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By

Systemic Design for Rural Tourism in China

The Case of Design Harvests on Chongming Island

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Declaration

I hereby declare that, the contents and organization of this dissertation constitute my own original work and does not compromise in any way the rights of third parties, including those relating to the security of personal data.

Huang Shengyu, Li Chen

2022

We would like to dedicate this thesis to our loving parents

Abstract

With the continuous development of China's economy and the accelerating process of urbanization, as of August 2021, the urbanization rate of China's permanent population reached 63.89%, and this process is accelerating. Urban residents are increasingly bored with the fast-paced, homogeneous urban life, giving birth to the "rural tourism" industry around the city. The barbaric development of the industry has led to a large number of urban tourists, putting the already fragile rural ecological environment under enormous pressure. The rise of the concept of sustainable tourism is in response to this environmental crisis. In order to explore the unsustainable status and causes of rural tourism, and how to analyze the system elements and operation mode of rural tourism ecological cycle from the perspective of circular economy, the research focus of this paper. Guided by circular economy and zero emission, this research adopts advanced systemic design methods, and combines practical projects (a famous rural tourism project located in Shanghai Chongming Island - Design Harvest) to build a Linear rural tourism system under the current situation and conduct ecological assessment and evaluation.

This study firstly builds a prototype of a Linear rural tourism system, and establishes the use of life cycle assessment method to quantitatively assess the global warming potential of element nodes in the system, and at the same time conducts a qualitative assessment of the system from the perspective of various forms of tourism. On this basis, we build a Linear system and a sustainable system respectively, and find the iterative method and path of the two-layer system. The first level is the Linear rural tourism system model based on the status quo. Due to the complex nature and variability of the tourism system, in order to conduct a quantitative assessment of global warming potential, we carried out the analysis on the existing elements with larger environmental impact factors in the scenario carrier. In the classification and definition, the system models based on the elements "tourist behavior", "food and planting" and "energy" are built respectively, and high-frequency environmental related factors are extracted at the end of this level to establish the final Linear rural tourism system model. The second level is the sustainable rural tourism system model. During the construction process, the carbon emission problem nodes of the Linear system model are solved one by one from input to output, looking for the correlation between subsystems and systematically integrating them in the end.

Finally, based on the established sustainable rural system model, a balanced solution that meets both environmental friendliness and user experience orientation is proposed, and guidelines for a sustainable rural tourism system are established to provide rural tourism managers, designers and other stakeholders. Provide references and references.

Keywords: sustainable design, systemic design, rural tourism, circular economy

Contents

Chapter 1

Introduction

1.1 Origin of research

The 20th century is an era of unprecedented development of human society, rapid population increase, and unprecedented consumption of material wealth. Human beings develop and grow on the earth without hesitation in accordance with the belief of "conquering nature and obtaining from nature". In the process of conquering nature, human beings feel the pleasure of being the master of the earth for sustainable survival and development. However, with the rapid development of industrialization and technology, people gradually feel the boundedness of the earth and the threat of future living environment.

The "Report on China's Environmental Crisis - Preface" pointed out that if an ordinary Chinese from a hundred years ago was allowed to travel directly to the 21st century according to the plots of many movies, then he would be shocked by everything in front of him. From the towering skyscrapers, the endless stream of vehicles, the dazzling array of goods and the huge LED screens, he will be completely unable to connect with the poor and fragile China of the past.[1] China, which seems to be moving towards a new era, must bid farewell to the humiliating history of modern times in the flourishing

[1] Jiao Huidong, China Environmental Crisis Report - Foreword, 2016, https://max.book118.com/html/2015/0128/11849203.shtm

scene.

The fact is that no problem is more precarious than the environmental problems facing the Chinese people today. The fundamental reason is that the consequences of environmental problems are related to the life and death of our descendants. "This issue has gone far beyond national, ethnic and partisan lines, and has become the primary issue that confronts each of us and cannot be avoided. [1]

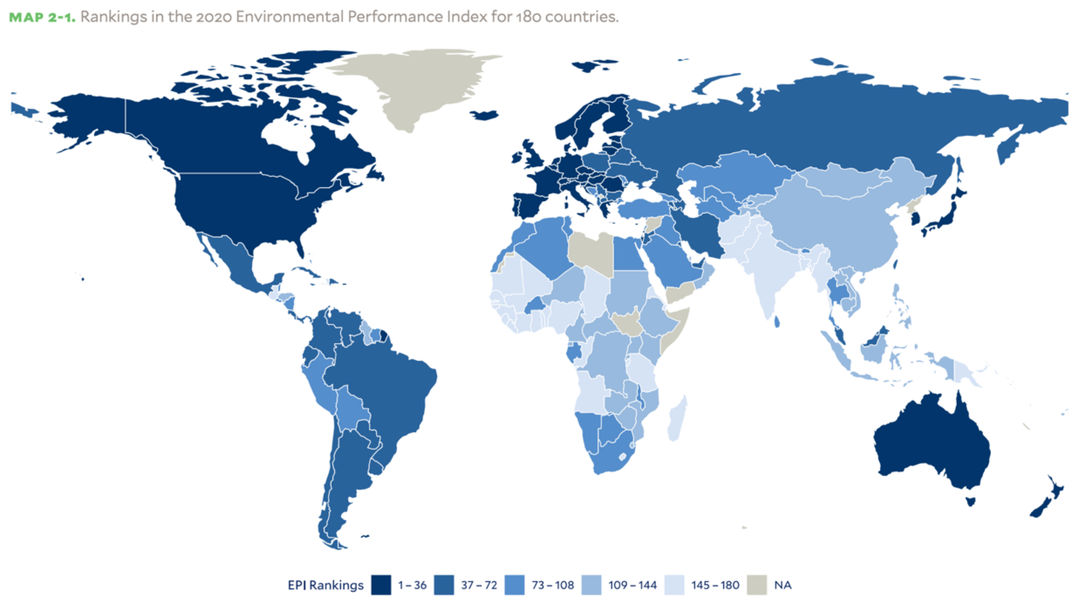


Figure 1.1 Environmental Performance Index 2020 (Image credit: https://epi.yale.edu/)

The environment represents the image of a country and a nation, and also determines the future of a country and a nation. Figure 1.1 The Global Environmental Performance Index released by ECOCLIMAX in 2016 shows that China's current environmental situation is optimistic. What the environment brings is not only the improvement of the quality of life, but also the foundation of a country's development and the cornerstone of its subsequent development potential. China's environmental issues deserve every responsible Chinese person to take seriously.

[1] Liu Ben, Wang Lide: Responding to China's Environmental Crisis Requires Institutional Change, 2013, http://www.cc362.com/content/LpyX1q.html

1.2 Research background

1.2.1 Rural environmental crisis

1. Rural environmental crisis

As an important part of the main body of the country, the countryside is the buffer zone where people are closest to the natural ecology. Due to the vast territory of China, the gap between the rich and the poor is large between the east and the west, and there are also large individual differences in regional locations and economic conditions. However, the overall economy and brain drain, the lack of environmental governance and the general situation of ecological disturbance still exist.

Looking at the rural crisis from an environmental point of view, "Silent Spring" provides a detailed answer. After the author uses a fable to describe the mutation of a beautiful village, he describes in detail the danger of chemical pesticides behind the environmental crisis. "From land to sea, The shadow of chemical pesticides flashes from the ocean to the sky. The author believes that the frequent and large use of toxic chemical pesticides, especially DDT, has caused direct damage to the natural environment and food chain." [1] Therefore, the author believes that the first step to protect the environment is to avoid the use of large quantities of pesticides without scientific basis. Once this book came out, it caused a great sensation, and environmental protection received unprecedented attention. The publication of this book indirectly led to the establishment of various environmental protection organizations.

China's tourism development has ushered in rapid development after entering the 21st century. The barbaric growth has led to many problems in my country's tourism development mechanism. The ecological environment where tourism is located is very serious, and the "product" of the tourism industry is precisely the charming scenery. Therefore, the intersection area of "tourism + countryside" is the problem area that this research focuses on. At present, most of the areas with natural scenery resources in China are developing the construction of rural tourism. However, in the process of development and putting into use, most areas are oriented to user growth and economic

[1] Li Li, Allegory of China's Rural Environmental Crisis, China Rural Observation, 2013, 29(5):84-88.

growth as the main development goals, and the consequences are obvious damage to the natural environment. The popularity of tourist attractions is positively correlated with the proportion of environmental damage. The reason is that the well-known scenic spots have a large base of tourists, but the management and policy implementation of the tourism industry are difficult. In addition, the domestic awareness of environmental protection, low-carbon, recycling and other tourism environments has been promoted late, and tourists' environmental protection concepts are not high. The combined effect of these factors has resulted in the serious destruction of the ecological environment of the more popular rural scenic spots.

2. The Birth of Intractable Problems

In the twenty-first century, society and government are deeply entangled with multiple issues intertwined among ecological, social, economic and governance systems. These problems are interrelated and develop into wicked problems that traditional approaches fail to address. [1]"It was found that no single discipline or method could solve it alone. Questions like this require a normative rethinking of future possibilities. That's why we now refer to these issues as the SDGs." (Peter Jones, 2018) The complex social system is also the "social system" presented by the intertwining of these "stubborn problems". "The SDGs address 17 global issues that were first defined by the United Nations and were proposed and adopted at the 2015 Global Leaders Summit." [2] All of these issues

[1] Peter Jones, translated by Ma Jin and Zhou Huilin, The Way of the Whole System: The Power to Change the World, 2018, Sheji (09)
[2] Ludwigvon Bertalanffy, General Systems Theory: Foundations, Developments, Applications (New York: Braziller, 1972).

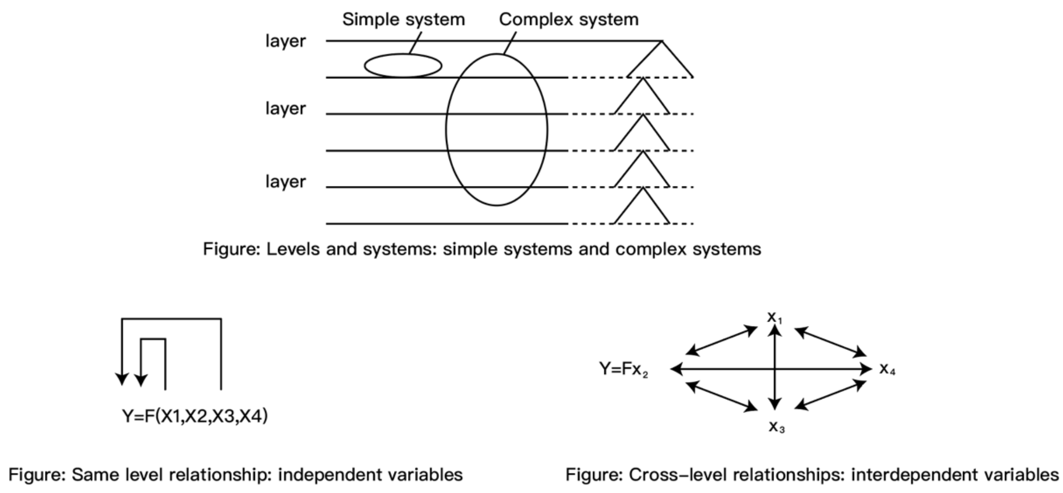


Figure 1.2 Complex social system (Image source: Complexity of social system and social methods

are not born by accident, but slowly pile up, just people Still immersed in the thrill of making rapid progress, there is no change in the way we approach these new problems.

There is moderate optimizm about this issue, but the fact that design practice has had little success in strategic efforts to achieve the SDGs worries us. Therefore, in order to cope with complex challenges, the whole systemic design integrates the thinking mode of interdisciplinary fields and solves the problems in a targeted manner. When faced with these problems, professionals in various fields always use more traditional means to deal with many macro issues, such as social changes, emerging technologies, climate warming, service systems, and ecological environment. The current situation is that when designers intervene in problems, some large-scale problems will be analyzed and superficially designed, but due to the lack of a real understanding of complex social ecological systems, they are often based on imaginary needs. [1]

1.2.2 Birth and challenges of circular economy

1. Overview of circular economy

Since the ultimate goal of this research is to build a regional "circular economy", the concept of circular economy also plays a crucial role in this research. "Circular economy is an abbreviation for the closed-loop flow economy of materials. It is an economic development model composed of

[1] Harold G. Nelson and Erik Stolterman, The Design Way: Intentional Change in an Unpredictable World (Cambridge, MA: MIT Press, 2012).

"resources-products-renewable resources" with repeated circulation of materials. Its basic characteristics are low mining, high utilization, and low emissions." [1]The "3R" principle is the core of its operation, that is, the three core processes of "reduce", "reuse" and "recycle".

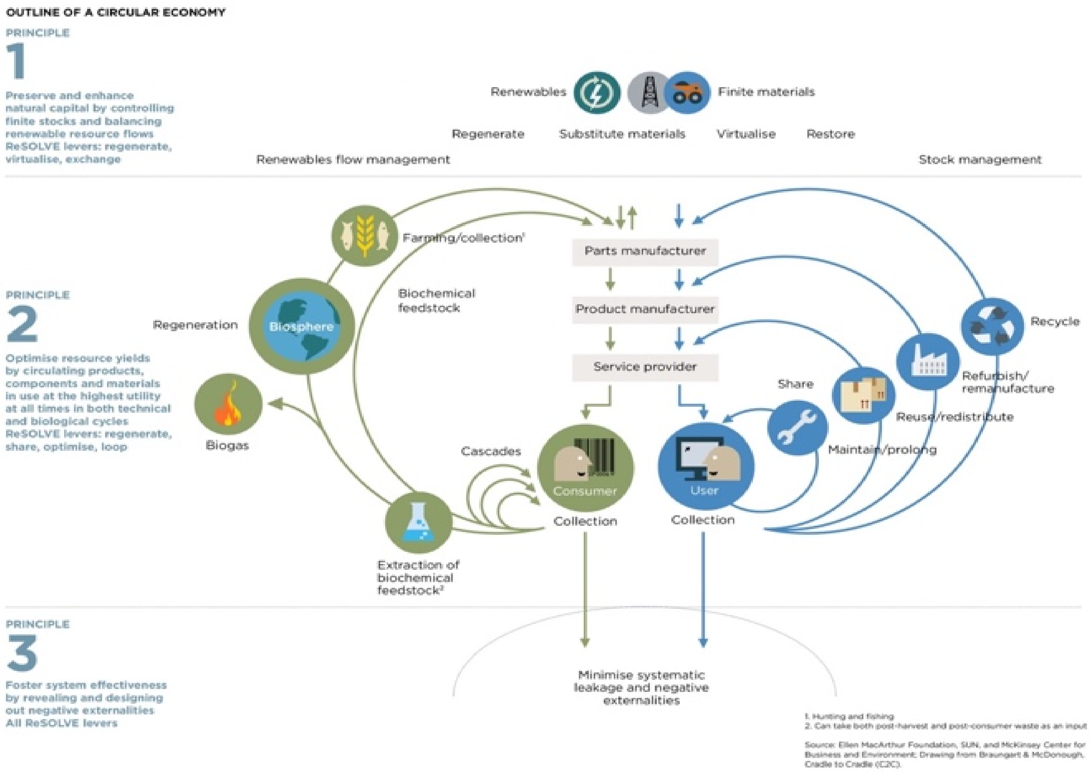


Figure 1.3 Circular economy system diagram (Image source: ELLEN MACARTHUR FOUNDATION)

[1] Circular Economy, Wikipedia, 2018, https://en.wikipedia.org/wiki/%E5%BE%

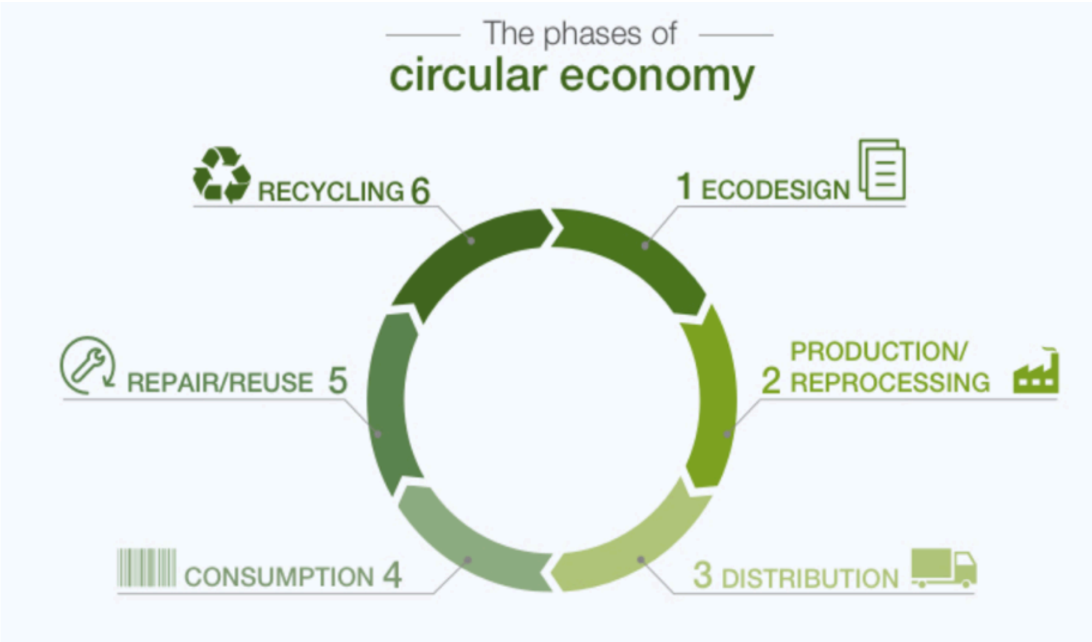


Figure 1.4 The phases of circular economy (Image source: Dr. Virginia Onyara)

2. Development history and schools of thought

The concept of circular economy has a long history, but it cannot be traced back to a specific day or author. But starting in the late 1970s, its practical application in modern economic systems and industrial production has accelerated, led by a handful of scholars, thought leaders, and businesses. The following schools of thought have distilled and developed general concepts:

Regenerative Design: In the United States, John T. Lyle first proposed the concept of regenerative design applicable to various systems (i.e., except agriculture), and the regenerative concept of these systems has been formed earlier. Arguably, he laid the groundwork for a circular economy architecture, and McDonough (with Lyle), Braungart, and Stahel made his theory significantly developed and notorious. Today, the Lyle Center for Regeneration Research offers a course on this topic.

The Performance Economy: In 1976, architect and economist Walter Stahel collaborated with Genevieve Reday and presented a study titled "The Possibilities of

Replacing Energy with Human Power"[1] to the European Commission. In his report, he described his vision for a circular economy (or "circular economy"), describing its impact on job creation, economic competitiveness, resource conservation and waste prevention. It is believed that Stahel coined the term "cradle to cradle" in the late 1970s. He proposed the "closed loop" principle of the production process, and more than 25 years ago established the Geneva Institute for Product Life. This approach has four main goals: extending product life, developing long-life commodities, restorative activities, and preventing waste generation. It also emphasizes the importance of selling services rather than products, an idea known as the "functional service economy" that is now more broadly incorporated into the "performance economy" concept. Stahel believes that the circular economy should be viewed as a framework: as a general concept, the circular economy employs a number of more specific approaches that revolve around fundamental principles.

Cradle to Cradle Concept: German chemist and idealist Michael Braungart, together with American architect Bill McDonough, went on to develop the Cradle-to-Cradle concept and certification process. This design principle treats all materials involved in industrial and commercial processes as nutrients, which are divided into two main types: biotic and abiotic. Cradle-to-cradle architecture focuses on designing for the effectiveness of products that have a positive impact, reducing negative business impacts through efficiency.

Industrial Ecology: "Industrial Ecology studies the flow of materials and energy in industrial systems". This approach focuses on the relationships between operators in an "industrial ecosystem" and aims to create a dead-loop process that uses waste as an investment, eliminating the concept of undesired by-products. Industrial ecology adopts a systems perspective, striving to bring ecological constraints as close to living systems as possible, based on local ecological constraints and taking into account their global impact from the outset. Because of its interdisciplinary nature, this framework is sometimes referred to as the "Science of Sustainability," and its principles can also be applied to the service industry. Industrial ecology also emphasizes the restoration of natural capital and values social well-being.

Biomimicry: The Way Out for Humanity: In Search of the Mysteries of Biomimicry

[1]Walter Stahel, Genevieve Reday, The possibility of replacing energy with human power

(Bionics), author Janine Benuys defines her own approach as "an emerging discipline that studies nature's brilliant designs and then imitates them. and processes to solve problems facing humanity”. One example is the study of leaves to optimize solar cells. The authors see this as "innovation inspired by nature."

Blue Economy: The concept of "Blue Economy" was proposed by Belgian entrepreneur Gunter Pauli, the former CEO of Aikefo. It is an open-source movement incorporating specific case studies, a concept first developed by Pauli in a report of the same name to the Club of Rome. The official statement is that: "Using the resources available in the cascade system, a product can be turned into an investment that can generate new cash flow after it is scrapped." The blue economy consists of 21 founding principles, insisting on formulating solutions based on local environmental and physical/ecological characteristics, emphasizing that the earth's gravity is the main source of energy. The report, seen as a manifesto of the movement, describes "100 innovations that could create 100 million jobs over the next 10 years" and presents several successful examples of collaborative projects between countries in the Southern Hemisphere—another example of this approach original feature, dedicated to promoting the realization of practical focus.

1. 2. 3 The current situation of rural tourism from the perspective of circular economy

Compared with the increasingly solidified urban landscape form, the differences and characteristics of the countryside have become a new frontier for the development of the tourism industry. However, with the development of the rural tourism industry, the problem of load on the local ecological environment has become increasingly prominent, which is contrary to the concept of sustainable development. At present, most of the development strategies of rural tourism in China are oriented to the maximization of a single business and turn a blind eye to the environment-friendly circular economy development model. The current state of the application is analyzed.

1.Deterioration of ecological problems

In the process of the exponential development of rural tourism, the lack of awareness of ecology, sustainability, and environmental protection is a common problem for these rural tourism enterprises. Due to their lack of understanding of the circular economy, they blindly pursue the maximization of economic benefits and use users The establishment of an experience-oriented tourism model has led to the ecological environment load in rural areas reaching a critical point. "So the deterioration of ecological problems has become one of the main factors to curb the development of the rural tourism industry." Among them, the carbon emissions generated by rural tourism activities cannot be ignored, and as an important factor in measuring environmental indicators, its carbon emissions account for 4% of the total carbon emissions from tourism. The domestic research on the calculation of carbon emissions from the tourism industry is still at a blank stage.

2.Incomplete sustainable service system

As one of the important scenes of "tourism", the countryside is usually located in the more remote areas of the city. First, due to the widespread problems of most rural infrastructure, such as the lack of repairs on the traffic roads leading to the city, leading to commuting, and other problems, it has become the core pain point for urban tourists to experience rural tourism. Second, due to the single productivity of the village itself, the lack of economic model, and poverty as its main status quo, the service system page under the tourism model under this background needs to be improved. Therefore, to sum up, "the lack of innovation of tourism managers in service mode and user experience makes it difficult to meet the needs of tourists of different grades.[1]" From the perspective of ecological environment, the vast majority of sustainable rural tourism in China is not "sustainable" at present, the construction of sustainable service system is still in its infancy, how to combine environmental friendliness and user experience better, and how to integrate The real "implementation" of this seemingly "sustainable" hat into the rural tourism industry is the issue that the author will discuss next.

[1] Zhao Chenghua. Analysis and path selection of sustainable development of rural tourism [J]. Agricultural Economics, 2018(04):42-44.

1.2.4 Environmental Sustainability and Regeneration

1. Environmentally sustainable

Sustainable development covers social, economic, environmental and other aspects, and this study mainly focuses on the sustainable ecological environment. Carlo Vezzoli and Ezio Manzini define environmental sustainability as follows: "In a systemic environment, whether at the level of the entire planet or at the level of local areas, human activities that interfere with natural cycles cannot exceed the maximum capacity of the planet.[1]"

Human beings have taken many measures to deal with the environmental crisis, trying to slow down the deterioration of the crisis and achieve environmental sustainability. In terms of energy technology, develop new energy such as solar energy and wind energy to replace the original non-renewable fossil energy, or develop degradable packaging and recyclable plastics. At the political and economic level, the environmental tax system has become more and more perfect, and existing enterprises have begun to pay attention to environmental pollution-related issues and are willing to pay part of the environmental compensation fees. At the level of personal life, there are countless energy-saving and emission-reduction measures such as promoting cycling and restricting the use of disposable items. These measures have effectively restrained environmental degradation from various aspects and to a certain extent, and their shortcomings are also obvious. First, most environmental protection measures are in the downstream of the environmental crisis, and there is a lack of reflection and improvement on the root cause of the crisis; second, the current environmental protection measures are based on energy conservation and emission reduction, reducing the discharge of harmful substances, and their essence is to prolong the crisis. Time and reducing the frequency and intensity of crises, from a long-term perspective, do not fundamentally solve the crises; third, environmental protection measures are fragmented, and it is difficult to exert the greatest effect in the face of the real root cause of the crisis.

The original meaning of the word "sustainable" is to maintain the status quo and

[1] Vezzoli, Manzini. Environmentally sustainable design [M]. National Defense Industry Press, 2010.

develop, no matter how good or bad, the purpose is to keep it stable and sustainable. As can be seen from the previous definition, the focus of sustainable development is to "do not cause harm" and "do not deplete resources". Therefore, according to the original meaning of sustainability, the environmental conditions faced by future generations will be no different from the status quo. Looking at the current global environmental problems, is our current environmental status quo worth maintaining or should it be improved? Obviously, human beings need to provide a better living environment for future generations from the perspective of improving and optimizing the status quo.

2. Environmental regeneration

"Environmental regeneration design refers to: guiding an area into a better socio-ecological condition than before, making it have the potential to support future growth. Therefore, the environmental regeneration capacity should continuously improve the sustainable bottom line and indicators. In the mechanism of environmental regeneration, the environment will eventually be repaired, and in a sustainable mechanism, the lost ecological functions will not be restored, and the status quo will be maintained." If an

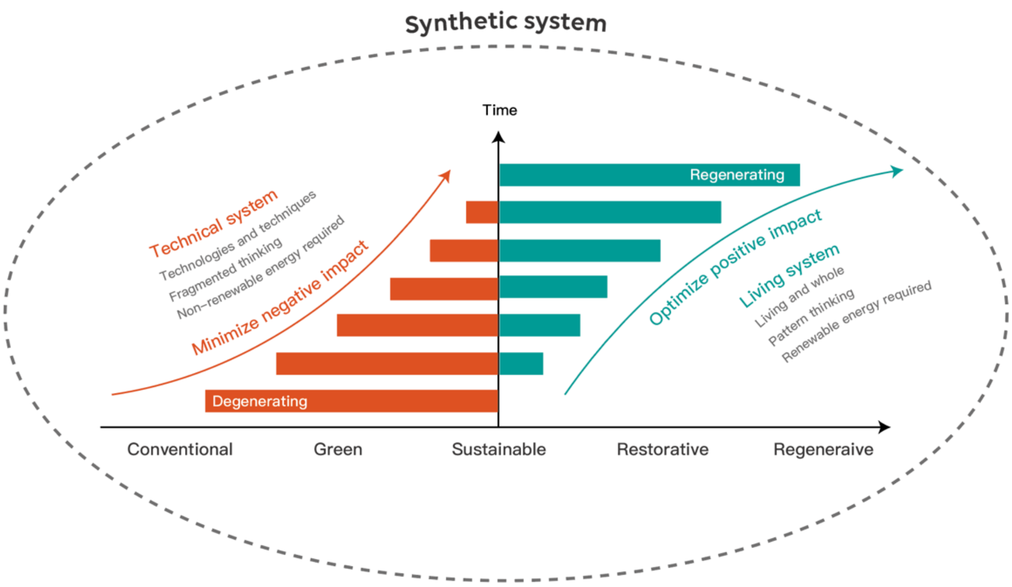


Figure 1.5 Regeneration design model (Image source: Gao Xiang, "Re-evaluation of Organic Planting Certification Standards from the Perspective of Systemic design, 2017)

area is damaged, only sustainable means will not make a difference. improvement, so it must first be regenerated before considering environmental sustainability."[1] In the face of the current environmental crisis, environmental regeneration should be discussed more than just sustainability. The Regenesis Group ranks the status of the environment, as shown in Figure 1.3, from linear, green, with negative impacts, to neutral, sustainable, and then restored, with positive impacts, regeneration.

