively assess the habitat area of giant pandas from 1976 to 2013, and to assess the habitat area and quality. From 1976 to 2001, the total habitat area of giant pandas decreased by 4.9%. However, in recent years, government pays more attention on environmental protection, so it has issued many regulations to protect the habitat of giant pandas and control the numbers of vehicles. From 2001 to 2013, even with the damage caused by the Wenchuan earthquake, the total habitat area increased by 0.4%. Although the area of habitat has increased, it has not made up for the loss in the past. (Weihua Xu, Andrés Viña, Lingqiao Kong, Stuart L. Pimm, Jingjing Zhang, Wu Yang, Yi Xiao, Lu Zhang, Xiaodong Chen, Jianguo Liu, Zhiyun Ouyang, 2017) Moreover, with the economic growth and the improvement of the national education level, the national quality of people has also improved. The awareness of environmental friendly is improved. Furthermore, as it says before, these areas are the poorest areas in China before. One of the main object of

implementing this panda-theme ecotourism is to improve the local's living standard and reduce poverty without the cost of environmental disruption. Therefore, the purpose of interview is to know deeply about the current state of local people and their emotional appeal of improvement. (Appendix 1)

3.2 Observations from Questionnaire

For the survey, research on eco-tourism project about giant panda based on system dynamics, there are 792 respondents from almost every province in China, aged from younger than 18 to older than 60. All the answers are attached in the end of this paper. Generally, the line graph below (Figure 6) implies different households earning differently pay different percentage of total incomes aiming to traveling. For example, 40% of those earning between 50,000 and 100,000 every year are willing to spend 15% of their total income when they are traveling. Besides, the age for families earning from 50,000 to 200,000 is almost 26 to 40 years old. These people have a steady income and enough vacation, so they are more willing to spend more money to pay for tourism. Moreover, people aged 26 to 40 are the main consumption force in the next 20 to 30 years and they are also the most important potential tourism resources to be exploited.

In these respondents, 76.5% of them have experienced eco-tourism before, however, almost half of them have never been to Wo Long. Besides, there are 90% more respondents support the project of panda eco-tourism and 40% more tourists would like to choose domestic tourism. Most of people never have the eco-tourism is because they are not familiar with this project, however, if they have a chance, over 70% of them prefer to eco-tourism. Additionally, as for the giant panda, this project is very welcomed among the public, who consider that this unique and creative panda-theme eco-tourism has a signification of education and it will improve the local living standard as well, while people are also worried about the influence that brings to wild livings, because the poor quality of tourists and the irregular management of scenic spots will bring some hidden dangers to the natural protection objects in the process of panda eco-tourism development, which is also one of the main problems to be solved urgently in this paper. In terms of environmental friendly consciousness, most of the respondents are aware of protecting the environment is their own duties, which can be implied that the measure taken by government to protect the

environment may achieve a certain effect to some degree. From these fundamental questions, it is obviously learned that the potential market of this eco-tourism project is large.

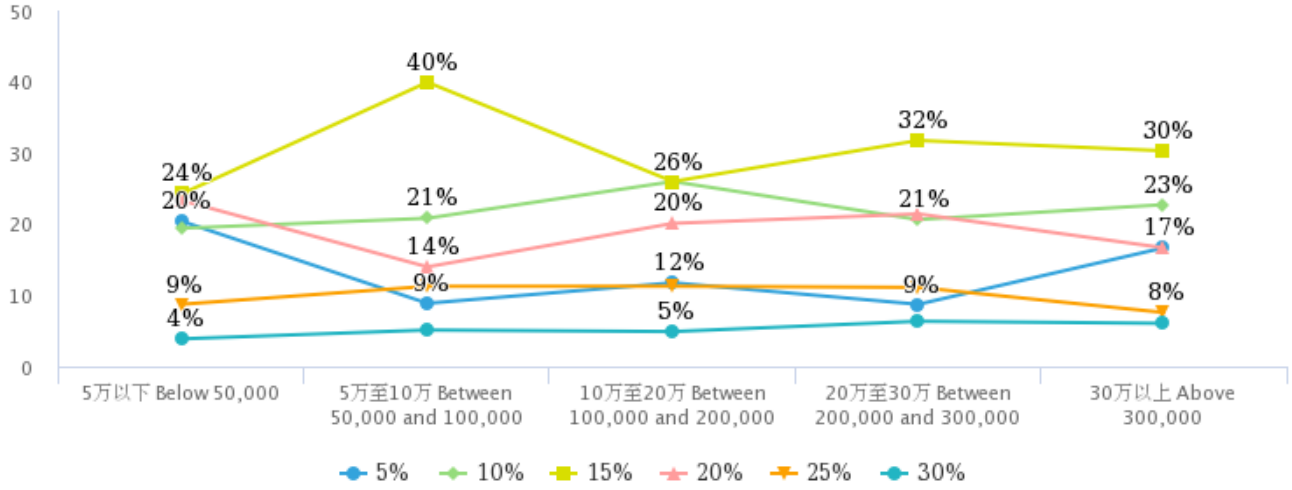


Figure 6. Yearly Family Income and the Proportion of Being Willing to Pay for Tourism

The questions focus on eco-tourism project to Wo Long nature reserve show that tourist preference, consumption habit, tourists' attitude towards environmental protection and public participant in protective actions. It helps us to understand what possible breakthroughs can be made in the future improvement measures of the panda eco-tourism project in Wolong, especially for the policy proposals in this paper, which provides some theoretical basis.

4. Hypothesis

4.1 CLD Hypothesis

As the objective of this article is to balance the environment friendly and the development of economy via the giant panda eco-tourism, how the tourism affects the wildlife should also be taken into account in different forms as well, including short-term and long-term effects. Short-term effects include: behavioral abnormalities, physiological stress, loss of suitable habitat (Griffiths et al. 1993, French et al. 2010, Marchand et al. 2014); long-term effects are manifested after a long period of time after the persistent impact of tourism, such as reproductive obstruction, low growth rate, decreased immunity, interruption of genetic communication and so on (Green et al. 2001, Lusseau et al. 2007, Moss et al. Et al. 2014). Therefore, in the case of wild giant panda eco-tourism in China, the aspects that would be mainly considered are summarized as tourism capacity industry, giant panda ecosystem, local people community and pollution. Figure 6 below describes the main feedback loops represented in the model.

On one hand, the tourism reception capacity increases more coming tourists. As Wo Long is located over 100 kilometers from Chengdu, capital city of Sichuan Province, and the road there is along the mountains, travelers can only reach there by vehicles or tour bus. So the desired cars or bus for them increase with the rising coming tourists. Then desired vehicles and bus lead to carry more cars driven by more tourists. More cars means that there are more exhausted gas emission in the air, which produces more air pollution reducing the life expectancy of giant pandas. Thus the panda will live shorter, the death rate of wild animal goes up, the number of panda are declined then. (R1)

On the other hand, more tourist capacity brings more yearly revenue from tourist site so that there are more investment going to the tourist site which expands the reception area of the tourist spot. If the reception area of the tourist site is increase, the living area for the giant panda is decrease without any doubt. This is the short term effect of the relationship between the tourism and the wildlife. The loss of suitable habitat, together with the air pollution effect, could result in the decreasing number of wild giant pandas. As for the relationship between the panda number and attractiveness due to pandas, it is definitely a nonlinear relationship

between the two factors. If there is no panda, there is no attractiveness. If the number of panda tends to infinity, the attractiveness is also not too high. (R2)

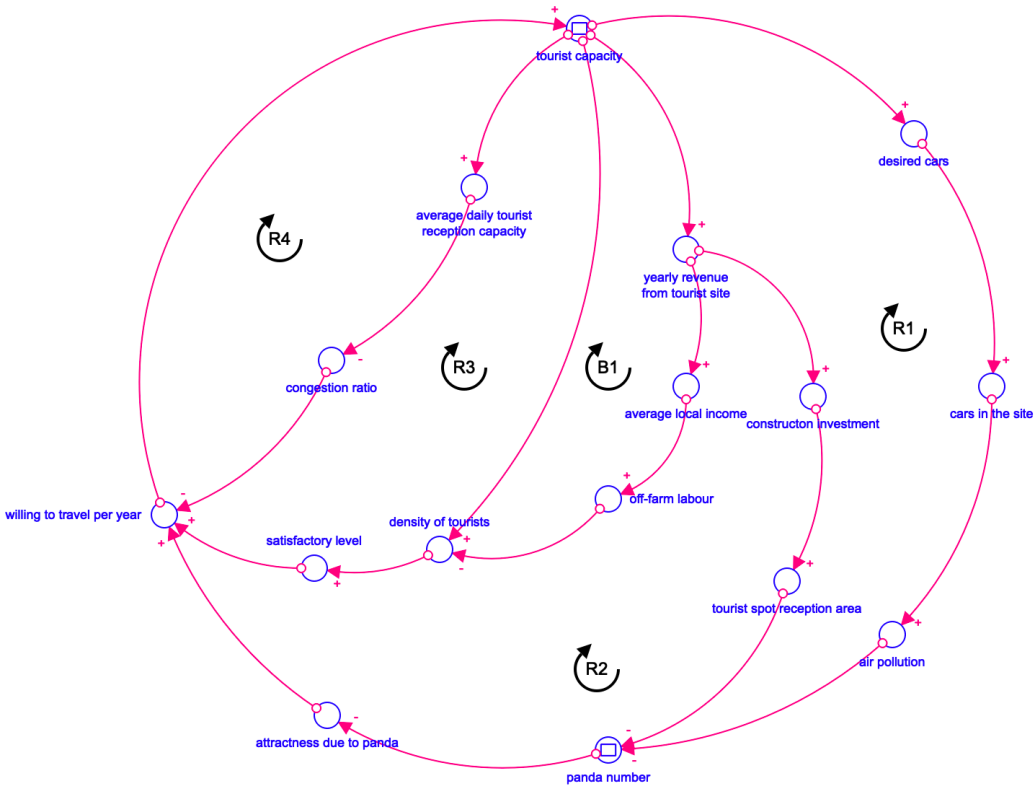


Figure 7. Draft Causal Loop Diagram of the Main Mechanisms Represented in the Model

Besides, the rising yearly revenue from tourist site can also result in the increasing average local income, which attracts more labour to give up farming. More locals change to work in the tourist industry, the density of tourists, proportion of tourism capacity and off-farm labour, is becoming smaller. The lower density of tourists implies that more off-farm labour are going to tourist industry. Generally, the more workers in the tourism service, the higher satisfactory level of the tourists could get. So does the willingness for tourists to travel per year. (B1& R3) Moreover, the increasing tourist capacity could endure more average daily tourist reception capacity and then the congestion ratio would be abated. As the congestion ratio is increasing too much, there are less people willing to travel. So does the congestion ratio goes down too much, people may think there is nothing interesting that attracts them to travel. Therefore, it is

also another nonlinear relationship between these two elements. If the willingness to travel is getting higher, more people are willing to travel so that the more tourist capacity are needed. (R4)

For the whole Eco-Tourism system in this case, there are 4 reinforcing feedback loops and 1 balancing feedback loop as followed. The reinforcing loops propagate through the loop and return to the variable reinforcing the initial deviation. This kind of loops are associated with the exponential increases or decreases in the tourist capacity via lots of elements, namely giant panda ecosystem, tourist reception area and tourist reception capacity. While the loop is balancing if the result contradicts the initial assumption, The relationship between tourism capacity, yearly revenue from tourist site, off-farm labour, density of tourists, satisfactory level and willingness to travel shows the negative growth. Under the influence of these different loops, the tourist reception shows an exponential growth at the beginning of first 5 years and then reaches an equilibrium. Nevertheless, the number of panda falls due to the increasing air pollution from the vehicles of more coming tourists.

4.2 Model Hypothesis

According to the previous analysis, through the summary and reference of the theoretical model, it has a rough understanding of the actual model. Combining with the previous theoretical models, the model in this paper has some assumptions, which then is required to be tested whether the model can cover all problems that are going to solve in this paper in order to achieve the purpose of this paper.

If we want to study eco-tourism, then eco-tourism system is necessary. The elements that influence ecotourism system is a lot. What emphasized in this paper is the impact of traveller's behavior intention on panda ecotourism, which is divided into the impact of local community elements and giant panda ecosystem. Thus, the whole relative system comprises people's intention to travel, potential tourist volume, factors affecting tourists’ choice of tourism destination, the proportion of pandas in tourists' choice and so on.

4.2.1 Tourist Behavioral Intention

Firstly, in order to establish a tourism system related to tourists’ behavioral intentions, we first need to know what factors affect tourists' behavioral intentions. There are many studies on this point. It is a difficult part to illustrate.

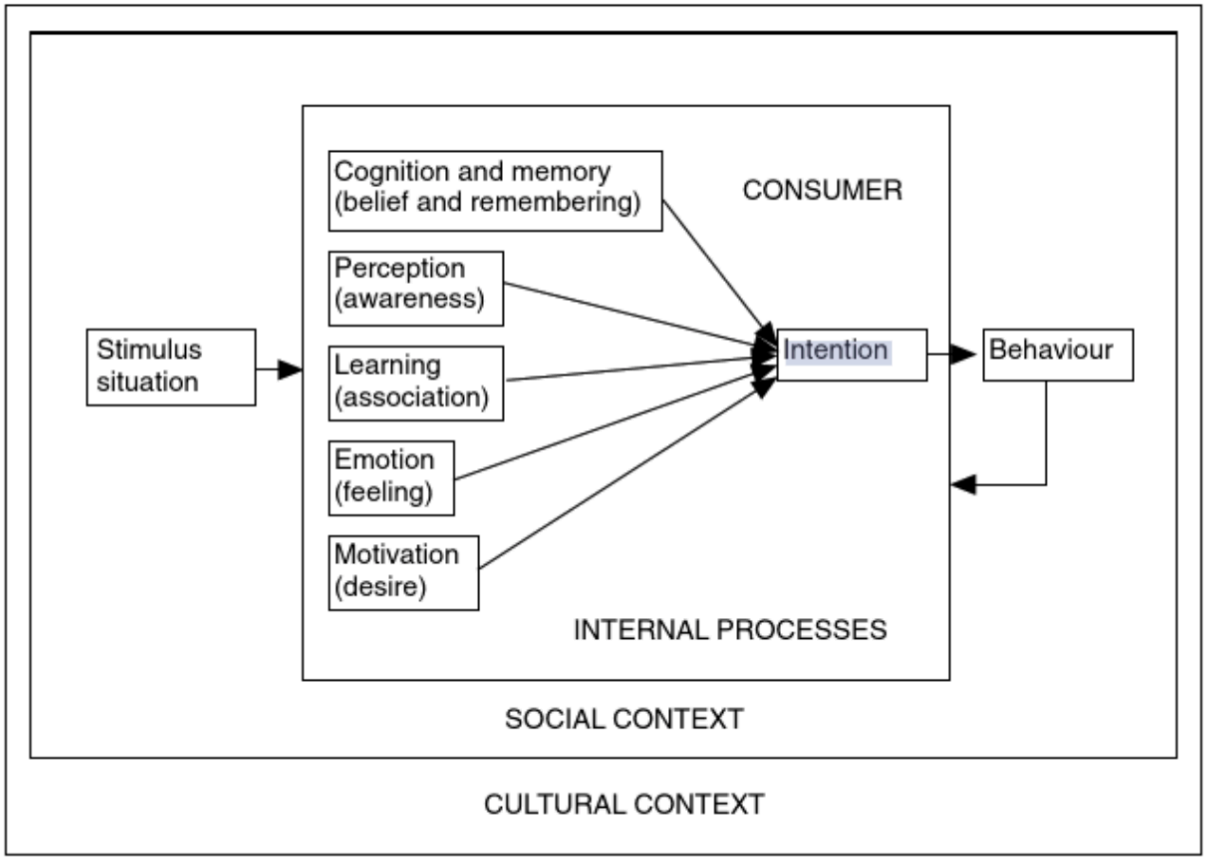


Figure 8. Consumer Psychology (Mullen & Johnson, 1990)

From Mullen and Johnson, they defined the psychology of consumers as the scientific study of behavior. Besides, behavior intention is consist of the service quality, previous experience, word of mouth, marketing promotion and so on. (Oliver, 1980) Additionally, there is a significant positive correlation between the overall service quality and the perceived value, satisfaction and behavioral intention of tourists. (Yu Tian, 2010) In this paper, what is to be considered is only perceived value, tourist motivation and satisfaction (Yanqing Zhang, 2008) in Figure 9. Although the perceived value from tourists is including the perception of monetary value, time value and physical value, (Ming Gao, 2011) what is considered in this research is only the monetary value from tourists. It stands for how much they would like to pay from their own perspectives. According to the concept of Zeithaml, tourism perceived value is defined and measured, that is, "perceived value is the overall evaluation of product utility by customers on the basis of weighing costs and gains". (Zeithaml, V A. ,1988) In addition, some scholars believe that testing the perceived value of urban tourism

needs to be evaluated from the objective functional attributes of social environment, tourism facilities, tourism public services, tourism attractiveness and tourism destination services. (Kai Bai & Shengwei Guo, 2010) Moreover, the common four dimensions of perceived value were identified, namely functional value, emotional value, social value and value for money. (Yi Fu, Xiaoming Liu, Yongqiang Wang & Ren-Fang Chao, 2018.) In this paper, we mainly do a simple analysis from the value of money.

Furthermore, motivation, as an important determinant of tourist behavior, has been widely investigated by academics since the 1940s. (Tahir Albayrak & Meltem Caber, 2018) Motivations of tourists has relationships with other constructs, for example destination image (Li, Cai, Lehto, & Huang, 2010), destination loyalty (Huang & Hsu, 2009), destination brand personality (Murphy, Benckendorff, & Moscardo, 2007), destination choice (Awaritefe, 2004), to name a few. In this paper, tourists motivation is an attractiveness for travelers due to pandas. As the theme of eco-tourism project is focused on the giant panda, the unique for this destination that visitors would like to choose is panda. This motivation also occupies the largest part in these three factors that affects tourists behavioral intentions, from literature shown in figure 9. (Yanqing Zhang, 2008) Under the assumption of maintaining the natural birth rate, the reason that affects the survival of wild giant pandas is attributed to mortality. Within the boundary of this study, the reduction of habitat and the increase of air pollution reduce the survival time of giant pandas.

Ultimately, tourists' satisfaction is also another big role in this research. The factors that influence satisfaction of tourists is complicated, accommodation preparation, facilities, environmental atmosphere, transportation and catering, service quality, core experience, post-residential evaluation are the main factors affecting tourist satisfaction. (Bian Yuting, 2018) The psychological expectation of tourists is one of the most important factors related to the quality of service. Bo Jiang and Honghua Zheng put forward in the service quality evaluation model that the construction of the model needs to consider community and personnel services, that is, the relationship

between people. (Bo Jiang and Honghua, 2007) So the satisfactory of tourists is related with the local community part in this paper. Firstly, the crowded scenic spots will inevitably lead to the gathering of tourists, the limited use of space resources and tourism resources, which will easily reduce the satisfaction of tourists and the willingness of word-of-mouth propaganda. Reduce the perception of crowding in scenic spots, guide tourists to actively adjust their psychological expectations and behavior, and then construct on-site expectations. (Jin Chen, 2014) From Rathnayake Mudiyanselage and Wasantha Rathnayake, they examined the relationship between crowding and visitor satisfaction. They found that visitor satisfaction decreased with crowding. (Rathnayake Mudiyanselage & Wasantha Rathnayake, 2015) However, from others' research, crowding is more complex concept to analyze. For example, Wang Xiaoyan and Sun Xirui mentioned in their articles that people's subjective reactions to crowding. (Xiaoyan Wang & Xirui Sun, 2014) Chang concludes that the main factors influencing tourism congestion are personal characteristics (expectation, preference, experience and demographic characteristics), other tourist characteristics and environmental factors (geographical location, degree of development, quantity and quality of public facilities). (Chang C Y, 1993) Thus, combined with the object of this study, the factors affecting tourists' satisfaction only consider the crowding degree and service quality of scenic spots, and the service quality only takes the proportion of the most direct tourists and staff as the basis.