1.3 Research Scope, Research Objects and Research Questions

1.3.1 Research scope

Before explaining the specific research objects and research questions, the scope of this research needs to be limited. The 20th century is an era of unprecedented development of human society, rapid population increase, and unprecedented consumption of material wealth. Human beings develop and grow on the earth without hesitation in accordance with the belief of "conquering nature and obtaining from nature".In the process of conquering nature, human beings feel the pleasure of being the master of the earth for sustainable survival and development. However, with the rapid development of industrialization and technology, people gradually feel the boundedness of the earth and the threat of future living environments.

" According to the ecologist Harding, we can equate a modern society with a vast pasture, while using advanced industrial technology after the Industrial Revolution, humans can be regarded as wanton grazing shepherds[2]， Therefore, the shepherds grazing recklessly in the industrial society have become a linear economy or a shepherd boy economy consisting of a single channel of "natural resources, products, and supplies, and waste discharge". [3] It is through this one-way flow from resources to products, and then from products to waste, that economic growth is achieved through this impact on the bottom line of the earth's environmental load. "A very important "disaster area" or source of this ever-increasing load on the natural environment comes

[1] China Agricultural Science and Technology Herald ,International Conference on Renewable and Environmental Materials[J]., 2011,13(02):58.
[2] Harding, Shared Tragedy, Science [J], 1968
[3] Zhang Kun, Theory and Practice of Circular Economy Zhang Kun, China Environmental Science Press [M], 2003(04): 48-49

from the countryside.

Before 2000, China's rural areas were less affected by the process of industrialization. However, under the background of social and economic development at the current stage, the country has been vigorously promoting industrial transformation and actively adjusting its strategic layout. Tourism, as a traditional service industry, has also ushered in transformation and upgrading. To make a breakthrough, accelerate the development of rural tourism, government policy orientation, rural tourism has become the focus of national tourism reform and innovation.

The rapid development of rural tourism is accompanied by the destruction of the local ecological environment. The single-channel process mode of "natural resources-products and supplies-waste discharge" accelerates the imbalance of the ecological environment. Taking homestays or other forms of rural tourism as a quantitative measure the carrier is particularly prominent. Secondly, with the continuous development of my country's economy, "the main contradiction in society has been transformed into the contradiction between the people's growing needs for a better life and unbalanced and insufficient development. [1] The rapid growth of the spiritual and cultural life of urban residents has given birth to the rapid development of rural tourism, but at the same time, the unregulated and unsustainable rural tourism model has caused serious damage to the natural ecological environment of the countryside.

The sustainable circulation system has not been used and popularized in most rural tourism. As a member of Professor Lou Yongqi's sustainable research project "DESIGN HARVESTS", I hope to take China's urban-rural interaction design as an entry point and use sytemic design Thinking to drive the development of rural tourism in China and rebuild the new homestay ecosystem with sustainable and low-carbon methods. Therefore, I hope to make full use of the systemic design method I learned at the Politecnico di Torino, and use the Chongming Island Design Harvest Project as a research carrier to build a sustainable system of rural tourism in China.

1.3.2 Research objects

The relevant research objects involved in this study include circular economy,

[1] Xi Jinping, work report of the 19th National Congress of the Communist Party of China [R], 2018

sustainable rural tourism, and systemic design, which are explained here one by one.

From the perspective of circular economy: Using technical means, behavior definition and system remodeling, the optimization of the whole process integrates and optimizes the target object, and integrates elements such as resource utilization and ECO Design recycling consumption during its operation. This form is quite different from the previous traditional economic model, and is a completely innovative new economic development model. Its main purpose is not only to focus on "people-oriented", but also to a greater degree between people and the environment, people and means of production, Redefine and integrate the relationship between people and society.[1] From the perspective of sustainable rural tourism, "sustainable tourism is the ultimate goal of rural tourism development. Sustainable rural tourism" emphasizes the coordinated development of tourism and the rural environment, and re-engineering tourists and residents on the basis of environmental friendliness Interest coordination and resource allocation. "The author gives the current definition of sustainable rural tourism, and builds a sustainable rural tourism model map based on four factors: tourists, community residents, development managers, and the government (see Figure 1.6). The absence of any element between them will lead to affect the normal operation of the entire system.

1 Definition of circular economy, Baidu Encyclopedia, https://baike.baidu.com/item/xunhuan/

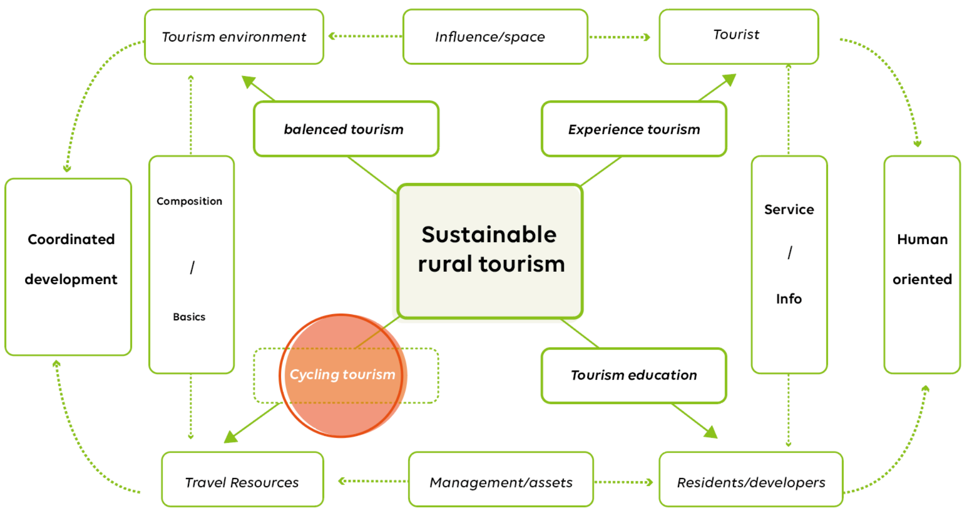


Figure 1.6 Sustainable rural tourism system diagram (Image source: drawn by the authors)

From the perspective of systemic design, in a sense, systemic design can be defined as a set of design methodology. This paper hopes to explore a set of standardized, process-based, Reproducible rural tourism circulation system solution, determine the design goals, design principles, design elements, select the research method and process design of the system, and finally build a sustainable rural tourism circulation system that can cope with different situations. Use this standardized and process-oriented system to design solutions, and apply them to actual projects for practical problems to form a practical application prototype of the modified plan.

1.3.3 Research questions

The environment is the external surrounding conditions that human beings rely on for survival, and human beings cannot produce and develop without the environment. In recent years, we have sacrificed the environment in some aspects in order to obtain industrial-technological. However, with the continuous deterioration of the environment, people began to gradually pay attention to the existing ecological problems, and gradually proposed methods such as sustainable design and circular economy. In China, with the vigorous development of rural tourism, more and more urban tourists are pouring into the countryside, but at the same time, it is a huge test for the relatively balanced ecological environment in the countryside. How to improve the circulation system of country houses through systemic design thinking, and try our best to control carbon emissions (input and output) has become a new topic in design. The exploration questions are summarized as follows:

（1）Explore the current situation and causes of unsustainable rural tourism.

（2）How to analyze the system elements and operation mode of rural tourism ecological cycle from the perspective of circular economy？

（3）How to use the variable control method to analyze and simulate the elements in these processes and systems, assist systemic design decisions, and locate the design direction that can optimize carbon emissions？

（4）How to use the intervention method of systemic design to optimize the carbon emission cycle system of rural tourism, and form a set of reproducible design methods and guidelines？

1.4 Research methods

1.4.1 Literature analysis and content analysis

Bibliographic analysis and content analysis are two basic research methods necessary for researchers. They are of great help in the collection, analysis and definition of research questions. According to their definition: "Document analysis is an economical and Information collection method, which obtains job information by systemically analyzing the existing literature related to the work. The author will use the literature analysis method in the early stage of the research to determine the specific research direction and sort out the research question[1]。”

Content analysis is a research method that mainly takes various data and literature content as the research object. It originates from the social sciences borrowing the methods of natural scientific research to carry out quantitative analysis of various

1 Wei Shunping, Literature Research Method Supported by Technology: An Attempt in Digital Education Research [J], Modern Educational Technology, 2015(09): 29-34

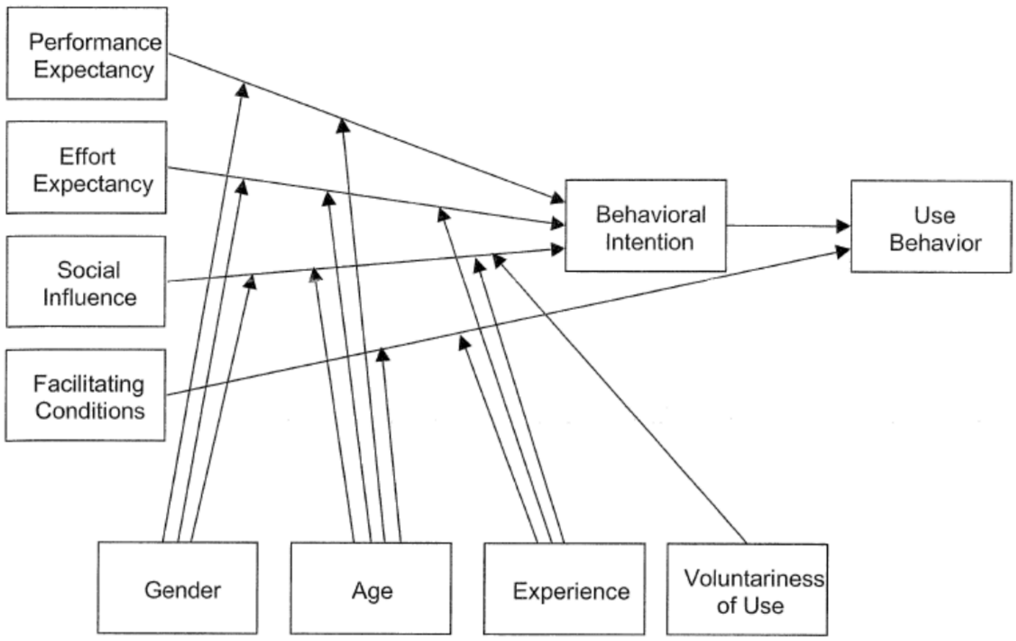


Figure 1.7 An example of a systemic diagram of the document analysis method (Image source: Wikipedia, Document analysis, 2018)

literature content and data. [1] The general process includes: "Establishing research objectives and determining population and analysis sample units, designing analysis dimensions or systems that can decompose the data content of the analysis unit into a series of items, and extracting representative data samples (extracted samples/typical samples) , convert the sample into the data form of the analysis category, and finally perform statistical reasoning and analysis on the data[2]， I will use the content analysis method a lot when I study the activities of characters and formulate sample users.

1.4.2 Environmental Measure Markers

Environmental issues are complex and non-linear. Therefore, in order to study a sustainable rural tourism model, it is necessary to use markers to measure and evaluate the environment. In this study, two markers of global warming potential and habitat were selected to reflect the situation of tourism environment.

[1] Wang Liang, "Exploration of Educational Management" [M], Feitian Electronic Audio and Video Publishing House, 2004-1,(03):66-68

[2] Cao Chunyan, Research on the Development of Middle School Mathematics Curriculum during the Republic of China, Doctoral Dissertation of Northwest Normal University, 2016 (03): 45-47

1. Global Warming Potential

The reason for choosing the global transformation potential as a marker for environmental measurement is due to the following reasons: First, the global warming problem has exceeded the safe load of the ecological environment, and the problem is still aggravating, and its very important constituent elements are also Including rural areas; secondly, global warming is interrelated with other ecological problems and affects habitats and biodiversity; thirdly, the current research on carbon emissions and global warming potential is relatively mature and comprehensive.

The Special Committee (IPCC) has published the carbon emission coefficients of various crude oil products, namely global warming potential. The US Department of Environmental Science, China Institute of Ecology and Environment and other institutions also provided the carbon emission coefficients of various agricultural materials. These data sources are: This study provides detailed reference and basis. Therefore, this study selects global warming potential, a key environmental factor, as a marker for ecological assessment of rural tourism behavior.

	GWP of Specific Life Span		
Gases	20 Years	100 Years	500 Years
CO_2	1	1	1
CH_4	72	25	7.6
NO	275	296	156
N_2O	289	298	153
CCl_2F_2	11000	10900	5200
$CHClF_2$	5160	1810	549
SF_6	16300	22800	32600
CHF_3	9400	12000	10000
CH_2FCF_3	3300	1300	400

Figure 1.8 Global Warming Potential for Specific Time Span (Image credit: China Carbon Emission Trading Network)

The basic principle of GWP assessment in this study is to use the idea of life cycle assessment, which is a quantitative study. Convert the greenhouse gases produced by the input and use of materials in all aspects of the production process such as "planting", "food", "energy", and "tourist activity" in rural tourism into carbon dioxide equivalents, and convert them into global warming potential values, this measures the global warming potential brought about by rural tourism. In the terminology of this study, carbon emissions are measured in carbon dioxide equivalents, which reflect global warming potential.

2. Habitat

The term "Habitat" refers to the range of environmental space in which organisms appear, generally referring to the place where organisms live, or the eco-geographical environment in which organisms live. Habitat is the concept of environment in ecology, also known as habitat."[1] which was proposed by Grinnell at the beginning of the last century.

This research will carry out two aspects of human activity behavior and environmental material consumption generated by rural tourism. Human activities refer to the physical consumption (using carbon dioxide equivalent as an indicator) of a series of human behaviors in rural tourism, such as commuting to the place. The environmental material level mainly refers to the two categories of "food" and "energy" consumption that the author observes from rural tourism activities. This study analyzes the current "sustainable" state of rural tourism and gives improvements to the current situation through the systemic streamline of the three elements of "people", "food" and "energy", using carbon dioxide equivalent as a measure.

1.4.3 Carbon emission monitoring and calculation methods

The tourist activity system in the countryside is a complex and comprehensive system, and the calculation of carbon emissions is very difficult. The research method of this paper is based on the tourist data of the research carrier (Design Harvests) in the past one year. "Typical tourists" are used as samples to conduct behavioral activities in their time unit, and there are output and input substances of activities to calculate the carbon emission statistics and average value generated in their time unit, so as to deduce the annual carbon emission of the project. Therefore, it is necessary to use Personal Carbon

[1] Concept of Habitat, Grinnell

Trading (hereinafter referred to as PCT) to record and evaluate. Due to the lack of carbon emission calculation standards for tourism projects in China, we make substitutions based on the relatively mature household carbon emission calculation. The carbon emission detection mainly includes direct carbon emission and indirect carbon emission:

1. Calculation of direct carbon emissions

"Direct carbon emissions refer to the carbon emissions from direct energy use (coal, gasoline, diesel, kerosene, liquefied petroleum gas, natural gas, gas, electricity, water, heat, etc.) and private transportation (private cars, motorcycles). Its calculation formula is:

$$E_d = E_{home} + E_{personal\ travel}$$

In the formula: Ed represents the annual direct carbon emissions of households (tCO2); Ehome represents the annual direct carbon emissions of household energy (tCO2); Epersonal travel represents the annual carbon emissions of human traffic (tCO2). The carbon emission of direct household energy consumption is usually obtained by multiplying the actual annual consumption of fossil fuels or energy products by the corresponding CO2 emission coefficient:

$$E_{home} = \sum_n (Fuel_n \times \mathrm{CO_2} Coefficient_n)$$

In the formula: Ehome represents the annual carbon emissions from direct energy use (tCO2); n represents the type of fossil fuel or energy product; Fuel n represents the actual annual consumption of the nth type of fossil fuel or energy product (t); CO2Coefficientn represents the nth types of fossil fuels or energy products[1].

2. Calculation of indirect carbon emissions

$$X_i = \sum_j CES_{Tj} \times CPI_{Bj} / CPI_{Tj} \times T_{ji}$$

$$E_d = \sum_i (CI_i \times X_i)$$

[1]Zeng Jingjing, Zhang Zhiqiang, Qu Jiansheng, Li Yan, Liu Lina, Dong Liping. Analysis and Evaluation of Calculation Methods for Household Carbon Emissions[J]. Geographical Science Exhibition, 2012,(10): 41-52..

The main source of indirect carbon emissions is the consumption of non-energy products and services in the process of human clothing, food, housing and use, which mainly include food, daily necessities, household equipment and supplies, medical care, housing, communication, transportation, education, culture and entertainment. Carbon emissions generated by elements such as services in the behavior or production process. The general calculation method is to use the input-output method and the consumer behavior method to calculate the indirect carbon emissions from human activities:

3. Carbon footprint calculation method

Gasoline： _____ litre ✕ Conversion Coefficient 2.7 = _____ $KgCO_2$
Electricity Consumption： _____ KWH ✕ Conversion Coefficient 0.785 = _____ $KgCO_2$
Meat Consumption： _____ KWH ✕ Conversion Coefficient 1.24 = _____ $KgCO_2$
Flight Mileage
Short Distance (≤200km): _____ km ✕ Conversion Coefficient 0.275 = _____ $KgCO_2$
Medium Distance (200km-1000km): (_____ -200)km ✕ Conversion Coefficient 0.105 +55= _____ $KgCO_2$
Long Distance (≥1000km): _____ km ✕ Conversion Coefficient 0.139 = _____ $KgCO_2$

Figure 1.9 Calculation method of carbon footprint emission (image source: drawn by the authors)

In theory, carbon emissions can be obtained by direct monitoring through technical means, or obtained through indirect calculation, but only high-level scientific research institutions in China can use technical means to directly measure, and most of them are for microscopic activities that require high precision. Yes, most organizations use carbon emission factors to calculate large-scale carbon emissions from human activities. Therefore, instead of using the direct measurement method, we mainly analyze and integrate the indirect carbon emissions commonly used by the people.

The last summary mentioned the calculation formula of indirect carbon emissions, that is, the commonly used calculation formula is: "annual electricity consumption × carbon emission factor of electricity = indirect carbon emission." Pay attention, replace the complicated formula with a very intuitive carbon footprint calculation by calculating the formula with the same amount of commonly used substances, as shown in Figure 2.12, so that more people can use the carbon footprint calculator to calculate the collected data. Strengthen its own low-carbon concept.

The emission of carbon dioxide gas is the main element for calculating the carbon footprint, and other gases such as carbon monoxide will also have an impact on global warming to varying degrees. In order to help decision-makers measure the impact of various greenhouse gases on global warming." [1] Secondly, the author will use the carbon footprint calculator in the process of research and data collection, Accurate carbon emissions in individual units are calculated based on the behavior of tourist activities (specified time units), and data modeling is performed in the later stage.

"According to international practice, the greenhouse effect caused by each greenhouse gas is not the same. The GWP value of CO2 gas is 1, and the ratio of the greenhouse effect of other gases to the greenhouse effect of CO2 is the GWP value of the gas (generally much larger than GWP value of CO2). The CO2 gas is used as the reference gas because it has the greatest impact on global warming, and we still believe that CO2 is the culprit of the greenhouse effect". [2]

Obviously, with the advancement of the Internet and technology, for the calculation of

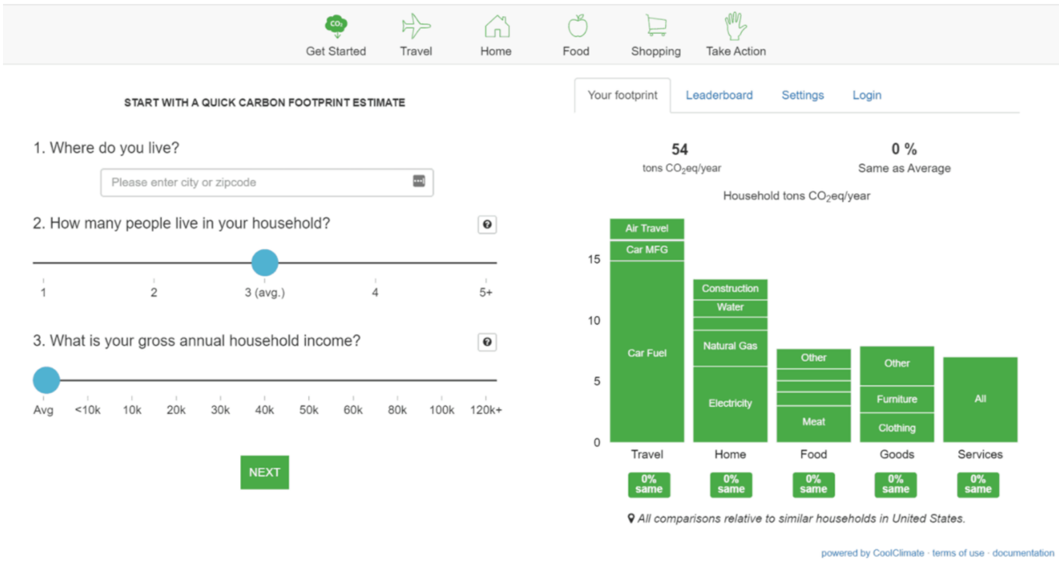


Figure 1.10 Carbon footprint calculator (Image credit: https://footprinthero.com/best-carbon-footprint-calculators)

personal carbon emissions, we can directly use the carbon footprint calculator, which mainly calculates the carbon emissions of various home life based on individual energy consumption and activity behavior. With the rapid cooling and rapid heating of the

[1] Luo Cheng.Research on the combined optimization model of multiple transportation modes considering carbon emission control[J].Journal of Shaanxi University of Science and Technology(Natural Science Edition),2011,29(05):113-116+125.

[2] Daniel A.Lashof, Dilip R.Ahufa, Zhu Ximin. The relative contribution of greenhouse gas emissions to global warming[J]. Advances in Earth Science, 1991(03):72

climate environment, climate change has become a major global issue of general concern. As a responsible big country, China formulated and promulgated the "China's National Plan for Addressing Climate Change" in 2007. The China Showdown Trading Center (Trading Network) and some non-governmental organizations have launched new carbon footprint calculators, hoping to use the This intuitive and fast calculation method improves the participation of the general public and the influence of the "low carbon" and "cycle" sustainable concepts, so as to alleviate and control the climate trend of global warming.

1.4.4 Systemic Design Method

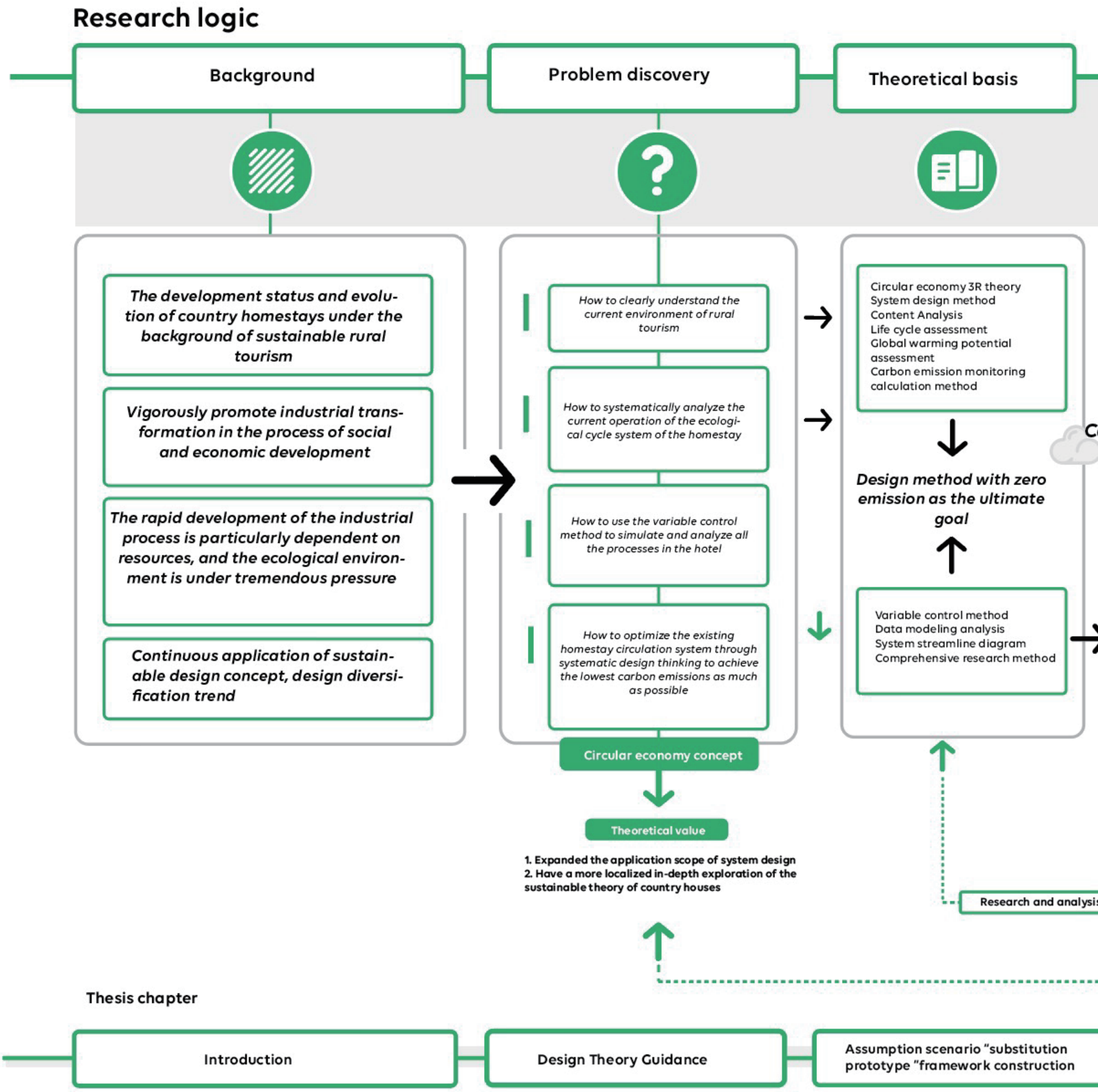
A system is a set of interrelated elements that develop towards a common goal.[1] Systemic design is when the input of one subsystem is the output of another subsystem.[2] Specifically, it is to study the production process, method, and the relationship between all the substances involved, and to analyze a production or behavior from a macro level. This research needs to use the method of sytemic design to quantitatively analyze the carbon emissions generated by tourists' behavior in rural tourism and the input and output of substances in the carrier.

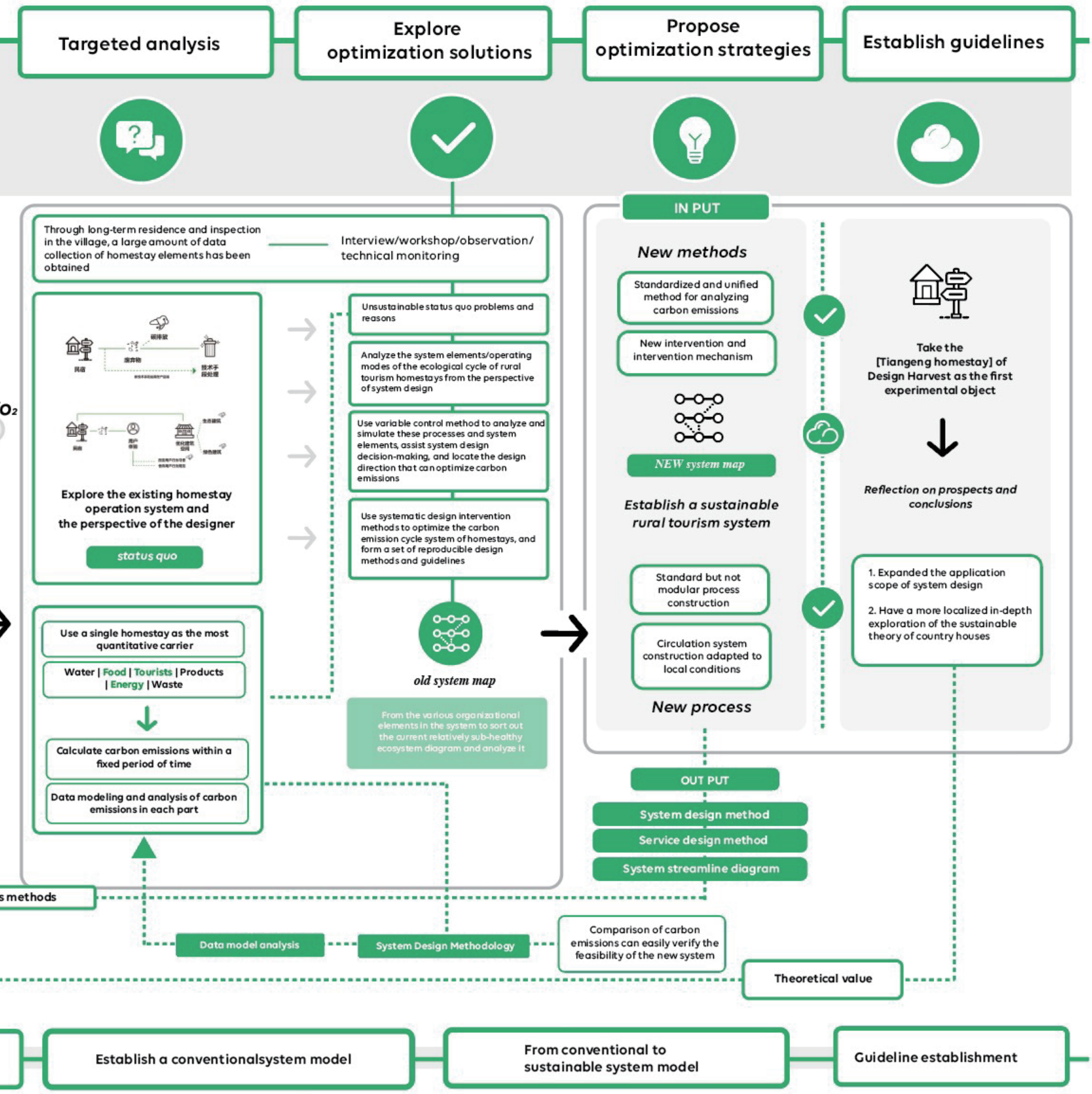
1.4.5 Life cycle assessment method

The measurement of the global warming potential of the rural tourism process needs to use the method of LCA (life cycle assessment) Then convert it into global warming potential value. Therefore, adopting a systemic design method can help quantitative analysis in the tourism process by sorting out the behavior and material relationship of species tourism. Therefore, the systemic design method is the main research method that can be followed in this study. The specific principles and steps of this research method will be described in detail in Chapter Two.

[1] Von Bertalanffy. General System Theory [M]. Social Sciences Literature Press, 1987.
[2] Bistagnino L. Systemic design: designing the productive and environmental sustainability [M]. Slow food, 2011.

Research Framework





Targeted analysis
Explore optimization solutions
Propose optimization strategies
Establish guidelines
Through long-term residence and inspection in the village, a large amount of data collection of homestay elements has been obtained
Interview/workshop/observation/ technical monitoring
Explore the existing homestay operation system and the perspective of the designer
status quo
Unsustainable status quo problems and reasons
Analyze the system elements/operating modes of the ecological cycle of rural tourism homestays from the perspective of system design
Use variable control method to analyze and simulate these processes and system elements, assist system design decision-making, and locate the design direction that can optimize carbon emissions
Use systematic design intervention methods to optimize the carbon emission cycle system of homestays, and form a set of reproducible design methods and guidelines
old system map
From the various organizational elements in the system to sort out the current relatively sub-healthy ecosystem diagram and analyze it
Use a single homestay as the most quantitative carrier
Water | Food | Tourists | Products | Energy | Waste
Calculate carbon emissions within a fixed period of time
Data modeling and analysis of carbon emissions in each part
IN PUT
New methods
Standardized and unified method for analyzing carbon emissions
New intervention and intervention mechanism
NEW system map
Establish a sustainable rural tourism system
Standard but not modular process construction
Circulation system construction adapted to local conditions
New process
Take the [Tiangeng homestay] of Design Harvest as the first experimental object
Reflection on prospects and conclusions
1. Expanded the application scope of system design
2. Have a more localized in-depth exploration of the sustainable theory of country houses
OUT PUT
System design method
Service design method
System streamline diagram
s methods
Data model analysis
System Design Methodology
Comparison of carbon emissions can easily verify the feasibility of the new system
Theoretical value
Establish a conventionalsystem model
From conventional to sustainable system model
Guideline establishment

1.5 Research Framework

The main content of the research is through the carbon emission monitoring of the current situation of rural tourism and the establishment of a cycle model.

The first chapter mainly introduces the background of the project and the research question and scope.

The second chapter mainly introduces the principles of systemic design, the current status of sustainable rural tourism development in the new era and the goals of change.

The third chapter is through the long-term research, inspection, and collection of a large amount of data, strictly controlling all materials, tourists, water, energy, food and other elements entering and leaving the homestay, and calculates each link in the current specified cycle through data model analysis. and element carbon emissions, and through the system map designed by the system to construct the current material circulation system of the homestay, and finally through the variable control method to find out the elements that have the greatest impact on carbon emissions in the current system map. Through continuous experiments, we can obtain that the various processes in the homestay are in unsustainable links, which can serve as the basis for the optimization of the next part.

The fourth chapter is based on the establishment of the continuous cycle model from the linear rural tourism cycle system to the sustainable cycle system. Through the construction of the country house cycle system, on the basis of the large data model and the current system diagram in the third chapter, we should take into account all aspects of the current system, and mobilize all the elements that can be mobilized in the system to lead a new sustainable production and consumption system. In addition, each node of the circulatory system may be opened up, not only from the optimization of behavior but also from the improvement of technical means. In the fifth chapter, the author will make an application and test of the established "sustainable" rural tourism cycle guidelines, and summarize and reflect on the results obtained in the sixth chapter, and propose replicable guidelines and prospects.

1.6 Existing research and literature review

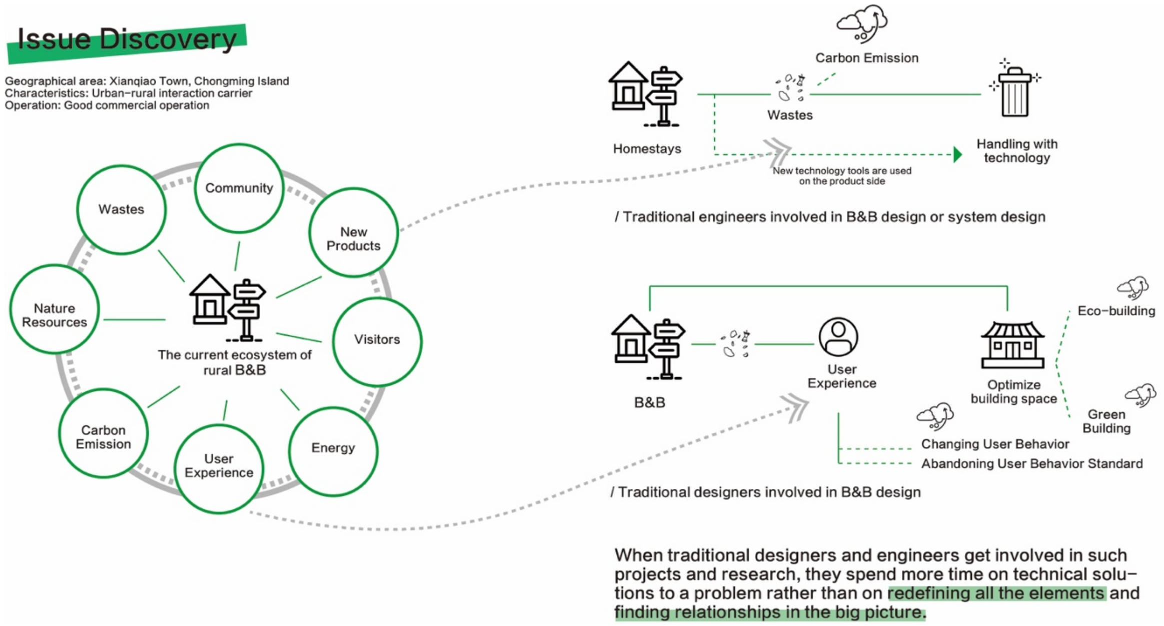


Figure 1.12 Problem identification and analysis (Image credit: author's drawing)

This research involves three aspects: systemic design, rural tourism, and circular economy, and has a high degree of interdisciplinary nature. Therefore, this section first briefly summarizes the current systemic design research, existing research on rural tourism, and existing research on circular economy, and then discusses an overview of the cross-study between the three.

We analyzed the international research trends for the key content of this study: "systemic design", "rural tourism" and "circular economy", and found that although the research on "systemic design" officially entered the research field in 1984, it reached its peak in 2014. The main research content mostly focuses on engineering fields such

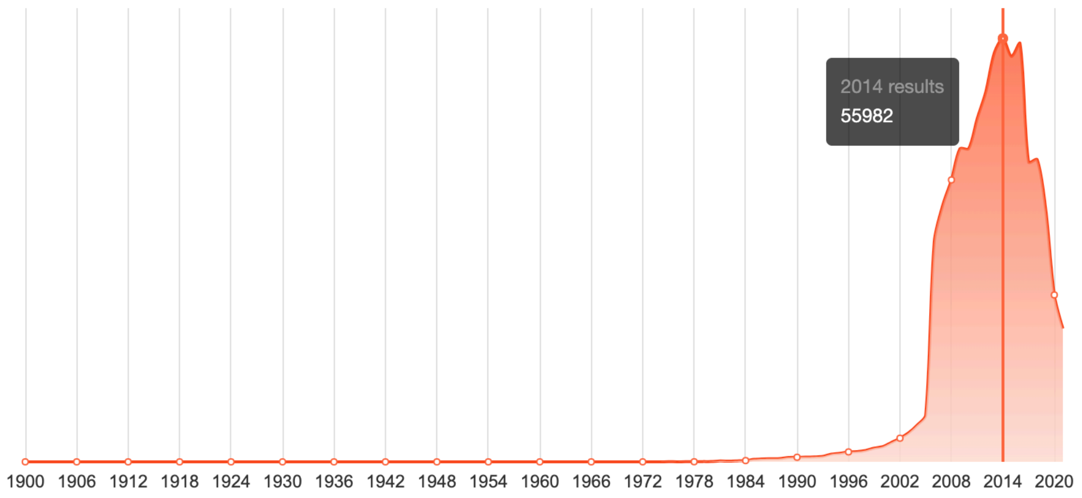


Figure 1.13 Analysis of research trends in the field of systemic design (Image source: Baidu Academic)

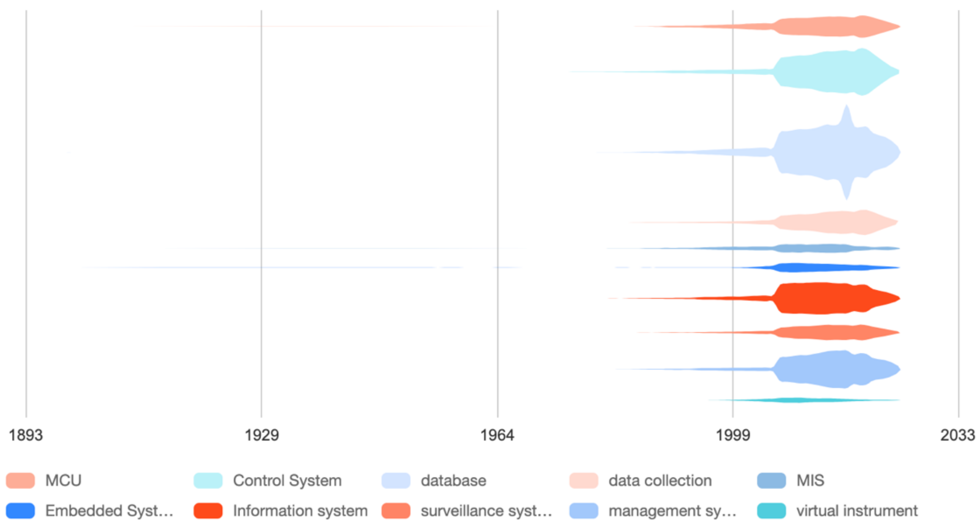


Figure 1.14 Analysis of research hotspots and related disciplines in the field of systemic design (Image source: Baidu Academic)

as automation, machinery, computer, and data science.

"Circular economy" reached the hottest in 2006, with 110,001 related papers so far. It has entered an outbreak stage since 2002 and has entered a research cooling period since 2010. Since 2020, with the global attention to carbon neutrality, carbon trading and other policy issues, the research output has shown a clear upward trend. It can be clearly observed from the chart that the research on circular economy focuses on sustainable development, clean production, comprehensive resource utilization technology, ecological environment protection, new energy economic development and other fields.

For the field of rural tourism, related research has appeared since 1987, and reached the hottest in 2019, with a total of 38,147 related papers. With the deepening of research,

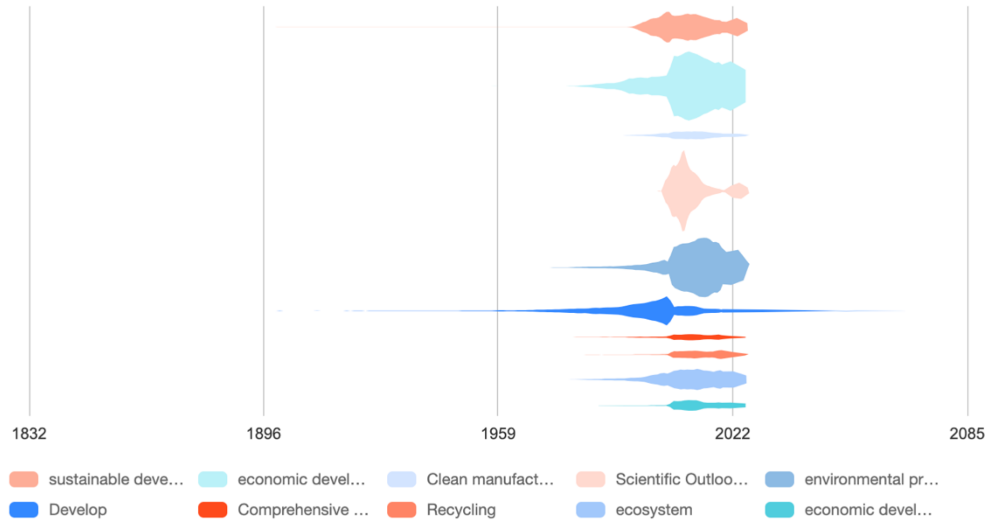


Figure 1.15 Analysis of research hotspots and related disciplines in the field of circular economy (Image source: Baidu Academic)

more and more research points related to "rural tourism" have emerged, forming a huge research network. The above are highly relevant research points and their research trends, involving leisure agriculture, new rural construction, farmhouses, tourism products, tourism management, rural tourism development and other research hotspots.

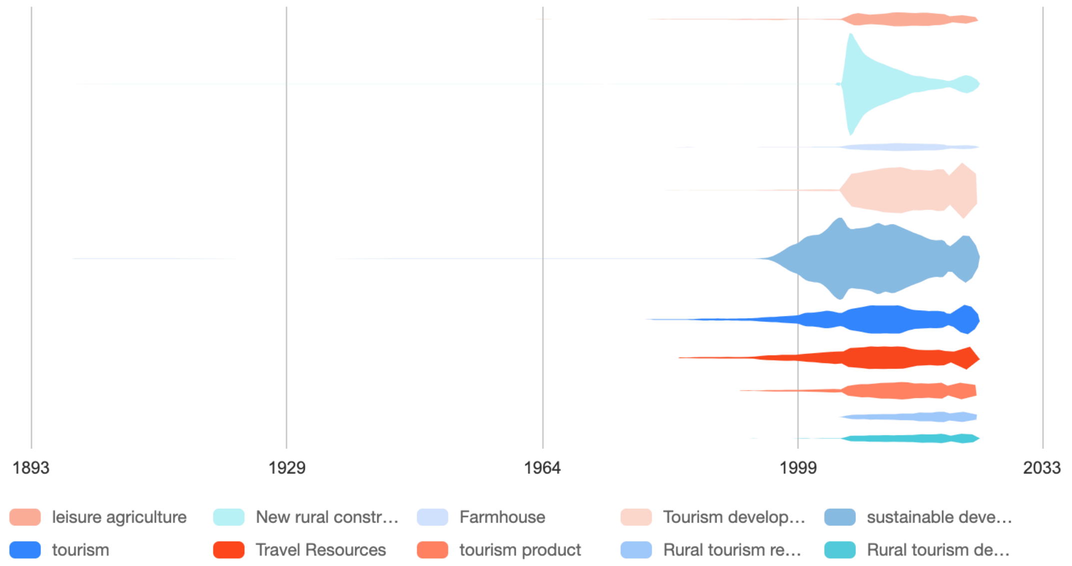


Figure 1.16 Analysis of research hotspots in the field of rural tourism (Image source: Baidu Academic)

Finally, we conducted a secondary analysis of the most relevant association studies of the keywords in this paper, and the results are as follows: Agricultural Economics (422 retrieval results), Building Science and Engineering (399 retrieval results), Sustainable Design (595 retrieval results) results), ecosystem design (177 search results), low-carbon development (1595 search results), rural economy (1771 search results).[1]。

1.6.1 Existing Theory Development

1. The cross-discipline in the field of systemic design research is relatively successfully

In 1968, Jay Wright Forrester defined the system as: A system is a grouping of parts that operate together for a common purpose. (Jay W. Forrester, 1968). In 2008, Donella Meadows redefined the system as: A system is an interconnected set of elements that is coherently organized in a way that achieves something. (Donella Meadows, 2008). Therefore, the system should have these three elements: elements, interconnections, and functional goals.

[1] Baidu Academic's search and analysis results for keywords such as "systemic design", "ecological design", and "circular economy"

The development of systems research can be divided into three dimensions: system theory dimension, system model dimension, and systemic design dimension. From the latitude of systems theory, Austrian theoretical biologist Bertalanffy put forward the idea of "general systems theory - the concept of organisms in biology, emphasizing that organisms must be studied as a whole or a system, so as to discover and optimize the principle of the entire parent system. "But this analogical system theory does not make a reasonable analysis of the order and purpose of the system.

In the late 20th century, American physicist Fritjof Capra put forward the general elements of living systems based on the summarization and induction of past research results in ecology, biology, mathematics and physics, namely self-generated organizational mode, dissipative structure and self. Cognition (Fritjof Capra, 1996) [1], Capra's theory of living systems is one of the authoritative works in the current system theory research.

From the perspective of design, the famous Italian architect BISTAGNINO LUIGI proposes the concept of systemic design and defines system thinking. Based on the principle and model of system input and output, Professor Luigi Bistagnino developed a systemic design method aiming at zero emission of the system, that is, the output of one subsystem is the input of another subsystem. [2] He pointed out that there is no waste in nature. Therefore, in human society, we should pay attention to the research of resource quality, redistribute resources, and allocate suitable resources to suitable processors in order to reduce waste and achieve zero emissions. His contribution is to build a bridge between system research and design. From the designer's point of view, he decomposes, simplifies and visualizes complex system theories and models, so that

[1] Naziel de Oliveira,Joanez Aparecida Airez. Analysis of the Present Conceptions of Environmental Biology Books in the National Textbook Year 2012, Brazil[J]. Procedia - Social and Behavioral Sciences,2014,120.

[2] Bistagnino L. Systemic design: designing the productive and environmental sustainability [M]. Slow food, 2011.

they can be objectively analyzed and designed.

Figure 1.17 Distribution of global systems studies (Image credit: Politecnico di Torino)

International research on related aspects has not only made progress at the theoretical level, but also made certain breakthroughs at the application level. The Slow Food Movement can be used as a typical example of the practicalization of systemic design. "Slow Food Movement" [1], proposed by Italian Carlo Petrini, calls on people to oppose fast food such as hamburgers produced according to standardization and standardization, and advocates traditional cuisine with individuality, balanced nutrition and regional characteristics. "The organization rebuilt the operation process of food production, cooking and sales by means of systemic design, so as to make the food as ecological, green and sustainable as possible. The team of Politecnico di Torino in Italy has carried out in-depth cooperation with the well-known coffee brand Lavazza,

[1] Slow food , https://www.slowfood.com/

providing a design opportunity from the recycling of coffee grounds at the output end of coffee. [1]

The Research of systemic design in China is in the early stage , Dr. Qiu Zhaoliang is a pioneer of general system research in my country. On the one hand, he translated a large number of foreign systemic works; on the other hand, he summarized the main models of various systems analysis (Qiu Zhaoliang, 2009), providing a basic reference for Chinese system researchers. However, at present, the vast majority of domestic researchers related to systemic design are equivalent to ecological design. Search through platforms such as CNKI as shown above: "Application of Ecosystem Design in Modern Landscape Architecture", "Application of Ecological Architecture Design in Architecture", "Ecological Civilization and Protection of Traditional Villages", "Linear Architecture Turning to Ecological Architecture" Renewal and Utilization; Exploration of Landscape Ecological Design Methods of "Rural Innovation" in Beautiful Villages, Waste Recycling in Ecological Design, etc. However, considering "systemic design" as a retrieval, there are a large number of documents related to computer system architecture and management. Relevant systems, this "system" is not another "system," In summary, the current domestic research on ecosystem design is mainly distributed in computer and software engineering, architectural science and engineering, and urban environmental landscape. Among them, in architectural science and engineering, Domestic research on ecological buildings and green buildings has achieved remarkable results, and there are many successful implementation cases. However, there is no domestic precedent for applying sytemic design methods to control carbon emissions in rural tourism and build a recycling system.

2.Rural tourism research started but progress was slow

International research on rural tourism started earlier, dating back to the 1960s and 1970s, but the progress was relatively slow. The reason is that the development speed and scale of the rural industry in European and American countries are proportional. As far as the specific research content is concerned, "from the initial focus on the form, function and conceptual definition of rural tourism to the user experience, social and cultural effects, and new tourism models under sustainable development, which are

[1] politenico di torino，https://www.polito.it/

gradually expanded to rural tourism." and The research methods it uses have gradually changed from qualitative analysis to quantitative research methods, such as structural modeling analysis, cluster analysis, sample statistics and other methods. From a research perspective, it has expanded from tourism, which only focuses on tourism, to sociology, ecological economics, design, psychology, etc., so as to expand research on the integration of disciplines. [1]

China's focus on rural tourism lies in the innovation of user experience and activity models. The vast majority of rural tourism research is experience-oriented. At the same time, there are also some scholars' research on sustainable tourism models, but specific solutions at the time of strategy, technical means are used to solve pain points, such as transferring raw materials, energy, waste disposal, etc. to professional and technical fields. However, these problems are an inseparable part of the design process. Find connections between these loose elements (raw materials, energy, waste, products, people) and find ways to use resources and energy wisely, rather than keeping them out of the process.

3. The research on the implementation of the concept of circular economy is gradually increasing

"The traditional economic development view holds that economic growth is not limited by the boundaries of resources and the environment. This is defined from the perspective of the evolution of Western economics. At the same time, it is from the market price that will convey a signal of resource scarcity to people, so people You don't have to give up growth to protect the environment. "[2] The traditional economic development has been greatly impacted and people are questioned, the consequences of economic growth are obvious - the environment and resources will reach the limit.

The Ellen Macarthur Foundation is a well-known institution in the UK devoted to the research of circular economy and based on promotion. It calls for the combination of industry, academia and research to use the concept of circular economy to support targeted solutions to existing unsustainable phenomena. It proposes that the research

[1] Sun Xiao, Li Yongwen, Liang Liuke, Product Strategy of Rural Tourism Marketing [J], Journal of Leshan Normal University, (05): 39-42
[2] Liu Jiankang, Sustainable Development Strategy and Ecology[J], Ecological Economy, 2013(03):121-125

on circular economy should be combined with enterprises, and designers, engineers, economists, and artists should work together to solve unsustainable environmental "stubborn" problems and develop new business models.

“Companies need to build core competencies in circular design to facilitate product reuse, recycling and cascading. Circular product (and process) design requires advanced skills, information sets and working methods. Important for economically successful circular design Areas of interest include: material selection, standardized components, design to final product, design for easy end-of-life sorting, separation or reuse of products and materials, and design manufacturing standards for applications where by-products and waste may be useful." [1]

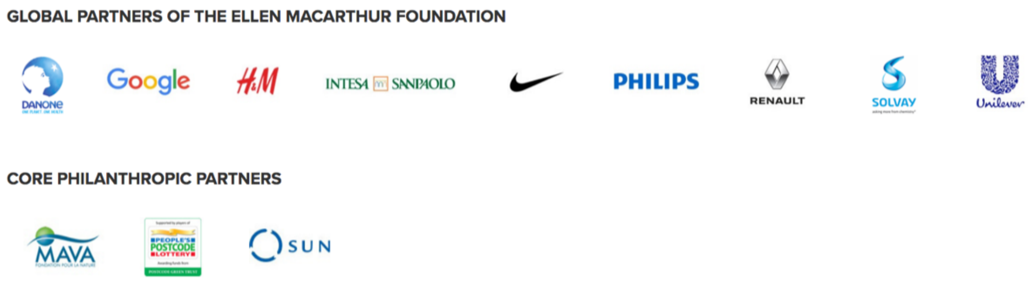


Figure 1.18 Ellen macarthur foundation partner institutions (Image credit: Ellen macarthur foundation official website)

The Ellen MacArthur Foundation launched the Circular Economy 100 program in 2016. To support businesses, governments and cities in realizing these opportunities, the Foundation established the Circular Economy 100 program. This global platform will lead companies, emerging entrepreneurs, small and medium-sized enterprises Enterprises, government departments, cities, academic partners and alliance networks come together to speed up the transition to a circular economy. The foundation has made gratifying achievements in research and implementation, and has united many large global companies such as Google, H&M, NIKE and other Internet, manufacturing companies, and world-class university research institutions, the purpose is to jointly promote the research and implementation of circular economy.

However, China's research in the field of circular economy started relatively late. In the early and late 1990s, the idea of circular economy was introduced. In the late 1990s,

[1] https://www.ellenmacarthurfoundation.org/circular-economy/building-blocks

the concept of circular economy in Germany was introduced, and the central position of the "3R" principle was established; in the following 20 years The concept of circular economy in China continues to develop, from the establishment of the scientific concept of development, involvement in industrial production, etc., but the circular economy is still in a rather embarrassing situation at the implementation level. Most enterprises do not strictly follow the concept of circular economy to implement industrial production and business activities.