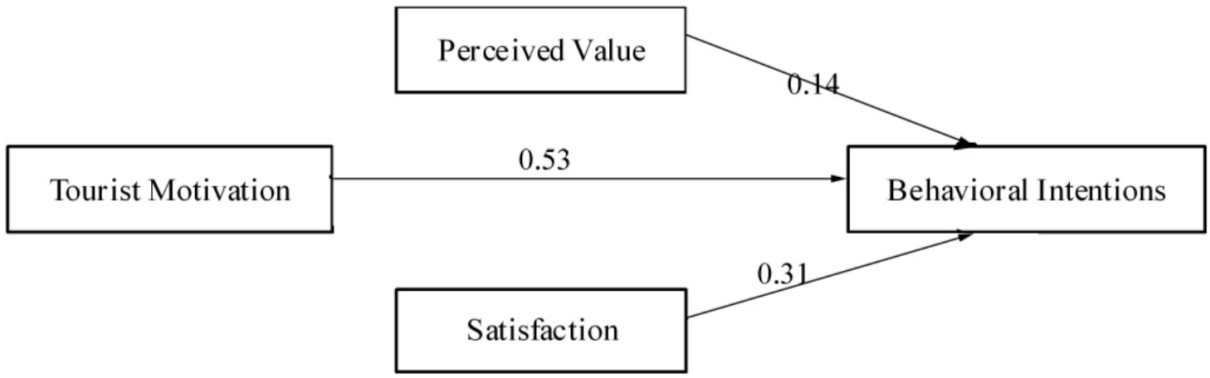


Figure 9. An Empirical Model of Comprehensive Function

4.2.2 Tourist System

Then the eco-tourism system can be built after understanding the behavioral intentions of tourists above. Tourist part is the main section in this case, which needs to be planed and designed in a more ecological and economical way. Tourism for Wo Long National Nature Reserve is generally calculated by the tourism reception capacity, corresponding to the monetary value that judges the tourism standard. Therefore, the tourism reception capacity every year should be a stock, which is consist of the inflow, capacity construction, and the outflow, the capacity depreciation. (Figure 10)

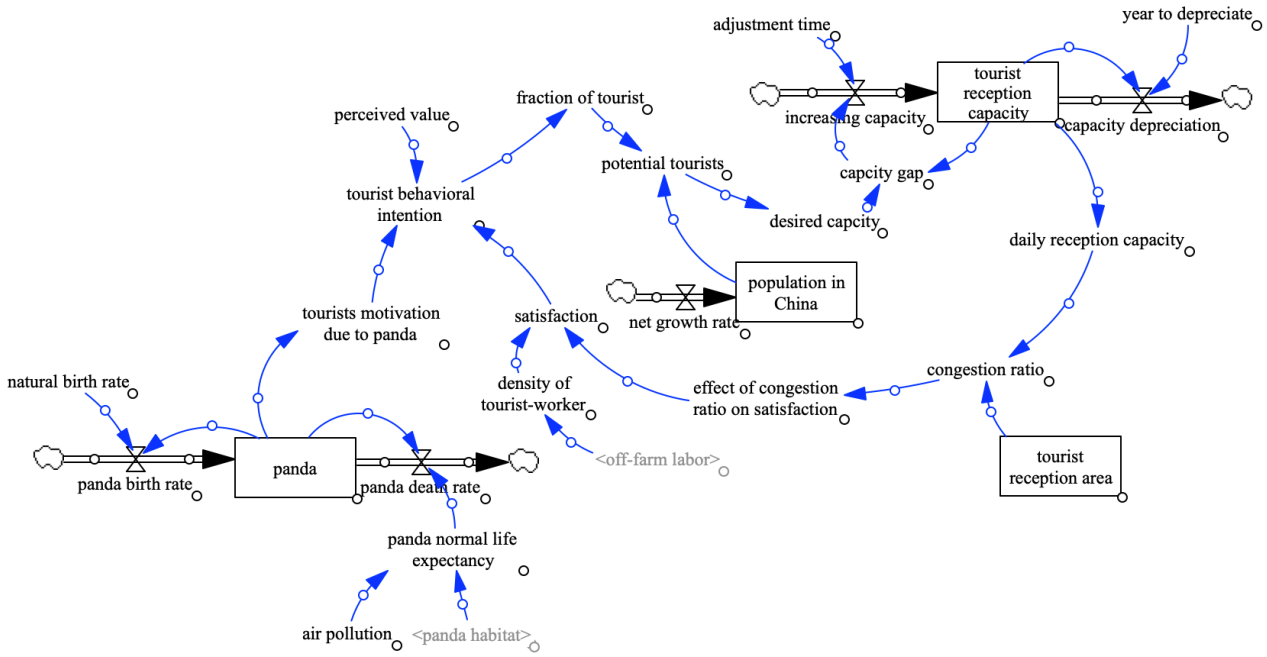


Figure 10. SDF for Tourism System

In order to get the amount of tourism capacity construction, it is obvious to have the desired capacity. If the gap between the desired capacity and the actual capacity at present is amplified, more constructions for capacity should be required. Desired capacity results from the potential number of tourists and the capacity that every tourist needs. For the population in China, which is roughly calculated by the population base multiplied by the net birth rate, it determines the potential number of tourists traveling to the site. With a certain fraction of potential tourists, the desired tourism capacity could be easily inferred, so it also helps to figure out the total construction of tourism capacity each year. As for the capacity required per tourist, a certain monetary investment required to receive for one person, it is the exogenous effect that will have an impact on both the desired tourism capacity and the experience quality of visitors. Specifically, for tourists reception capacity, it is easy to calculate the actual

reception capacity per day. Compared with desired reception per day, which comes from tourists reception and optimal daily reception area person, daily reception capacity could come to the relative congestion ratio. This ratio is influential for the tourists' satisfaction. Additionally, experience quality results from the density of tourists and workers. While the behavioral intentions for travelers is growing, the fraction of tourists that elicits potential tourists is rising as well.

4.2.3 Local Community

The local population is another part required to be investigated. This part has an impact on the customers' satisfactory level discussed in the context. One part of satisfaction is the density of tourist-worker, which is depended on off-farm labor in local community. As off-farm labour could be served for the tourism market, if there are more off-farm labour, the tourists-worker density is lower. Therefore, it is essential to work out the local population, which compromises the inflow of the births, the outflow of local deaths and also a biflow of the net immigration. The local population will be increased by more births and more migration from other region. Assuming that the birth rate for the local people is settled, the main variation is the immigration, which is depended on the population base in China and the attractiveness for people to immigrate. It can be inferred that if the wage impact gets larger, this area is more appealing for people to move in. On the contrary, if the wage impact is diminished, there are more people willing to move out of this region. Besides, the local deaths and emigrants determine the outflow of the local population, while the death rate is affected by air pollution. The more air pollution, the higher likelihood of diseases and shorter years people will live. Additionally, because the net immigration is related to the wage impact and wage compare. It is important to count the local population to get the off-farm labour through local population. It is imaged that if the salary level of the worker in the tourist part is higher than the farmers who are only self-sufficient, more farmers will give up farming and choose to work in the other field. From the interview to the local people, the minimal wage level of Wo Long county published by government is only around RMB 18000 per year, whilst the average salary level of Sichuan Province is higher than RMB 54000 every year. (Sichuan Provincial Bureau of Statistics, 2018)

Therefore, if the average local income becomes higher, it is more attractive to those who would like to change from farmers to workers. If the local people are getting richer, it could

solve the initial reason, reducing poverty and improving quality of life, of promoting Giant Panda Theme Eco-Tourism. Previously speaking, the element that makes more local population to change their farm-jobs to work into the tourism industry is the average local income. The average local income is relevant to the yearly revenue from tourist site. If the more travelers are coming, the more revenue will be received. Similarly, time to adjust income perception, initial average local income and off-farm labour are also influential. Last but not least, the net immigration is also influenced by the migrant capacity, which comes from the area of farming and living land. As each individual has space to live, the farming and living land should have the limitation, which can imply the maximum number of people for migrants. Therefore, there will be some restrictions on the migrant population to ensure that the local population is within its carrying capacity.

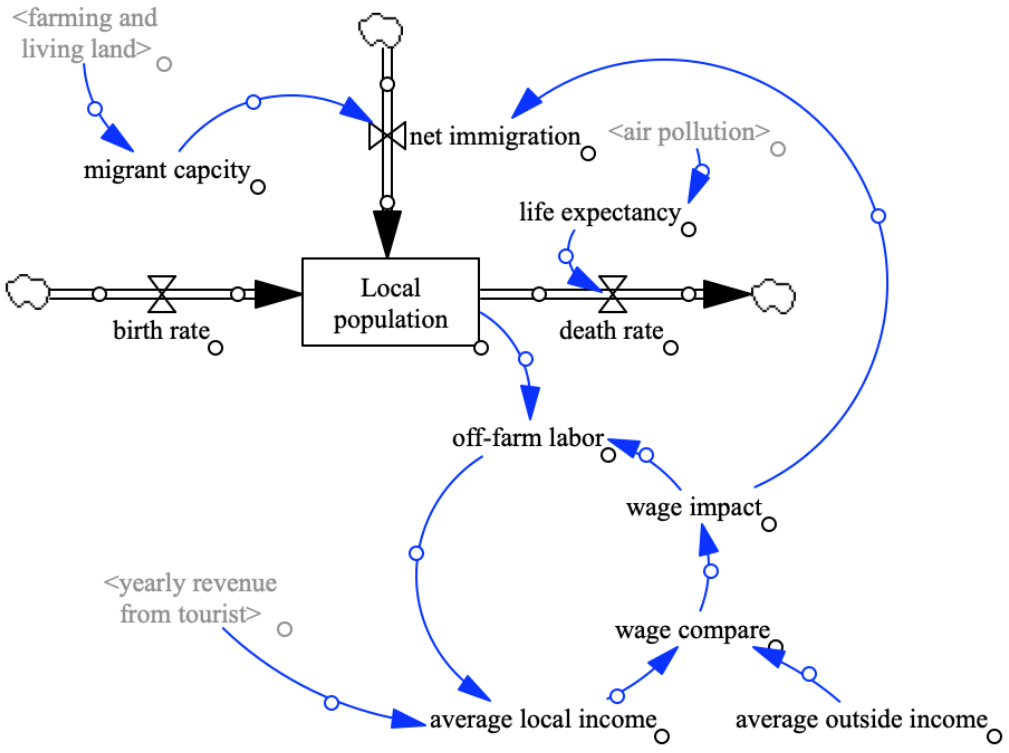


Figure 11. SDF for Local Community

4.2.4 Panda Biological Chain

Furthermore, due to the object is the panda theme eco-tourism project, another circle that affects tourism part is the panda biological chain, while two factors have a huge impact on the longevity of giant pandas, so the panda biological chain analyses around these two points. For

the stock and flow diagram, in order to build the stock of giant panda, we only take the natural birth rate into consideration for the inflow instead of the artificial breeding of giant pandas and the outflow of the panda stock is the death of panda. The factor affecting mortality is taken into account. It is the normal life expectancy of giant panda. However, the normal life expectancy is decreasing if the air pollution become more serious and the continuously decreasing habitat for this wild livings.

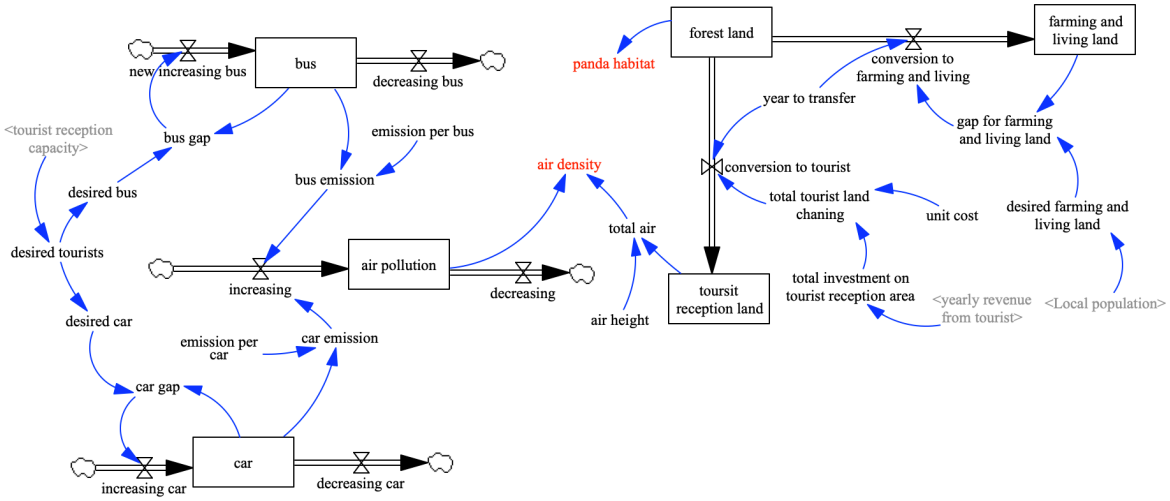


Figure 12. SDF for Panda Biological Chain

From some latest news, one of the biggest problem that influencing pandas' life expectancy in recent years is no place to exercise. Increased human activity will force people to seek more places to move, so cutting down trees, building new roads, building houses and so on will occupy forest land. At the same time, giant pandas are very timid animals, they are particularly demanding for their living environment. Besides, the quality of air will also reduce of the panda's life expectancy. Studies show that automobile exhaust contains hundreds of different compounds, the main pollutants are solid suspended particulates, carbon monoxide, carbon dioxide, hydrocarbons, carbon oxides, lead and sulfur oxides and so on. The composition of solid suspended particles is very complex, and has a strong adsorption capacity, can adsorb a variety of metal dust, strong carcinogen benzopyrene and pathogenic microorganisms. Solid suspended particles enter human lungs with respiration, and stay in different parts of respiratory tract by means of collision, diffusion and deposition, causing respiratory diseases, so air pollution could damage the natural environment of wild animals. Generally, growing tourists and development of tourist industry leads to more vehicles

coming, which arise air pollution in the habitat of panda. Therefore, when building stock and flow digram in this part, the life expectancy of giant panda is related to the air pollution density and the space of panda's habitat in the model.

Specifically, if enhancing the panda eco-tourism, more tourists would come into this destination. More coming tourists require more cars or bus to carry these tourists. However, the cars or bus could bring more exhausted gas which cause air pollution. The density of air pollution would be higher, then the life expectancy of wild giant panda would reduce. Moreover, in order to carry a larger capacity, the government needs to build more roads, which is changed by the forest land, and more people need more house to live in, more food to supply, which also require more land to build house and more land for farming. Forest land would change to land for tourists, farming and living. With the decline of the forest density, there are more roads and places for people and less land for the wild giant panda. The loss of living habitat is also another killer for wild animals. Panda living habitat and density of air pollution are connected with the eco-tourist part. As if there is no pandas leaving, there is no attractiveness of the tourists, which is one of the effects for tourists who are willing to travel to this area.

4.3 Model Calibration

Some quantitative findings from literatures, interviews and questionnaires that is related to the model hypothesis are given in Table 1. Most of these findings are related to tourism industry that is researched in this article, namely behavioral intentions, panda ecological system, land transforming and exhausted gas emission from private vehicles and tour bus. Together with some estimations of lacking quantitative data, these findings are used for the calibration of the simulation model. The identified variables are categorized based on their position in the simulation model. (All the RMB in this table, the unit is ten thousand yuan.)

Exogenous input	**Value**	**Unit**	**Data source**
Eco-tourism part			
disposable income per tourist	1	RMB/PEOPLE	Average salary from questionnaire, the subject is the respondents of the questionnaire.

share of spending	0.15	1	Data are derived from the average of the questionnaire.
expected consumption per tourist	0.01	RMB/PEOPLE	expected consumption from questionnaire.
effect of perceived value	0.14	1	Yanqing Zhang, 2008
effect of motivation	0.53	1	Yanqing Zhang, 2008
effect of satisfactory	0.31	1	Yanqing Zhang, 2008
panda nature birth fraction	0.645	panda/year	Hao Wang, Songgang Li & Wenshi Pan, 2002
wild panda normal life expectancy	20	Year	Fuwen Wei, 1988
effect of forest-site ratio on life expectancy	-0.3	1	Estimated by the common sense that if the panda habitat is decreasing, the deaths of panda will increase, so the year reducing from normal life expectancy will increase. (Negative correlation) Besides, the main reason for panda tend to become extinct is habitat reduction. (Junyi Shi, 1985)
effect of air pollution density on life expectancy	0.3	1	Estimated from literature that one of the reason for panda increasingly death is the environment. Integrate the concept boundary with this paper, the air pollution should be considered. (Junyi Shi, 1985) Moreover, if the air pollution is decreasing, the death of panda will decrease, so the year reducing from normal life expectancy will decrease. (Positive correlation)
optimal daily reception area per person	2	square meter/ (people/day)	Estimation and need to be sensitivity analysis to find the differences.
days to open	365	Day	unit transfer
net birth ratio	0.00532	1/Year	Data released by government.

time to construction	5	Year	Adjust it when doing the Theil's Inequality Test.
year for depreciating	20	Year	Adjust it when doing the Theil's Inequality Test.
capacity required per tourist	0.0348	RMB/PEOPLE	Adjust it when doing the Theil's Inequality Test.
Local community			
average income outside	6	RMB/PEOPLE	Average salary from statistic department.
initial average local income	1.35	RMB/PEOPLE	Base salary from local government.
time to immigration	2	Year	Estimation
local birth rate	0.006	1/Year	Data released by government.
proportion of economically active population	0.45	1	Estimation and need to be sensitivity analysis to find the differences.
year to transform	2	Year	Estimation
effect of attractiveness on net immigration	0.01	1	Estimation
normal fraction of off-farm labor	0.25	1	Estimation
time to adjust income perception	2	Year	Estimation
Pollution			
average people per bus	30	people/bus	The capacity of tour bus is 40 at its maximum. Assuming that the annual average attendance rate is 80%, the average people each bus is around 30 person.
share of tour bus	0.421	1	Fraction based on questionnaire.
average people per car	3.5	people/car	Average data from questionnaire.
share of private car	0.387	1	Fraction based on questionnaire.
time to adjust for car	1	Year	Estimation
adjustment time for bus	1	Year	Estimation
emission per bus	10	gram/kilometer/bus	Estimation
emissions per car	5	gram/kilometer/car	Xiaoqing, 2003

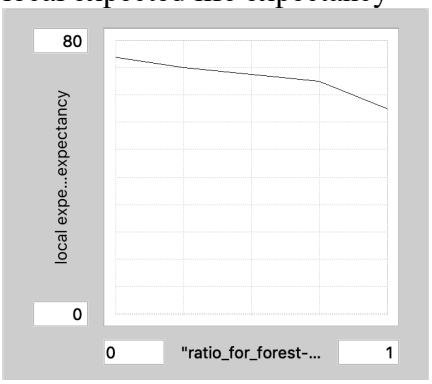
dispersion time	1	Year	Estimation
absorption time	1	Year	Estimation
air height	20	meter	It is assumed that air pollution affecting human or biological life is generally within 20 meters of the earth's surface.
unit Converter	1	gram/cubic meters	unit transfer
land section			
desired forest coverage	0.6	1	Estimated for the goal of forest coverage.
total area of land	2000000000	square meter	Wolong National Nature Reserve releases this data
time to construct	5	Year	Estimation
share of farming and living land	0.25	1	Estimation
construsture cost per unit area	0.1	RMB/square meter	Estimation
share of revenue to construction	0.05	1	Estimation
time to change	5	Year	Estimation
land requirement per person	873	square meter/ people	Yue Chen, 2019.
local expected life expectancy 	(0.000, 75.00), (0.250, 72.00), (0.500, 70.00), (0.750, 68.00), (1.000, 60.00)	Year	Estimation for nonlinear relationship between life expectancy and forest coverage. If forest coverage is high, the impact of pollution will decrease, so people will live longer. versa vice.

Table 1. Parameter Values from Data Sources and By Estimation

Part III : Analysis and Policy

5. Analysis

5.1 Boundary Adequacy Test

Simulation has been run in order to validate the model structure and test the whole system's operation. The ways to collect data are questionnaire, interview, literature, observations and common sense. The main logic of this research is summarized from some literature, which forms the four key parts of this thesis, namely eco-tourism part, local community, pollution and land section. These four parts are influenced mutually and interacted with each other, ultimately showing the relationship between tourism development and panda protection. The interview and questionnaire provide more detailed information and data for the research. Five local residents were interviewed, some of whom were immigrants and some of whom grew up there. From the interview, we learned about the development of panda eco-tourism, the changes of local residents' lives, the protection measures of local government and so on. The first-hand information collected from the first scene helps us to conduct further research more objectively. Alternatively, questionnaire is based on more respondents, questions from their views on eco-tourism, tourism habits, consumption capacity, environmental protection awareness and other aspects help to build more specific logic of the whole system and collect some internal functions and external basic data.

Starting from the purpose of this paper, the aim is to solve the local economic problems and improve the living standards of local residents through the development of giant panda eco-tourism and long-term sustainability without the cost of environmental damage. The article's boundaries are panda eco-tourism activities based on tourism behavioral intention. It links tourism system, panda ecosystem, local community, air pollution and land through the plates of local residential communities directly related to tourism activities, as well as the two sections of air pollution and land indirectly related to tourism activities. Comprehensive application of the tools and the thinking of research above is useful to archival all the materials in order to close the boundary of this thesis, to make more exogenous variable endogenous and to conduct the assessment of structure and parameters.

5.2 Behavior Reproduction Test

In order to assess the model's ability to reproduce the behavior of a system, the Theil's inequality statistics (Theil, 1966) is implemented at the beginning of the analysis part. The reference sample is collected from 2009, one year after the earthquake occurred in Sichuan, almost all the tourism industry in Sichuan suffered a disaster and the tourist spot closed that year. Most of the tourist spot is destroyed as well. The tourism is slowly recovered from 2009, which seems as a new start in there. Compared the current model data with the real historic data in Sichuan, showing in figure 13, it is indicated that the behavior of current model shows the similar pattern with the reference one, so utilizing this model structure could assist to make a comprehensive understanding of the trend for tourist reception capacity per year in the future. From the exceptional case in this study, as Wo Long located in Sichuan Province, where occurred an earthquake in 2013 as well. So the tourism in Sichuan showed depression at random, as the line chart (Figure 13) indicates a small decrease in the year of 2013.

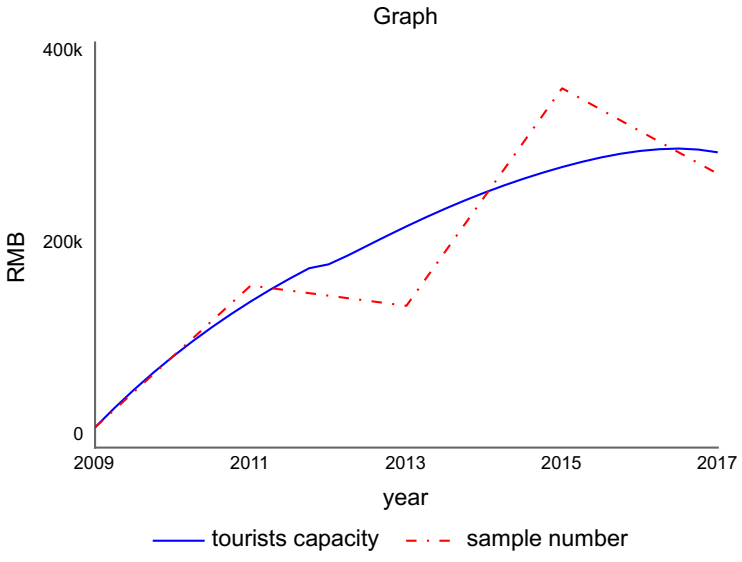


Figure 13. Reference Model VS Current Model

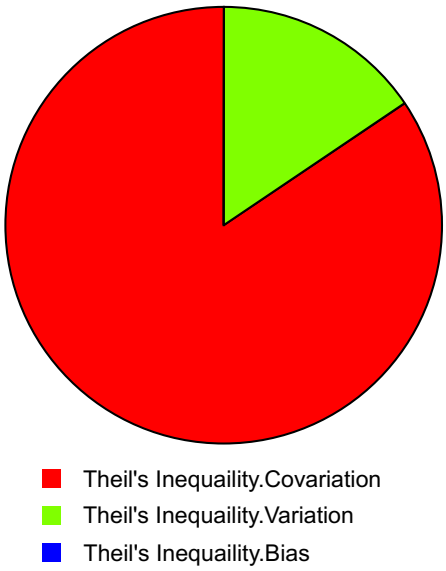


Figure 14. Error Type

Besides, the pie chart concluded as followed (Figure 14) provides the decomposition of the error. It implies that the unequal covariation occupies most of the error and small part errors are variation. This Theil's inequality test helps to characterize the sources of error. From Sterman's book, large errors and large bias or unequal variation fractions indicate systematic error and should lead to questions about the assumptions of model. The proper use of the behavior reproduction test is to uncover flaws in the structure or parameters of the model and

assess whether it is matched with the purpose of this article. If the majority of the error is concentrated in unequal covariation without bias, the model captures the similar mean and trends as data, but differs from the data point by point.(Sterman, 2000) So this is not the systematic error in this research, as studying the cycles is not the purpose of this article.

Therefore, these two charts make sense because the reference model is driven by some random noise which is not the element to consider in this article. The current model can be illustrated that it is reasonable to be used to estimate the trend of eco-tourism system in the further stage. It is verified that this system is reasonable and credible.

5.3 Extreme Condition

The external validity of the model is assessed by testing the robustness of the model, one of the external validation test is structure test. The structure verification test is about verifying if model structure does not contradict knowledge about the structure of the 'real' system. For this test, an assessment of compliance of the model with existing theory is performed. Based on existing theory about adoption and diffusion (e.g., Etzion, 2014; Ulli-Beer et al., 2010) there is reason to believe that the model includes all relevant structures. Thus, the structure verification test is passed. (J. Deckers (Jo), 2017) The direct extreme condition test is about verifying the response of the model to extreme conditions of a model parameter. In order to make sure that every equation makes sense, inputing extreme values to test the response to see whether the model will respond plausibly or not.

In this study, the initial value of the main stock, tourist reception capacity per year, is set to zero in order to examine conformance to basic physical law. From the Table 2, at the beginning of around 10 years, the behavior of stock is different due to the various starting values. However, the trend of behavior after that tends towards the same pattern. It can also be seen from the figure that although the starting point of the two lines is different, the behavior of trend is the same. Both lines are rising in the first decade, reaching the highest point, then falling slowly. Furthermore, when the natural births of panda are tested, if there is an increase in the year of 2028, that is, the annual natural birth of giant pandas will increase to five pandas, so the number of giant pandas is clearly on the rise in that year. As it can be seen from the following chart, after 2039, it also increases until reaching a peak. There is a delay between the number of giant pandas and the tourism system. The reason is unambiguous. First

of all, the impact of the three factors of tourists' behavioral intention on tourism, which is satisfactory, perceived value and tourist motivation due to panda, needs a certain time to be perceived. In addition, the improvement of tourism reception also needs a period of time to construct. But it is evident that an increase in the natural births of pandas has resulted in a growth in tourist reception capacity. Therefore, it could be inferred that the extreme test is plausible.

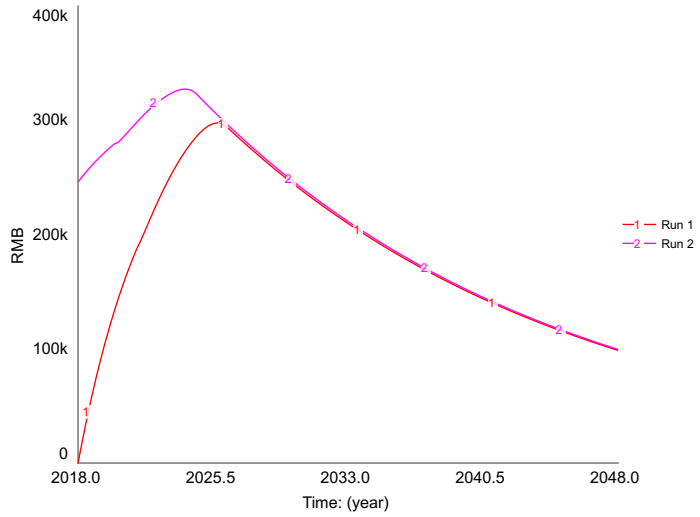
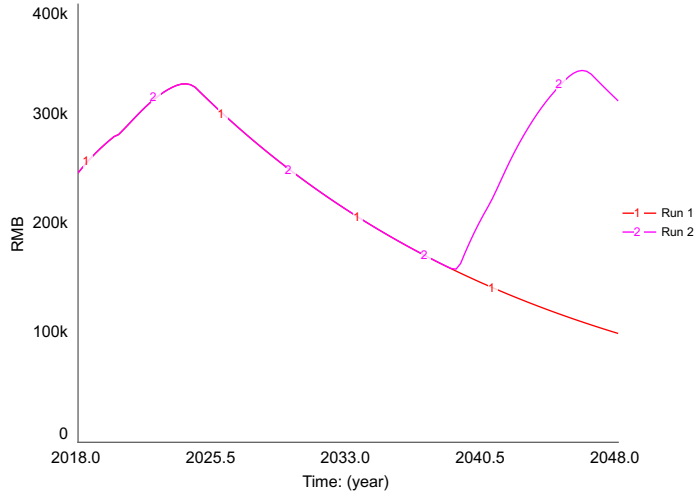
Extreme condition test	"Tourist reception capacity" simulation
Inspect the equation and test response to extreme values of the initial data of tourist reception capacity, which makes it no inventory. Run 1: Initial value=0 Unit: RMB Run 2: Initial value= 246000 Unit: RMB	
Panda natural birth rate Run 1: Equation: 0.0645 Unit: Panda/Year Run 2: Equation: 0.645+STEP(5, 2028) Unit: Panda/Year	

Table 2. Extreme Condition

5.4 Sensitivity Analysis

If assumptions are changed from time to time because of some uncertain situations, sensitivity analysis could assist to realize whether the conclusions change in ways important

to the purpose of the research. From Sterman's book, it summarizes that there are three ways of sensitivity analysis: numerical sensitivity, behavior mode and policy sensitivity.

In this part, the sensitivity test is conducted by first two types. When a change in assumptions changes the numerical values of the results and changes the patterns of behavior, the numerical sensitivity and behavior mode test should be measured.

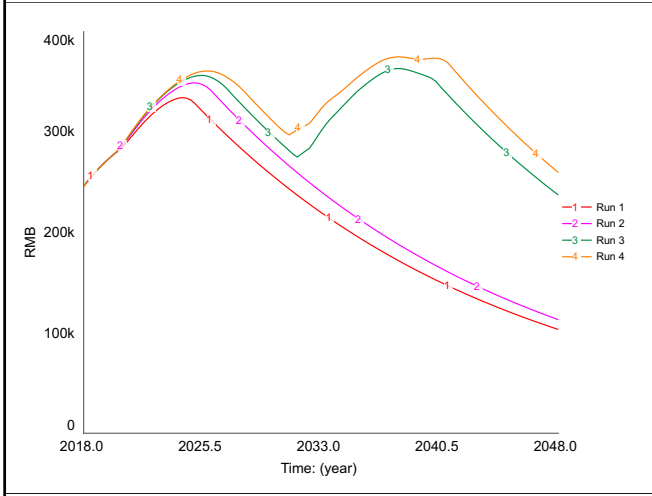
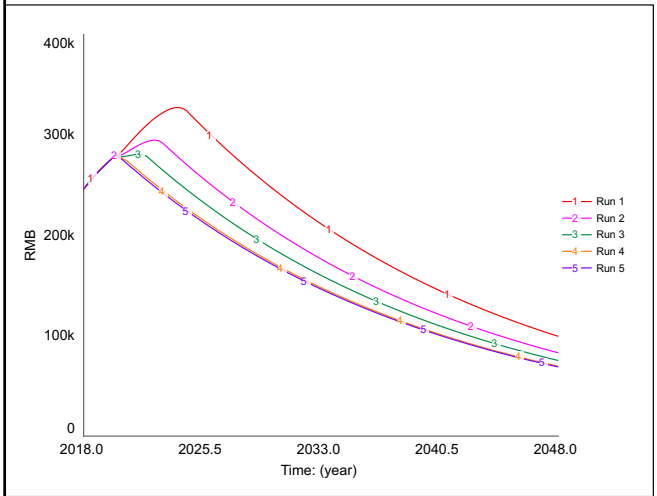
5.4.1 Numerical Sensitivity

Firstly, for the section of eco-tourism, perceived value is determined by the expected consumption and the actual consumption. when the average consumption per tourist is rising, the customers' satisfactory is leveled up, because the relative perceived value is going up. The average consumption per tourist is consist of two variables, disposable income and share of spending. When making the sensitivity analysis of the share of spending, which changes the actual consumption each tourist, then the relative perceived value would be altered. If tourists are willing to pay more for their traveling, there are more tourist reception capacity, which brings more revenue to local economy. On the other hand, it is implied that with the development of expected consumption per tourist, the relative perceived value is decreased, so is the customer's satisfactory. This also declines the intention for potential tourists to come to travel, which ultimately leads to the lower tourist reception capacity from point to point.

The proportion of economically active population is validated then, which is located in the local community section. It is estimated before to calculate the economically active population that attracts the locals to give up farming and increase the workforce to tourist industry. This factor will have an impact on off-farm labor, which is a part of satisfactory level. As the scenarios show, when there are more percentages of economically active population, it results in more off-farm workers, which will cause lower density of tourist and oscillate the satisfaction of tourists. So is the normal fraction of off-farm labor. This factor also affects the varieties of those who are giving up farming.

Last but not least, from the reviewed literatures, it indicates that the relationship between congestion rate and satisfaction is complicated. It is not only related to population density, social environment, individual characteristic but also the different research methods. (Pingping Cheng, Xiaozhong Yang & Min Peng, 2015) Therefore, it is required to have a test on the congestion rate as well, which is related to the tourist spot reception area. In the land section, with the increase of the local population, the need for construction land and living

land will increase correspondingly, which is reflected in the change of agricultural and living land in the model. Under the current situation, we can see that the current per capita land area is about 873 square meters. However, with the increase of population, the required land area per capita may change. When the local population remains unchanged, if the average land area decreases, the required agricultural and living land will also decrease. Therefore, for the government, the policy of controlling forest land reduction can also be adjusted from per capita land area. The table below has shown the different values of these parameters, the behavior is identically different.

Parameter values	Tourist Reception Capacity Simulation
Share of spending Run 1: 0.2 Unit: 1 Run 1: 0.4 Unit: 1 Run 1: 0.6 Unit: 1 Run 1: 0.8 Unit: 1	
Expected consumption per tourist Run1 : 0.01 Unit: RMB/People Run2 : 0.0325 Unit: RMB/People Run3 : 0.055 Unit: RMB/People Run4 : 0.0775 Unit: RMB/People Run5 : 0.1 Unit: RMB/People	

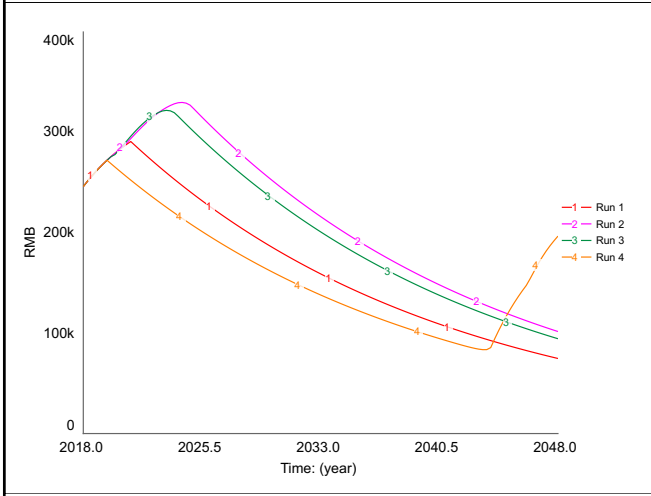
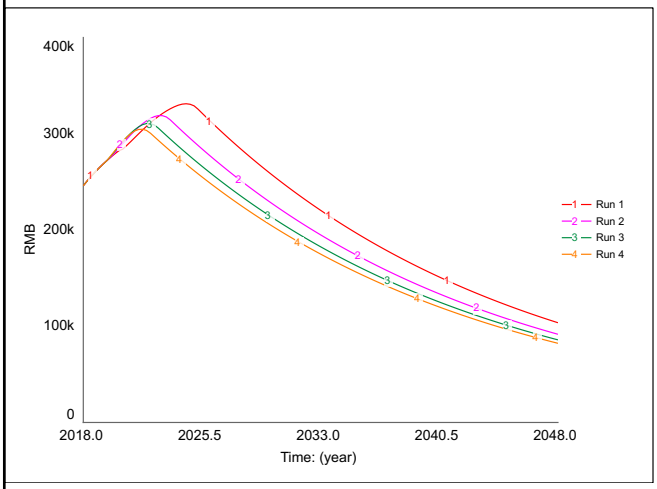
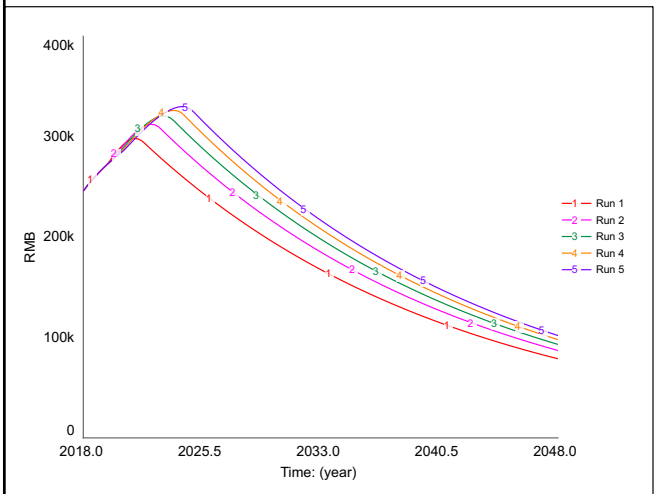
Proportion of economically active population Run 1: 0.2 Unit: 1 Run 2: 0.4 Unit: 1 Run 3: 0.6 Unit: 1 Run 4: 0.8 Unit: 1	
Normal fraction of off-farm labor Run 1: 0.2 Unit: 1 Run 2: 0.4 Unit: 1 Run 3: 0.6 Unit: 1 Run 4: 0.8 Unit: 1	
land requirement per person Run 1: 200 Unit: square meter/people Run 2: 400 Unit: square meter/people Run 3: 600 Unit: square meter/people Run 4: 800 Unit: square meter/people Run 5: 1000 Unit: square meter/people	

Table 3. Sensitivity Analysis for Tourist Reception Capacity

In conclusion, as for the policy to improve current circumstances, increasing the number of panda and enhancing the local tourist revenue at the meantime is a long run strategy for the sustainable eco-tourism industry. Based on the previous analysis and the key above as the entry point of the policy, we should formulate corresponding policies to help us to achieve the original goal of this paper.

5.4.2 Behavior Mode

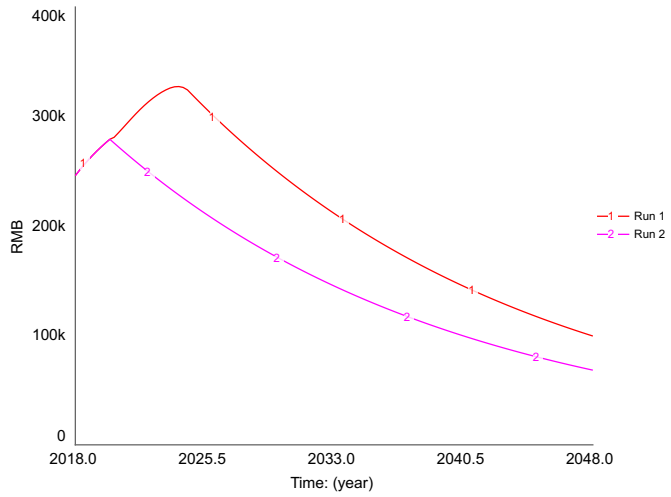
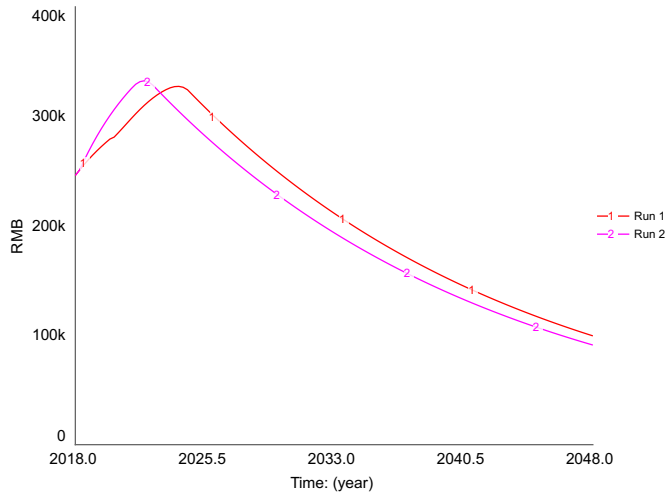
As panda is the core subject that is observed in this article , the behavior mode sensitivity is exhibited in order to test the changed ways of behavior between the factor of panda and tourist behavioral intention, which is named tourist motivation due to panda. From context, in this model, there are three elements that are closely to behavioral intention: tourist motivation due to panda, satisfaction and perceived value. The first two factors are tested respectively.

Firstly, tourist motivation is going to be analyzed. As the relationship between motivation and behavioral intention is not clear, the function is required to observe. On one hand, it is assumed that when there is no panda, there is no motivation. With the rising number of panda, people show increasing interest in panda until it reaches a peak. After that, pandas are not so rare for people, so the interest in pandas implies a downward trend. This assumption is a non-linear relationship between panda number and tourist motivation due to panda. The curve of this relationship tends to a parabola curve. While there is another assumption for this relationship, which is a linear function, it is simply described that the fewer panda exists, the more attractive it is. The outcome of this test shows that the nonlinearity relationship have more impact on the tourist reception capacity from tourist motivation than linearity.

In addition, when testing the experience quality, which is influential from density of tourist and worker, if the new arrival tourists are rising, the density will be increased. However, what is uncertain is the way of changing, with the increase of density, whether it increases in a parabolic manner, like it rises at first and then decreases after reaching the highest value, or it increases or decreases linearly. As the experience quality is examined, it goes with the similar pattern in different relationships.

Furthermore, the purpose of the tourist behavioral intention is estimated that a part of the traveler will put it into action. Assuming that under the circumstance of 100% of behavioral intention, one out of 1,000 people will actually travel. Specifically, there are three ways to describe the linear or nonlinear relationship between behavioral intention and fraction of

tourist that is willing to come. It is supposed that nonlinear relation approximates to a S-shape growth or an exponential growth and the linear relation is a straight line from low to high. The different ways to it express that various indexes of tourist behavioral intention correspond to different proportions of tourists coming to visit. As it is built on hypothesis, these three trends are tested to see the divergence of results. The fraction of tourists also presents different behaviors showed in the table 5. S-shape growth runs more robust than others. In general, it is reasonable that the function of factor, tourist motivation because of panda, is selected the non-linear one and the fraction of tourists is chosen S-shape growth in this system.