1.6.2 Research blind area

1. Mainly focus on technical solution strategy research

The current research on ecosystem design mainly focuses on the technical means level rather than the macro systemic design level, and most of the research fields are urban landscapes and densely populated cities. Google Scholar and other search data show that the literature in the field of ecosystem design mainly focuses on the innovation of ecological architecture, urban ecological landscape space and ecological technology means. It is mainly aimed at the construction of places and the application of construction technology in the context of indoor and outdoor spaces of ecological buildings. The starting point is to analyze from the case, and use the case to respond to the questions raised. The starting point of design in many literatures is how to pass the space Designed to enhance the sustainability and self-circulation of the building itself. There is no one who thinks about the layout to solve the carbon emission control and circulation system of rural tourism from the perspective of macro design.

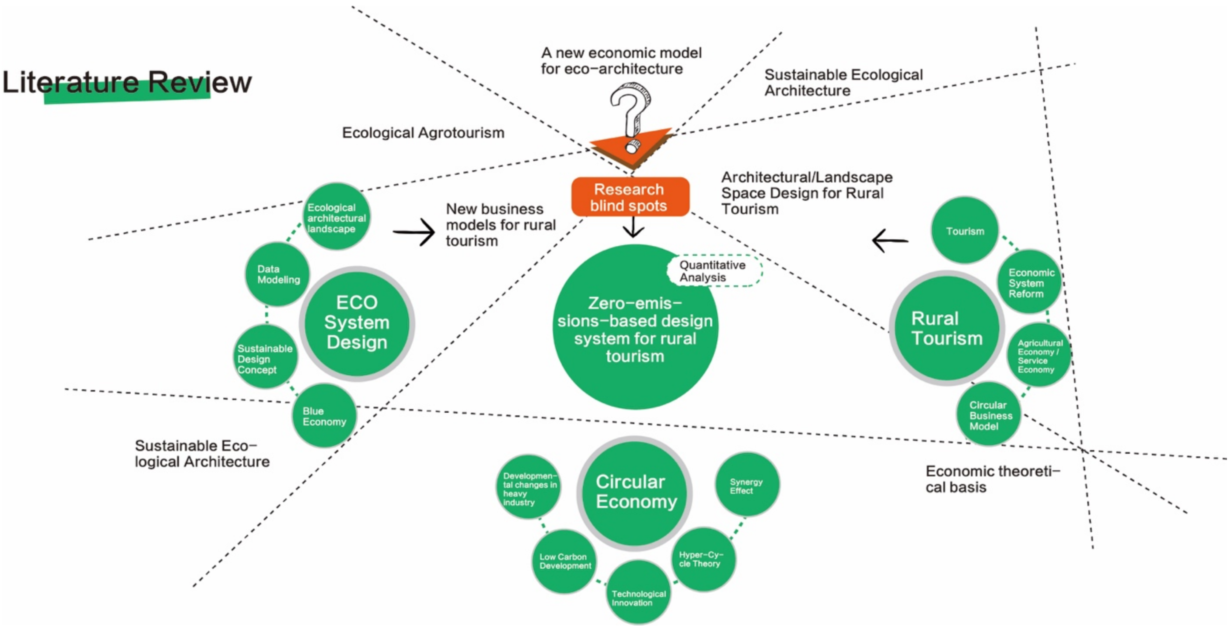


Figure 1.19 Research blind zone (Image credit: author's drawing)

2. User experience-oriented rural tourism research

China is a big country in rural areas, and it is also a big country in tourism. China's research on rural tourism mostly focuses on tourism forms, user experience, economic models and its benefits. There are relatively few studies from the perspective of ecological design. At present, my country's rural tourism has gone through a stage of rapid development and has entered a saturation stage. The rural tourism that survived in the market competition has changed from "blind expansion" to creating "the ultimate user experience", so the "user-centered" operation Concepts have become the way of survival in China's rural tourism, and "new business models", "tourism activity forms innovation", "rural tourism interactive design" [1] and so on are called the current research subject of China's rural tourism, "environmentally friendly oriented rural tourism research". At present, there are few, and most of the sustainable rural tourism is evaluated from a macro perspective without in-depth specific research and strategic and technical solutions." [2]

[1] Zhang Shumin, Zhong Linsheng, Wang Lingen.A Discussion on China's Rural Tourism Development Model Based on Tourism System Theory[J]. Geographical Research, 2012,31(11):94-103.
[2] Zheng Wenjun, Zhou Zhixiang.Basic characteristics of sustainable rural tourism and its realization ways[J].Ecological Economy,2007(09):127-130.

1.6.3 Interdisciplinary and research status

1. Eco-design and systemic design

Ecology and system are inseparable, and both ecological design and systemic design originate from people's re-understanding of in-depth research on ecosystems and sustainable development around the 1970s. Although both of them are currently developed as independent disciplines, they complement each other and are inseparable in the research process. For example, Brain Walker (2008) shows that the system has a threshold from the perspective of system resilience, and raising the system threshold can enhance the stability of the ecosystem. However, when it comes to systemic design, it is found that there is no evidence-based ecological assessment system for the established system to understand the impact of the system on the ecological environment.

2. Circular economy and rural tourism

In the relevant literature, "rural tourism" and "circular economy" do not appear in the same topic too much at the same time, and the two keywords do appear frequently, but related research based on "circular economy of rural tourism" is relatively rare. Since the discussion of the rural tourism development model based on the concept of circular economy has achieved fruitful results, it has important reference value for the development and construction of rural tourism in my country. [1]How to judge that foreign rural tourism follows the model of rural tourism and is an important exploration direction for us in this section? According to the views of Chinese ecologists and scholars Ming Qingzhong (2006) and Chen Xianghong (2006), this literature review believes that the concept of circular economy is embodied as "3Rs". Generally, the 3R principles (Reduce, Reuse, Recycle) specifically guides the harmonious development of tourism activities and the ecological environment, and is also the basic basis for judging the circular economy of rural tourism. "How to combine the two organically is also the focus of this thesis.

[1]Lai Bin, Yang Lijuan, Fang Jie.Research on the Sustainable Operation Mode of Rural Tourism Guided by Circular Economy Concept—Based on Foreign Experience[J].Township Economy,2009,25(09):104-109.

3. Interdisciplinary design drives the new trend of design development in the era

With the development of the times, innovation-driven has become another driving force for social and economic development, and future design has also undergone epochal changes. In future design, "design is more directly oriented to real challenges., ambiguity, contradiction and uncertainty" [1]（Yongqi Lou，2017）

The themes of design are diversified, and the design is also more linked to the design of nature, human and man-made objects, and more systemic thinking based on relationships. “These changes in design signify the need for new design methods to solve new and complex problems, and design is becoming a strategic contributor to social and industrial development” (Yongqi Lou, 2017); China’s “Three Rural Issues” Solving Requires design thinking and methods. In the face of different social groups, how to organically combine the "small and interconnected" network-based business model innovation with the "environmentally friendly concept of sustainable development at the core of development" becomes a way to meet new challenges and seize new opportunities. opportunity of opportunity.

1.7 Summary of this chapter

This chapter is the foundation of the research. Through the review and analysis of the research background and the clustering of several major characteristics in the new era, we established the research questions and research methods, and used advanced systemic design methods to intervene in the author's research objects. Jolywood mainly answered the question of "environmental pressures faced by rural tourism, the process of industrialization, and the growing spiritual and cultural needs of urban populations make rural tourism face a lot of pressure from the local ecological environment while it is booming. How to use circular economy as a Is it possible to solve the ecological environment pressure faced by the rapid development of rural tourism? The research method of this study adopts the systemic design method and the life cycle assessment method. The systemic design method can help to establish a new rural tourism cycle model, and the life cycle Assessments can perform ecological assessments of the system

[1] Lou Yongqi, Territorial Expansion and Paradigm Transformation of Design [J], Times Architecture, 2017,01(02):11-15

to determine the impact of the system on the environment.

The other part of this chapter is a literature review. Through reading and sorting out the literature, it summarizes the shortcomings of the existing research and clarifies the research direction of this research.

Chapter 2

Design Research Methodology and Systemic Prototype Framework for Rural Tourism

This chapter is divided into two parts: the first part introduces, analyses and expands on the most important research methods used in this study, which mainly include systemic design method and Life Cycle Assessment; the second part introduces and analyses details of the Chinese rural brigade, the author's quantitative research project called 'Design Harvests' in particular. the primary objective is sorting out and establishing the logic of System Prototype Framework and evaluation system which help to build system models in diverse planting scenarios in the subsequent research.

2.1 Sytemic design Method

2.1.1 Sytemic design Model

"The system delicately combines a series of intrinsically related elements to achieve a goal. (Donella Meadows, 2008). For example, bicycle elements are organized between each other to complete transportation; the organelles of a cell transfer material energy to each other for metabolism; "a football team of players run and pass the ball to each other to goal. The above cases demonstrate the abstract concept that a system responds to the connections between elements and the whole organization. [1] Therefore, having discussed how to analyze a system objectively or even Design Intervention. At the beginning of systemic study, it is necessary to visualize these elements and connections between them, which refer to creating a systemic model. Effective system modeling tools need to be applied in a targeted manner for systems with different functions or manifestations. The main modeling methods include behavior patterns graph, entity-relationship diagrams, input-output schema, multiple reasons diagram, Ishikawa diagrams, casual loop diagram, stock and flow diagrams, and so on, according to figure 2.1.

As shown in the picture, any systemic modeling approach demonstrates some

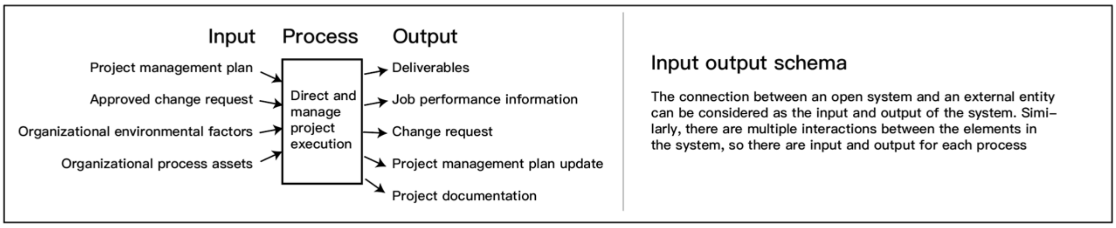


Figure 2.1 different system analysis models (Photo credit: Zhaoliang Qiu, 2009)

relationship between each element in the system. Generally, these elements have different levels and categories; thus, different associations exist between them. For example, the occurrence of a sequence of events is connected by many causal relationships. While a series of actions may be connected through the transmission and exchange of substances, Behavior-related participants may interrelate through information and interests. These interrelationships, which exist at different levels, form into complex, three-dimensional, dynamic systems through factors such as time and space.

In seven basic systemic models of the figure, the input-output schema, based on substance analysis of the behavioral process, creates a resource management system by delving into material transport relationships between behaviors and itself. For example, "tourist behavior model" in rural tourism is similar to "behavior patterns graph" in Figure 2.1, which consists of an “X" and "Y'" axis, using a curve to demonstrate a problem or a variable with the evolution of time. The number of visitors is variable,

[1] Huang Tai Yan and Yang Wan Dong (2005). *Zhong guo jing ji re dian qian yan.(02)*. Bei Jing: Jing Ji Ke Xue Publisher, pp.159–166.

while environmental factors are quantification. Hence, we can use "behavior patterns graph" to build a model. nevertheless, we should use "input-output scheme" for "energy" and "food" modules in rural tourism. For example, a complete process that contains input and output of production during the process of growing food. The process of harvesting, transporting, cooking, and post compost treatment is also a complete output that includes "input and output." What can be seen is, 'food process' and 'energy use process' in rural tourism systems are typical resource management systems. Thus, we could use the input-output systemic research model to build model systems and analyze and design them.

Luigi Bistagnino has developed a methodology for sytemic design based on the input-output systemic research model, as shown in Figure 2.2 the core of systemic design regards the output of one system as the input of another. the system achieves zero emissions based on recycling and efficient use of resources. Just as with ecosystem, there is no absolute garbage in nature. Any organism can be regarded as a source of food and energy for another. This concept can also be adapted to human society. While upholding this core concept, sytemic design theory also emphasizes the exploitation of

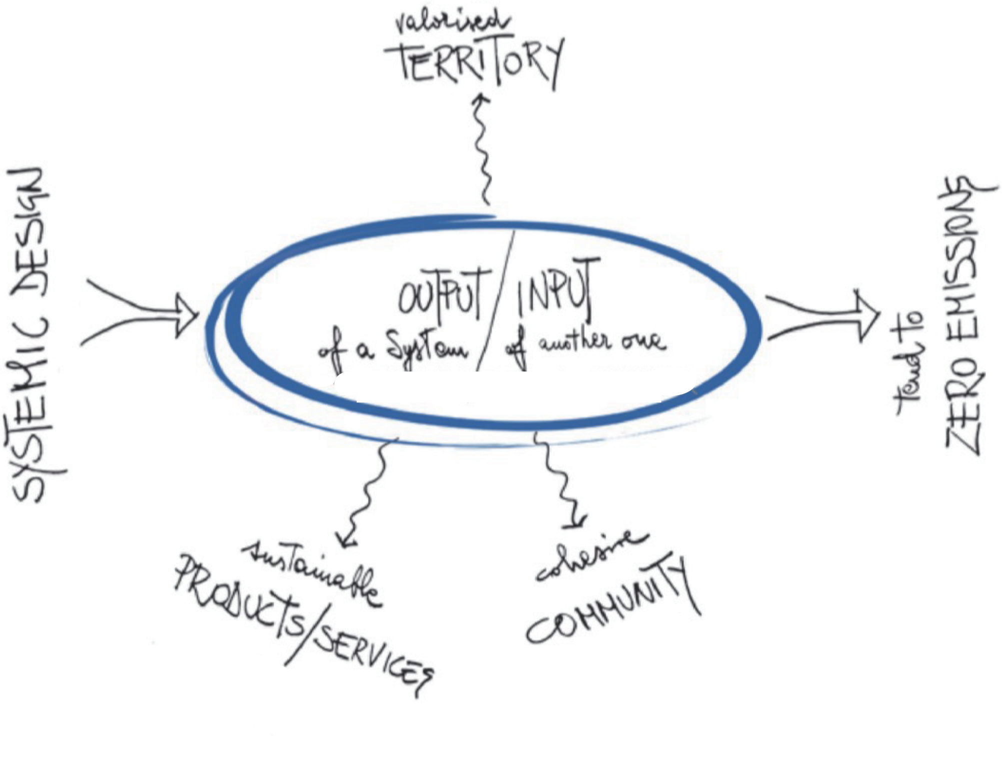


Figure 2.2: Sytemic design Methodology (Photo credit: Luigi Bistagnino, 2011)

local material and human resources, and so on. In order to enhance system stability through community collaboration. Furthermore, when the system is finally implemented, the system's proper functioning is achieved through specific design of products, services, and other aspects.

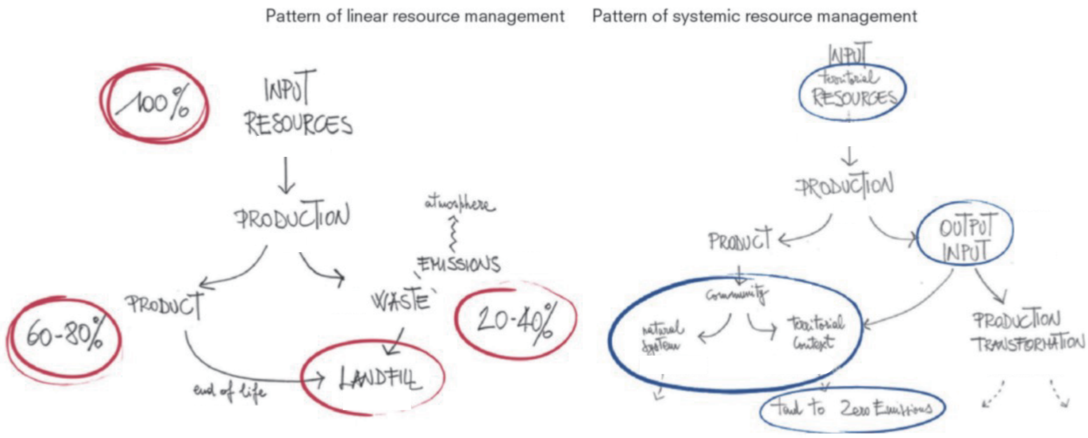


Figure 2.3 Linear and systemic resource managements (Photo credit: Luigi Bistagnino, 2011)

Figure 2. 3 illustrates the current state of resource use in production in the left part of the diagram and the resource use achievable with systemic design in the right part. In the existing, linear resource management model, 60-80% of the resources are used to produce the product, while the remaining 20-40% are considered waste to discharge or deal with landfills. "The system operates in a single line from top to bottom, with the sole objective of getting a product, a linear resource management model, which is undoubtedly a huge waste of resources."[1] In a systemic-designed resource management model, production is no longer the only goal; instead, creating a continuous cycle and achieving zero emissions through processing remaining secondary products that are also used as input resources for other production. In addition to this, a systemic resource management model in which resources are almost always sourced locally, local products and services are more effective in digging through local value.[2] Systemic networks can enhance the well-being of human life, can activate financial flows between systemic participants, and optimize production processes between continuous

[1] Bin Lai, Lijuan Yang and Jie Fang(2009). Study on the sustainable operation mode of rural tourism guided by the concept of circular economy-Learning based on foreign experience. Journal of Anhui Administrative College, [online] 25(9), pp.104–109. Available at: http://60.205.143.183/academic-journal-cn_journal-anhui-academy-governance_thesis/020122290617.html [Accessed 25 Jan. 2022].

[2] Petrini, C. (2013). Slow food nation : why our food should be good, clean, and fair. New York, Ny: Rizzoli Ex Libris, New York, Ny.

material transfers. The ecological environment will benefit, while culture and values will be redefined.

2.1.1 Sytemic design Discipline

"The basic principles of sytemic design include input-output, correlation, self-production, indigeneity, and human connection to the outside world. The input-output principle refers to the core idea that the output of one system is the input of another; the correlation principle means that the interconnectedness of elements, each of which contributes to the functioning of the system and is a vital element of the system;

The self-generating principle means that the system produces necessary resources for its continuous functioning, which is sufficient for the living system. "[1]

On this basis, the author elaborates on these five principles at the environmental dimension. "The input-output principle can be thought of as "3R principles"(Reduce, Reuse, Recycle). When a system uses secondary resources from other systems, it reduces the use of the original resources, and when secondary resources flow within or between systems, it is a reuse and recycling of resources; relevant principle contributes to the search for the primary sources of environmental problems, and because elements are related, Therefore, the environmental problems caused by the elements are also correlated. The essence of the self-generating principle is a mechanism for learning from nature how life works, which is non-threatening and sustainable for the environment"; localization principle requires the full use of indigenous natural resources rather than the destruction of the local environment through one-way inputs or the depletion of the local environment through one-way outputs. The principle of connections between humans and the outside world requires shifting perspective to consider environmental issues from an ecological perspective, rather than relying on cultural values that humans have built up themselves.

This study will use sytemic design approaches to focus in-depth research on the more environmentally relevant cycle systems in rural tourism systems. These three categories currently generate the primary carbon emissions from rural tourism. After this chapter,

[1] Bistagnino, L. (2011) Systemic Design: Designing the productive and environmental sustainability, 2nd ed., Slow Food, Bra.

a prototype framework for a cycle system based on these three categories will be constructed.

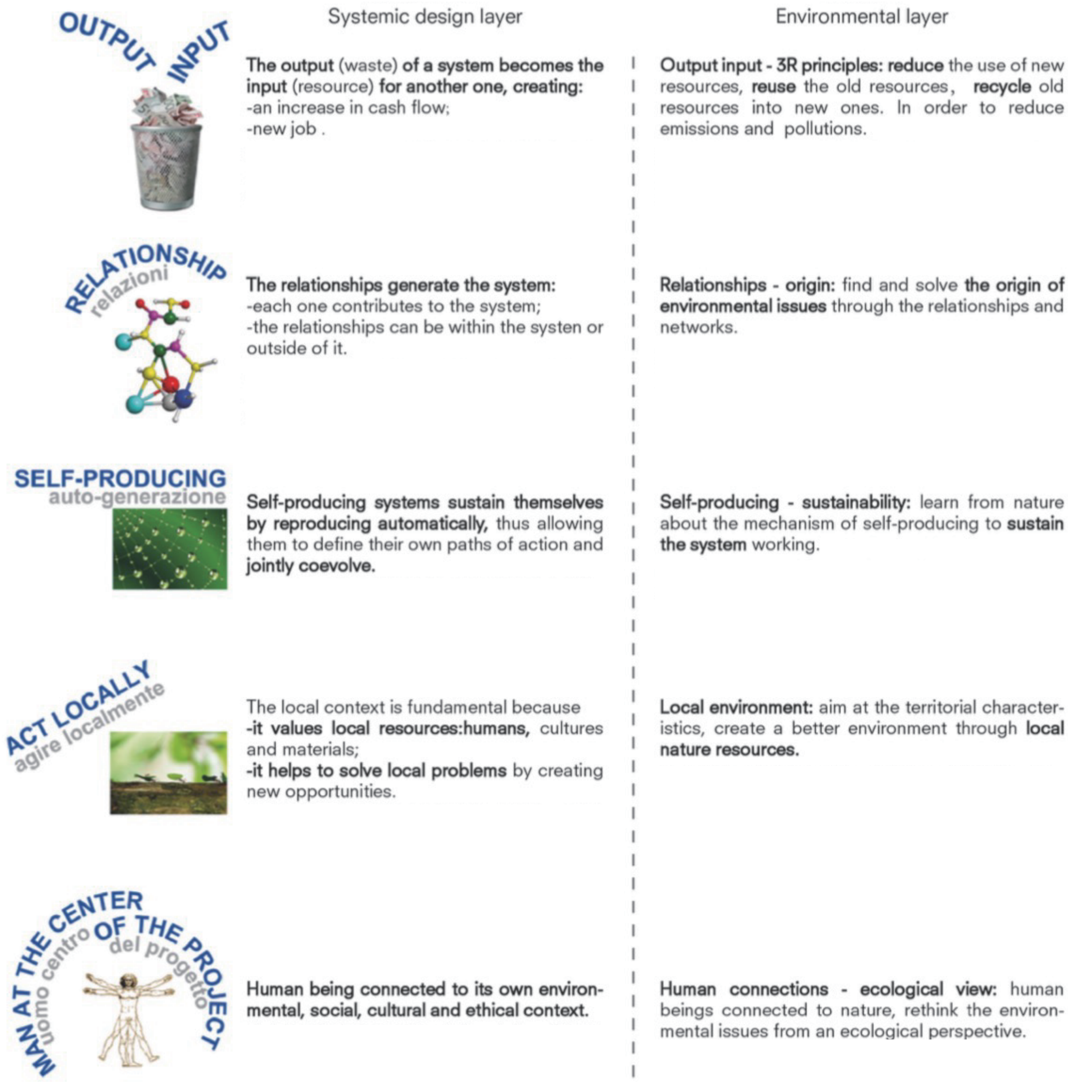


Figure 2.4: Sytemic design methodology guidelines (The author has adapted Luigi Bistagnino's systemic design principles and Gao Xiang's "Re-evaluation of certification standards for organic farming from a systemic design perspective.")

2.2 Life-cycle Assessment

Life-cycle assessment is an essential environmental management tool developed since the 1960s to measure the environmental impact of products from resource acquisition, production, packaging, and transport, use to disposal. The life cycle of production is slightly different from that of the product and is the first half of the product life cycle, which the author adjusts into four parts: resource acquisition, resource use and product production, waste resource treatment and product packaging and transportation,

(1) Objectives and scope: Firstly, the functions and character of the product and production system to be assessed should be determined and the objectives of the life cycle assessment defined. Secondly, it is necessary to define the system boundaries, which determine the beginning and end of the life cycle. Thirdly, the method of distributing the inputs and outputs of the system. Therefore, it is necessary to analyze the production system and draw up a system map at this phase.

(2) Substance Inventory: We need to quantify the resources, energy inputs, and waste emissions over the entire life cycle of a product or service system—various types of data required to collect during the process and ensure its effectiveness.

(3) Influence analysis: we combine analysis results in substance inventories with corresponding environmental impact types for analysis and judgment.

(4) Optimization analysis: possibilities need to be searched for and evaluated for optimization, which may reduce the input of energy, matter, or optimization possibilities that exist in each life cycle.

Figure 2.5: Life Cycle Assessment methods (Photo credit: Xiang Gao, Reassessment on the certification standards for organic farming from systemic design perspective,2017)

As already mentioned, this study is a study focusing on the rural tourism cycle system, which at a horizontal level places the material and immaterial movements in the rural tourism system into three main systems: The first system is the activity behavioral system based on "tourist" activity in the tourism process.

The second is regarding “food” as a life cycle activity in the rural tourism system. The third is the "energy" activity system based on activity places involved in rural tourism. The final measurement is assessed by carbon emissions of "global warming potential." In summary, the boundaries of these three systems are the input of "means of production" to the system of product output and then to the next system.

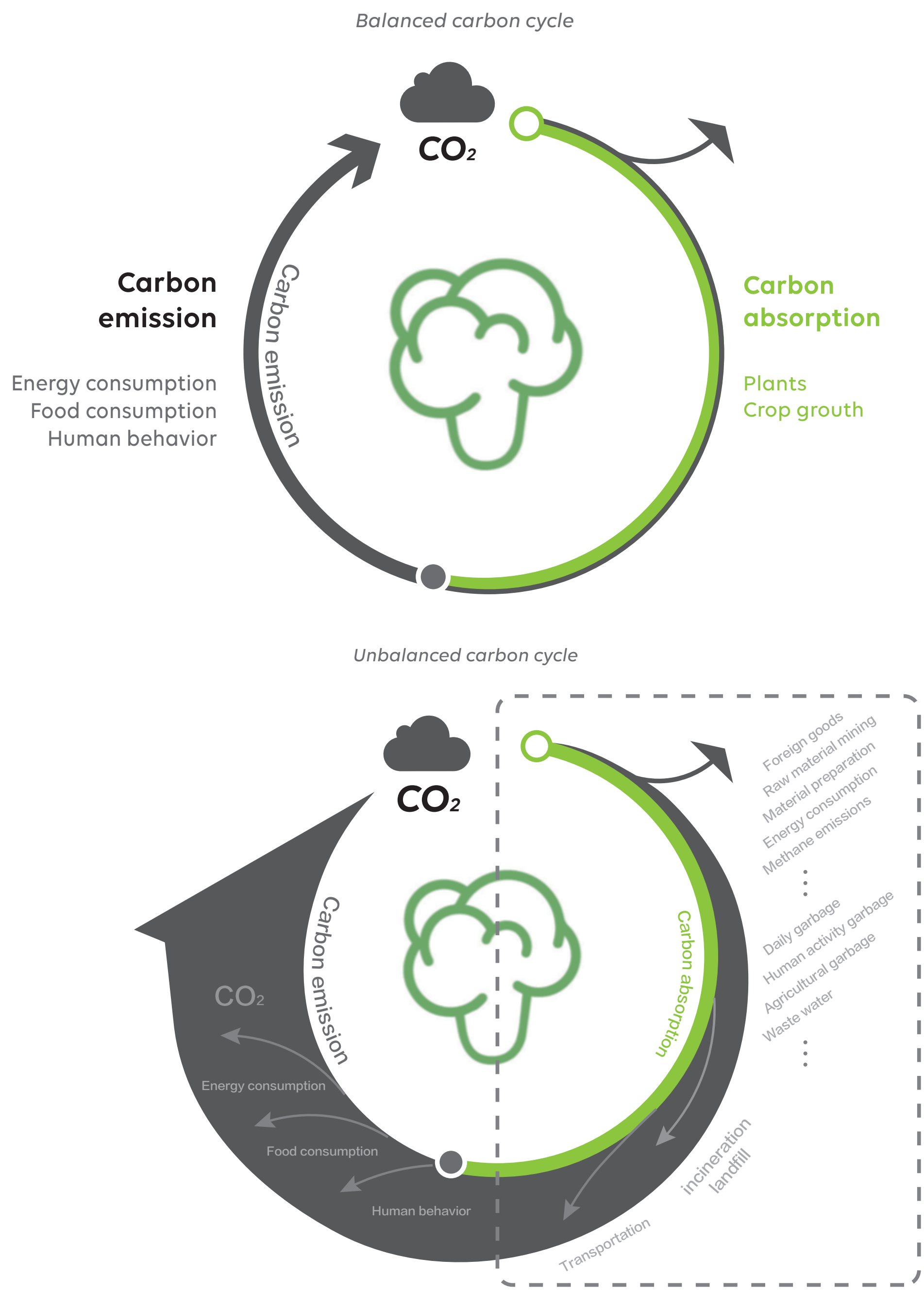


Figure 2.6: Carbon cycling in the life cycle of elements in rural tourism systems

The figure above further illustrates the scope of Life-cycle assessment in terms of carbon emissions from rural tourism (in this study, the amount of carbon emissions reflects the magnitude of the global warming potential). The carbon emissions from energy consumption, food, cultivation, and tourist activities in rural tourism activities constitute the carbon emissions of the entire rural tourism system. As the tourism carrier is countryside, the presence of carbon sequestration is due to multiple green plants and some species of plants. The activity behavior pattern of humans generates additional carbon emissions at various stages, resulting in carbon emissions that far exceed the carbon that plants absorb. As indicated by the dashed line in Figure 2.6, the range of life cycles selected for this study visualizes the complete state of the rural tourism carbon emission cycle, using the range of activities of linear rural tourism as the boundary and the activity behavior within the tourism system as a sample within the time unit.