Parameter values	Tourist reception capacity Simulation
Tourist motivation due to panda Run 1: Nonlinear Unit: 1 Run 2: Linear Unit: 1	
Experience quality Run 1: Non-linear Unit: 1 Run 2: Linear Unit: 1	

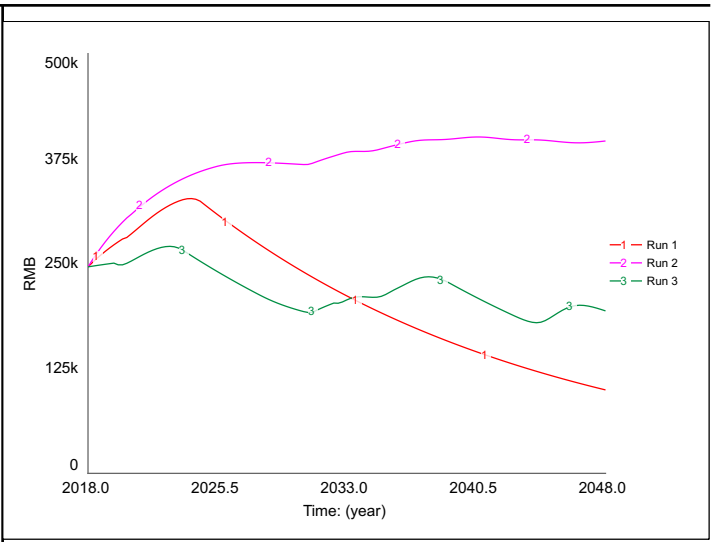
Fraction of tourists Run 1: Nonlinear- S-shape growth Unit: 1 Run 2: Nonlinear- Exponential growth Unit: 1 Run 3: Linear Unit: 1	

Table 4. Behavior Mode Sensitivity

According to the result of the behavior mode sensitivity shows in table 4, which tests the plausible range of uncertainty in the values of each parameter or nonlinear relationship, it illustrates the system has certain robustness, although there remains a tiny discrepancy. The different equations for the parameter definitely results in different behavior, as the relationship is distinguished from point to point. Even if there is a part of the error, the general trend of the whole behavior and the importance of the error are within the acceptable range.

6. Result

6.1 Introduction

From the validation part, the outcome gives different outcomes over the period of time. It is suggested that the simulation could not only reflect the past data, but also predict the future. Recalled the hypothesis part in chapter 4, after analyzing, the whole system model reveals more distinctly. A more specific causal loop diagram is presented in Figure 11 as followed. Compare to the highly abstract one in Figure 7, this new diagram indicates more detailed factors. There are totally 6 balancing loops and 7 reinforcing loops in this whole system.

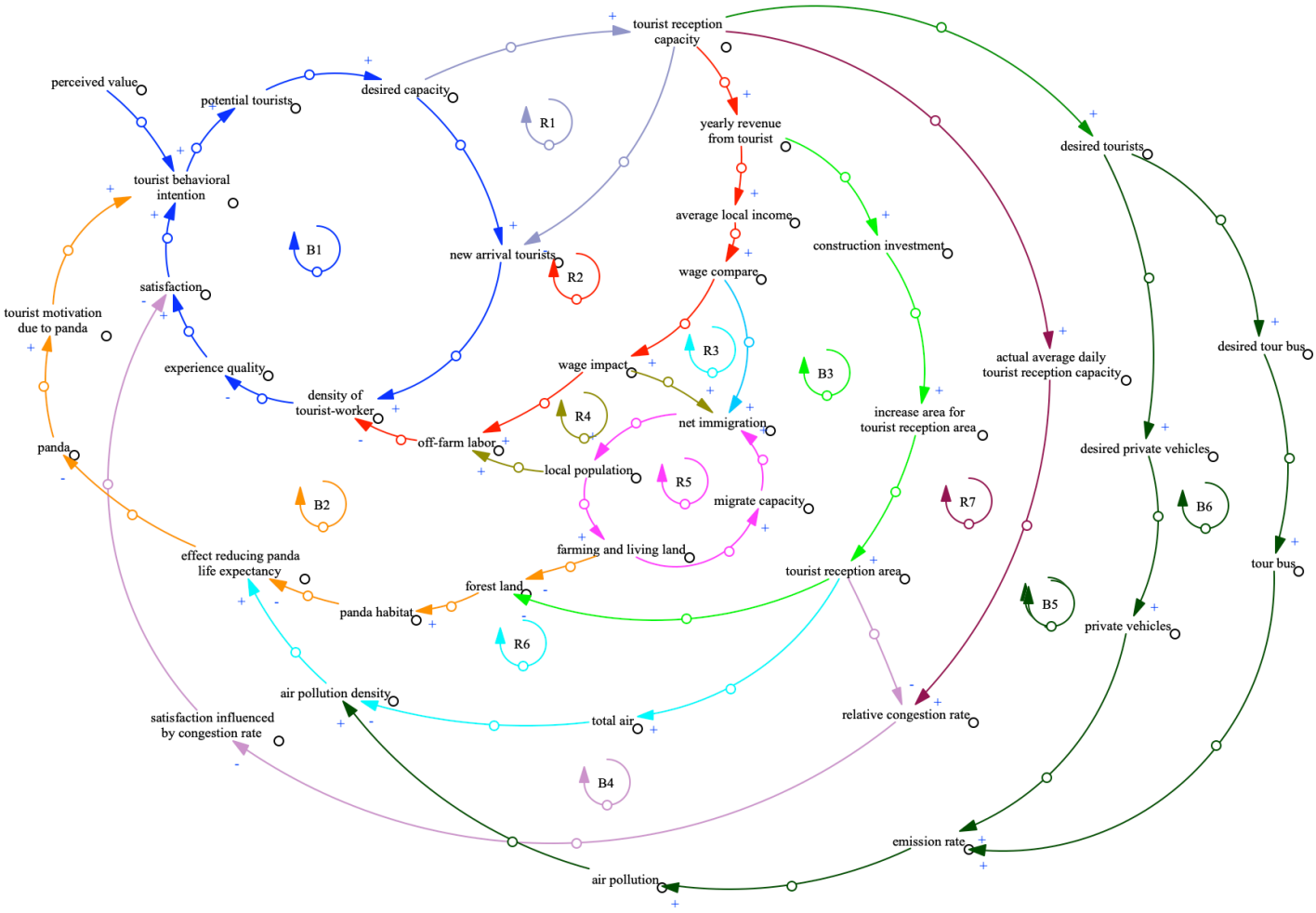


Figure 15. Causal Loop Diagram

Tourist reception capacity has a core impact on new arrival tourists, which is the negative correlation with density of tourist-worker. This ratio cause the level of tourists' satisfaction, a major part of tourist behavioral intention, and higher satisfaction assessment from customers

means more capacity (R1) and more desired capacity, but lower experience quality (B1). The other connection between tourist reception capacity and density of tourist-worker is the off-farm labors, which is affected by the wage impact, tracking back to yearly revenue from tourist that is determined by capacity. (R2) In terms of off-farm labor, the other factor is local community, that is to say, with the development of capacity and yearly revenue, the income of local people will be improved, which will encourage more people to stay in their hometown and attract more migrants, so there will be more off-farm labors there. (R3&R4) However, more local population implies more farming or living land for ever-increasing population, reducing ceaselessly the scare of forest land, so does the panda habitat. The less habitat exits, the higher death rate of wild giant panda would have. If there is no panda, this panda-theme eco-tourism project will become meaningless. (B2) Within the local community, the land for people enhances the capacity of local population. (R5) Besides, the yearly revenue helps to get more investment on construction to tourist reception area, which is also from forest land. (B3) Moreover, tourist reception area also has a negative impact on air pollution density (R6) and relative congestion ratio (B4). Last but not least, the higher tourist reception capacity would lead to more desired tourists and more transportations, which is the main cause of more air pollution. As for the higher density of air pollution, it has more effect on climate changes and increase the probability of panda's death. (B5 & B6) This more detailed causal loop diagram assists to make a further understanding of the whole system and also give the conceptual boundary of this paper.

6.2 Simulation

The eco-tourism project on wild giant panda is simulated with the actual data based on parameterization before, the outcomes is demonstrated from Figure16 to 20. Firstly, the tourist reception capacity reveals that it will increase sharply in the first 10 years and it reaches its peak. After that, it comes across with a depression in the future years. (Figure 16)

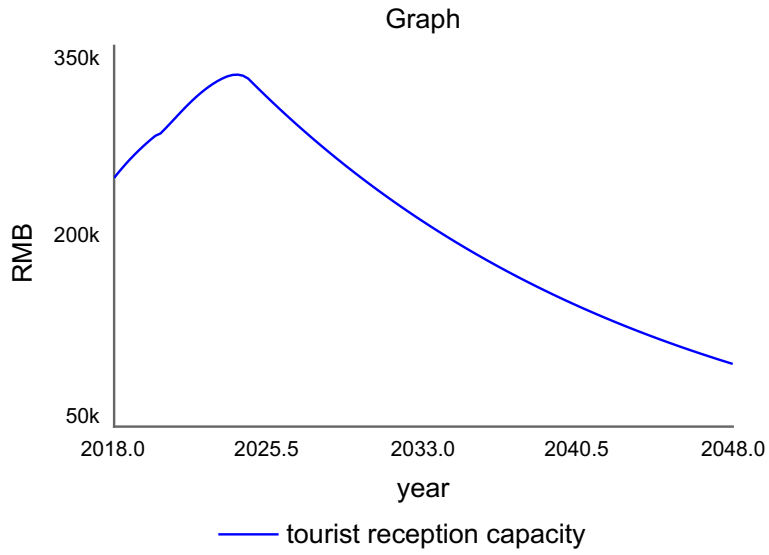
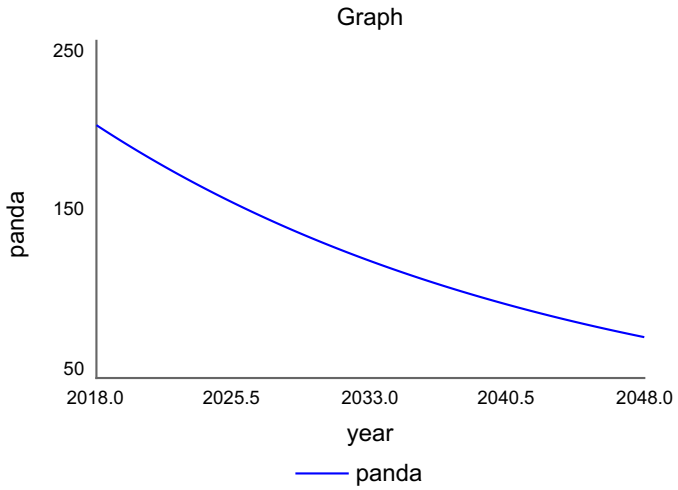


Figure 16. Simulation of Tourist Reception Capacity

Furthermore, when running the base model, the giant panda shows a persistent decline in the next 30 years, (Figure 17) which is a hidden trouble for government to think it twice. If the development of giant panda ecotourism needs to be at the expense of the disappearance of giant pandas, it is obvious that people can not accept the project at all. As for the local community, the population in Wo Long and Gang Da shows an exponential growth in the beginning of first 20 years and then fluctuates up and down in a range. This mainly stems from the wage impact on the migrate or emigrate. (Figure 18)



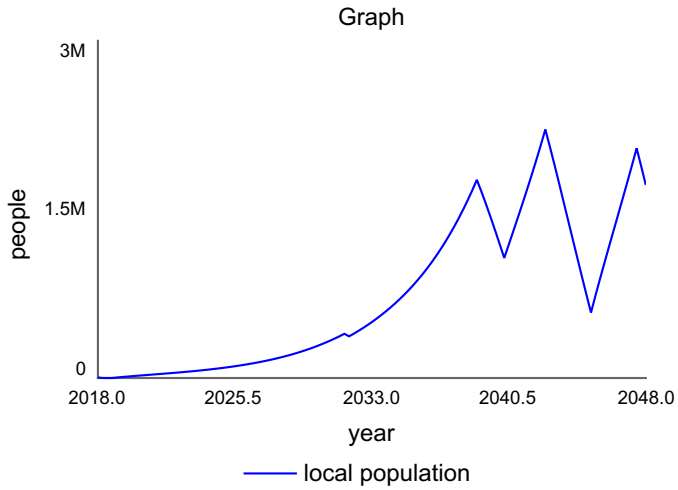


Figure 17. Simulation of Panda Number

Figure 18. Simulation of Local Population

With the development of reception capacity, there are more air pollution produced by more tourists(Figure 19), the figure shows a similar behavior with the tourist capacity, but merely

less volatile. From figure 20, the comparison on the different land use, if there is no strategy to control, as more and more people will come to live, they will cut down more trees to build more roads, build more houses and grow more food, so that the area of the forest will become smaller and smaller. This is bound to seriously affect the habitat area of wild giant pandas, resulting in a sharp decline in the number of giant pandas.

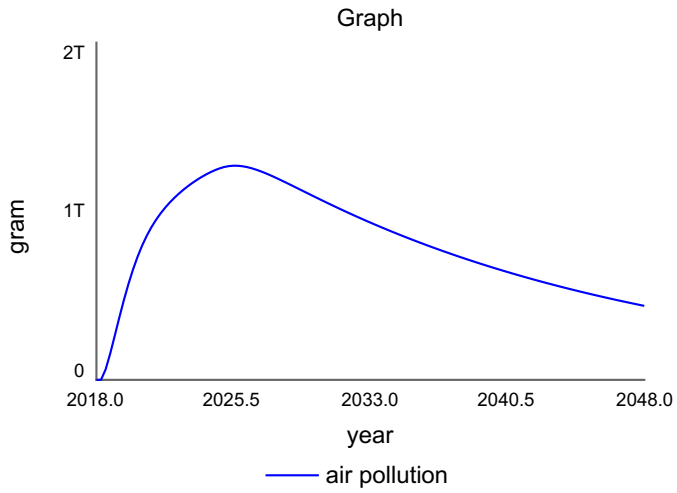


Figure 19. Simulation of Air Pollution

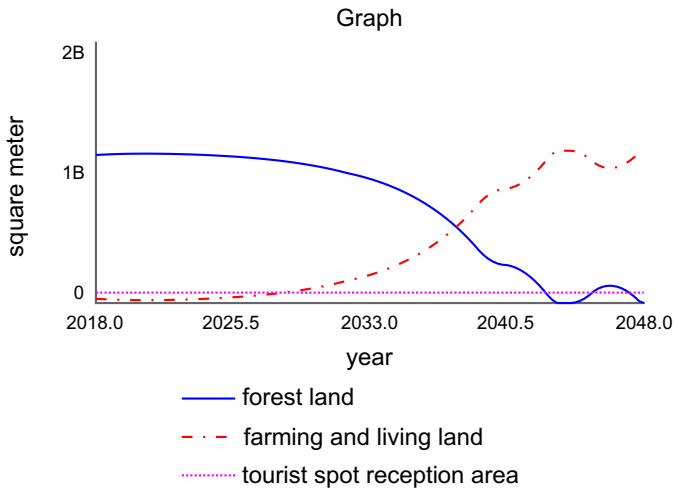


Figure 20. Simulation of Land Section

7. Policy Analysis

For a long run strategy of ecotourism, to open the tourism sites seasonally and alternately, to limit the maximum number of tourists to travel, to attract the travelers around the country and to continue to redevelop innovations of the old attractions in the tourist site may be policies. It relies on the eco-system planning and designing in order to make a full use of the tourist sites within the environmental friendly scope. Opening the sites seasonally and alternately could give the environment some time to recover its environmental capacity. As the number of tourists are decreasing, the wastes from tourists are supposed to be declined. The living cycle of Wo Long national nature reserve could be extended. Besides, limiting the tourists number can not only increase a sense of mystery to the attractive, but also control the pollution as well. These factors could be taken into consideration in a further step. In this article, the more direct policy is put forward as followed.

Because air pollution is one of the main causes for panda death in recent years, controlling the air pollution is the direct way to protect the eco-system. As more and more tourists come to visit, the construction of expressways will also directly and indirectly affects the survival of giant pandas, such as temporary land for construction and construction equipment sites, transportation sideways and guidance, sand and gravel yards, and improper disposal of construction waste, which will cause vegetation destruction, soil hardening and soil erosion, noise and explosion caused by vehicle and mechanical operations. Vibration will adversely affect some animal activities (habitat, migration, communication, reproduction, etc.). Also, the dust, asphalt smoke and other main air pollution are produced during construction. These materials would also reduces the life expectancy for livings. (Yuewei Ma, Yongtao Zhao, Fubin Chen & Libo Lan, 2011) From our model, the air pollution comes from the cars, which carries the tourism capacity to the certain site. For the government, investing more new-energy transportation instead of petrol or diesel cars may be one of the most efficient way to solve this problem, which decreases the level of air pollution rapidly.

Furthermore, if there are more and more construction in the tourist site, which transferring the forest land into the tourist spot reception area, there will be less and less for pandas' living area. Meanwhile, in order to build the eco-tourism for the whole system, it needs a carrying capacity for the space for tourist spot reception area rather than transferring from forest land without limitation. Therefore, there are two policies below to put forward in order to solve the

problems. When implementing policies below, the birth rate of wild giant panda is supposed to increase by common sense. As there are more giant panda alive, the mating rate would increase, so does the births. Therefore, the effect of influencing panda's life expectancy will not only decrease the deaths of giant pandas each year, but also increase the births of them.

7.1 Single Policy Development and Testing

7.1.1 Vehicle Replacement Policy

In recent years, air pollution is one of the most destructive pollutions during more tourism activities. When tourists arrive at the tourist area by means of transportation, a certain amount of exhaust gas will be emitted by the transportations. As the research is announced before, automobile exhaust is a kind of exhaust gas produced in the use of automobiles. It contains hundreds of different compounds, including solid suspended particles, carbon monoxide, carbon dioxide, hydrocarbons, nitrogen oxides, lead and sulfur oxides. Exhaust gas not only directly endangers human health, but also has a far-reaching impact on the environment of human life. For example, sulphur dioxide in tail gas has a strong stimulating odor. When it reaches a certain concentration, it is easy to cause acid rain, acidification of soil and water sources, and affect the growth of crops and forests. Moreover, the more construction on roads, houses, tourist spot will also bring air pollution as it mentioned before. Therefore, if large-scale development of tourist attractions will attract more and more tourists, which will bring more and more air pollution. Accordingly, the first policy to improve this project is to replace traditional vehicle or bus with new energy transportation, which has less emission of exhaust gases.

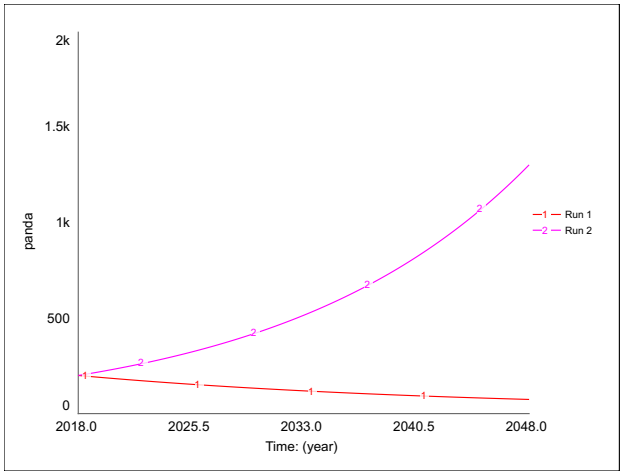


Figure 21. Panda with Policy 1

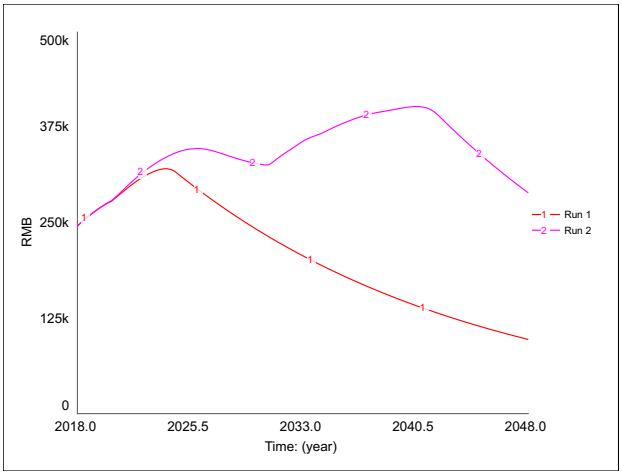


Figure 22. Tourists Reception Capacity with Policy 1

When carrying out the first strategy, the results have revealed in the figures above, that is, the number of pandas is increasing significantly. To be frank, with the reduction of automobile exhaust emissions, the air quality becomes better and the air pollution is decreasing. Therefore, the density of air pollution, as one of the factors affecting the survival rate of giant pandas, its decrease means that giant pandas have higher birth rate and lower death rate. In figure 22, it indicates that the tourist reception capacity surpass the previous outcome, which means it could accommodate more tourists. Therefore, after the adoption of policy 1, tourist reception capacity appears a better results, which could attract more investment that is put into the construction and development of tourist reception capacity later because of more tourists' revenue received by local government. Besides, it also reflects an improvement of the environment of wild animals.

7.1.2 Panda Habitat Policy

After eight years of field work in Qinling Mountains, researchers tracked pandas' activities by wearing radio coils. They found that bamboo blossom and death were not the main reasons for threatening the survival of giant pandas. When a kind of bamboo blossoms, pandas can easily find alternative food. Actually, the survival and reproductive capacity of giant pandas are not weak. The professor said: "Only in nature will the genetic diversity of species continue to increase in order to survive better. The last position we have to defend today is to protect the wild, free-living giant panda population. At present, the best way to protect them is to protect their habitats. Using good habitats, giant pandas can be conducive to breeding." (Xinhua News Agency, 2001) Additionally, Lu Zhi, an expert of the research team, recently collected various protected areas and zoos. The blood samples collected from giant pandas were taken to the United States for DNA testing. The genetic diversity ratio of giant pandas is 46%, which is almost the same as that of human beings. The team also found that pandas grow at an annual rate of 3.5% in nature, faster than human growth rates of 1% to 2%.