This study will ultimately use a quantitative approach to analyze, present and describe rural tourism concerning global warming. The specific research methodology and presentation will be developed in the second part of this chapter when establishing an ecological assessment system for tourism systems.

2.3 Life Cycle in Sytemic design

According to the analysis of the two research approaches above, many similarities and complementarities between systemic design and life-cycle assessment could be identified, facilitating the organic integration of the two approaches. The similarity is that life cycle assessment must rely on a bounded system and the inputs and outputs. Also, establishing an input-output system is the most fundamental part of the system's design. The complementary aspect is that the Life-cycle assessment results provide the ecological assessment criteria for the system and serve as a design basis and starting point for the systemic design. Similarly, LCA is mostly objective quantitative research and no further qualitative design research. In contrast, sytemic design is beneficial in deepening the application of Life-cycle assessment through the improvement from a systemic level.

In this study, rural tourism systems' carbon emissions and energy consumption are analyzed quantitatively using these methods and combined with a large amount of data collection to explore a genuinely eco-sustainable rural tourism system.

2.4 Direction for Rural Tourism Reform from the Perspective of Circular Economy

2.4.1 Current Issues in Rural Tourism in China

As the most critical research carrier of this thesis, the author needs to make specific elaborations and additions to the concept of rural tourism at this stage, to talk about the concept of existing tourism from the origin, and to provide a background basis for the pain points of the problems that exist in rural tourism that follow.

Traditional rural tourism has gradually developed into a "back home" (rural) vacation in other countries. Although this phenomenon has positively affected the rural economy, it is still quite different from modern large-scale and standardized rural tourism. The primary difference is that the specific time of activities gradually changes from "holiday" to "full time," which further raises the rural economy's stimulation. According to the statistics of relevant data collected by the author through Zhiwang and Wanfang, nearly 50 scholars in China have defined rural tourism from different perspectives. Those definitions from different perspectives can be broadly divided into four categories after being summed up: "The first category is equating rural tourism with agricultural tourism. The second category considers that tourism activities in the countryside are all rural tourism. The third category is the tourism activities that attract people by natural landscapes and human tourism resources with rural characteristics. the last category is bidirectional defining rural tourism from tourism objects and subjects' demand characteristics.[1]

So, to sum up, first of all, the main current form of rural tourism is based on farmers' houses in the countryside, materials, and peasant lifestyle behavior. The form is operated on a peasant family model, which refers to an "agritainment" concept. Secondly, many well-known developers and business people moved their capital from urban to rural areas when they have discovered the broader development prospects and overwhelming market demand for rural tourism in recent years, using high-quality construction planning and promotion methods to move urban tourism carriers to rural

[1] Kunxin Wang and Zhang, M. (2019). Research on New Format of Rural Tourism. Hang Zhou: Zhejiang University Press.

areas. Meanwhile, they combine those approaches with local Eco-cultural characteristics to construct a new rural tourism type named "Homestay."

Although they have quite different forms, these two types of rural tourism regard "ultimate user experience" as development orientation, which means the preferences and behavior of tourists are the criteria for setting tourism models. However, all user-centered design or layout is not necessarily correct due to the varying quality of public behavior, leading to uncertain impacts on the environment and ecology. Nevertheless, these managers and operators have always overlooked the development model of "environmentally friendly" oriented rural tourism.

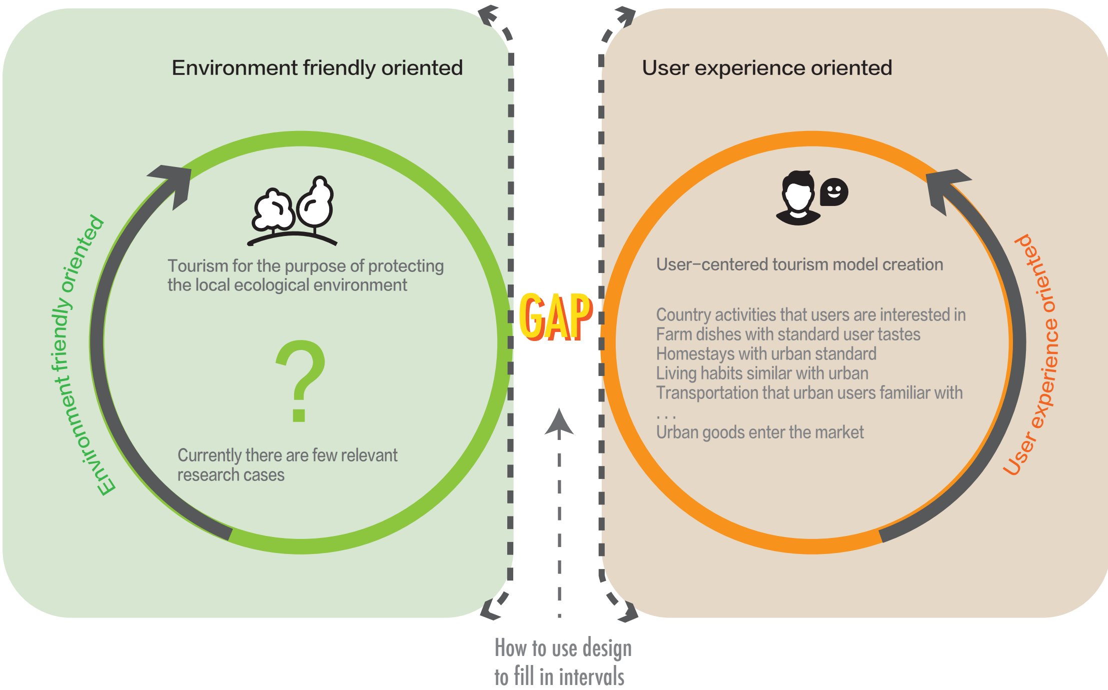


Figure 2.7: The current state of multidimensional orientation of rural tourism

2.4.2 The Current Status of "Sustainable design" in Rural Tourism

the rural tourism industry has entered a stage of explosive growth since the beginning of the 21st century, and the speed of its brutal growth prevented the relevant regulatory authorities from issuing countermeasures in time. The economic maximization-oriented rural tourism industry currently focuses on a good user experience as its core selling point. The local ecological environment cannot be well maintained and carry out sustainable development when a massive range of visitors arrive. At this stage, however, there is a gap between environmentally friendly rural tourism projects, as the environmental orientation is at the expense of the "user experience" of the visitor and the economic benefits. Finding a coherent solution to this contradiction, using design thinking and systemic design tools to build a bridge, is also the focus of the next phase of sustainable design interventions in the rural tourism industry.

2.5 Prototype framework for rural tourism systems

2.5.1 Scenario carrier definition – Design Harvests

The forms of tourism, farming resources, management methods, and products involved in rural tourism will vary according to geographical and differences in cultural characteristics, which are formed due to various factors such as climate, geology, resources, and culture that are unique to each place. So, first of all, culture is crucial in defining rural tourism. For example, rural tourism in northern China is mainly concerned with the cultural characteristics of the north as its primary form of tourism, such as the ancient town of Yiyan, the particular farming ancient town around Beijing.[1] A number of leisure agriculture field complexes with prominent cultural themes have been formed, including Qionglai Daliang Winery, Dujiangyan Chaxi Valley, Pujiang County Mingyue Village, and Wenjiang District Tianxing Village. Rural tourism in Jiangsu and Zhejiang is dominated by "high-end" and "best quality" homestay, which has become an industrialized model form of tourism supported by many property developers. The "Moganshan" homestay is one of the representatives of this form of tourism, with its relatively high prices and quality of experience.

[1] Ma, H. (2017). See how these parts of the country are doing well in rural culture to boost industrial development. [online] www.sohu.com. Available at: http://www.sohu.com/a/137827878_774486.

Therefore, before building a prototype framework for the system, it is essential to make assumptions and extrapolations about the system's context so that the system study can be further developed sustainably. In the present study, the system scenario assumption contains the following main aspects: area coverage, farm size, and farm cultivation management.

Figure 2.8: Maps of Shanghai (Photo credit: Design Harvest official website)

Firstly, the author is based in Shanghai, and the harmonization of urbanization with the rural environment is an integral part of Shanghai's environmental construction work. However, the negative impact of urban and town development and construction on the environment is almost irreversible, especially as Shanghai's air quality continues to decline and has become the focus of sustainable design concerns in recent years. Thus, rural agroecology plays a positive role in the whole urban environment, and this role should be applied to environmental regeneration to maximize its ecological benefits. So, the author wanted to find an established and influential project around Shanghai as a scenario carrier, which is why the influential Design Harvest project incubated by Tongji University was chosen.

The concept of "Design Harvest" was first used by a research project named "social innovation," initiated by Professor Yongqi Lou from the College of Design and Innovation, Tongji University.[1]Since 2007, the relevant team has officially launched "Design Harvest - Chongming" project. Designers from Tongji University have transformed idle village houses from rented homes into creative lodges, altering vegetable sheds into open spaces for dining and entertainment, while encouraging urbanites to participate in farming activities such as rice planting and wheat cutting, working with the land, and experiencing the delicious preparation process from field to table. They are trying to transform the environment, experience, and knowledge into a business model, using design to reflect the untapped value of the countryside.

Figure 2.9: Innovation Centre and Organic Farm of "Design Harvest" (Photo credit: Design Harvest official website)

Figure 2.10: Huami homestay of "Designing Harvest." (Photo credit: Design Harvest official website)

"Design Harvest" is a strategic project that addresses the issue of urban-rural interaction in a highly targeted manner, using design thinking to import superior resources from an urban perspective, stimulate the rural economy, increase the cultural influence of the countryside, promote rural employment and enrich the diversity of industries in the

[1] Design Harvest (n.d.). *Introduction*. [online] Design Harvest. Available at: www.designharvests.com.

countryside. The project is designed to receive a large amount of urban flow from the village's perspective, which will help to relieve the pressure of the urban population within the time unit, renew the traditional impression of the village by the urban population, and achieve the purpose of injecting new vitality into the old town.

The project is being carried out in the village of Xianqiao on Chongming Island because, on the one hand, the island has a unique geographical position, with flat terrain and an excellent location next to Shanghai. On the other hand, some of Chongming's villages have relatively good infrastructure, making it to realize more easily. For these reasons, Design Harvest has also set its sights strategically on this excellent testing ground.

2.5.2 Organizational Structure of Scenario Carrier

"Design Harvests" design-driven strategic design research on urban-rural interaction was first initiated by Professor Yongqi Lou, dean of the College of Design and Innovation, Tongji University. Since 2008, Design Harvest has been conducting design research in Xianqiao Village, Chongming Island, Shanghai, to explore the potential of traditional rural production and lifestyles through design thinking and to promote urban-rural exchange and sustainable development. A network of innovation centers bridging rural and urban areas in China, using "sustainable design strategies in a highly targeted manner" to promote urban-rural interaction. At present, the basic model of "Innovation Centre + Homestay+ Organic Farm + Creative Agricultural Products +

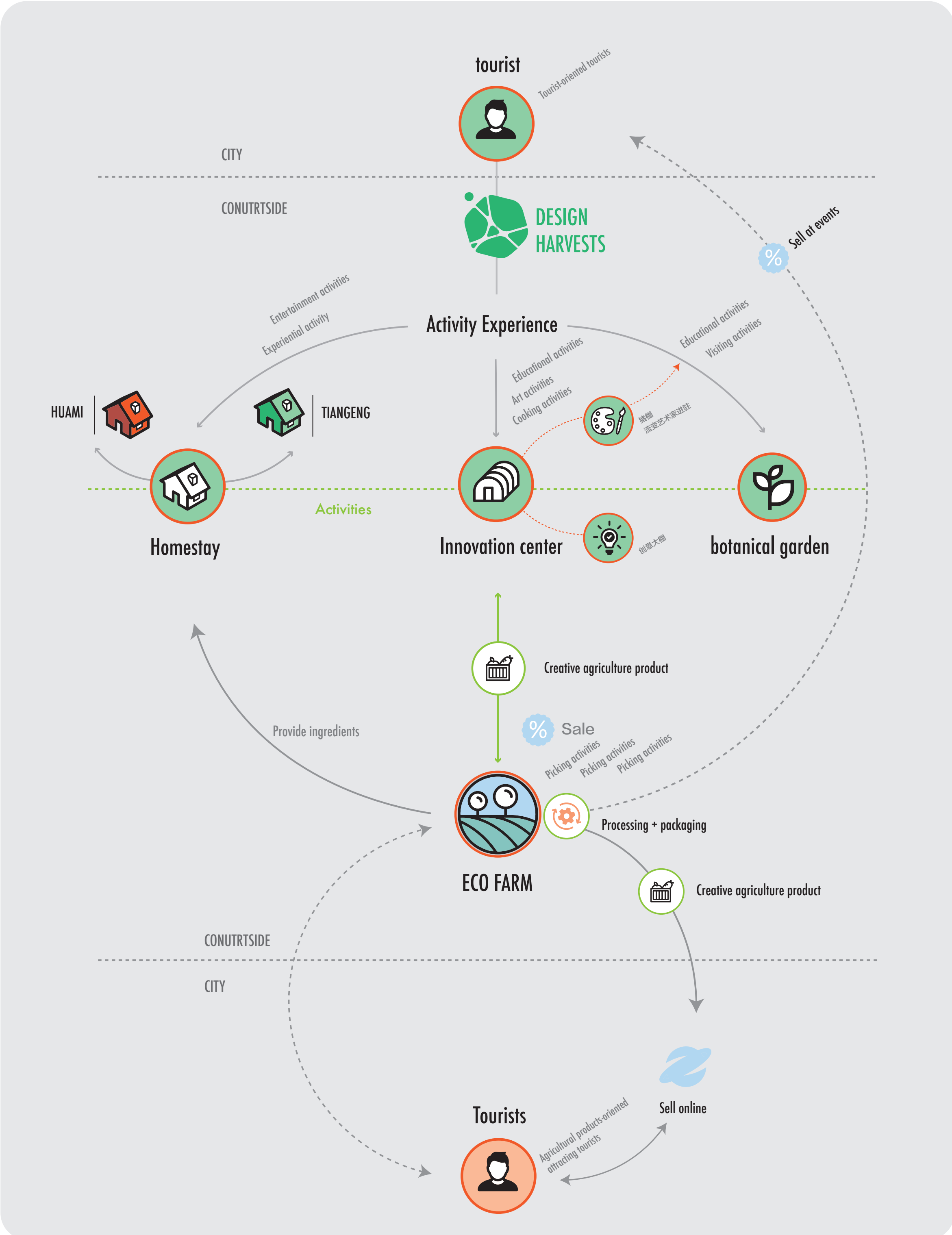


Figure 2.11: Tourism model framework of "Designing Harvest."

Activity Experience" has been formed in Xianqiao Village, Chongming Island, Shanghai, and developing new models of urban and rural development based on this model.[1]

2.5.3 Model Object Definition in Scenario Carrier

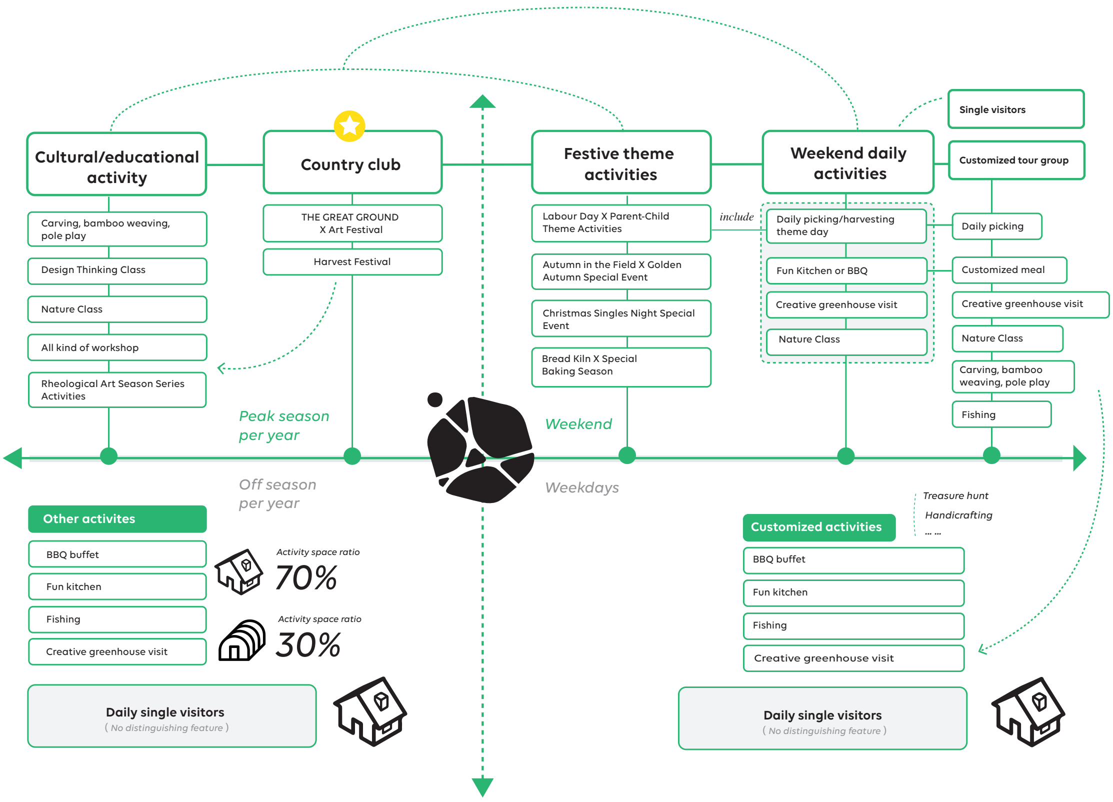


Figure 2.12: Classification chart for the "Designing Harvest" activity model

A rural tourism system is a complex system of activities that includes tourist behavior, food, energy consumption, and various material and non-material vectors. Therefore, before building the cycle model in this chapter, we should classify the carriers of the scenarios more precisely to model the different types of activities, behaviors, or substances through better sytemic design and life assessment methods. The basic structure and operation mode of the "Design Harvest" project are clearly illustrated in Figure 2.11. They are based on the various activity forms within the "Design Harvest" structure and the ultimate orientation of "forming a new circular economy model with zero emissions oriented." hence, we extract and classify information for the following

[1] Design Harvest (n.d.). *Introduction*. [online] Design Harvest. Available at: www.designharvests.com.

reasons:

Periodic systemic model of behavioral activity(immaterial) based on the 'tourist'

Periodic systemic model(matter) based on "food."

Periodic systemic model(matter) based on "energy."

Based on identifying these three elements, we sort and classify the carriers in hypothetical scenarios in Figure 2.13, i.e., the fundamental activity site classification of the project. We can divide the area into four main visitor activity areas: the "Tiangeng B&B", the "Huami B&B", the "Creative Greenhouse" and the "Botanical Garden" vegetable plantation. We have divided scene carriers into a vertical dimension and the three elements of 'people,' 'food,' and 'energy' into a horizontal dimension. The model process of "Design Harvest" dictates that these three elements must intersect.

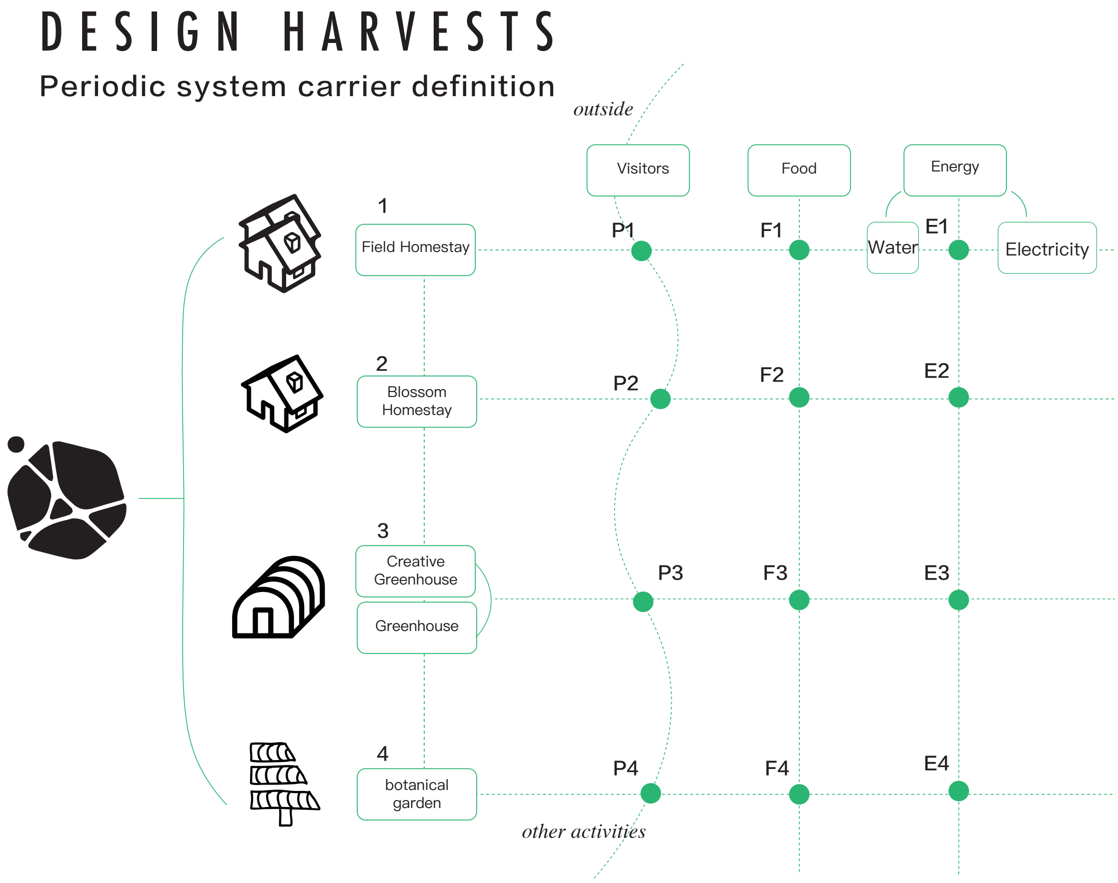


Figure 2.13: The definition diagram of periodic system carrier

As shown in Figure 2.13, firstly, the author allows each element and carrier to generate node correlations and excludes nodes that do not exist in reality (nodes with no correlation, such as "Botanical Garden, " has little correlation with the food cooking process). Finally, the remaining nodes are necessary for later model building.

According to Figure 2.13, it can be clearly seen that the horizontal dimension is the object of study of the cycle system. In contrast, the vertical dimension is the environmental carrier in the scenario setting. By sorting through "Design Harvest" activities, I have sorted out the intersection of the two dimensions in the above diagram. The behavioral flow of visitor activities is abbreviated as P and corresponds to each node in the scenario:

Node P1 is the flow of visitor activities at the "Tiangeng B&B." Node P2 is the flow of visitor activities at the "Huami B&B." Node P3 is the flow of visitor activities at the "Creative Greenhouse." Node P4 is the flow of visitor activities at the "Botanical Garden." As each scenario vector is quantitative, we can simulate behavior flow with visitors in everyday situations through field tracking studies and calculate the carbon footprint based on this. Finally, we filter the sixteen nodes in the above diagram according to the actual situation of tracking studies, and valid nodes were selected to build the node model.

2.6 The Assessment Method for Global Warming Potential

A detailed typology of scenario carriers has been carried out, which is the basis for the logic and data for the later model building. However, the construction of the system model is only a current analysis of the entire tourism system. The research focus of this chapter is how we ecologically assess the linear model and later sustainable model. In the process of building the model, we need to use the input-output approach to calculate carbon emissions for the non-material behavioral nodes and material consumption nodes of the model. The assessment method for Global Warming Potential is the most critical in the ecological assessment of the system model. This assessment method provides a detailed explanation of carbon emissions and carbon sequestration and an initial framework for the carbon emissions system within scenario carriers, laying the foundation for the later carbon emissions calculation logic.

2.6.1 Carbon Emission

Generally, Global Warming Potential refers to "an index of the greenhouse effect of a substance. In a time, frame of 20, 100, and 500 years, the greenhouse effect of each greenhouse gas corresponds to the mass of carbon dioxide with the same effect, i.e., Carbon Dioxide Equivalent".[1] As shown in Figure 2.14, the warming potential of methane and nitrous oxide is 25 and 298 times that of carbon dioxide, respectively, i.e., the greenhouse effect of releasing 1t of methane is equivalent to releasing 25t of carbon dioxide. Based on this principle, the carbon emission factors for various resources and human activities are derived, and in the end, we could estimate the total carbon emissions of given human activity as:

Carbon emissions = carbon emission factor * usage amount

For example, according to carbon emission factors of each energy source published by the IPCC, the emission factor for diesel is 0.6kg CO2eq/kg, if we convert the emission factor to that of a large displacement transport vehicle, we get 0.21kg CO2eq/km, which means that the greenhouse gases produced by the vehicle are equivalent to 21kg of CO2 emitted when it travels 100km.[2]

The carbon emissions refer to greenhouse gas emissions in this research and represent global warming potential, so the data does not denote actual CO2 emissions. Methane is only 25 times greater than CO2 on a global warming potential level, but methane is only 36% the mass of CO2 per molecule on an actual material level. These two concepts

Industrial Designation or Common Name (years)	Chemical Formula	Lifetime (years)	RadiativeEfficiency ($W\ m^{-2}\ ppb^{-1}$)	Global Warming Potential for Given Time Horizon: SAR‡ (100-yr)	20-yr	100-yr	500-yr
Carbon dioxide	CO_2	See below[a]	[b]$1.4x10^{-5}$	1	1	1	1
Methane[c]	CH_4	12[c]	$3.7x10^{-4}$	21	72	25	7.6
Nitrous oxide	N_2O	114	$3.03x10^{-3}$	310	289	298	153

Figure 2.14: Global warming potential for a given number of years (Photo credit: China Carbon Emissions Trading Network)

1 Different Sources of Greenhouse Gases and Their Global Warming Potential, China Carbon Emissions Trading Website [online] Available at: http://www.tanpaifang.com/tanguwen/2015/0610/44960.html [Accessed 3 Feb. 2022].