Therefore, the main reason for panda extinction is that with the development of tourism activities and people's activities, increasing to log and constructing roads, the habitat of panda declines continuously. To solve this problem, increasing the habitat of panda is another way to

increasing the survival rate and decreasing the death rate of panda, which can control the decreasing number of panda.

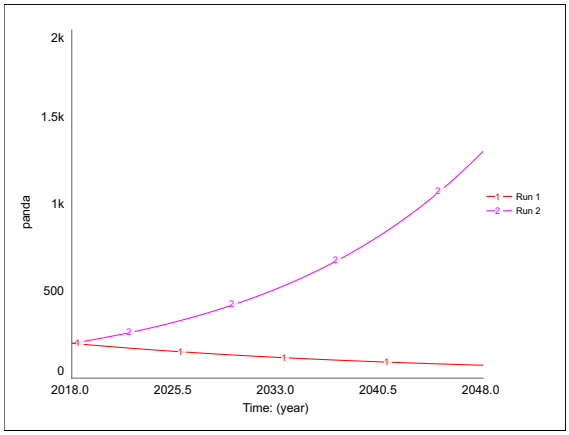


Figure 23. Panda with Policy 2

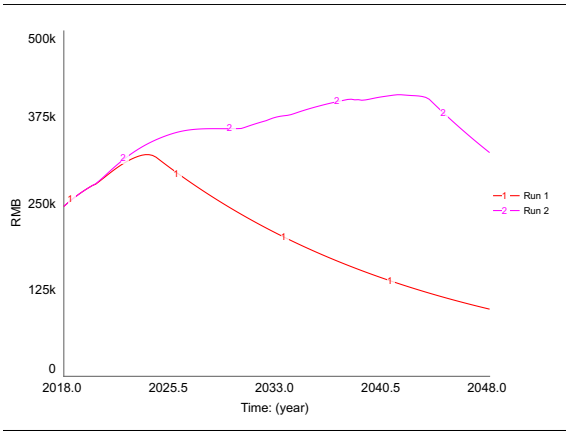


Figure 24. Tourists Reception Capacity with Policy 2

From the outcome of this policy, it is apparent that with the increase of forest land, the habitat of giant pandas is also expanding. This makes wild pandas have more space to live, breed and move, so it gives the same results as the first policy showed. Because panda eco-tourism is based on wild pandas, if the number of pandas arises, there is higher interests for tourists in giant panda eco-tourism. So people's tourism activities will increase and will not be subject to any restrictions. The tourism reception capacity will also increase. From this trend, it is inferred that in the next few decades, the number of giant pandas will be rising and tourism reception capacity will get higher capacity as well, so that the local tourism income can continue to rise, and because of the limitations on the local population, the average income of the local people can also be further improved. Thus, this policy could resolve the problem of eliminating local’s poverty.

7.2 Joint Policy Development and Testing

The result of a single policy improves the outcome of model clearly. If two policies are implemented together, the result would be much better as it shows in the following two graphs. When the policy of cutting down the emission of exhaust gas and raising the habitat of giant panda is assisted to achieve the goal, there are more births and less deaths of giant pandas, which cause a general upward trend. From the following two graphs, it is obviously

that the number of giant panda is improved as well as the tourist reception capacity, which increases the local tourism income and greatly enhance the local people's economy, help them eradicate poverty. It makes an achievement if implementing these 2 policies.

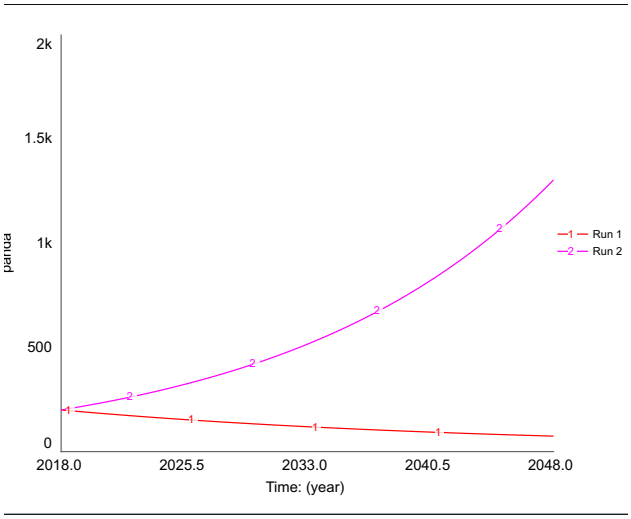


Figure 25. Panda with Joint Policy

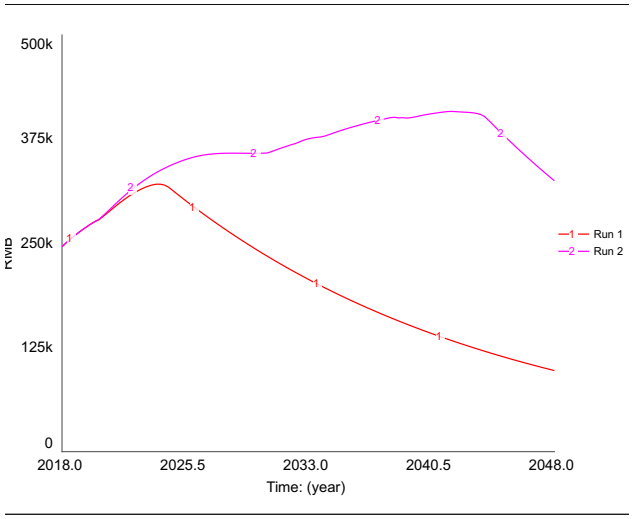
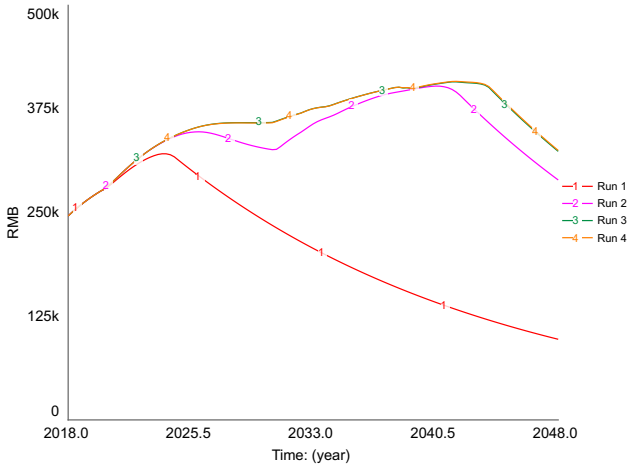


Figure 26. Tourists Reception Capacity with Joint Policy

Besides, When both policies are enabled at the same time, it is indicated that the effect of the policies become better. From the comparison chart of the policies, outcomes without policies is highly different from those with policy. More specific, the scenarios of the parameter, the effect of influencing life expectancy, shows a very distinct discrepancy.

Policy scenario	Tourist Reception Capacity Simulation
Run 1: no policy Run 2: policy 1 Run 3: policy 2 Run 4: Joint policies	

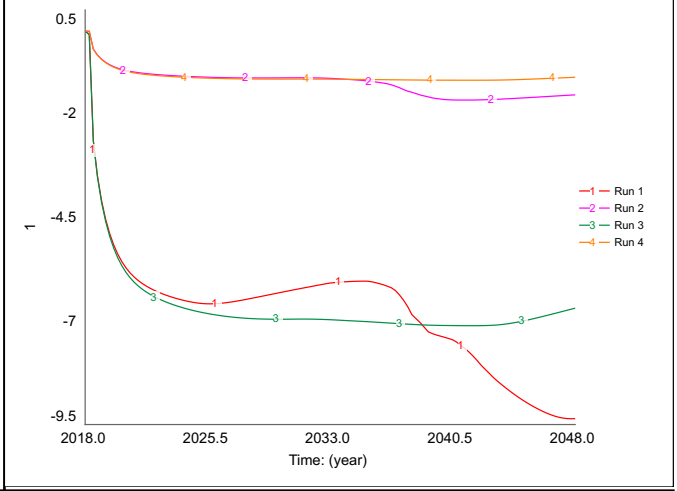
Policy scenario	Effects of influencing life expectancy
Run 1: no policy Run 2: policy 1 Run 3: policy 2 Run 4: Joint policies	

Table 5. Policy Scenario Comparison

7.3 Policy Sensitivity Analysis

From context, the sensitivity analysis has three means to validation, the first two items have been verified in the previous article and the last one is the policy sensitivity. There are two policies, one is the vehicle replacement, which is devoted to the replacement of new energy vehicles so as to reduce the exhausted gas emission of cars or tour buses carrying tourists, and the other one is about the habitat of wild giant panda.

At the beginning of policy sensitivity analysis, different values of external factors can lead to different changes. For example, after planting trees, it takes a certain time to plant trees, it also takes a certain time to plant trees, or the initial forest coverage rate will also affect the number of trees planted. If the forest coverage rate is higher, which means the target is higher as well, the difference between the target and the actual coverage rate becomes greater, so there are more trees needed to be planted. From table 6, it shows the outcome of the sensitivity analysis of this policy. When running the time to plant trees, if it takes more time to plant and grow to forest, the number of planting trees per year would be less, so the conversion to forest goes more smoothly. Additionally, the area for tourist reception and farming and living land occupies more.

As for the desired forest coverage, if the goal is lower, forest required is less, too. The gap between the desired and actual is smaller, so the area of the forest is smaller. The habitat of wild pandas is a part of forest land. If the forest area is smaller, the habitat of wild pandas will

be smaller and smaller. The reduction of giant pandas' habitats means that they do not have more space to move, and the survival rate of giant pandas will be reduced. In this way, there will be fewer and fewer wild pandas until they are extinct.

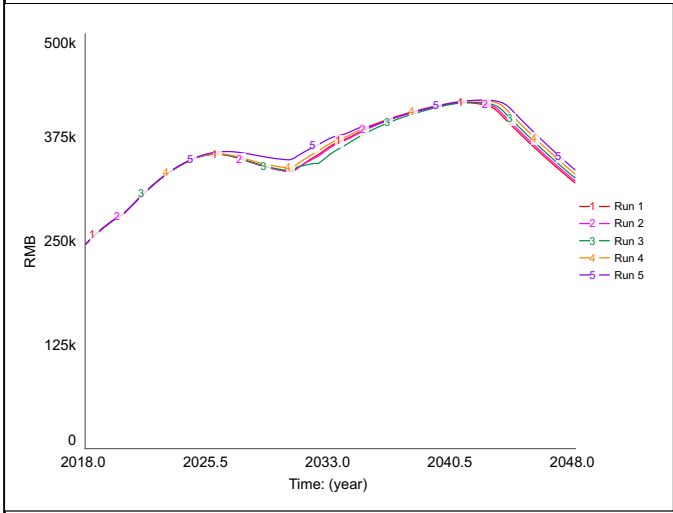
Parameter values	Tourist Reception Capacity Simulation
Desired forest coverage Run 1: 0.1 Unit: 1 Run 2: 0.2 Unit: 1 Run 3: 0.3 Unit: 1 Run 4: 0.4 Unit: 1 Run 5: 0.5 Unit: 1	

Table 6. Policy Sensitivity

In conclusion, the year of planting trees and the desired forest coverage have an impact on the effect of policies. From the different scenarios above, if it takes more years to plant trees in order to achieve the goal of forest coverage, there is lower tourist reception capacity. Besides, if the goal of forest coverage is set higher, it implies more tourist reception capacity as well. Therefore, if we want to develop the effect of the policy, we can shorten the time of planting trees and increase the forest coverage.

Part IV : Implementation

8. Discussion and Limitation

8.1 Consideration of Stakeholders

When implement the strategies, the first thing to consider is money. Funds for construction, advertising and education are essential when implementing the measurement, meanwhile the benefit of stakeholders is also required to think twice. Stakeholders in this paper are including the local community, the local government, tourist companies, ecotourism association, tourism administration department, the public, to name a few. In order to apply improvement measures to practice, it is better to understand the requirements and pursuit of the different stakeholders. Taking the local government as an example, briefly speaking, the pursuit of local government is to gain more economic benefit from this Panda-theme eco-tourism project while the requirement of local government is the environmental protection, which should be taken into account, not at the cost of damaging the environment. While for the local community, the economic return is the most important issue they may concern. However, if we want to get 100% satisfaction from all the stakeholders, there are many possibilities needed to be considered thoroughly. In the process of actual implementation, it is still difficult to achieve. Therefore, before solving all the problems, it is more important to solve main problems, those more important contradictions, so that all parties can get some rewards in this project. Moreover, a part of stakeholders require to invest in two policies. When new energy vehicles became popular these years, the public is willing to replace their own private vehicles with electric automobile, whilst travel corporations also buy new energy tour bus. Besides, when implementing this policy of increasing the panda habitat, returning farmland to forests is a way. For the forestation, more trees are needed to be planted in this area. If there are more forests, panda habitat is going to increase. In reality, what is going to take out from tourist revenue is the local workers' salaries and the investment for constructing the tourist reception area in this model. The direct cost for this policy is the cost of planting trees, the amount of trees, the area of land, the labor cost of local people, transportation cost, removal cost and so on should be taken fully into account. In the model, the cost of trees has been calculated. It is indicated that if 20% of revenue is going into tree-planting policy, in order to recover the forest coverage and reach the goal at 60%, there are still more than

1,000,000,000 Yuan needed to carry out this policy. The plan will take a long time to implement and see the results. For example, in China, it took 17 years from 2000 to 2017 to make the net increase of green leaf area as high as 1.351 million square kilometers. (NASA, 2019) Therefore, planting trees is a long-term strategy to work out, but it is going to promote the idea of sustainable tourism.

8.2 Limitation and Restriction

Firstly, the boundaries of this paper are not particularly large. The main issues discussed in this paper are air pollution and habitat reduction, the impact of panda ecosystem on tourism market, the interaction between tourism market and local communities, and the impact of local residents and tourism market on panda ecosystem. In fact, there are many other factors that are not taken into account in the whole system, such as education, economy, population, roads, hotels, restaurants, water pollution, garbage disposal and so on.

Secondly, the basic data of this paper is less. Previous literatures collect data through qualitative research, using observation, interviews, physical analysis and other methods to explore social phenomena as a whole, using inductive thinking to analyze and form theory, through interaction with research objects to understand and explain their behavior. Quantitative research generally uses mathematical models to do some specific calculations, and does not form an interactive system. Therefore, there is little theoretical support for causality among various factors, but sensitivity research method is used to test the influence of linear or non-linear relationship among multiple factors on the main stock.

Last but not least, this paper does not consider the future changes of some external data, such as in the local community sector, the change of external income will have some impact on salary comparison, but the model does not show the future changes of external income. In this part, we need to add the economic plate model to analyze the economy of the whole region and even the whole country in order to get more accurate data. Besides, with the increase of environmental protection, the increase of the habitat of giant pandas and the enhancement of people's awareness of environmental protection, the rate of mating, fertility and survival of wild giant pandas will increase accordingly.

9. Conclusion

With the increasing demand for tourism, the project of this wild giant panda eco-tourism gives us a case study. From the SWOT analysis in the following table, it can be clearly seen that the giant panda eco-tourism project has many advantages: for example, it is a unique tourism product around the global, so its competitiveness is relatively high. However, wild giant pandas have a higher requirements to living environment, mostly concentrated in mountainous areas. Those area is the poorest area in China as mentioned before. Therefore, the choice of transportation is relatively single and the hardware conditions of tourism industry are relatively poor for tourists. Mountain road, weather and natural disasters may decrease the willingness of traveling, to some extent. With the development and research of this project, people also find that there are many opportunities for giant panda eco-tourism. The development potential of this project is huge. If we can make good use of it and strengthen the management of tourism in this area, we will get great economic returns. But at the same time, if we want greater development, we will also face many visible challenges, such as how to strengthen the environmental awareness of tourists, reduce environmental pollution to the lowest level while developing tourism, how to develop tourism vigorously and receive more tourists and how to manage the region properly without affecting the normal life of giant pandas, to name a few. Thereby, the aim of this paper is to develop the strengths and avoid the weaknesses and balance the opportunities and challenges brought by the development of tourism industry.

Strength	Weakness
- The giant panda is a mysterious animal for most tourists around the world, so the giant panda eco-tourism is unique. - Ecotourism is of great educational significance and an important way to develop sustainable tourism.	- Rail transit is underdeveloped, and the choice of traffic mode will be relatively single. - There are many natural disasters in mountainous areas and their safety is relatively low.

Opportunity	Threaten
- Eco-tourism is still in its infancy and there is more room for growth in the future. - The government's support is constantly strengthened and the potential for its development is relatively large. - People's awareness of environmental protection has been strengthened, and more and more attention has been paid to protecting the environment during the journey of tourism.	- The development is difficult and the cost is high. - The potential negative impact on giant pandas is incalculable. - Regional area is wider and management is more difficult.

Table 7. SWOT Analysis

At the beginning of this article, several questions needed to be solved are put forward and then are answered step by step in subsequent articles.

a. Which causal factors are related to panda theme ecotourism?

Firstly, the characteristics of eco-tourism, the destination of eco-tourism is to protect a complete natural and cultural ecosystem. Participants can get a unique experience, which has the characteristics of primitiveness and uniqueness. Eco-tourism emphasizes the miniaturization of tourism scale and limits it to the affordability, which is conducive to the quality of tourists' sightseeing without causing great damage to tourism, and it can allow tourists to participate in it personally, understand the mystery of eco-tourism in practical experience, and thus love nature more, which is also conducive to the protection of natural and cultural resources. Furthermore, ecotourism is a kind of responsible tourism, which includes the responsibility of protecting tourism resources and sustainable development of tourism. Because these characteristics of eco-tourism can meet the needs of tourism demand and tourism supply, the rise of eco-tourism is possible. Therefore, giant panda ecotourism is in connection with the panda biological system and the local society.

b. Which factors is consist of tourist behavioral intention and how much each factor can influence it?

For the tourist behavioral intention, it determines how many potential tourists will become real tourists and put tourism into action. The tourist behavioral intention is a very complicated concept that a plenty of experts are doing researches from the past to the present. In this paper, it draws lessons from Yanqing Zhang's conclusion that the components influencing tourists behavioral intention are only tourist motivation, perceived value and satisfaction.

c. Which element in local community is casually related with the satisfaction of tourists when launching ecotourism?

In fact, there are many factors affecting the satisfaction of tourists, such as crowding, infrastructure construction, service attitude of staff, basic expectations of tourists and competitors, etc. But this paper focuses on two factors, one is the ratio of tourists to staff, which determines the quality of service of staff to a certain extent, and the other is the ratio of tourists to staff. Thirdly, the degree of crowding in the scenic spot is one of the main factors that a large number of tourists decide whether to visit the scenic spot or not.

d. Which components of land construction will have a causal relationship with giant panda Ecotourism?

For land conversion, in order to improve customer satisfaction and reduce the crowding of scenic spots, one way is to expand the area of scenic spots. And these new scenic spots can only be transformed from forest land, so that tourists can feel the living environment of wild pandas more closely. However, the tremendous encroachment on forest land for visitors will inevitably have a great impact on the daily activities of giant pandas. With the decrease of forest area, the habitat on which giant pandas live will gradually decrease. The influx of tourists will affect the normal life of giant pandas, so that they will leave their habitat and find other new undisturbed areas.But the migration of giant pandas will also have more invisible negative effects, which will not be discussed in depth here. In addition, it is irreversible that with the decrease of woodland and the increase of tourist reception, the impact on these wild livings from the air pollution, noise pollution and garbage thrown by tourists.

e. Which factor brought by coming tourists is related to the increasing deaths of Panda?
In this paper, we focused on the reduction of giant panda habitat and the impact of air pollution on the mortality of giant pandas. These two factors are the most mentioned and two of the most serious problems in recent years. The treatment of air pollution needs to be combined with various factors. In addition to the improvement and replacement of automobiles, this paper focuses on the construction of dust control and measures for converting farmland to forests. On the other hand, the settlement of animal habitats and the increase of forestland are also one of the most simple and direct methods. In reality, pandas also need to consider various types of land, habitat altitude selection and other factors.

Therefore, this paper solve the problem mentioned before step by step. The panda eco-tourism project launched in Sichuan Province is mainly aimed at eliminating local poverty, promoting local economic development and solving the employment problems of local residents. The main purpose of this paper is to achieve this goal, while not at the cost of the local environment, to balance the local economic development and environmental protection. Therefore, when the relevant policies, such as motor vehicle replacement scheme, conversion of farmland to forestry and increasing vegetation coverage, are implemented, it can be seen that the results have been significantly improved and the giant panda has been protected. Although there are still many areas to be improved, the project of eco-tourism for giant pandas, on the premise of sustainable development, can indeed promote the development of local economy and has great potential in the near future.

Reference

Tourism Development Committee of Aba Qiang Autonomous Prefecture (2018). Aba Tourist Address Book.

Bertalanffy, L. V. ,1971. General system theory: foundations, development, applications. London: Allen Lane The Penguin Press.

Bian Yuting, 2018. Research on Influencing Factors of Tourist Satisfaction in Home Stay Based on Grounded Theory. Jiangsu Commercial Forum, 2018-09.

Bo Jiang and Honghua, 2007. The study on service quality evaluation models based on the “8 factors” of destination. Commercial Research, Aug 2007, No 364.