2 Rao, Q., Qiu, Y., Cai, R. and Zhao, Y. (2009). A study on the current situation of ODS production, consumption, and its impact in Fujian Province. Journal of Fuqing Branch of Fujian Normal University, 94(1008-3421), pp.65–70.

are not to be confused so that this thesis can interpret all carbon emissions appearing as global warming potential.

2.6.2 Carbon sequestration/Carbon Neutrality

"Carbon sequestration" refers to sequestering and storing greenhouse gases, such as free carbon dioxide by technology to reduce the amount of carbon in the atmosphere.[1] According to the author's observations, the "Design Harvest" project does not address carbon sequestration through technology. If the common criterion for carbon sequestration is the area's " green " area - the number of green plants. The carbon in plants is transformed by absorbing carbon dioxide by photosynthesis and is called the plant's carbon stock.

[1] Wikipedia Contributors (2019). *Carbon sequestration*. [online] Wikipedia. Available at: https://en.wikipedia.org/wiki/Carbon_sequestration.

2.6.3 The Systemic Framework for Carbon Emissions within Scenario Carriers

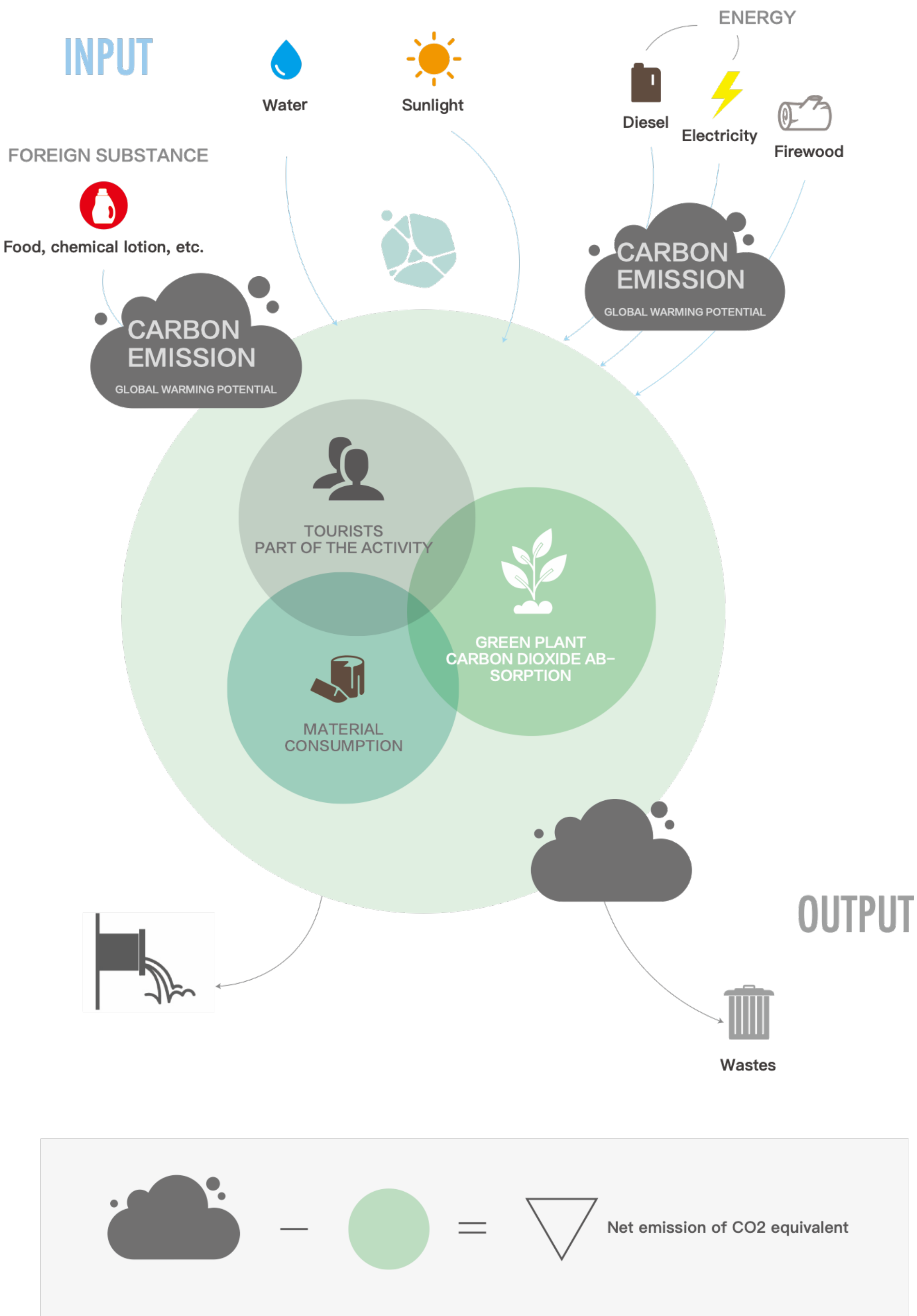


Figure 2.15: The systemic framework for carbon emissions within scenario carriers

2.7 Chapter Summary

This chapter begins with a brief overview of sytemic design approaches and Life Cycle Assessment method. Systemic design approaches are used to model the environmentally relevant elements of a rural tourism system, while Life Cycle Assessment method is used to assess the system's carbon emissions. The model built by the sytemic design is the basis for Life Cycle Assessment.

Firstly, this chapter focus on bringing this design research approach to scenario carrier - rural tourism system. We also built the systemic prototype for the most environmentally relevant factors of the tourism system, so we applied the hypothetical scenario carrier to the relatively well-known "sustainable" urban-rural interaction project "Design Harvest." Secondly, in order to obtain more accurate data on carbon emissions, we have classified the research elements in "Design Harvest" more precisely. The horizontal dimensions are divided into three categories: "visitor behavior," "food," and "energy," on the basis of which the corresponding journey maps and life cycle model are developed and systematically expressed in bot system diagrams and tables. After that, the ecological assessment system for the system is built, divided into global warming assessment and ecological environmental assessment. In global warming assessment, data collection calculations are used to obtain the net carbon emissions for a specific time unit of the system, thus calculating the carrier's net carbon emissions for the whole year. Based on the research logic established above to build and apply the rural tourism system in Chapters 3, 4, and 5.

Chapter 3

Establishment and Analysis of Linear Rural Tourism System Model

This chapter focuses on constructing the current tourism system model of Design Harvest through a systems design approach and a life cycle assessment approach. The prototype framework has been developed in the previous chapter to identify the scenario vector. Since we want to conduct a more accurate ecological assessment, in addition, our ultimate goal is "A new circular economy model with zero emissions." we classify the high-frequency behaviors: tourist behavior, food, and energy (water and electricity). So, the later model building is also based on these three elements.

1. Behavioral Activity Cycle System Model Based on Tourists (Non-material)

2. Periodic system model based on food (material)

3. Periodic system model based on energy (material)

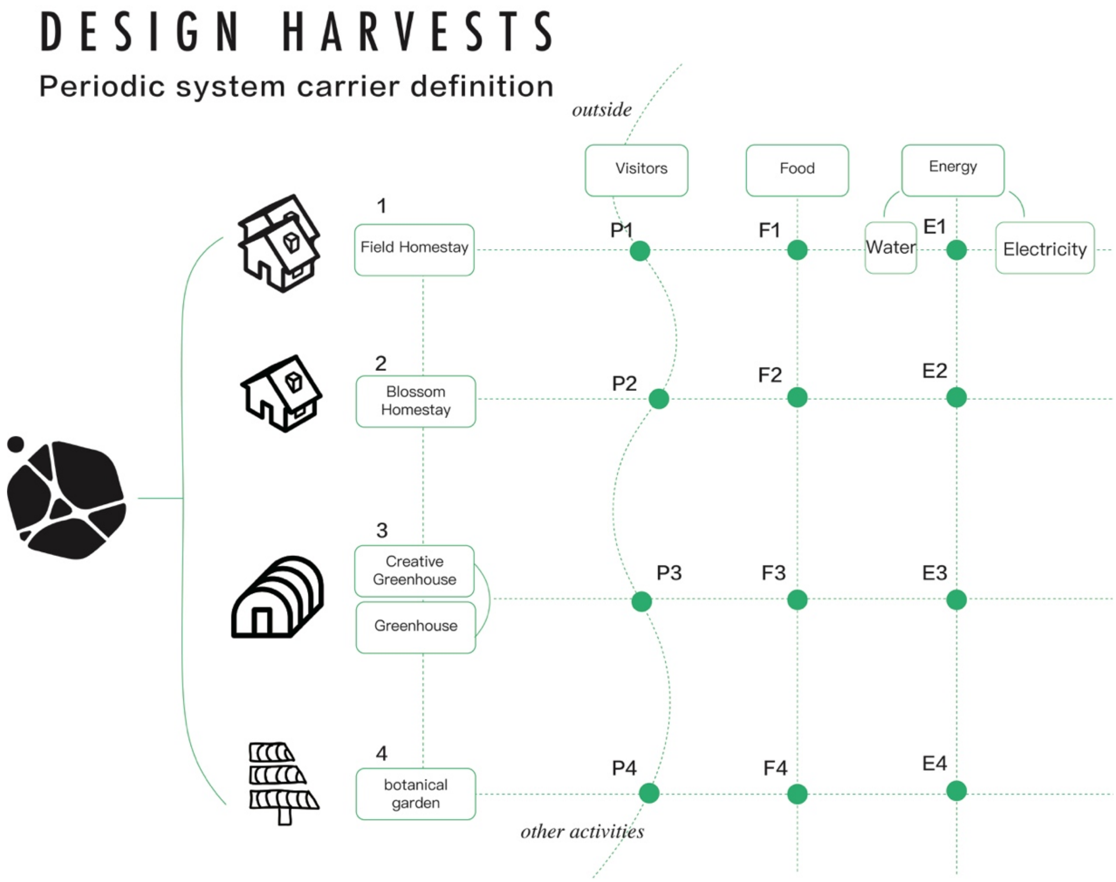


Figure 3.1 Node diagram for designing harvest activities (Image credit: author's drawing)

3.1 General "Visitor Behavior" System Modeling

3.1.1 Analysis of visitor flow dispersion

Based on the data collection in the previous chapter, the author proceeds to build a system prototype framework for the behavioral activities of 'people' (visitors), starting with the extraction of a regular unit of time. By collecting data on the number of visitors to the Design Harvest, the author found that sampling had to be done in the variable volume of data on the number of people. As shown in Figure 3.2, it is clear that the current Design Harvest (rural tourism industry) is greatly influenced by non-human factors such as geography, climate and season. The distinction between low and high seasons leads to considerable differences in the number of visitors received, even to the extent that the number of visitors received in the high season months is twice or more than in the low season. Such differences in data lead to the need to extract a sample of months from the variation in data and build accurate models.

Average number of tourists in low season per week		Average number of tourists in peak season per week		Average number of tourists in neutral season per week	
2020-7	12	2020-4	37	2020-6	22
2020-8	16	2020-5	38	2020-11	25
2021-1	15	2020-9	33	2020-12	22
2021-2	11	2020-10	42	2021-3	27
		2020-11	29		

Figure 3.2 Statistics of visitor arrivals during low and high seasons (Image source: author's drawing)

Average number of tourists during off-season/weekdays per week		Average number of tourists during peak season/weekdays per week		Average number of tourists during neutral season/weekdays per week	
2020-7	3	2020-4	11	2020-6	9
2020-8	8	2020-5	9	2020-11	11
2020-9	6	2020-9	7	2020-12	8
2021-1	7	2020-10	11	2021-3	10
2021-2	6	2020-11	6		

Figure 3.3 Statistics of visitor arrivals on weekdays and weekends (Image credit: author's drawing)

Our data analysis also concluded that there is also a significant difference between the number of visitors received on weekdays (Monday to Friday) and the number received on weekends. Due to geographical constraints, the excessively long travel times result in visitors rarely choosing to travel on weekdays. The longer time cost becomes the core reason for the fewer weekday visitors. In contrast, the educational/cultural section of the Design Harvest makes up for this by organizing workshops or educational activities for schools or institutions during the weekdays. However, there is still a significant difference in the overall number of visitors received on weekends.

In summary, we can visualize in Figure 3.3 the trend and direction of the number of visitors received throughout the year and observe the difference in the number of visitors received on weekdays and weekends. Based on the above data, we finally calculate that the average number of visitors per month throughout the year is 26.3333, which equates to 26 visitors. Of course, this figure excludes significant themed events such as the "Countryside Fun Fair". According to the data, the few significant events such as the Countryside Fun Fair and the Flux-Artist Activities, which usually receive more than 500 visitors per day, are not universal and have a short lifespan, so they are outside the scope of the model. As this study hopes to sustainably change the rural tourism system (Harvest by Design) through a zero-emissions orientation, the model ultimately needs to select for universally representative data per unit of time.

3.1.2 Visitor groups classification

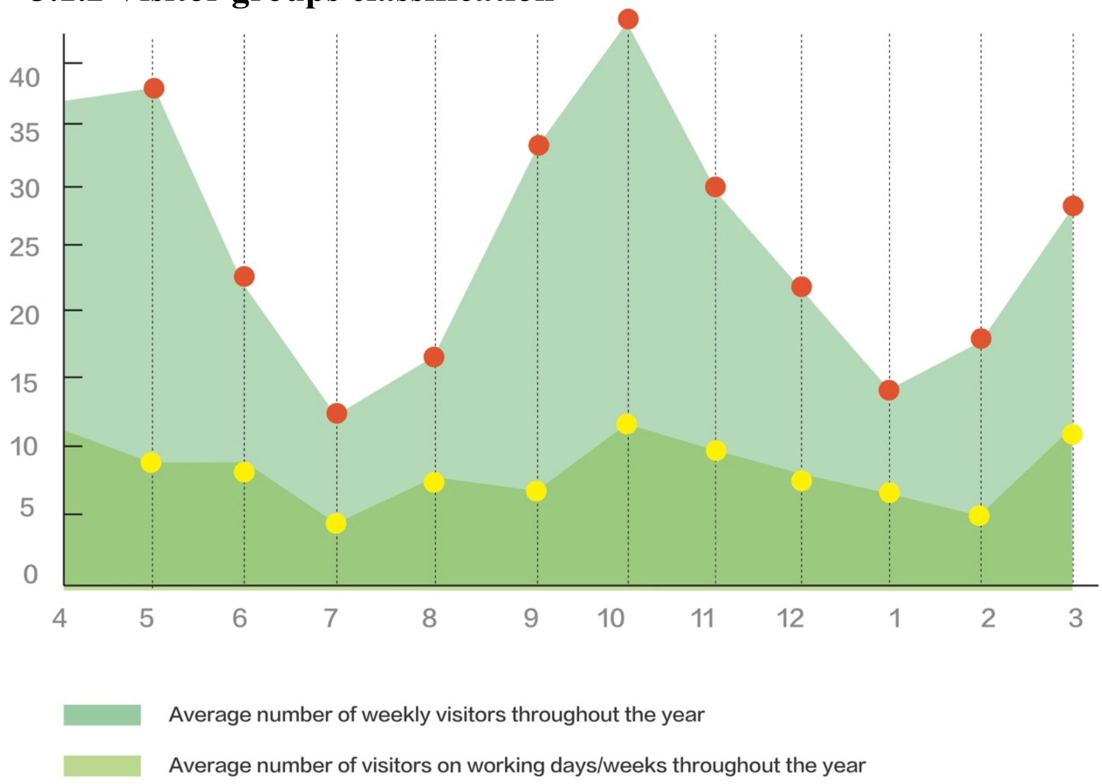


Figure 3.4 Histogram of the number of visitors received during the low and high seasons (Image credit: author's drawing)

This chapter simulates a typical user profile (Persona) of a group of 'tourists' in a time unit, using the final selected visitors in a regular time unit as a reference. The persona is shown in Figure 3.5 and is based on actual B&B user characteristics and data, which are extracted and manipulated into a virtual persona. The personas are visualized as a model of the target B&B user, laying the foundation for quantitative research and providing a solid basis for design interventions such as the overall system service process.

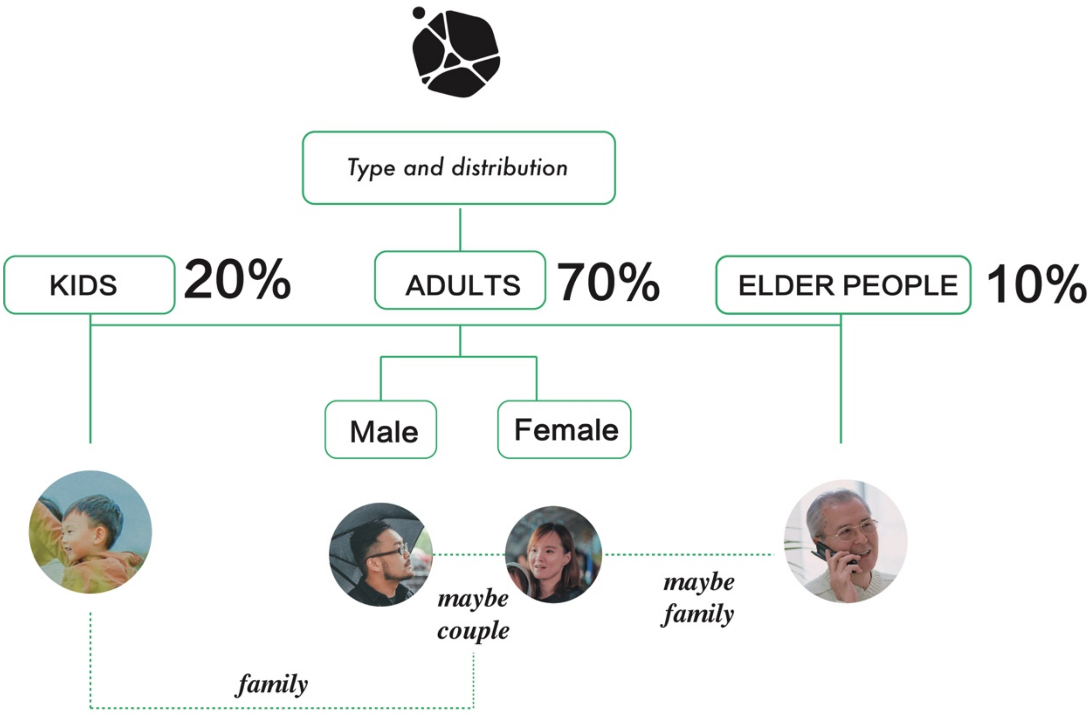


Figure 3.5 Distribution of Design harvest visitors by type (Image credit: author's drawing)

A more accurate selection of user groups is made based on a sample of time units selected in advance. Based on the previous questionnaire data, the author divided the types of tourists in this time range into "children", "adults (men/women)", and elderly people by the "age" indicator. As the purpose of the model is to calculate the carbon emissions of an individual sample, the age difference will lead to a significant difference in carbon emissions between different visitor groups. The author performed post-calculations based on the three visitor groups' energy consumption and behavioral activity data, taking the average and selecting a representative sample. The study samples were September 2020, when 37 visitors were received, and October 2020, when 42 were received. The data shows that nearly 70% of the weekend visitors were "family groups of three", consisting of "adults (male + female) and children", which is generally representative. That is why the author has taken the 'weekend family group' as the sample for this module. Based on the data analysis and screening, we have identified the characteristics of the sample: *weekend groups of tourists in the neutral season.* The team chose "family tours" as the preferred option.

3.1.3 Visitor persona establishment

Based on the above summary, a "sample group of tourists" was established by analyzing a large amount of data. In November and March 2020, the author twice selected the corresponding sample visitor groups to be followed throughout and researched in-depth. An accurate portrait of the sample visitor groups was built based on the data collected after the field tracking.

1. Female Adult- Ms Ye's Persona Establishment

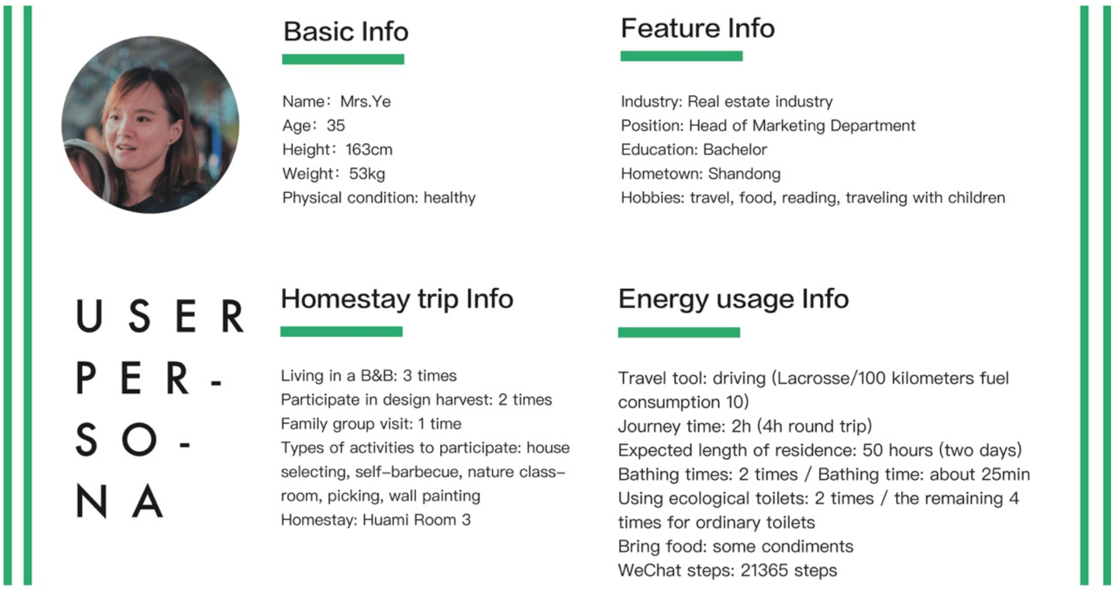


Figure 3.6 User persona 1- Ms Ye (Image credit: author's drawing)

Through extensive data calculations, the author calculated the average energy usage values from dozens of follow-up interviews, with Ms Ye's family, in particular, matching each average value. Therefore, the author created a universal user profile for this family to provide a sample carrier for later user journey map building. This user is Ms Ye from Shanghai (Shandong origin), who currently works for a real estate company and has a six-year-old son (Figure 3.7) with Mr Chen (Figure 3.6). Ms Ye loves food and usually chooses short trips to the countryside for her holidays. She loves the rural environment and enjoys coming to the countryside to enjoy the idyllic life. Ms Ye believes that being close to nature, breathing fresh air, enjoying flowers, farming, and other farming-related things are beautiful ways for city dwellers to relax on holiday. She is particularly interested in the living conditions, infrastructure and hygiene of the

B&Bs, as well as healthy, unique, local farming food. She likes to bring her children and her colleagues' children to participate in memorable and meaningful family activities at B&Bs. The price factor and accessibility of transport are also important indicators for Ms Ye's choice, with cost-effective rural tourism being the first choice for travel. In addition to this user's personality traits, the author also focused on tracking and researching Ms Ye's family's various behavioral activities during their 50 hours at Design Harvest. Detailed records were kept on commuting patterns, activities they participated in, number of baths, number of toilet visits and number of electrical appliances used. As shown in Figure 3.5, Ms Ye's values for various indicators are representative of the overall data, especially among female users. Figure 3.6 and Figure 3.7 show the specific user profiles of Mr Chen and their son, Chen Xiaobao, respectively, which are also common among adult males and children.

2. Male Adult- Mr Chen's Persona Establishment

As a representative of the middle class in a first-tier city, Mr Chen has a stable income, a certain level of spending power, a high level of education and a certain level of love for travel. Regarding factors to consider when choosing a countryside B&B, Mr Chen is particularly interested in the different living and culinary experiences that a countryside B&B can provide. When choosing a B&B for rural tourism, he wants a local interior style and living culture rather than a traditional hotel style. He also cares

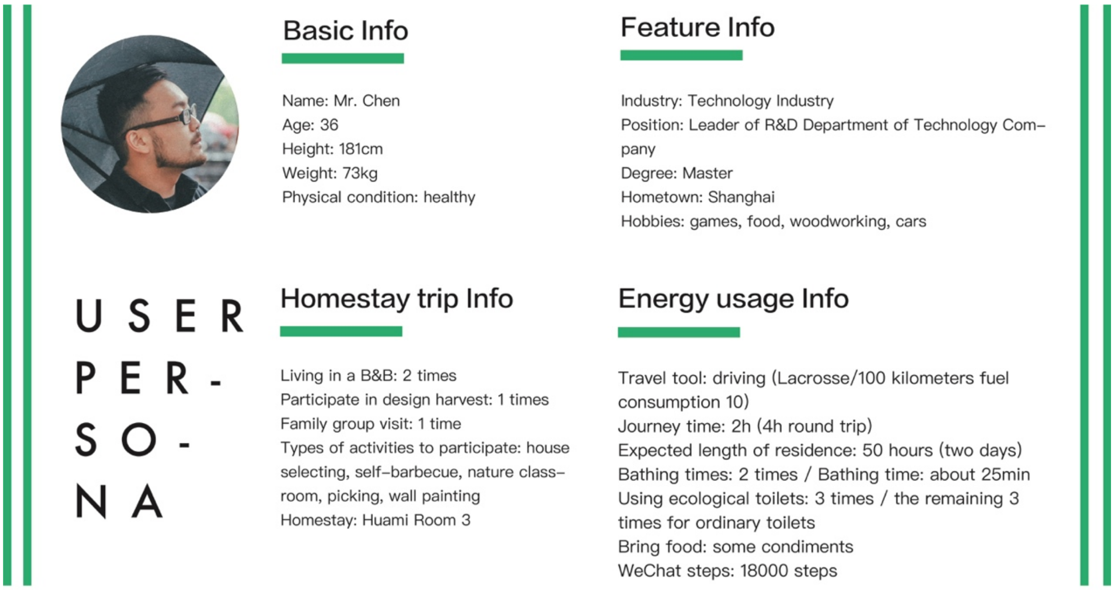


Figure 3.7 User persona 2- Mr Chen (Image credit: author's drawing)

about the impact of the tour on his children. The author has also followed up on Mr Chen's behavior and habits. For example, although he has good habits, Mr Chen is a heavy smoker, with 20-30 cigarettes a day. In terms of diet, he is a heavy eater, eating fewer vegetables and fruits and drinking more drinks. These characteristics and data provided the basis for creating Mr Chen's journey map later on.