Chang C Y, 1993. A Simulation Approach to Crowding in Outdoor Recreation. Mckeesport Allegheny: The Pennsylvania State University.

Chengdu Business Daily, 2014. Who makes money in Sichuan scenic spots? The income of Wenchuan tourist area exceeds that of Jiuzhai and Huanglong. http://news.ifeng.com/a/20140926/42087380_0.shtml

Choi G C. Situational and Personal Factors in Perception of Crowding, 1978. Laramie: The University of Wyoming.

Christiansen F, Lusseau D, Stensland E, et al, 2010. Effects of tourist boats on the behavior of Indo-Pacific bottlenose dolphins off the south coast of Zanzibar. Endangered Species Research, 11(1): 91–99.

Christiansen F, Rasmussen M H, Lusseau D, 2013. Inferring activity budgets in wild animals to estimate the consequences of disturbances. Behavioral Ecology, 24(6): 1415–1425.

Dyck M G, Baydack R K. 2004. Vigilance behavior of polar bears (Ursus maritimus) in the context of wildlife-viewing activities at Churchill, Manitoba, Canada. Biological Conservation, 116(3): 343–350.

Etzion, D, 2014. Diffusion as classification. Organizational Science, 25 (2): 420-437.

Fuwen Wei, Jinchu Hu, Guangzan Xu, Mingdao Jiang, Qitao Deng & Zhaomin Zhong, 1989. Preliminary compilation of life table of wild giant panda. Acta Theiologica Sinica, 1989, 9 (2) :81-86.

Fuwen Wei, 1988. Age and longevity of giant pandas, Nature, No. 01, 1988.

French S S, Denardo D F, Greives T J, et al. 2010. Human disturbance alters endocrine and immune responses in the Galapagos marine iguana (Amblyrhynchus cristatus). Hormones & Behavior, 58(5): 792–799.

Green R, Higginbottom K, 2001. Negative effects of wildlife tourism on wildlife. Wildlife Tourism Impacts Management and Planning, 8(1): 16–20.

Gunn, C. A. , 1994. Tourism planning: basics, concepts, cases (3 ed.). Washington, D.C: Taylor & Francis.

Guillemain M, Blanc R, Lucas C, et al., 2007. Ecotourism disturbance to wildfowl in protected areas: historical, empirical and experimental approaches in the Camargue, Southern France. Biodiversity & Conservation, 16(12): 391–409.

Griffiths M, van Schaik C P. ,1993. The impact of human traffic on the abundance and activity periods of Sumatran rain forest wildlife. Conservation Biology, 7(3): 623–626.

Honggang Xu & Jigang Bao, 2003. The Use of System Dynamic Method in Tourism Planning. Economic Geogrophy, Vol 23, No 5. Sep 2003.

Hao Wang, Songgang Li & Wenshi Pan, 2002. Population viability analysis of giant pandas (ailuropoda melanoleuca) in Qinling Mountains. Journal of Peking University (Natural Science Edition)*, 38*(6), 756-761.

Honggang Xu & Shanshan Dai, 2012. A system dynamics approach to explore sustainable policies for Xidi, the world heritage village, Current Issues in Tourism, 15:5, 441-459, DOI: 10.1080/13683500.2011.610499

Holloway A. ,2011. Exploring the Influence of Survey Item Order and Personality Traits on Perceived- crowding and Recreational Satisfaction in an Urban Park Environment. Tempe: Arizona State University.

Jin Chen, 2014. Study on Evaluation System of Scenic Area Crowding Degree. Doctoral dissertation.

John D. Sterman, 2000. Business Dynamics: systems thinking and modeling for a complex world, 21, 874-887.

J. Deckers (Jo) , 2017. Valorization of side streams in the food supply chain: a case study of the adoption of misshapen produce in the Netherlands.

Johnson T E., 1978. Perceptual Determinants of Crowding Stress. Edmonton: The University of Alberta.

Junyi Shi, 1985. Effects of environmental factors on the survival of giant pandas. Biological Bulletin, Vol 4, 1985, 19-21.

Kai Bai & Shengwei Guo, 2010. An Empirical Study on the Impact of Symbiotic Image of Tourist Scenic Spots on Tourists'Willingness and Word-of-mouth Effect--Taking Qujiang Cultural Theme Scenic Spot in Xi'an as an Example. Journal of Tourism, 2010, 25 (1): 53-58.

Knight R L, Gutzwiller K J. ,1995. Wildlife and recreationists: coexistence through management and research. Society & Natural Resources, 10(6): 591–595.

K. Stave, 2010. Participatory System Dynamics Modeling for Sustainable Environmental Management: Observations from Four Cases. Sustainability, vol. 2, no 9, 2010: 2762-2784.

Lijun Peng & Jian Yang, 2008. Talking about the Development of Giant Panda Tourism Products, Sichuan Forest Exploration and Design, No 2. June 2008.

Lusseau D, Bejder L. 2007. The Long-term consequences of short-term responses to disturbance experiences from Whale watching impact assessment. International Journal of Comparative Psychology, 20(2): 228–236.

L. Murphy, P. Benckendorff, G. Moscardo, 2007. Linking travel motivation, tourist self-image and destination brand personality. Journal of Travel & Tourism Marketing, 22 (2) (2007), pp. 45-59.

M. Li, L.A. Cai, X.Y. Lehto, J.Z. Huang, 2010. A missing link in understanding revisit intention—the role of motivation and image. Journal of Travel & Tourism Marketing, 27 (4) (2010), pp. 335-348.

Manor R, Saltz D. ,2003. Impact of human nuisance disturbance on vigilance and group size of a social ungulate. Ecological Applications, 13(6): 1830–1834.

Mallord J W, Dolman P M, Brown A F, et al. ,2007. Linking recreational disturbance to population size in a ground-nesting passerine. Journal of Applied Ecology, 44(1): 185–195.

Marchand P, Garel M, Bourgoin G, et al. , 2014. Impacts of tourism and hunting on a large herbivore′s spatiotemporal behavior in and around a French protected area. Biological Conservation, 177: 1–11.

Ming Gao, 2011. Relationship among Tourist Perceived Value，Tourist Satisfaction and Behavioral Intentions——A Literature Review.Journal of Jiangxi Agricultural University, Vol. 10，No.3 Sep. 2011.

Morris D W, Kingston S R. , 2002. Predicting future threats to biodiversity from habitat selection by humans. Evolutionary Ecology Research, 4(6): 787–810.

Moss R, Leckie F, Biggins A, et al. , 2014. Impacts of human disturbance on capercaillie tetrao urogallus distribution and demography in Scottish Woodland. Wildlife Biology, 20(1): 1–18.

Mullen, B and Johnson, C. , 1990. The psychology of consumer behavior. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

NASA, 2019. Human Activity in China and India Dominates the Greening of Earth, NASA Study Shows. https://www.nasa.gov/feature/ames/human-activity-in-china-and-india-dominates-the-greening-of-earth-nasa-study-shows

O. Awaritefe, 2004. Motivation and other considerations in tourist destination choice: A case study of Nigeria. Tourism Geographies, 6 (3) (2004), pp. 303-330.

Oliver, R. , 1980. a cognitive model of the antecedents and consequences of satisfaction decision. Journal of Marketing Research 17, 460-469.

Pingping Cheng, Xiaozhong Yang & Min Peng, 2015. Research progress and enlightenment of tourism congestion at home and abroad.Tourism Tribune Vol.30 No.3， 2015

Qing J, Yang ZS, He K, Zhang ZJ, Gu XD, Yang XY, Zhang W, Yang B, Qi DW, Dai Q. 2016. The minimum area requirements (MAR) for giant panda: an empirical study. Scientific Reports, DOI: 10.1038/srep37715.

Rathnayake Mudiyanselage & Wasantha Rathnayake, 2015. How does 'crowding' affect visitor satisfaction at the Horton Plains National Park in Sri Lanka? Tourism Management Perspectives 16 (2015) 129–138.

Rujia Li, 2010. Development of Giant Panda Tourist Products from the Perspective of New Tourism: A Case Study of Tangjiahe National Nature Reserve. Journal of Southwest University for Nationalities: Humanities and Social Sciences, Edition 10, 2010.

Roe D, Leader-Williams N, Dalal-Clayton B. , 1997. Take Only Photographs, Leave Only Footprints: The Environmental Impacts of Wildlife Tourism. Wildlife and Development Series No.10. London: International Institute for Environment and Development.

Sichuan News Network, 2018. Over the past ten years, the total income of butterfly tourism in Wenchuan has increased by more than 55% annually. http://www.wenchuan.gov.cn/

Statistic Center, 2017. The Report for Operational Analysis of China Economy in 2017 and the Estimate for 2018.

S. Huang, C.H.C. Hsu, 2009. Effects of travel motivation, past experience, perceived constraint, and attitude on revisit intention. Journal of Travel Research, 48 (1) (2009), pp. 29-44.

Tahir Albayrak & Meltem Caber, 2018. Examining the relationship between tourist motivation and satisfaction by two competing methods, Tourism Management, Volume 69, December 2018, Pages 201-213.

Tian Yu, 2010. Study on the relationship between travel agency service quality and tourists' perceived value, satisfaction and behavioral intention. Doctoral dissertation, Huazhong University of Science and Technology.

Theil, H. , 1966. Applied Economic Forecasting. Amsterdam: North Holland Publishing Company.

Todaro, M.P. , 1969. A model of labor migration and urban unemployment in less developed countries. American Economic Review, 69, 486–499.

Ulli-Beer, S., Gassmann, F., Bosshardt, M. & Wokaun, A., 2010. Generic structure to simulate acceptance dynamics. System Dynamics Review, 26(2): 89-116.

Van Mai, Thanh and Bosch, O. J. H. , 2010. Systems thinking approach as a unique tool for sustainable tourism development: a case study in the Cat Ba biosphere reserve of Vietnam. In: Jennifer Wilby, 54th Annual Conference of the International Society for the Systems Sciences 2010: Governance for a Resilient Planet. Proceedings. ISSS2010: 54th Annual Conference of the International Society for the Systems Sciences 2010: *Governance for a Resilient Planet*, Waterloo, ON, Canada, (827-845). 18-23 July, 2010.

Viola, 2017. The shrinking habitat of giant pandas in China is exacerbated by tourism. http://oversea.huanqiu.com/article/2017-09/11287422.html?agt=540

Na Wang, 2016. Report on Government Work in 2015 : Report on the Work of Wenchuan County People's Government. http://www.wenchuan.gov.cn/

Weaver C L., 2010. A Case Study of the White Salmon River in Washington. Morgantown: West Virginia University.

Wei, F. et al, 2018. The Value of Ecosystem Services from Giant Panda Reserves, Current Biology.

Weihua Xu, Andrés Viña, Lingqiao Kong, Stuart L. Pimm, Jingjing Zhang, Wu Yang, Yi Xiao, Lu Zhang, Xiaodong Chen, Jianguo Liu, Zhiyun Ouyang, 2017. Reassessing the conservation status of the giant panda using remote sensing. *Nature Ecology & Evolution*; DOI: 10.1038/s41559-017-0317-1

Wenchuan County Statistical Bureau, 2018. Statistical Bulletin on National Economic and Social Development of Wenchuan County in 2017. http://www.wenchuan.gov.cn/

Wenchuan Net, 2012. Report on Government Work in 2011, http://www.wenchuan.gov.cn/

Wen Keat, Khoo & Musa, Nadianatra Bt, 2014. Responsible tourism system dynamic planning model for rural area.The 5th International Conference on Information and Communication Technology for The Muslim World, Nov. 2014, pp.1-6.

Xiaoqing, 2003. Emission Regulations and Directives for European Light Vehicles (Vehicles with Total Mass not exceeding 3.5t) (Euro I, Euro II, Euro III, Euro IV). Tianjin Vehicle Journal, Aug, 2003 (4)

Xiaoyan Wang & Xirui Sun, 2014. A study of destination selection of tourists in the context of “being crowed” — A case study of the imperial palace. Journal of Zun Yi normal college, Vol 16, No3. Jun 2014.

Xinhua News Agency, 2001. Protecting giant pandas is protecting our own future. http://www.people.com.cn/GB/huanbao/57/20011226/635767.html

Xuyu Yang & Rujia Li & Li Cheng & Shengjian Liu & Yuewu Xiong, 2006. Study on strategy of Ecotourism Development in Tangjiahe National Nature Reserve, Sichuan. Sichuan Journal of Zoology, vol 25, No 1, 2006.

Yongde Yang & Jun Lu, 2004. A New Presentation of Eco-tourism and Its Connotation. Journal of Guilin Institute of Tourism, Vol 15, No 6. Dec 2004.

Yanqing Zhang, 2008. An Empirical Study on Visitors' Behavior Trend after Travel——A Case of Leisure Tourists in Qingdao, TOURISM TRIBUNE, 2008, 23(3), pp 74-78.

Yi Fu, Xiaoming Liu, Yongqiang Wang & Ren-Fang Chao, 2018. How experiential consumption moderates the effects of souvenir authenticity on behavioral intention through perceived value.Tourism Management ,Volume 69, December 2018, pp 356-367.

Yue Chen, 2019. Paying Attention to "National Treasure" Giant Panda—Wolong Nature Conservation. http://www.cctv.com/special/536/3/25149.html

Yuewei Ma, Yongtao Zhao, Fubin Chen & Libo Lan, 2011. Impact of Yakang Expressway on the World Natural Heritage Site of Giant Panda Habitat in Sichuan Province. Resources and Environment in the Yangtze Basin, Vol 20, No 8. Aug 2011.

Zeithaml, V A. ,1988. Consumer perception of price, quality and value: A means-end model and synthesis of evidence. Journal of Marketing, 1988, 52(3):2-22.

Zhao, Y.H. , 1999. Labor migration and earnings differences: The case of rural China. Economic Development and Cultural Change, 47, 767–782.

Zhang, S.Z., & Dong, Y.F. , 2006. Viewing tourism development of world heritage of Xidi Hongcun from tourist experience. East China Economic Management, 20, 43–46.

Zhixue Liao, Peiyu Ren, Maozhu Jin & Zhenzhong Zhang, 2017. A system dynamics model to analyze the impact of environment and economy on scenic's sustainable development via a discrete graph approach. Journal of Difference Equations and Applications, 2017. VOL. 23, NOS. 1–2, 275–290.

Appendix 1 - Interview Outline

The Interview Outline

— Research on Ecotourism Project about Wild Giant Panda Based on System Dynamic

A. Purpose of the Interview

— In order to better understand the current living and income situation of the local population, the local ecological environment and the locals' understanding of wild giant pandas and their protection in Wo Long National Nature Reserve, field interviews were conducted. Interviews had been tape-recorded. All the interviews was conducted in Chinese and the translation literature is seen below.

B. Interview Method

— Face to face interview

C. Interviewee

— Local people in Wo Long county. They are living around the tourist site in Shenshuping Base, Wolong Giant Panda Garden, Sichuan.

D. Interview outline

(i)Opening remarks of the interview

Good afternoon. I am a student in University of Bergen, majoring in System Dynamic and now I doing my master paper about the research on Eco-tourism project about wild giant panda. As the tourism department has launched a eco-tourism project in Sichuan Province, the project is about wild giant panda, the threats and challenges are studied in my thesis. That is the reason I am coming for this interview. I want to collect some information about the locals here. So I appreciate that you accept my interview. This is the first time that I make an interview, if there is some questions that you do not want to answer. Please feel free to tell me. Finally, I hope everything will be good. Thank you.

(ii)Interview and dialogue

1. Question 1: Are you a local here? How long have you been here?

Answer: Yes, I was born here. I have been living here for over 70 years. / Yes, me too. He is my neighbor and I am living here for 55 years. / No, I am not a local here. I have moved here for 3 years. I run a hostel here with relatives. / Yes, I am local here and living here for 60 years. / Yes, I am local here. I am 68 year old this year and always lived here from born.

2. Question 2: What do you live for?

Answer: We are all famers before. After government bans people from going up mountains and closes a mountain pass, our agricultural land has been occupied. Therefore, all the farmers have changed work from farming. For those families whose

land is occupied, every household is received some money every month from government. / I am not the local here. I am from Yinxiu near here. I moved here 3 years ago. One of my relatives is married with a local here. They wanted to run a hostel, so I moved here with my wife to do business with them. They had a private plot of land and rebuilt a three-storey house for the hostel. Because of its high forest coverage, good air quality, cool summer time and the giant panda protection base, it is well known and it also attracts many tourists from home and abroad every year.

3. Question 3: How much is the funding from government every month?
   Answer: In our county, it's RMB 1,500 per person, which is much less than average.

4. Question 4: Can this amount of money afford the living of your family?
   Answer: It's not too much, but there are 6 people in my family. My two kids and grandsons are living in the town. Only my wife and I live here. We don't have too much expense, so it's affordable. But it's just a basic living standard. Most of the younger people are working or studying in the town, certainly there are some in other places.

5. Question 5: Which month is the high season in this area?
   Answer: High season here is from March to May and from September to November, the scenery is suitable and very attractive. So there are lots of tourists coming. The occupancy rate of my hostel could reach 90% on average in the high season.

6. Question 6: How much is the ADR in these area?
   Answer: ADR is around RMB 100 in the low season and up to RMB 200 in the high season, which is much less than ADR in Dujiangyan, where is only around 60 kilometers far away from Wo Long. In Dujiangyan, the ADR in some hotels could reach up to RMB 900. And the occupancy rate here is much lower than Dujiangyan as well. So Wo Long's tourism industry still has a lot of room for developing.

7. Question 7: How much is the annual profit for your hostel?
   Answer: I am coming here for 3 years and the average annual profit last year is around RMB 100,000.

8. Question 8: It's much higher than government subsidy. Have you ever considered working in tourism industry like him?
   Answer: We are too old and we also have some cultivated land. So in our region, the women in the family basically do farm work at home and men go out to work or do business. Some of our kids are also running a restaurant or hostel, some are working as a tour guide, some are driving a tour bus.

9. Question 9: Do you know what are the general sources of tourists?

Answer: The customers in my hostel are mainly individual travelers. Most of them are from Online travel agency (OTA). As a matter of fact, I am not willing to receive customers from OTA, because I have to pay them 10% to 20% commission from the reservation. But I have to use OTA, because the popularity here is limited. And most tourists will not choose to stay here for even one night. (Q: Why?) It's near Dujiangyan and Shuimo Town, which are two sites that is more famous than Wo Long, tourists prefer to stay there rather than here, even though the ADR in Wo Long is much lower. / The majority of the tourists drive here by private vehicle, of course there are some coming by tour bus. Because Wo Long is different from some other tourist destination. The reserve is a region, so driving private car may be much more convenient for most tourists./ You can see, if going into the Panda garden, although there is a storage battery car, tourist will prefer to drive by themselves.

10. Question 10: What do you think is the threaten for tourism here?

Answer: Transportation is one of the biggest obstacle to the development of tourism industry in this area. Because there are many mountains, the roads here are almost all mountain roads, there is no highway, so it is not particularly convenient. It takes more than 40 minutes to get down from the nearest express way./ Another is weather, I think. Summer is a rainy season, when there is a lot of rain. The terrain here is surrounded by mountains. After the earthquake several years ago, the rainy season is prone to some geological disasters particularly, such as landslides, debris flows and so on. Due to the security factor and transportation convenience factor said before, arrived tourists have not been maximized yet. Therefore, the tourism development in this area is always limited. / Like I said before, maybe the infrastructure is the reason for tourists who are choosing Dujiangyan or Shuimo Town for accommodation. Because of many objective conditions, the development here is not too fast. The fact is the accommodation environment is not as good as the surrounding two hot spots. Although Wo Long has better ecological environment, tourists are not willing to come to stay.

11. Question 11: Do you find any changes or development in these years?

Answer: When I was a little boy, wild giant pandas lived in these high mountains and people often saw them when going up the hill or sometimes pandas would come downhill to find food in farmhouse. In my impression, there are many pandas on these mountains above. After Wo Long joined Man and Biosphere Reserve, more people get to know these area. Investments, tourists, researchers are coming in. So does the pollution. Government started to realize that protecting wildlife is a main and arduous work, especially wild giant panda. Pandas have a single source of food and only eat bamboo. Once bamboo is destroyed, its survival will be affected. A large-scale bamboo blossom took place between 1984 and 1987. The bamboos of Minshan and Qionglaishan systems in Sichuan Province blossomed and died in large areas, threatening the survival of local giant pandas. Then the number of pandas are

decreasing rapidly. The government has also embarked on a number of measures, such as not allowing people to re-enter the mountains, not allowing trees to be cut down on the mountains, not allowing damage to the environment of giant pandas' habitats, to name a few. So now wild pandas live in the mountains. But sometimes when there is no food, we would see some pandas come down and go to our farm house to find food. Pandas don't just eat bamboo, sometimes they eat meat as well. / When the earthquake hit here a few years ago, the target of Hong Kong's assistance was Wo Long, so a lot of money was invested here. Many of the tunnels and roads you drove in were repaired at that time, so the infrastructure is much better than before. This gives tourism a big chance to develop.

(iii)Conclusion of the interview
Thanks so much for answering my questions today.