3. Children- Chen Xiaobao Persona Establishment

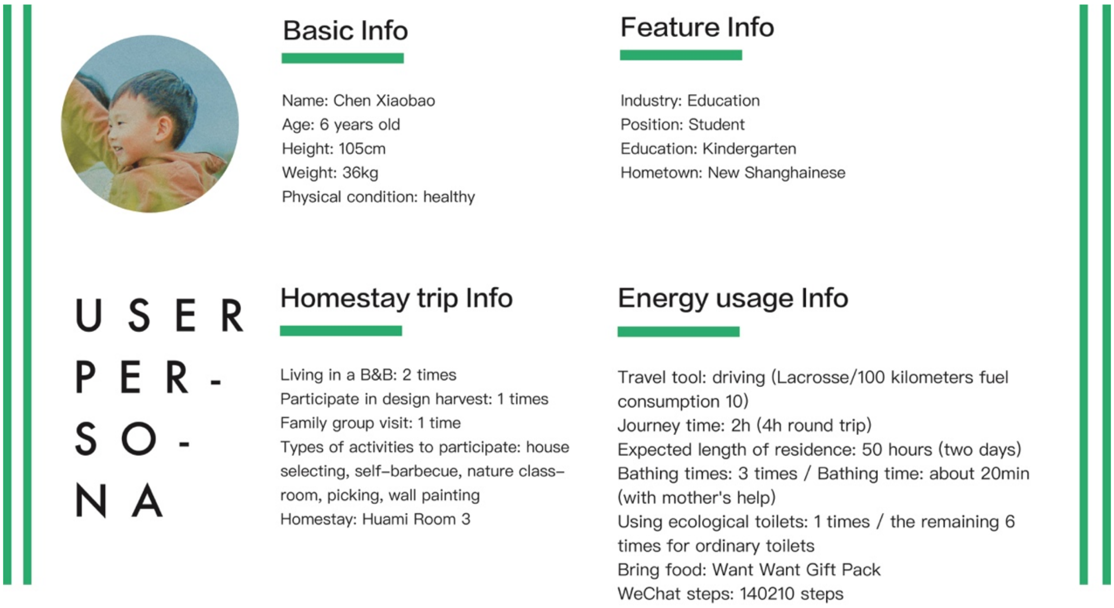


Figure 3.8 User persona 3- Chen Xiaobao (Image credit: author's drawing)

Chen Xiaobao, the son of Mr Chen and Ms Ye, has just turned six years old and enjoys watching anime and playing with pads, has a common hobby for children today. For Chen Xiaobao, who grew up in a big city, travelling to the countryside is new and exciting, and following his parents on holiday trips is something he enjoys. Chen Xiaobao got a lot of dust and mud from playing in the countryside and forgetting everything. With the help of his mother, he had three baths in two days, each lasting over 25 minutes.

3.1.4 User (visitor) journey map establishment

This chapter builds a user journey map based on the data from the previous chapters for the "user persona" sample to simulate the flow of all the activities of Ms Ye's family at Design Harvest. Based on nearly 50 hours of follow-up research (excluding sleep time), The author has initially constructed a basic user journey map for Ms Ye's family. The female adult Ms Ye - user journey map (Design Harvest user) is shown in Figure 3.9

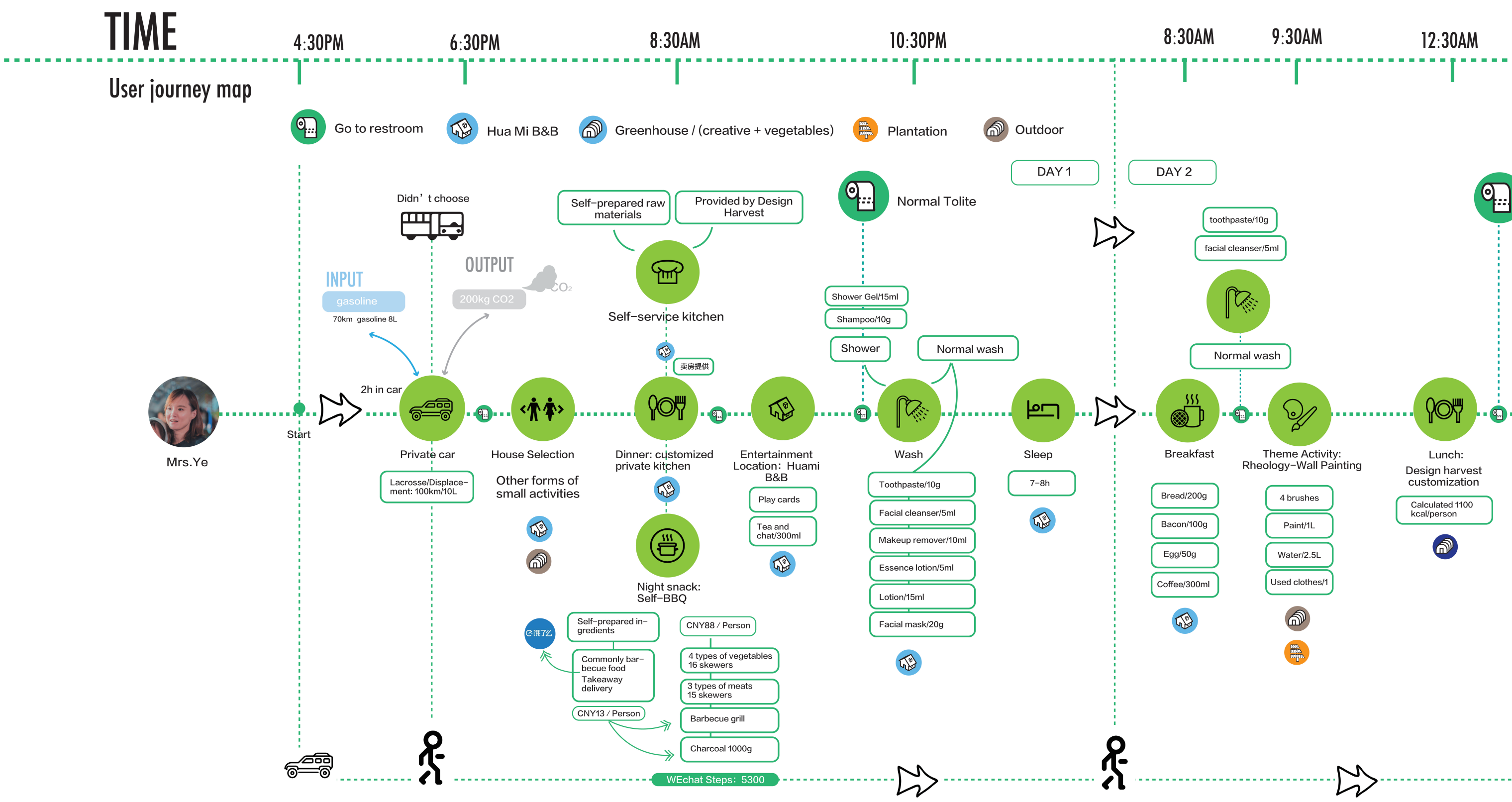
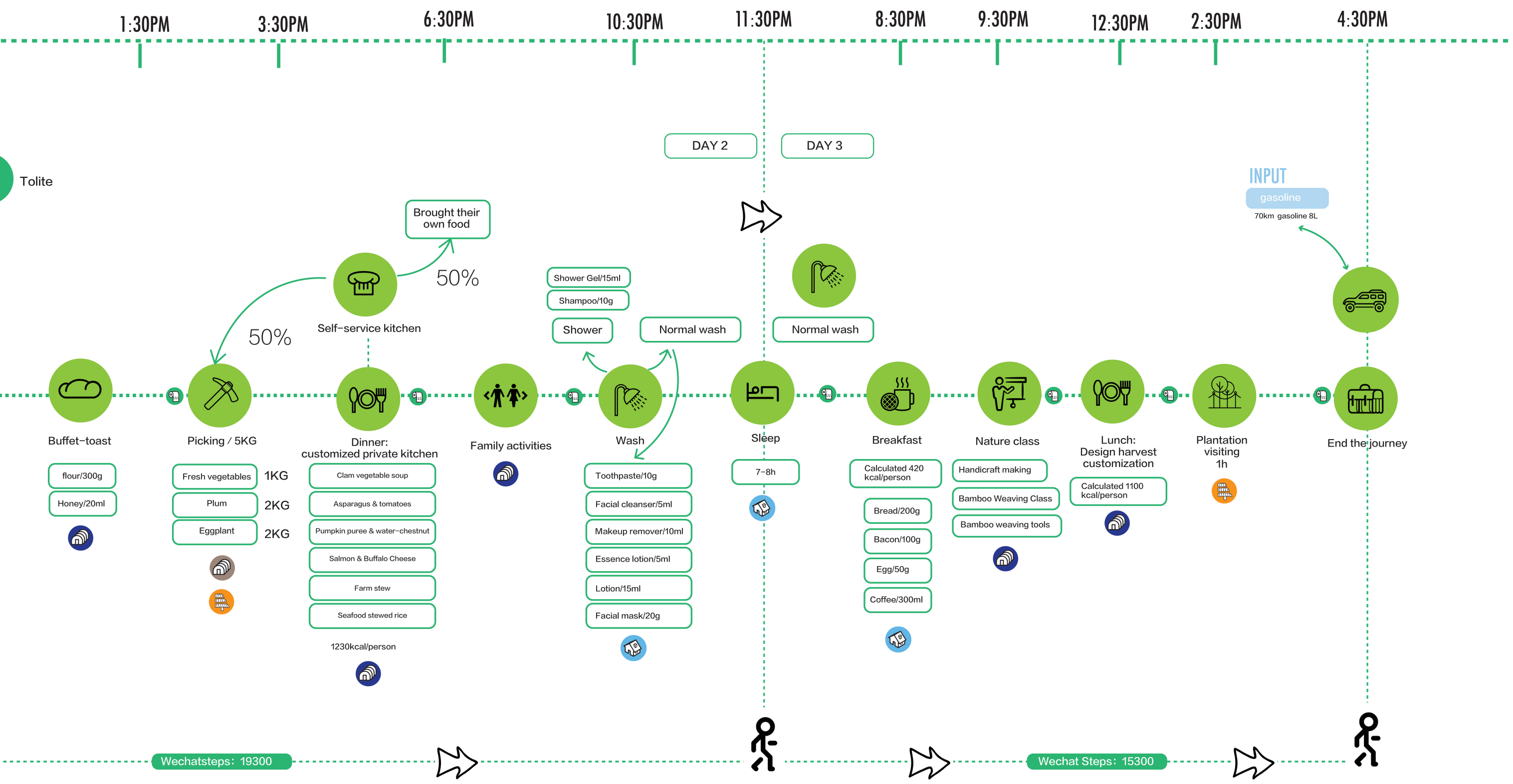


Figure 3.9 Ms Ye's user journey map (Image credit: author's drawing)



1:30PM
3:30PM
6:30PM
10:30PM
11:30PM
8:30PM
9:30PM
12:30PM
2:30PM
4:30PM
DAY 2
DAY 3
Tolite
INPUT
gasoline
70km gasoline 8L
Brought their own food
50%
50%
Self-service kitchen
Shower Gel/15ml
Shampoo/10g
Shower
Normal wash
Normal wash
Buffet-toast
flour/300g
Honey/20ml
Picking / 5KG
Fresh vegetables
1KG
Plum
2KG
Eggplant
2KG
Dinner:
customized private kitchen
Clam vegetable soup
Asparagus & tomatoes
Pumpkin puree & water-chestnut
Salmon & Buffalo Cheese
Farm stew
Seafood stewed rice
1230kcal/person
Family activities
Wash
Toothpaste/10g
Facial cleanser/5ml
Makeup remover/10ml
Essence lotion/5ml
Lotion/15ml
Facial mask/20g
Sleep
7-8h
Breakfast
Calculated 420 kcal/person
Bread/200g
Bacon/100g
Egg/50g
Coffee/300ml
Nature class
Handicraft making
Bamboo Weaving Class
Bamboo weaving tools
Lunch:
Design harvest customization
Calculated 1100 kcal/person
Plantation visiting
1h
End the journey
Wechatsteps: 19300
Wechat Steps: 15300

As can be seen from the above diagram, the author has strictly recorded each of Ms Ye's activity behaviors and made an objective list of the substances and quantities involved in her behavioral carriers. We take node A as the basis for the following construction Figure 3.7. Ms Ye's travel method from her home (Lane 570 Pingyang Road, Minhang District) to Design Harvest (Xianqiao Village, Chongming Island) is by car (carrying three people) (Buick Grand Prix / displacement: 100km / 10L), with a total count of 70KM, using 8L of fuel, and the amount of CO_2 produced is calculated by the "Carbon Footprint Calculator The amount of carbon dioxide generated is calculated by the "Carbon Footprint Calculator" as 28.70Kg. Based on three people driving one car, the average carbon emission per person is calculated to be 9.56kg.

The above is based on a visual depiction of Ms. Yip's personal journey map and a sample input and output diagram of the nodes within the journey map. The author has established a 'sample' of the family unit as the standard in the previous chapter, so Mr Chen's son is also included in the creation of the user journey diagram, as shown in Figure 3.8 and 3.9.

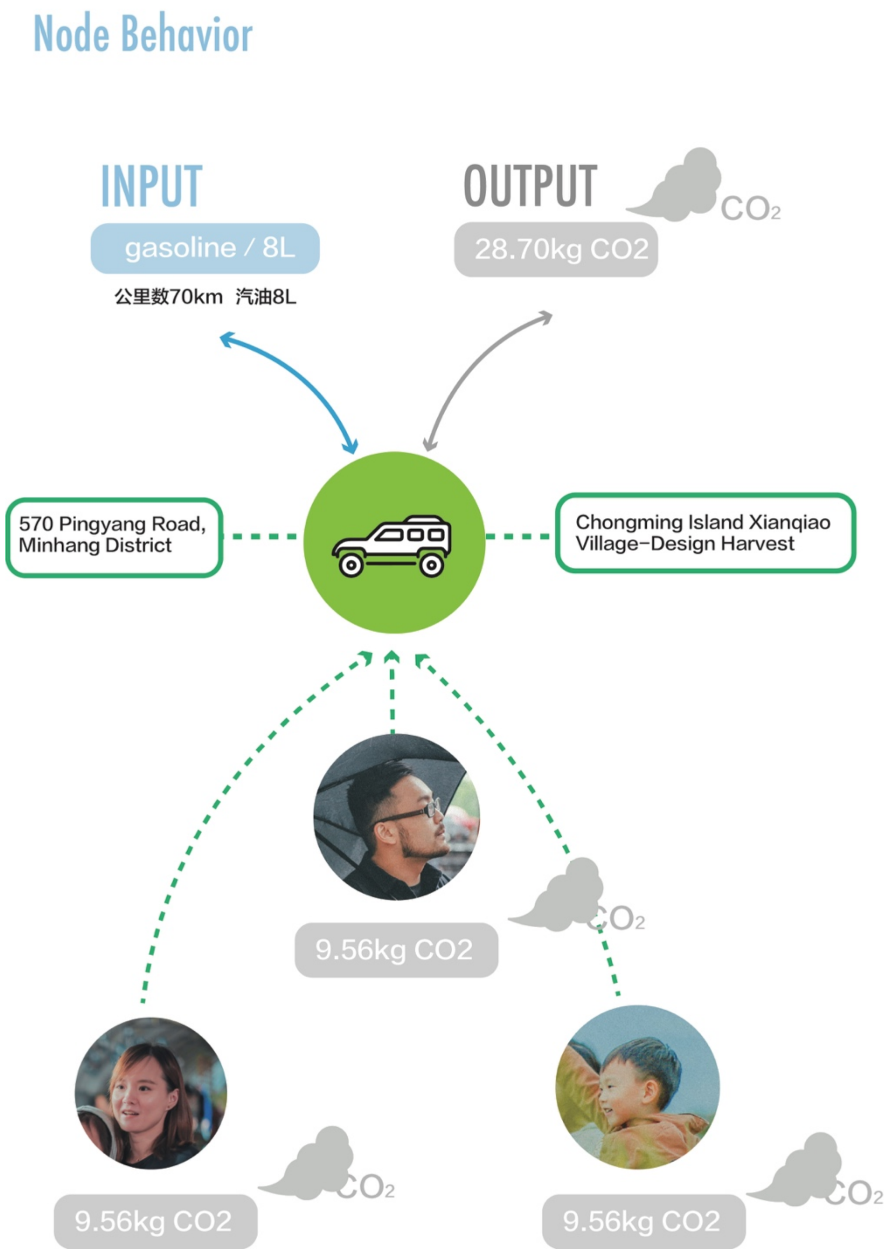


Figure 3.10 Problem node input-output diagram (Image credit: author's drawing)

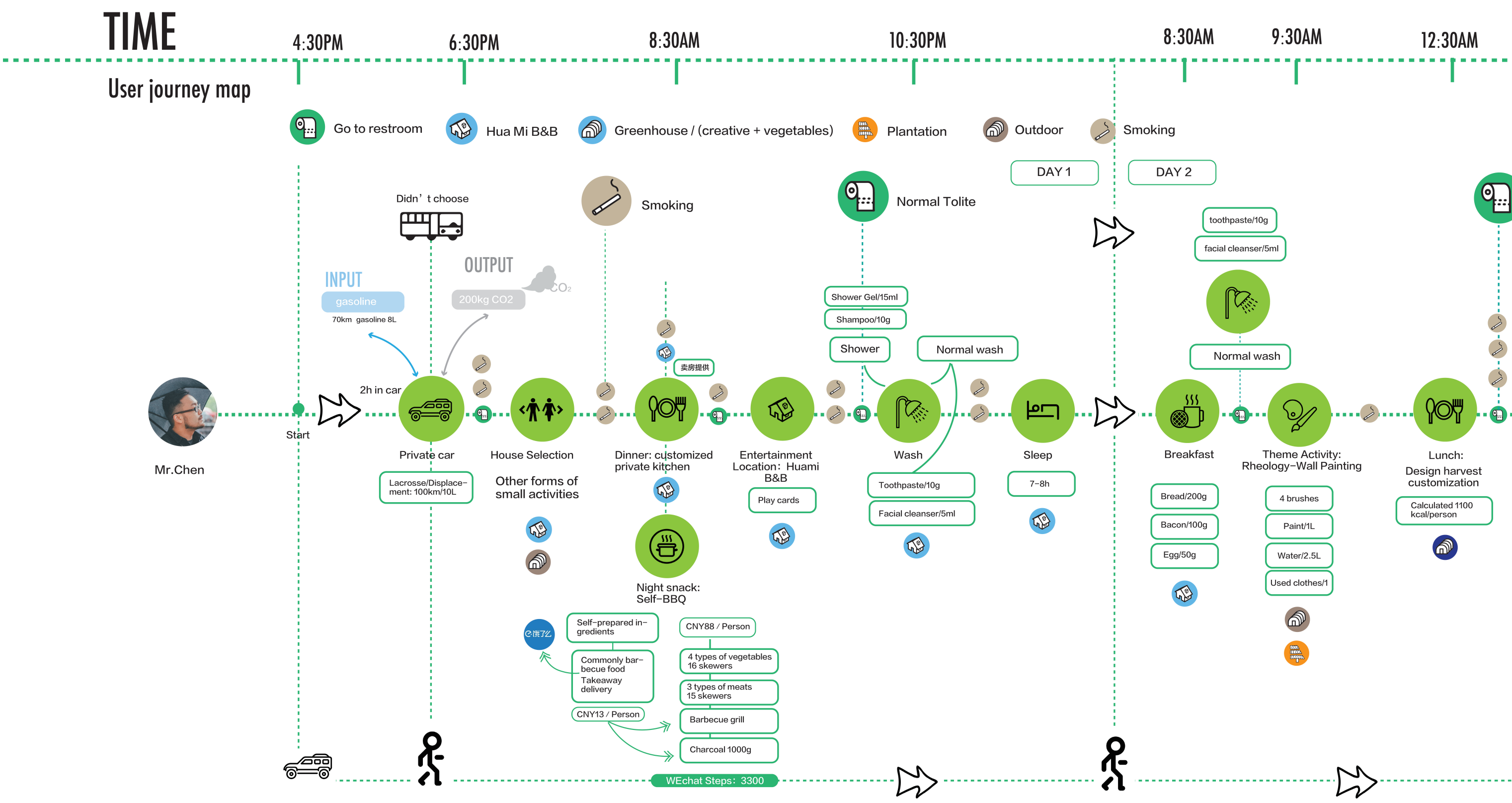
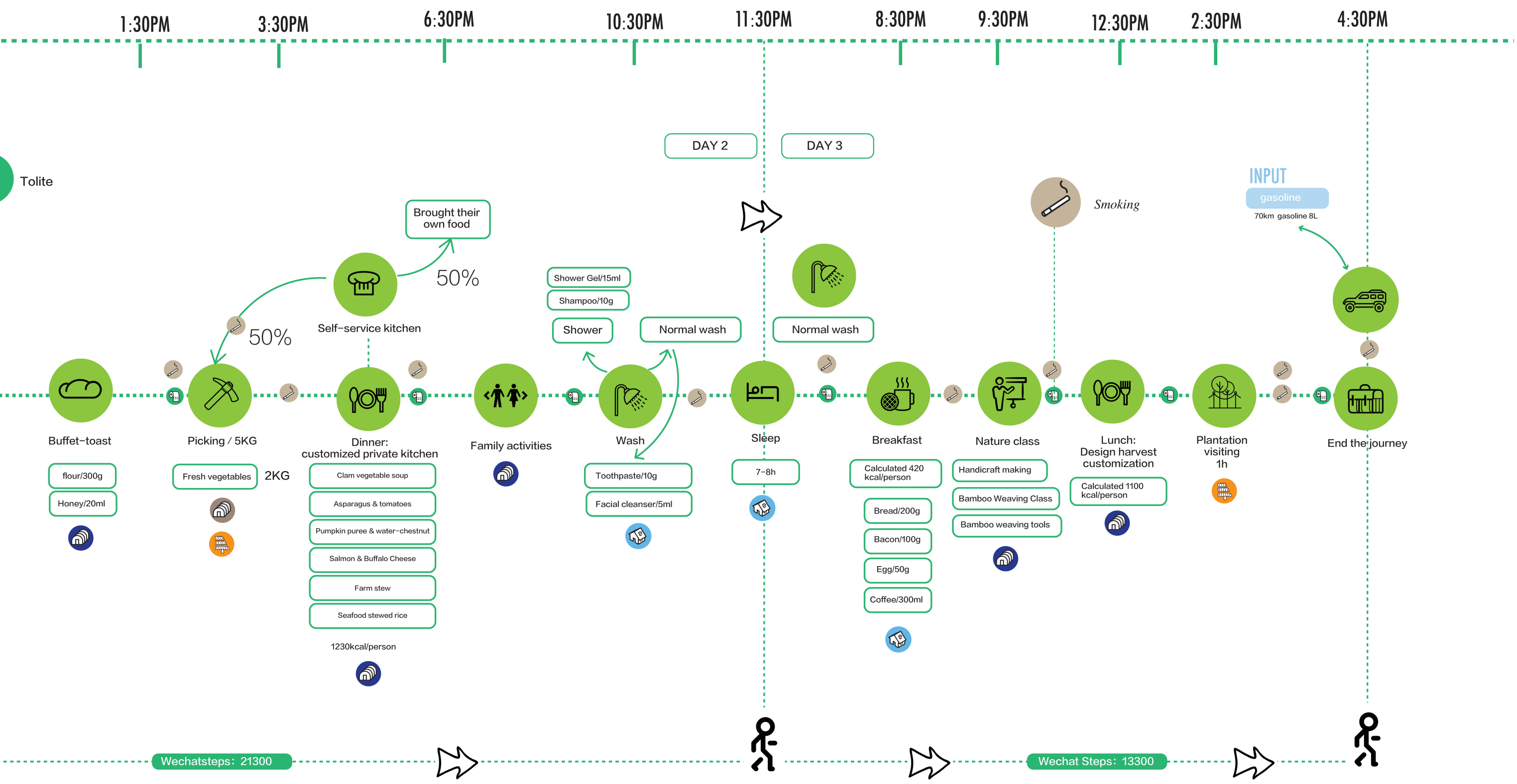


Figure 3.11 Mr Chen's user journey map (Image credit: author's drawing)


1:30PM
3:30PM
6:30PM
10:30PM
11:30PM
8:30PM
9:30PM
12:30PM
2:30PM
4:30PM
DAY 2
DAY 3
Tolite
Brought their own food
50%
50%
Self-service kitchen
Smoking
INPUT
gasoline
70km gasoline 8L
Shower Gel/15ml
Shampoo/10g
Shower
Normal wash
Normal wash
Buffet-toast
flour/300g
Honey/20ml
Picking / 5KG
Fresh vegetables
2KG
Dinner:
customized private kitchen
Clam vegetable soup
Asparagus & tomatoes
Pumpkin puree & water-chestnut
Salmon & Buffalo Cheese
Farm stew
Seafood stewed rice
1230kcal/person
Family activities
Wash
Toothpaste/10g
Facial cleanser/5ml
Sleep
7-8h
Breakfast
Calculated 420 kcal/person
Bread/200g
Bacon/100g
Egg/50g
Coffee/300ml
Nature class
Handicraft making
Bamboo Weaving Class
Bamboo weaving tools
Lunch:
Design harvest customization
Calculated 1100 kcal/person
Plantation visiting
1h
End the journey
Wechatsteps: 21300
Wechat Steps: 13300