Appendix 2 - Questionnaire

基于系统动力学的大熊猫生态旅游研究

Research on Ecotourism Project about Giant Panda Based on System Dynamic

1. 您的年龄 Your age

选项	小计	比例
18岁以下 below 18	16	2.03%
18到25岁 18~25	160	20.28%
26到30岁 26~30	210	26.62%
31到40岁 31~40	180	22.81%
41到50岁 41~50	120	15.21%
51到60岁 51~60	83	10.52%
60以上 Above 60	20	2.53%
本题有效填写人次	789	

2. 您的状态 Your State

选项	小计	比例
读书 School	55	6.97%
工作 Work	689	87.33%
退休 Retired	20	2.53%
无业 No job	25	3.17%

本题有效填写人次	789	

3. 您的学历 Your Education

选项	小计	比例
高中及以下 High School and Below	162	20.53%
大专 College	257	32.57%
大学本科 Undergraduate	280	35.49%
硕士研究生 Postgraduate	67	8.49%
博士及以上 PhD and Above	23	2.92%
本题有效填写人次	789	

4. 参加工作的年度 Years to work

选项	小计	比例
1年以下 Less Than One Year	78	9.89%
1到5年 One to Five Years	190	24.08%
5到10年 Five to Ten Years	167	21.17%
10到20年 Ten to Twenty Years	130	16.48%
20到30年 Twenty to Thirty Years	175	22.18%
30年以上 More Than Thirty Years	49	6.21%
本题有效填写人次	789	

5. 家庭年收入（人民币/年） Family Income （RMB/Year）

选项	小计	比例

5万以下 Below 50,000	101	12.8%
5万至10万 Between 50,000 and 100,000	293	37.14%
10万至20万 Between 100,000 and 200,000	203	25.73%
20万至30万 Between 200,000 and 300,000	126	15.97%
30万以上 Above 300,000	66	8.37%
本题有效填写人次	789	

6. 每年旅游的支出占家庭年收入的比重 Annual expenditure on tourism as a proportion of annual household income

选项	小计	比例
5%	90	11.41%
10%	175	22.18%
15%	255	32.32%
20%	144	18.25%
25%	84	10.65%
30%	41	5.2%
本题有效填写人次	789	

7. 您是否有过生态旅游的体验?
Have you ever had an eco-tourism experience?

选项	小计	比例
是 Yes	605	76.68%
否 No	184	23.32%

本题有效填写人次	789	

8. 生态旅游的次数是The number of ecotourism is

选项	小计	比例
0	1	0.17%
1-2	329	54.38%
3-5	179	29.59%
>5	96	15.87%
本题有效填写人次	605	

8. 您没有生态旅游的经历的原因是
The reason you have no experience of eco-tourism is

选项	小计	比例
不了解 Don't understand	122	24.8%
不喜欢 Don't like	28	5.69%
不认可 Disagree	21	4.27%
其他 Others	321	65.24%
本题有效填写人次	492	

8-1. 除了生态旅游，平均每年旅游次数 Traveling time per year

选项	小计	比例
0	27	3.72%
1-2	172	23.72%
3-5	156	21.52%

> 5	370	51.03%
本题有效填写人次	725	

8-2. 每次旅行的人均消费 (元/人)
Average tourist consumption each time (RMB/Person)

选项	小计	比例
≤ 3,000	131	31.41%
3,000 - 5,000	140	33.57%
5,000 - 10,000	68	16.31%
10,000 - 20,000	60	14.39%
≥ 20,000	18	4.32%
本题有效填写人次	417	

8-3.旅游信息获取来源Source of travel information

选项	小计	比例
网络 Internet	378	47.91%
电视 TV	384	48.67%
报纸 Newspaper	342	43.35%
杂志 Magazine	281	35.61%
朋友推荐 Recommendation	331	41.95%
传单 Leaflets	185	23.45%
本题有效填写人次	789	

8-4. 常选的旅行目的地 Frequent tourist destination is

选项	小计	比例
省内游 In province	222	28.14%
国内游 Domestic Travel	318	40.3%
东南亚游 Southest Asia	186	23.57%
其他地区 Other Region	63	7.98%
本题有效填写人次	789	

8-5. 相较于国内游，您选择东南亚的原因是
Compared with domestic tourist，the reason you prefer Southeast Asia is

选项	小计	比例
人均消费低，性价比高 Low average consumption and high cost-effective	58	31.18%
游客相对少，拥挤度低 Few tourists and low crowding	67	36.02%
异域风情，吸引力更大 More exotic and more attractive	61	32.8%
本题有效填写人次	186	

8-6. 如果有机会选择一次生态旅游，您愿意吗?
If you have the opportunity to choose an eco-tour, would you like to?

选项	小计	比例
愿意 Yes	656	83.14%
不愿意 No	133	16.86%
本题有效填写人次	789	

9. 您选择到生态旅游地旅游的目的是?
What is the purpose of choosing an ecotourism destination?

选项	小计	比例
呼吸新鲜空气, 休闲度假 Breathe fresh air, vocational recreation.	304	38.53%
认识动植物，学习为主要目的 Recognize plants and animals, learning as a main task.	269	34.09%
感受当地民俗文化 Experience local culture	216	27.38%
本题有效填写人次	789	

10.您眼中的生态旅游更接近哪旅游方式?
In your eyes, which tourism mode is closer to eco-tourism?

选项	小计	比例
资金投入较多,商业开发和建设较好的经济旅游 More capital investment, commercial development and construction of better economic tourism	173	21.93%
无过多人工修造开发的景区 There are no too many artificial scenic spots	238	30.16%
完全欣赏纯正自然风景的原生态旅游 Fully appreciate the authentic natural scenery of the original ecological tourism	192	24.33%
感受原汁原味的地区民俗文化节庆 Experience the authentic local folk culture festivals	147	18.63%
其他 Others	39	4.94%
本题有效填写人次	789	

11. 对生态旅游资源保护的态度是
Your attitude towards the protection of eco-tourism resources is

选项	小计	比例
无所谓，自己开心就好 It doesn't matter.	156	19.77%

不会刻意保护，也不会刻意破坏 There is no deliberate protection and also no deliberate destruction	214	27.12%
保护生态，从我做起 Protect the environment	419	53.11%
本题有效填写人次	789	

12.您认为”生态旅游’计划的实施,能否改善现存的旅游开发和生态保护矛盾现状?
Do you think the implementation of the eco-tourism plan can improve the existing contradiction between tourism development and ecological protection?

选项	小计	比例
不能 Cannot	156	19.77%
能，但效果不大 Yes, but not much	370	46.89%
不知道，无法预计 I don't know and can't predict	263	33.33%
本题有效填写人次	789	

13. 您知道四川省推出的“大熊猫生态旅游”的项目吗?
Do you know the ecotourism project about Giant Panda from Sichuan Province?

选项	小计	比例
是 Yes	481	60.96%
否 No	308	39.04%
本题有效填写人次	789	

14. 对于“大熊猫生态旅游”的项目，您是否支持?
Do you support the project of "panda eco-tourism"?

选项	小计	比例
是 Yes	711	90.11%
否 No	78	9.89%
本题有效填写人次	789	

14-1. 您支持“大熊猫生态旅游”的原因是
The reason you support the “panda eco-tourism” is

选项	小计	比例
富有创意及特色，有吸引力 Creative, unique and attractive	232	29.97%
提高当地人的收入，有一定的经济利益 Raise the income level of the local	187	24.16%
具有一定的教育意义 Education significance	355	45.87%
本题有效填写人次	774	

15.如果开展“大熊猫生态旅游”的项目，您认为潜在的最大的威胁是
If the project of panda eco-tourism is carried out, the biggest potential threat in your mind is

选项	小计	比例
商业开发严重 Serious business development	95	27.38%
水污染、空气污染等 Water pollution, air pollution etc.	100	28.82%
自然保护对象受影响 Conservation objects are affected	105	30.26%
当地文化受冲击 Local culture suffered	47	13.54%
本题有效填写人次	347	

16. 您认为大熊猫生态旅游开展过程中可能出现问题有哪些?
What do you think are the problems in the development of panda eco-tourism?

选项	小计	比例
生态旅游活动的开展没有标准的规范 There is no standard specification for eco-tourism activities	169	21.42%
游客素质文明差，景区管理不规范 Tourist quality civilization is poor, scenic spot management is not standard	294	37.26%

政府注重开发发展，却很少注重保护 Governments focus on development, but little on protection	183	23.19%
生态旅游环保意识未深入人心 Awareness of ecological tourism and environmental protection has not been deeply rooted	143	18.12%
本题有效填写人次	789	

17. 你是否到卧龙国家级自然保护区旅游过？Have you ever traveled to Wolong National Nature Reserve?

选项	小计	比例
是 Yes	436	55.26%
否 No	353	44.74%
本题有效填写人次	789	

18. 对于该大熊猫生态旅游，您愿意支付的人均消费(元/人)
Average consumption you'd like to pay in this Panda Eco-tourism (RMB/Person)

选项	小计	比例
< 1000	228	28.9%
1000 - 3000	237	30.04%
3000 - 5000	146	18.5%
5000 - 10000	103	13.05%
10000 - 15000	40	5.07%
> 15000	35	4.44%
本题有效填写人次	789	

19. 对于该大熊猫生态旅游，每次出游天数 Days for traveling in this panda eco-tourism each time

选项	小计	比例
< 3	315	39.92%
3-5	287	36.38%
6-9	108	13.69%
>10	79	10.01%
本题有效填写人次	789	

20. 该大熊猫生态旅游倾向选择的交通方式 Transport type you prefer during this Panda Eco-tourism

选项	小计	比例
私人汽车 Private car	205	25.98%
旅游大巴 Tourist bus	283	35.87%
公共交通工具 Public Transportation	212	26.87%
其他 Others	89	11.28%
本题有效填写人次	789	

21-1. 如果一辆私家车载重5人，您觉得出游时一辆车坐几人最好？If a private car carries five people, how many people do you think are the best in a car when traveling to Wolong?

选项	小计	比例
1	90	11.41%
2	159	20.15%
3	177	22.43%
4	254	32.19%

5	109	13.81%
本题有效填写人次	789	

22.假设卧龙大熊猫生态旅游景区的容量预计为每天最多可接纳100人，那么每天接纳人数多少让您感觉100%满意？Assuming that the capacity of Wolong is expected up to 100 people per day, how many people it receives per day will make you feel 100% satisfied?

选项	小计	比例
200	63	7.98%
150	141	17.87%
100	201	25.48%
50	298	37.77%
0	86	10.9%
本题有效填写人次	789	

23. 关于卧龙大熊猫生态旅游的景区，您认为服务员与游客的比重为多少时，能让您觉得100%满意？Regarding to Wolong, you could get 100% satisfactory when the proportion of waiters and tourists is?

选项	小计	比例
2:1	91	11.53%
1.5:1	159	20.15%
1:1	287	36.38%
0.5:1	252	31.94%
本题有效填写人次	789	

24. 您对经济发展和环境保护的态度是
Your attitude towards economic development and environmental protection is

选项	小计	比例
经济更重要，要先搞好经济发展再进行环境保护 The economy is more important. We should first develop the economy and then protect the environment	96	12.17%
环保更重要，任何的经济发展不能以牺牲环境为代价 Environmental protection is more important. No economic development can be achieved at the expense of the environment	192	24.33%
两方面都很重要，二者需要兼顾 Both are important, and both need to be taken care of	320	40.56%
视具体情况而定，以获得利益为前提 Depending on the specific circumstances, the premise is to gain benefits	181	22.94%
本题有效填写人次	789	

25. 您认为政府部门该怎样加强大熊猫生态保护区的环境保护工作?
How do you think the government should strengthen the environmental protection to the ecological reserve?

选项	平均分	比例
制定健全各种法律规章制度，加强法律执法力度 We will formulate and improve various laws and regulations and strengthen law enforcement	26.51	27%
加大环保方面的教育和宣传力度，提高人们的环保意识 Increase environmental protection education and publicity efforts to raise people's awareness of environmental protection	24.73	25%
旅游景区加强规范管理，保护好生态旅游资源 The tourist scenic spots should strengthen the management and protect the ecological tourism resources	26.27	26%

更新游客的固有观念，使其正确认识生态旅游 Update the inherent concept of tourists so that they correctly understand eco-tourism	19.23	19%

26. 您是否同意并做到景区对游客的以下要求:
Can you meet the following requirements for tourists in the scenic spot:

该矩阵题平均分：**1.77**

题目\选项	同意 Agree	中立 Neutral	不同意 Disagree	平均分
禁止随意投喂食物 No feeding at will	316(40.05%)	222(28.14%)	251(31.81%)	1.92
携带环保袋，不乱扔垃圾 Carry environmental bags instead of littering	346(43.85%)	176(22.31%)	267(33.84%)	1.9
严禁吸烟或点火 No smoking or lighting up	440(55.77%)	172(21.8%)	177(22.43%)	1.67
不乱刻乱画，损毁旅游资源 No graffiti, damage tourism resources	232(47.06%)	95(19.27%)	166(33.67%)	1.87
尊重当地风俗习惯、文化传统及宗教信仰 Respect local customs, cultural traditions and religious beliefs	320(64.91%)	95(19.27%)	78(15.82%)	1.51
遵守公共秩序，爱护公共设施 Observe public order and take good care of public facilities	280(56.8%)	61(12.37%)	152(30.83%)	1.74
小计	1934(50.29%)	821(21.35%)	1091(28.37%)	1.78

27. 您同意对于破坏生态环境等游客罚款或处罚吗?
Do you agree to fine or punish tourists for damaging the ecological environment?

选项	小计	比例
同意，必须严惩 Yes，Must be punished severely	384	48.67%
同意，只是稍加惩戒就行 Yes, with a little discipline	331	41.95%

不同意 No	74	9.38%
本题有效填写人次	789	

28. 您是否赞成限制游客人数以减少对环境的损失?
Are you in favor of limiting the number of visitors to reduce the damage to the environment?

选项	小计	比例
赞成 Agree	649	82.26%
不赞成 Disagree	140	17.74%
本题有效填写人次	789	

29. 您是否同意利用统一的公共交通工具代替私家车等进行游玩?
Do you agree to use public transport instead of private cars?

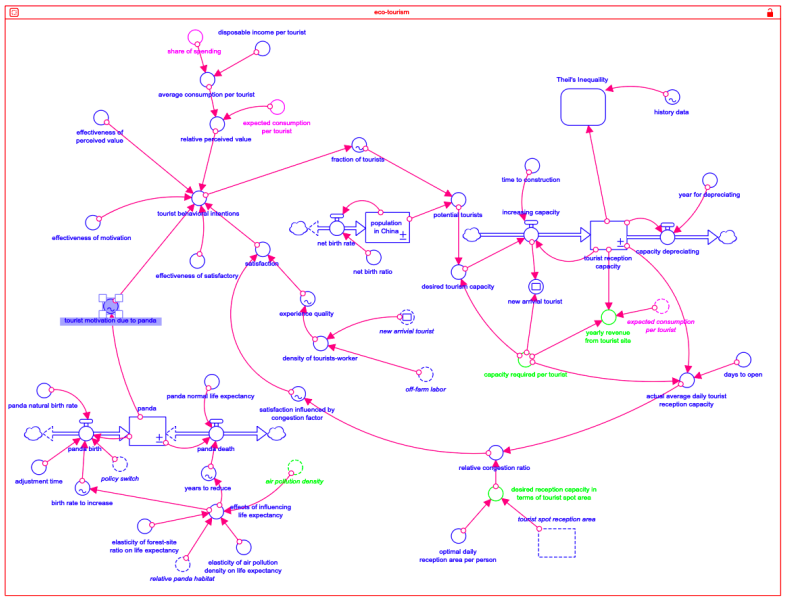
选项	小计	比例
是的 Yes	629	79.72%
不是 No	160	20.28%
本题有效填写人次	789	

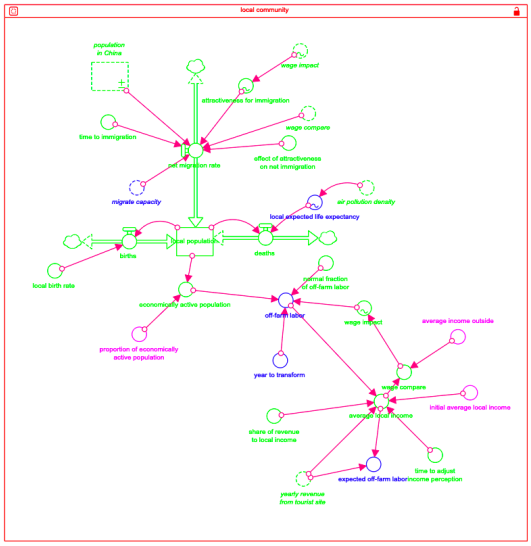
30. 您会积极响应国家的环保政策，参与到环保的行动中来吗?
Will you actively respond to national environmental policies and take part in environmental actions?

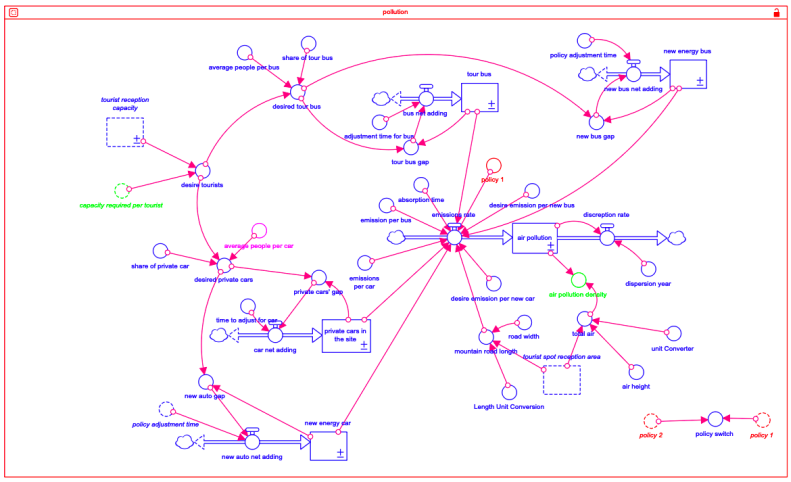
选项	小计	比例
会，不仅自己做到，还会带动周围的人都爱护环境 Yes, not only oneself do, but also will drive around the people to love the environment	304	38.53%
自己本身会切实做到保护环境 I will protect the environment myself	286	36.25%
如果环保政策不会损害自身利益，我会参与 If environmental policies do not harm my interests, I will participate	131	16.6%

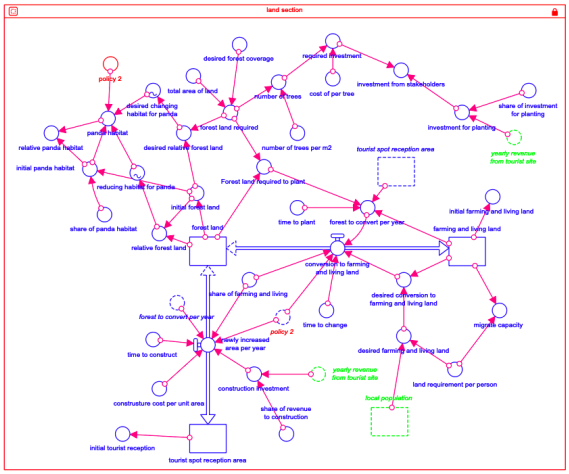
有强制措施时会，不然看自己心情 When have coercive measure, see oneself mood otherwise	68	8.62%
本题有效填写人次	789	

Appendix 3 - Model Brief









Appendix 4 - Documentation of simulation model

policy_switch = IF(policy_2+policy_1<1) THEN 0 ELSE 1
  UNITS: 1

Theil's_Inequaility.Bias = (Mm-Md)*(Mm-Md)/MSE
  UNITS: unitless

Theil's_Inequaility.count(t) = count(t - dt) + (add_one) * dt
  INIT Theil's_Inequaility.count = 1e-9
  UNITS: unitless

  INFLOWS:
    Theil's_Inequaility.add_one = pick/DT
      UNITS: Per Year

Theil's_Inequaility.Covariation = 2*Sm*Sd*(1-R)/MSE
  UNITS: unitless

Theil's_Inequaility.Di = pick*sample_number*units_conversion
  UNITS: stats

Theil's_Inequaility.end = 5000 {any time greater than the end of the simulation run}
  UNITS: Years

Theil's_Inequaility.Md = Sum_Di/count
  UNITS: stats

Theil's_Inequaility.Mdsq = Sum_Dsq/count
  UNITS: stats^2

Theil's_Inequaility.Mi = pick*tourists_capacity*units_conversion
  UNITS: stats

Theil's_Inequaility.Mm = Sum_Mi/count
  UNITS: stats

Theil's_Inequaility.Mmd = Sum_MY/count
  UNITS: stats^2

Theil's_Inequaility.Mmsq = Sum_Msq/count
  UNITS: stats^2

Theil's_Inequaility.MSE = "Sum_M-Dsq"/count
  UNITS: stats^2

Theil's_Inequaility.pick = PULSE(DT,start,1)*(STEP(1,start)-STEP(1,end+DT/2))
  UNITS: unitless

Theil's_Inequaility.R = (Mmd-Mm*Md)/(Sm*Sd+(1e-9))
  UNITS: unitless

Theil's_Inequaility.RMSPE = SQRT(Sum_PE/count)
  UNITS: unitless

Theil's_Inequaility.Rsq = R^2
  UNITS: unitless

Theil's_Inequaility.sample_number = .history_data
  UNITS: RMB

Theil's_Inequaility.Sd = SQRT(Mdsq-Md*Md)
  UNITS: stats

Theil's_Inequaility.Sm = SQRT(Mmsq-Mm*Mm)
  UNITS: stats

Theil's_Inequaility.start = STARTTIME
  UNITS: Years

Theil's_Inequaility.Sum_Di(t) = Sum_Di(t - dt) + (add_Di) * dt
  INIT Theil's_Inequaility.Sum_Di = 0
  UNITS: stats

  INFLOWS:
    Theil's_Inequaility.add_Di = Di/DT
      UNITS: stats/Years

Theil's_Inequaility.Sum_Dsq(t) = Sum_Dsq(t - dt) + (add_Dsq) * dt
  INIT Theil's_Inequaility.Sum_Dsq = 0
  UNITS: stats^2

  INFLOWS:
    Theil's_Inequaility.add_Dsq = Di*Di/DT
      UNITS: stats^2/Years

Theil's_Inequaility."Sum_M-Dsq"(t) = "Sum_M-Dsq"(t - dt) + ("add_M-Dsq") * dt
  INIT Theil's_Inequaility."Sum_M-Dsq" = 1e-9
  UNITS: stats^2
  INFLOWS:
    Theil's_Inequaility."add_M-Dsq" = (Mi-Di)*(Mi-Di)/DT
      UNITS: stats^2/Years

```
Theil's_Inequaility.Sum_Mi(t) = Sum_Mi(t - dt) + (add_Mi) * dt
   INIT Theil's_Inequaility.Sum_Mi = 0
   UNITS: stats
   INFLOWS:
      Theil's_Inequaility.add_Mi = Mi/DT
         UNITS: stats/Years

Theil's_Inequaility.Sum_Msq(t) = Sum_Msq(t - dt) + (add_Msq) * dt
   INIT Theil's_Inequaility.Sum_Msq = 0
   UNITS: stats^2

   INFLOWS:
      Theil's_Inequaility.add_Msq = Mi*Mi/DT
         UNITS: stats^2/Years

Theil's_Inequaility.Sum_MY(t) = Sum_MY(t - dt) + (add_MD) * dt
   INIT Theil's_Inequaility.Sum_MY = 0
   UNITS: stats^2

   INFLOWS:
      Theil's_Inequaility.add_MD = Mi*Di/DT
         UNITS: stats^2/Years

Theil's_Inequaility.Sum_PE(t) = Sum_PE(t - dt) + (add_PE) * dt
   INIT Theil's_Inequaility.Sum_PE = 0
   UNITS: unitless

   INFLOWS:
      Theil's_Inequaility.add_PE = IF Di > 0 OR Di < 0 THEN  (((Mi-Di)/Di)^2)/DT ELSE 0
         UNITS: Per Year

Theil's_Inequaility.tourists_capacity = .tourist_reception_capacity
   UNITS: RMB

Theil's_Inequaility.units_conversion = 1
   UNITS: stats/RMB

Theil's_Inequaility.Variation = (Sm-Sd)*(Sm-Sd)/MSE
   UNITS: unitless

**********
"eco-tourism":
**********
actual_average_daily_tourist_reception_capacity = tourist_reception_capacity/
capacity_required_per_tourist/days_to_open
```

UNITS: People/Days

adjustment_time = 1
UNITS: year

average_consumption_per_tourist = disposable_income_per_tourist*share_of_spending
UNITS: RMB/PEOPLE
birth_rate_to_increase = GRAPH(effects_of_influencing_life_expectancy)
(0.00, 0.1), (4.00, 0.09837), (8.00, 0.0962), (12.00, 0.09076), (16.00, 0.08152), (20.00, 0.06196), (24.00, 0.0212), (28.00, 0.00924), (32.00, 0.00435), (36.00, 0.00163), (40.00, 0)
UNITS: unitless

capacity_required_per_tourist = 0.0348
UNITS: RMB/people

days_to_open = 365
UNITS: day

"density_of_tourists-worker" = new_arrivial_tourist/"off-farm_labor"
UNITS: 1

desired_reception_capacity_in_terms_of_tourist_spot_area = tourist_spot_reception_area/optimal_daily_reception_area_per_person
UNITS: People/Days

desired_tourism_capacity = potential_tourists*capacity_required_per_tourist
UNITS: RMB

disposable_income_per_tourist = 1
UNITS: RMB/PEOPLE

effectiveness_of_motivation = 0.53
UNITS: 1

effectiveness_of_perceived_value = 0.14
UNITS: 1

effectiveness_of_satisfactory = 0.31
UNITS: 1

effects_of_influencing_life_expectancy = -relative_panda_habitat^"elasticity_of_forest-site_ratio_on_life_expectancy"*air_pollution_density^elasticity_of_air_pollution_density_on_life_expectancy
UNITS: 1

elasticity_of_air_pollution_density_on_life_expectancy = 0.3

UNITS: 1

"elasticity_of_forest-site_ratio_on_life_expectancy" = -0.3
UNITS: 1

expected_consumption_per_tourist = 0.01
UNITS: RMB/People

experience_quality = GRAPH("density_of_tourists-worker")
(0, 0.2000), (100, 0.4033), (200, 0.7093), (300, 0.9038), (400, 0.9781), (500, 1.0000), (600, 0.9760), (700, 0.9104), (800, 0.7705), (900, 0.5301), (1000, 0.2000)
UNITS: 1

fraction_of_tourists = GRAPH(tourist_behavioral_intentions)
(0.000, 0), (0.150, 0.000135), (0.300, 0.00036), (0.450, 0.000946), (0.600, 0.002162), (0.750, 0.005495), (0.900, 0.007568), (1.050, 0.008874), (1.200, 0.00955), (1.350, 0.00991), (1.500, 0.009955)
UNITS: 1

history_data = GRAPH(TIME)
(2009.000, 20000.00), (2011.000, 160000.00), (2013.000, 140000.00), (2015.000, 354800.00), (2017.000, 270300.00)
UNITS: RMB

net_birth_ratio = 0.00532
UNITS: 1/year

new_arrivial_tourist = increasing_capacity/capacity_required_per_tourist
UNITS: people/year

optimal_daily_reception_area_per_person = 2
UNITS: square meter/(people/day)

panda(t) = panda(t - dt) + (panda_birth - panda_death) * dt
INIT panda = 200
UNITS: panda
INFLOWS:
panda_birth = IF policy_switch=1 THEN panda_natural_birth_rate+panda*birth_rate_to_increase/adjustment_time ELSE panda_natural_birth_rate
UNITS: panda/year
OUTFLOWS:
panda_death = panda/(panda_normal_life_expectancy-years_to_reduce)
UNITS: panda/year

panda_natural_birth_rate = 0.645

UNITS: panda/year

panda_normal_life_expectancy = 26
UNITS: year

population_in_China(t) = population_in_China(t - dt) + (net_birth_rate) * dt
INIT population_in_China = 1390080000
UNITS: People
INFLOWS:
net_birth_rate = population_in_China*net_birth_ratio
UNITS: people/year

potential_tourists = population_in_China*fraction_of_tourists
UNITS: people

relative_congestion_ratio = actual_average_daily_tourist_reception_capacity/
desired_reception_capacity_in_terms_of_tourist_spot_area
UNITS: 1

relative_perceived_value = average_consumption_per_tourist/
expected_consumption_per_tourist
UNITS: 1

satisfaction = experience_quality+satisfaction_influenced_by_congestion_factor
UNITS: 1

satisfaction_influenced_by_congestion_factor = GRAPH(relative_congestion_ratio)
(0.000, 0.000), (0.100, 0.202), (0.200, 0.399), (0.300, 0.609), (0.400, 0.803), (0.500, 1.000),
(0.600, 0.801), (0.700, 0.598), (0.800, 0.404), (0.900, 0.189), (1.000, 0.000)
UNITS: 1

share_of_spending = 0.15
UNITS: 1

time_to_construction = 5
UNITS: year

tourist_behavioral_intentions =
SMTH1(tourist_motivation_due_to_panda^effectiveness_of_motivation*satisfaction^effectiv
eness_of_satisfactory*relative_perceived_value^effectiveness_of_perceived_value, 0.5, 1)
UNITS: 1

tourist_motivation_due_to_panda = GRAPH(panda)
(0, 0.000), (100, 0.419), (200, 0.694), (300, 0.869), (400, 0.937), (500, 0.977), (600, 1.000),
(700, 0.941), (800, 0.842), (900, 0.689), (1000, 0.423)
UNITS: 1

tourist_reception_capacity(t) = tourist_reception_capacity(t - dt) + (increasing_capacity - capacity_depreciating) * dt
  INIT tourist_reception_capacity = 246000
  UNITS: RMB
  INFLOWS:
    increasing_capacity = (desired_tourism_capacity-tourist_reception_capacity)/ time_to_construction
      UNITS: RMB/year
  OUTFLOWS:
    capacity_depreciating = tourist_reception_capacity/year_for_depreciating
      UNITS: RMB/year

year_for_depreciating = 20
  UNITS: year
yearly_revenue_from_tourist_site = tourist_reception_capacity/ capacity_required_per_tourist*expected_consumption_per_tourist
  UNITS: RMB

years_to_reduce = GRAPH(effects_of_influencing_life_expectancy)
(-1.00, 0.00), (0.60, 0.068), (2.20, 0.18), (3.80, 0.495), (5.40, 1.74), (7.00, 5.16), (8.60, 7.93), (10.20, 9.02), (11.80, 9.51), (13.40, 9.78), (15.00, 9.95)
  UNITS: year

****
land_section:
****
construction_investment = yearly_revenue_from_tourist_site*share_of_revenue_to_construction
  UNITS: RMB

construsture_cost_per_unit_area = 0.1
  UNITS: RMB/square meter

cost_of_per_tree = 0.0001
  UNITS: RMB/tree

desired_changing_habitat_for_panda = GRAPH(desired_relative_forest_land)
(0.000, -30000000), (0.120, -29500000), (0.240, -27800000), (0.360, -23500000), (0.480, -15100000), (0.600, 4600000), (0.720, 16500000), (0.840, 23800000), (0.960, 27000000), (1.080, 28900000), (1.200, 30000000)
  UNITS: square meter

desired_conversion_to_farming_and_living_land = desired_farming_and_living_land-farming_and_living_land
  UNITS: square meter

desired_farming_and_living_land = local_population*land_requirement_per_person
UNITS: square meter

desired_forest_coverage = 0.6
UNITS: 1

desired_relative_forest_land = forest_land_required/initial_forest_land
UNITS: 1

farming_and_living_land(t) = farming_and_living_land(t - dt) +
(conversion_to_farming_and_living_land) * dt
INIT farming_and_living_land = 32030000
UNITS: square meter
INFLOWS:
conversion_to_farming_and_living_land = IF policy_2=0 THEN
desired_conversion_to_farming_and_living_land/time_to_change ELSE
MIN(forest_to_convert_per_year*share_of_farming_and_living,
desired_conversion_to_farming_and_living_land/time_to_change)
UNITS: square meter/year

forest_land(t) = forest_land(t - dt) + (- conversion_to_farming_and_living_land -
newly_increased_area_per_year) * dt
INIT forest_land = 1138000000
UNITS: square meter
OUTFLOWS:
conversion_to_farming_and_living_land = IF policy_2=0 THEN
desired_conversion_to_farming_and_living_land/time_to_change ELSE
MIN(forest_to_convert_per_year*share_of_farming_and_living,
desired_conversion_to_farming_and_living_land/time_to_change)
UNITS: square meter/year

newly_increased_area_per_year = IF(policy_2=0) THEN (construction_investment/
construsture_cost_per_unit_area)/time_to_construct ELSE MIN((construction_investment/
construsture_cost_per_unit_area)/time_to_construct, forest_to_convert_per_year*(1-
share_of_farming_and_living))
UNITS: square meter/year

forest_land_required = total_area_of_land*desired_forest_coverage
UNITS: square meter

Forest_land_required_to_plant = forest_land-forest_land_required
UNITS: square meter

forest_to_convert_per_year = (Forest_land_required_to_plant-farming_and_living_land-
tourist_spot_reception_area)/time_to_plant
UNITS: square meter/year

initial_farming_and_living_land = INIT(farming_and_living_land)
   UNITS: square meter

initial_forest_land = INIT(forest_land)
   UNITS: square meter

initial_panda_habitat = initial_forest_land*share_of_panda_habitat
   UNITS: square meter

initial_tourist_reception = INIT(tourist_spot_reception_area)
   UNITS: square meter

investment_for_planting =
yearly_revenue_from_tourist_site*share_of_investment_for_planting
   UNITS: RMB

investment_from_stakeholders = required_investment-investment_for_planting
   UNITS: RMB

land_requirement_per_person = 873.3333333
   UNITS: square meter/people

migrate_capacity = farming_and_living_land/land_requirement_per_person
   UNITS: People

number_of_trees = forest_land_required*number_of_trees_per_m2
   UNITS: tree

number_of_trees_per_m2 = 1
   UNITS: tree/square meter

panda_habitat = IF policy_2=0 THEN initial_panda_habitat+reducing_habitat_for_panda
ELSE initial_panda_habitat+desired_changing_habitat_for_panda
   UNITS: square meter

policy_2 = 1
   UNITS: 1

reducing_habitat_for_panda = GRAPH(relative_forest_land)
(0.000, -30000000), (0.120, -29500000), (0.240, -27800000), (0.360, -23500000), (0.480, -15100000), (0.600, 4600000), (0.720, 16500000), (0.840, 23800000), (0.960, 27000000), (1.080, 28900000), (1.200, 30000000)
   UNITS: square meter

relative_forest_land = forest_land/initial_forest_land

UNITS: 1

relative_panda_habitat = panda_habitat/initial_panda_habitat
UNITS: 1

required_investment = number_of_trees*cost_of_per_tree
UNITS: RMB

share_of_farming_and_living = 0.25
UNITS: 1

share_of_investment_for_planting = 0.2
UNITS: 1

share_of_panda_habitat = 0.05
UNITS: 1

share_of_revenue_to_construction = 0.05
UNITS: 1

time_to_change = 5
UNITS: year

time_to_construct = 5
UNITS: year

time_to_plant = 15
UNITS: year

total_area_of_land = 2000000000
UNITS: square meter

tourist_spot_reception_area(t) = tourist_spot_reception_area(t - dt) +
(newly_increased_area_per_year) * dt
INIT tourist_spot_reception_area = 79853000
UNITS: square meter
INFLOWS:
newly_increased_area_per_year = IF(policy_2=0) THEN (construction_investment/
construsture_cost_per_unit_area)/time_to_construct ELSE MIN((construction_investment/
construsture_cost_per_unit_area)/time_to_construct, forest_to_convert_per_year*(1-
share_of_farming_and_living))
UNITS: square meter/year

****
local_community:
****

attractiveness_for_immigration = GRAPH(wage_impact)
(-1.000, -1.000), (-0.600, -0.703), (-0.200, -0.189), (0.200, 0.315), (0.600, 0.658), (1.000, 1.000)
  UNITS: 1

average_income_outside = 6
  UNITS: RMB/PEOPLE

average_local_income = SMTH3((yearly_revenue_from_tourist_site*share_of_revenue_to_local_income)/"off-farm_labor", time_to_adjust_income_perception, initial_average_local_income)
  UNITS: RMB/people

economically_active_population = proportion_of_economically_active_population*local_population
  UNITS: people

effect_of_attractiveness_on_net_immigration = 0.01
  UNITS: 1

"expected_off-farm_labor" = yearly_revenue_from_tourist_site/average_local_income
  UNITS: People

initial_average_local_income = 1.35
  UNITS: RMB/PEOPLE

local_birth_rate = 0.006
  UNITS: 1/year

local_expected_life_expectancy = GRAPH(air_pollution_density)
(0, 75.00), (250, 72.00), (500, 70.00), (750, 68.00), (1000, 60.00)
  UNITS: year

local_population(t) = local_population(t - dt) + (births + net_migration_rate - deaths) * dt
  INIT local_population = 5000
  UNITS: people
  INFLOWS:
    births = local_population*local_birth_rate
      UNITS: people/year
    net_migration_rate = IF(wage_compare<1) THEN - (MIN(migrate_capacity, population_in_China)*attractiveness_for_immigration^effect_of_attractiveness_on_net_immigration)/time_to_immigration ELSE (MIN(migrate_capacity, population_in_China)*attractiveness_for_immigration^effect_of_attractiveness_on_net_immigration)/time_to_immigration
      UNITS: people/year
  OUTFLOWS:

deaths = local_population/local_expected_life_expectancy
UNITS: people/year

"normal_fraction_of_off-farm_labor" = 0.25
UNITS: 1

"off-farm_labor" = (economically_active_population*"normal_fraction_of_off-farm_labor"*wage_impact)/year_to_transform
UNITS: people/year

proportion_of_economically_active_population = 0.45
UNITS: 1

share_of_revenue_to_local_income = 0.2
UNITS: 1

time_to_adjust_income_perception = 2
UNITS: year

time_to_immigration = 2
UNITS: year

wage_compare = average_local_income/average_income_outside
UNITS: 1

wage_impact = GRAPH(wage_compare)
(0.00, 0.000), (1.00, 0.014), (2.00, 0.054), (3.00, 0.095), (4.00, 0.194), (5.00, 0.410), (6.00, 0.748), (7.00, 0.883), (8.00, 0.955), (9.00, 0.986), (10.00, 1.000)
UNITS: 1

year_to_transform = 2
UNITS: year

****
pollution:
****
absorption_time = 0.1
UNITS: year

adjustment_time_for_bus = 1
UNITS: year

air_height = 20
UNITS: meter

air_pollution(t) = air_pollution(t - dt) + (emissions_rate - discreption_rate) * dt

INIT air_pollution = 1000
UNITS: gram
INFLOWS:
emissions_rate = IF policy_1=0 THEN
(1*((emissions_per_car*private_cars_in_the_site+tour_bus*emission_per_bus)*mountain_road_longth*2/absorption_time)
+0*((desire_emission_per_new_bus*new_energy_bus+desire_emission_per_new_car*new_energy_car)*mountain_road_longth*2/absorption_time)) ELSE
(0*((emissions_per_car*private_cars_in_the_site+tour_bus*emission_per_bus)*mountain_road_longth*2/absorption_time)
+1*((desire_emission_per_new_bus*new_energy_bus+desire_emission_per_new_car*new_energy_car)*mountain_road_longth*2/absorption_time))
UNITS: Gram/Year
OUTFLOWS:
discreption_rate = air_pollution/dispersion_year
UNITS: Gram/Year

air_pollution_density = air_pollution/total_air
UNITS: 1

average_people_per_bus = 30
UNITS: people/bus

average_people_per_car = 3.5
UNITS: people/car

desire_emission_per_new_bus = 0.05
UNITS: gram/kilometer/bus

desire_emission_per_new_car = 0.01
UNITS: gram/kilometer/car

desire_tourists = tourist_reception_capacity/capacity_required_per_tourist
UNITS: People

desired_private_cars = (desire_tourists*share_of_private_car)/average_people_per_car
UNITS: car

desired_tour_bus = (desire_tourists*share_of_tour_bus)/average_people_per_bus
UNITS: bus

dispersion_year = 1
UNITS: Year

emission_per_bus = 10
UNITS: gram/kilometer/bus

```
emissions_per_car = 5
   UNITS: gram/kilometer/car

Length_Unit_Conversion = 0.001
   UNITS: kilometer/meter

mountain_road_longth = (tourist_spot_reception_area/road_width)*Length_Unit_Conversion
   UNITS: Kilometer

new_auto_gap = desired_private_cars-new_energy_car
   UNITS: car

new_bus_gap = desired_tour_bus-new_energy_bus
   UNITS: bus

new_energy_bus(t) = new_energy_bus(t - dt) + (new_bus_net_adding) * dt
   INIT new_energy_bus = 0
   UNITS: bus
   INFLOWS:
      new_bus_net_adding = new_bus_gap/policy_adjustment_time
         UNITS: bus/year

new_energy_car(t) = new_energy_car(t - dt) + (new_auto_net_adding) * dt
   INIT new_energy_car = 0
   UNITS: car
   INFLOWS:
      new_auto_net_adding = new_auto_gap/policy_adjustment_time
         UNITS: car/Years

policy_1 = 1
   UNITS: 1

policy_adjustment_time = 1
   UNITS: year

private_cars_in_the_site(t) = private_cars_in_the_site(t - dt) + (car_net_adding) * dt
   INIT private_cars_in_the_site = 1
   UNITS: car
   INFLOWS:
      car_net_adding = private_cars'_gap/time_to_adjust_for_car
         UNITS: car/Years

private_cars'_gap = desired_private_cars-private_cars_in_the_site
   UNITS: car
```

```
road_width = 8
   UNITS: meter

share_of_private_car = 0.387
   UNITS: 1

share_of_tour_bus = 0.421
   UNITS: 1

time_to_adjust_for_car = 1
   UNITS: year

total_air = air_height*tourist_spot_reception_area*unit_Converter
   UNITS: gram

tour_bus(t) = tour_bus(t - dt) + (bus_net_adding) * dt
   INIT tour_bus = 1
   UNITS: bus
   INFLOWS:
      bus_net_adding = tour_bus_gap/adjustment_time_for_bus
         UNITS: bus/year

tour_bus_gap = desired_tour_bus-tour_bus
   UNITS: bus

unit_Converter = 1
   UNITS: gram/cubic meters

{ The model has 187 (187) variables (array expansion in parens).
  In root model and 1 additional modules with 4 sectors.
  Stocks: 20 (20) Flows: 24 (24) Converters: 143 (143)
  Constants: 60 (60) Equations: 107 (107) Graphicals: 13 (13)
  There are also 15  expanded macro variables.
  }
```