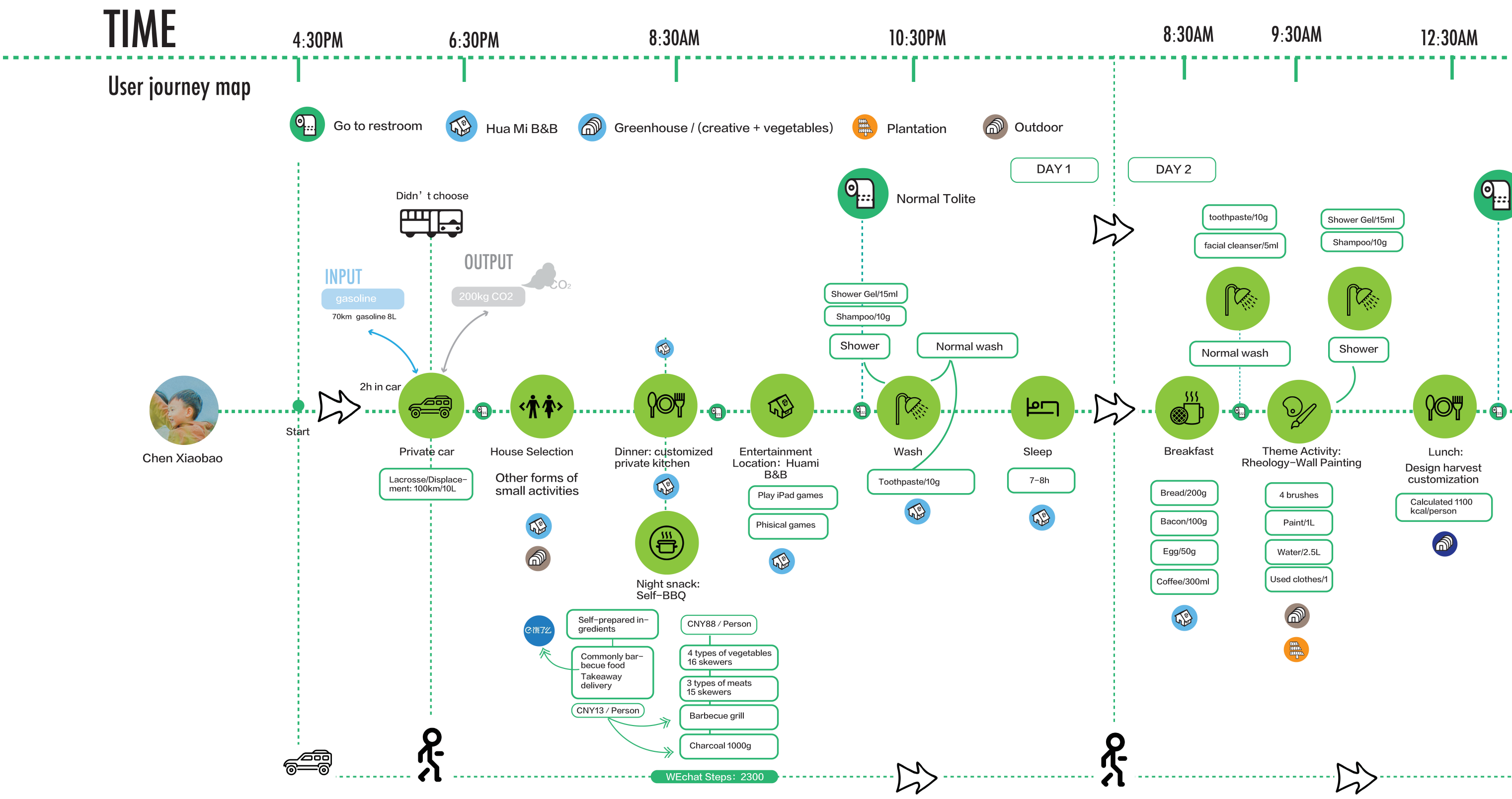
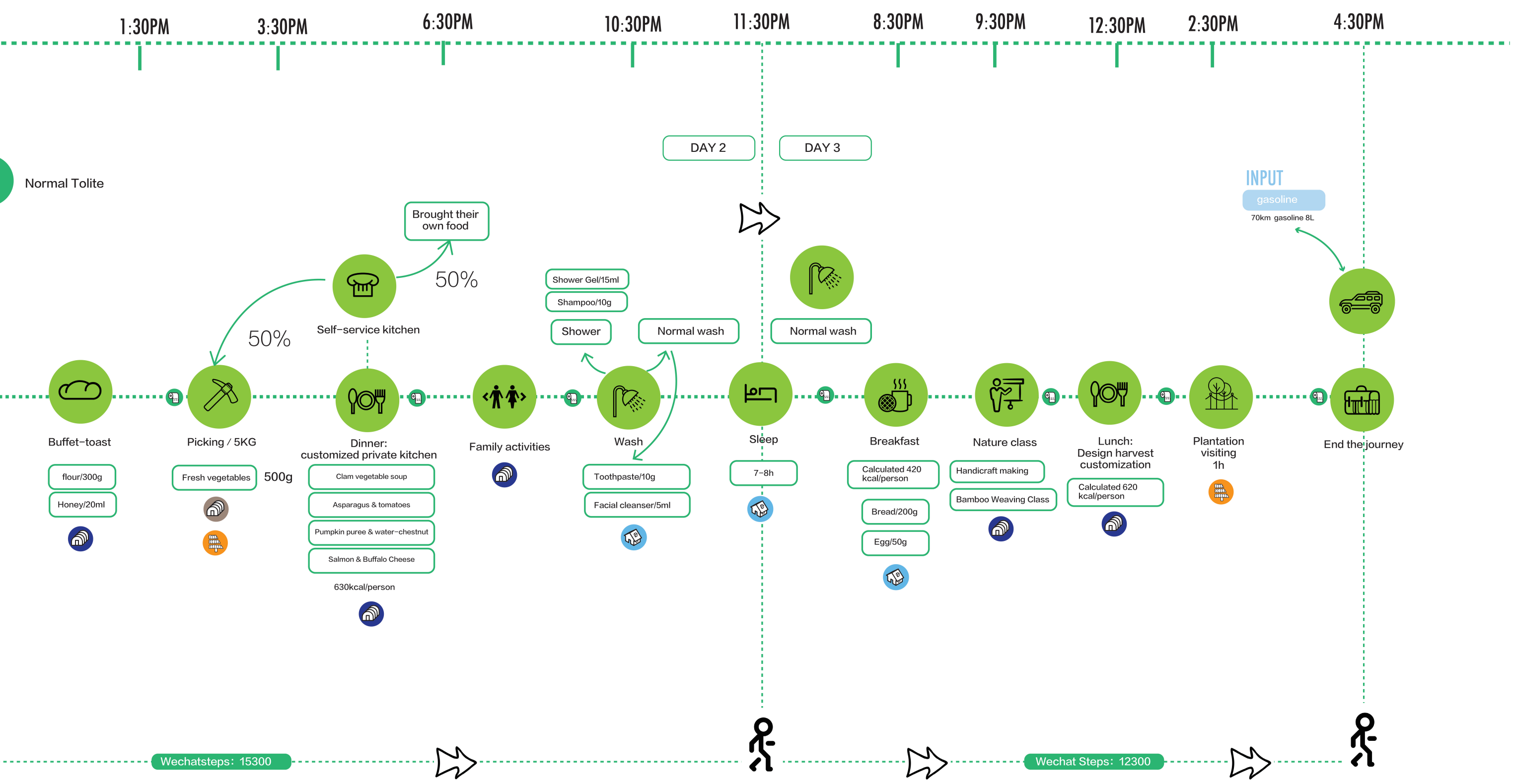


Figure 3.12 Chen Xiaobao’s user journey map (Image credit: author's drawing)



1:30PM
3:30PM
6:30PM
10:30PM
11:30PM
8:30PM
9:30PM
12:30PM
2:30PM
4:30PM
DAY 2
DAY 3
Normal Tolite
INPUT
gasoline
70km gasoline 8L
Brought their own food
50%
Self-service kitchen
50%
Shower Gel/15ml
Shampoo/10g
Shower
Normal wash
Normal wash
Buffet-toast
flour/300g
Honey/20ml
Picking / 5KG
Fresh vegetables
500g
Dinner:
customized private kitchen
Clam vegetable soup
Asparagus & tomatoes
Pumpkin puree & water-chestnut
Salmon & Buffalo Cheese
630kcal/person
Family activities
Wash
Toothpaste/10g
Facial cleanser/5ml
Sleep
7-8h
Breakfast
Calculated 420 kcal/person
Bread/200g
Egg/50g
Nature class
Handicraft making
Bamboo Weaving Class
Lunch:
Design harvest customization
Calculated 620 kcal/person
Plantation visiting
1h
End the journey
Wechatsteps: 15300
Wechat Steps: 12300

The three user journey diagrams above show a similarity, with a high degree of overlap in activity behavior. However, there are significant differences in diet and lifestyle habits. For example, Mr Chen smokes 20-30 cigarettes a day, but Ms Ye uses nearly 70Ml of chemical lotion daily (lady maintenance). Chen Xiaobao, on the other hand, takes two showers a day and changes his clothes twice a day due to playing without paying attention to his surroundings, etc. All these differences we need to put into the whole system to add individual differences. Also, these differences this is due to gender, age. So we will take the average value of these differences in behavior to arrive at the best sample of all our "tourist behavior" samples.

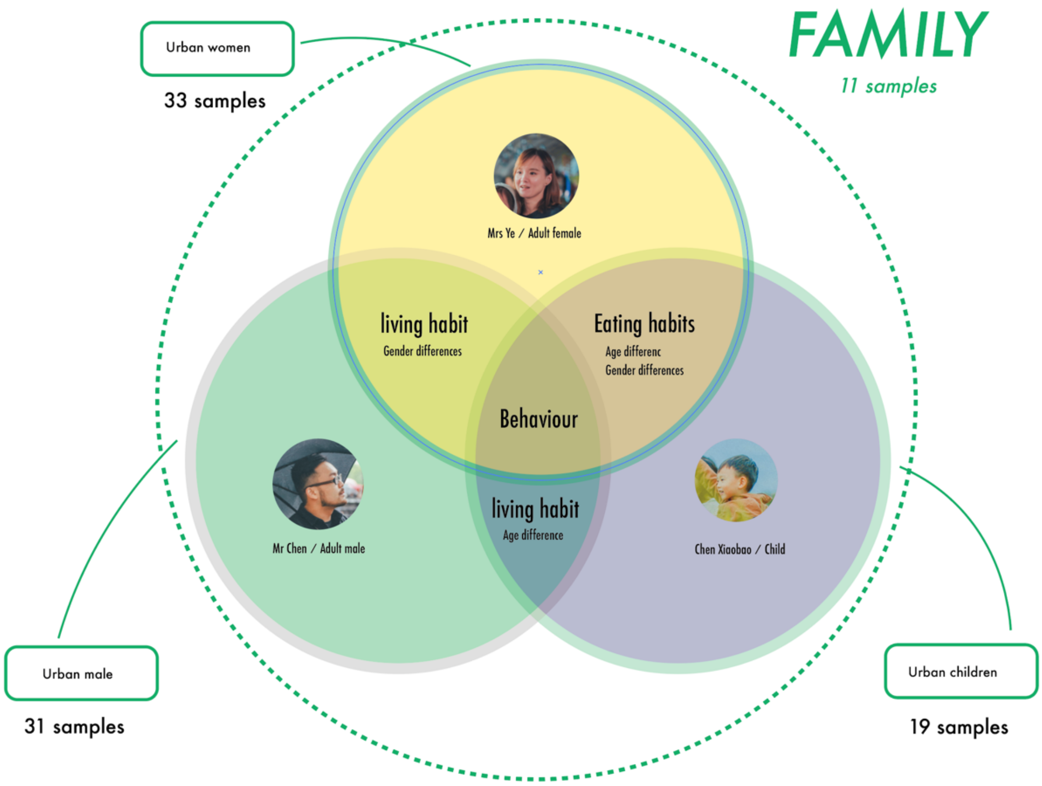


Figure 3.13 High-frequency behavioral overlap diagram (Image credit: author's drawing)

We can see that the best sample is our 'typical' user from the above chart. Based on the differences between the three user journeys above, we can see that behavioral habits are the intersection between them and the least controllable of them all. Each of the three 'users' is a representative sample of each domain based on different sample sizes. However, in order to create a final 'typical' sample of users, we had to continue to refine the data by integrating the behavioral habits and differences between the three and averaging the values based on realistic situations, for example, the differentiated 'calories per meal', 'number of chemical beauty products used' and 'number of cigarettes smoked per day were extracted and averaged. After extensive calculations, we developed the following figure 3.13: Typical user journey diagram.

3.1.5 General "visitor behavior" system modelling

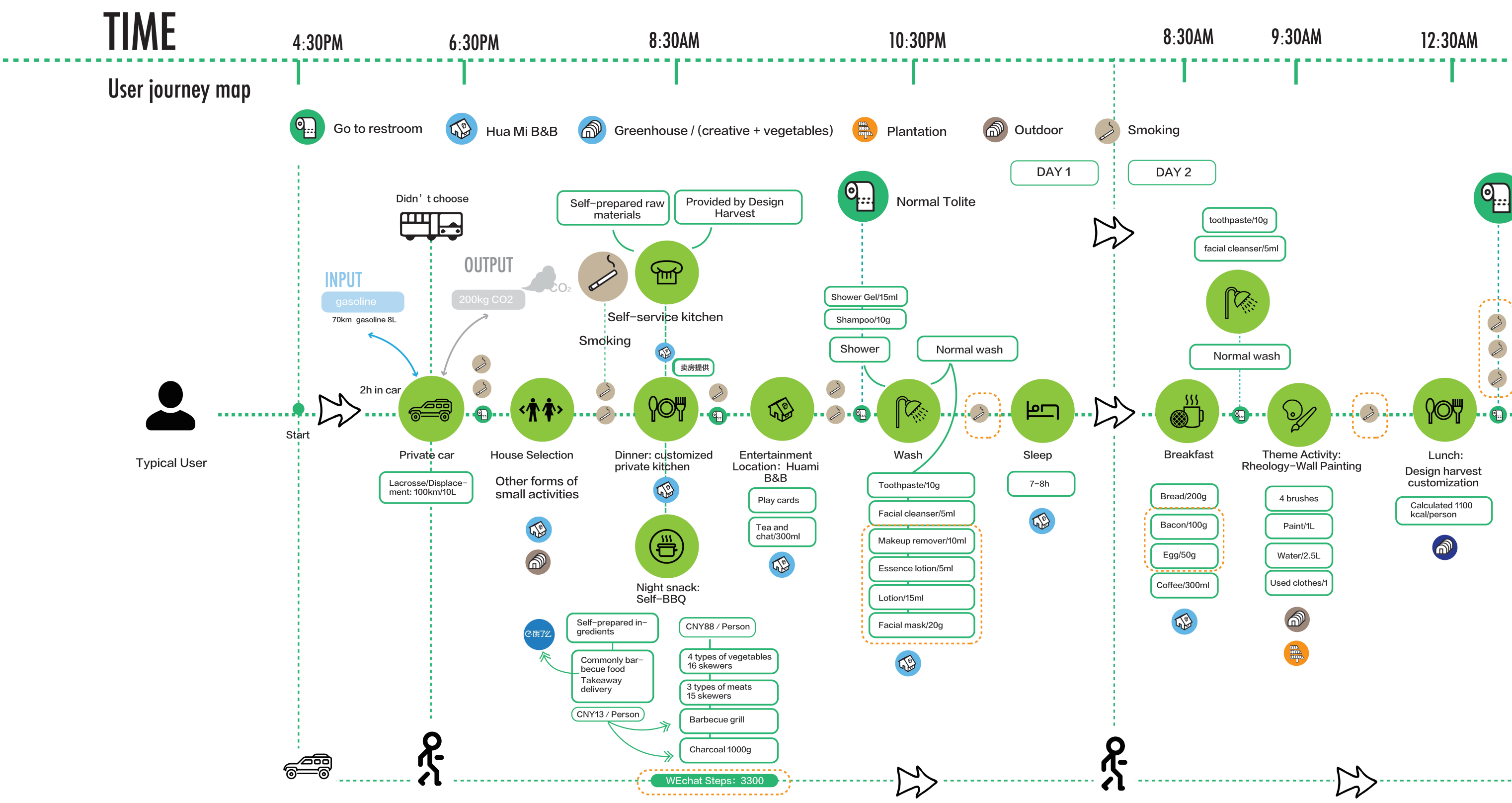
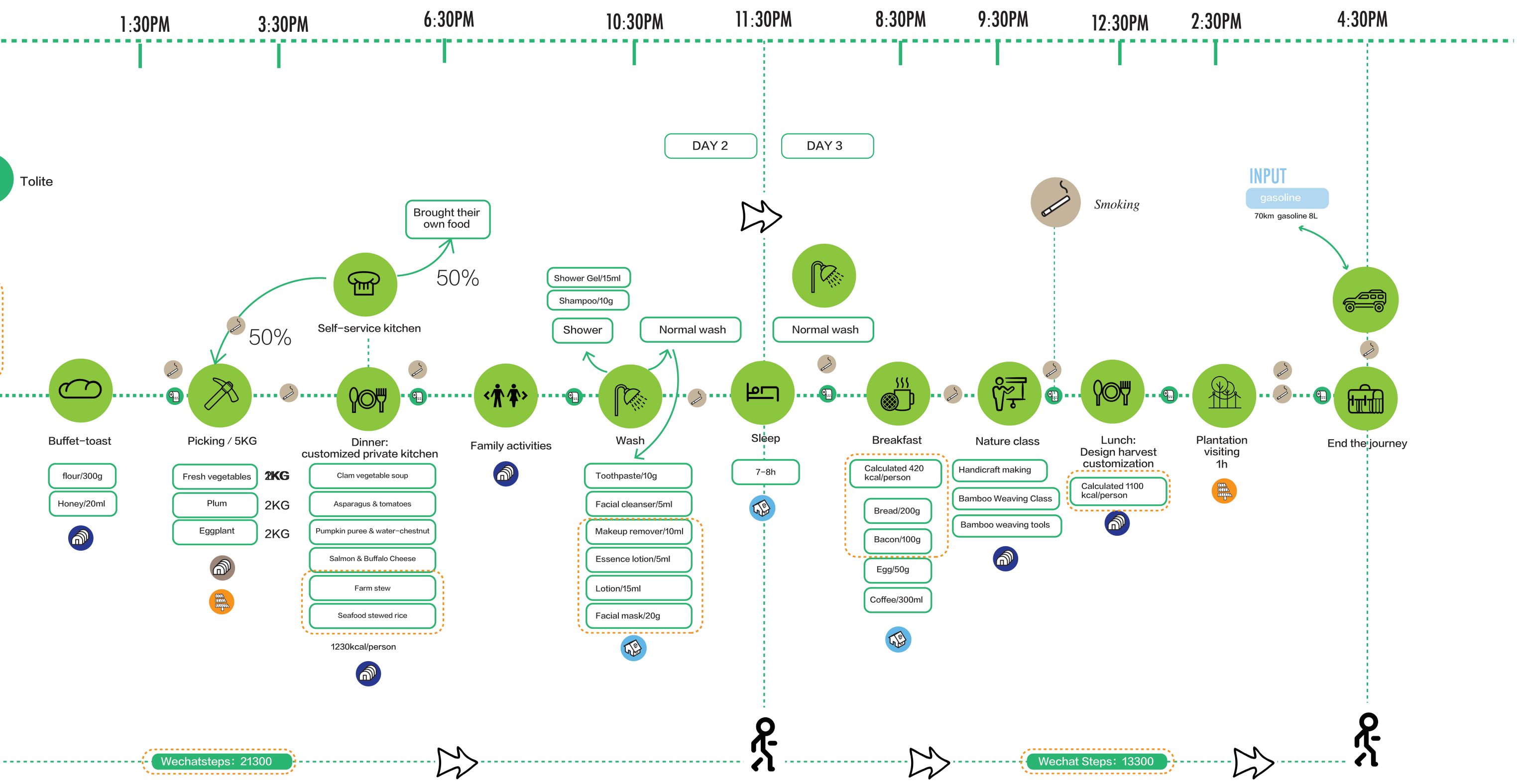


Figure 3.14 Typical user journey map (Image credit: author's drawing)



1:30PM
3:30PM
6:30PM
10:30PM
11:30PM
8:30PM
9:30PM
12:30PM
2:30PM
4:30PM
DAY 2
DAY 3
Tolite
Brought their own food
50%
50%
Self-service kitchen
Smoking
INPUT
gasoline
70km gasoline 8L
Shower Gel/15ml
Shampoo/10g
Shower
Normal wash
Normal wash
Buffet-toast
flour/300g
Honey/20ml
Picking / 5KG
Fresh vegetables
2KG
Plum
2KG
Eggplant
2KG
Dinner:
customized private kitchen
Clam vegetable soup
Asparagus & tomatoes
Pumpkin puree & water-chestnut
Salmon & Buffalo Cheese
Farm stew
Seafood stewed rice
1230kcal/person
Family activities
Wash
Toothpaste/10g
Facial cleanser/5ml
Makeup remover/10ml
Essence lotion/5ml
Lotion/15ml
Facial mask/20g
Sleep
7-8h
Breakfast
Calculated 420 kcal/person
Bread/200g
Bacon/100g
Egg/50g
Coffee/300ml
Nature class
Handicraft making
Bamboo Weaving Class
Bamboo weaving tools
Lunch:
Design harvest customization
Calculated 1100 kcal/person
Plantation visiting 1h
End the journey
Wechatsteps: 21300
Wechat Steps: 13300

3.2 Linear "food" system model Establishment

The catering industry has been a new force in China's economic development in recent years. However, due to the extensive operation of the traditional catering industry, they also resulted in a tremendous waste of resources, such as catering waste not being managed in a standard way and not being disposed of in a reasonable way, which has brought tremendous pressure on the environment.[1]

"The catering industry is both a major consumer of energy and materials and a source of laundry pollution emissions. Most catering companies suffer from management problems such as energy waste, over-consumption of goods and inappropriate use of resources." Gradually increasing energy prices have also caused a significant cost impact on the management of the catering industry. With the concept of a recycling-based society and recycling-based enterprises being widely promoted, the catering industry should also conform to the objective rules of the times and imply economizing management with the 3Rs principle of "reduce, reuse and recycle" advocated by the circular economy. As a major attraction of rural tourism, rural tourism catering is the closest catering industry to the original ecological environment, although the volume is smaller than the average level of the urban catering industry. If rural tourism catering does not make good use of resources and adapt to local conditions when developing, it will cause irreversible damage to the local ecological environment.

This section focuses on an in-depth study of the farming and catering sectors of Design Harvest to identify the specific cyclical patterns of the source of the catering node - 'food'. A prototype framework for a linear 'food' system is developed based on actual data. The' sample's carbon emissions per unit time are calculated based on per capita consumption.

[1] Xie Chaowu Chen Yanying, Research on circular economy and Economizing Management of Hotel Corporation in China[J], Science and Technology and Industry,(03):55-57

3.2.1 Design Harvest's food source classification

The author enjoyed a total of six meals at Design Harvest during two field trips, two of which were in private kitchens (in collaboration with the brand - No.7 Kitchen), with Design Harvest providing some of the raw materials and the brand providing high-end cooking techniques. The other time, the visitors cooked on their own, with Design Harvest providing some of the ingredients and the user bringing their own ingredients (purchased from a major supermarket). The rest of the time, the Design Harvest room provides standardized Chinese food (cooked by Design Harvest's partner farmers). Figure 3.15 gives a clear idea of the types of meals and the sources of food ingredients at Design Harvest.

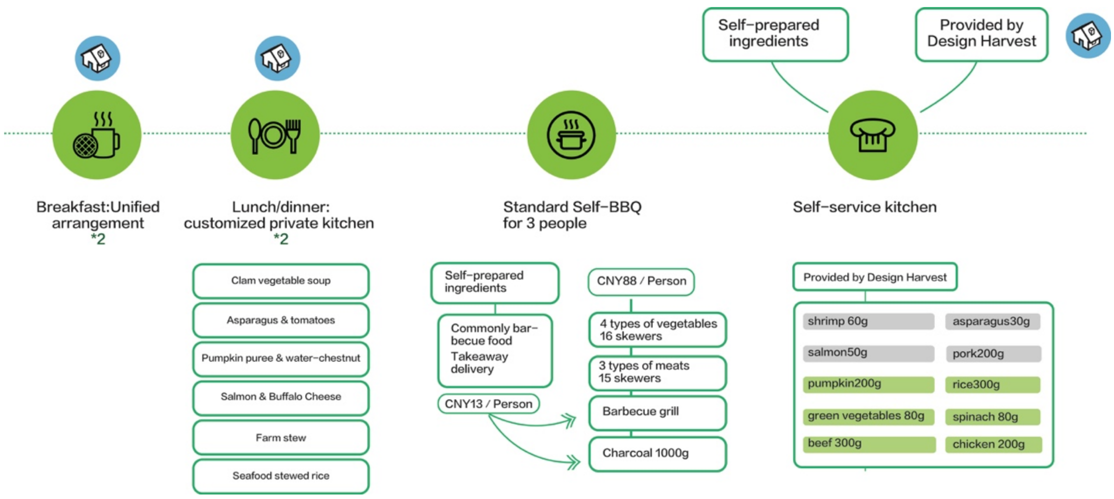


Figure 3.15 Types of catering in Design Harvest (Image credit: author's drawing)

After quantifying the diet based on a sample of users, the author hopes to understand further the entire food flow framework of Design Harvest based on the source of ingredients. According to the interviews with Design Harvest's housekeepers, there are specific differences in the food sources of these four forms of catering at Design Harvest (branded private kitchen customization - self-service kitchen - self-service barbecue - farmhouse customization). Some of the ingredients come from Design Harvest's own ecological and organic farm, and another part comes from the brand's own or visitors' own, with a specific ratio of 50% to 50%. The author hopes to build a specific life cycle flow of food in Design Harvest and find out the Input and Output of each node, which can further calculate the carbon emission of the whole catering chain more accurately. As shown in Figure 3.16

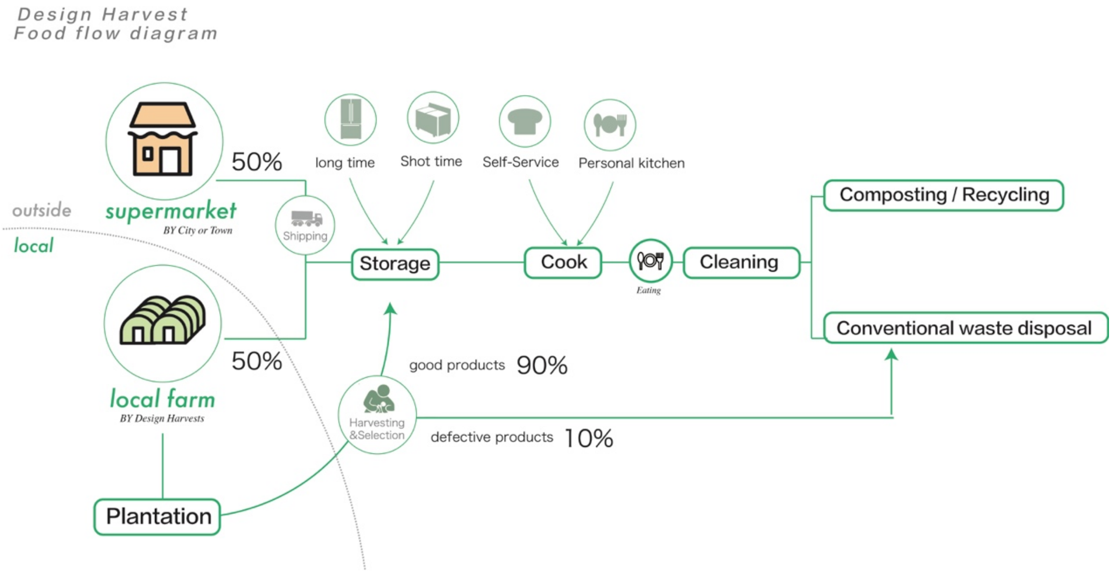


Figure 3.16 Food circulation flow system (Image credit: author's drawing)

3.2.2 Planting Industry System Analysis of Design Harvest

The source of food, "planting", occupies a significant position in Figure 3.15, and 60% of Design Harvest's food comes from this source, so the author hopes to conduct more in-depth research and calculations on the nodes of the planting industry. The author organized the current system flow of the main crops grown in Design Harvest based on the input-output system diagram, as shown in Figure 3.16. Design Harvest's planting sheds have grown from low output initially to successfully providing an adequate food supply for the B&B project in the last two years and are also able to export the surplus products from Design Harvest's eco-farm.

Design Harvest's planting industry covers a total of 37 acres, including 22 acres of paddy fields and four acres of greenhouses, each covering 320 m² (half an acre). The open field already planted: rice, sunflower, pepper, purple eggplant, green eggplant, tomato, sweet potato, peanut, black bean, sugar sorghum, white lentil, red lentil, bok choy, lettuce, soybean, okra, cosmos. The greenhouse is planting: gourd, bitter melon, pumpkin; to be planted: okra, jar beans, gourd, zucchini, strawberry, towel gourd, mint, etc.

Figure 3.17 Actual view of Design Harvest organic farming industry (Image credit: Design Harvest official WeChat)

3.2.3 Plantation cycle system modelling

The author extracted the main planting objects at the current stage of the Design Harvest planting industry to construct input-output diagrams. The following diagrams show the input and output materials needed for vegetables, rice, and the whole planting process in the Design Harvest ecological greenhouse.

In terms of inputs: firstly, fertilizers and pesticides are necessary for all linear farming methods. Secondly, vegetable growth is susceptible to pests and climate disturbances and needs to be taken care of more carefully, so agricultural films are essential in linear vegetable cultivation. River water is the primary source of irrigation water for crops, while tap water is mainly used for soaking seeds and washing crops after harvest.

A certain amount of diesel fuel is consumed by agricultural machines when sowing and harvesting rice and wheat, but human hands do vegetable cultivation.

In terms of output: vegetables produce much less organic waste than rice and wheat straw. In addition, agricultural greywater is mainly generated from rainwater runoff, with rice cultivation requiring a paddy environment that generates more greywater.

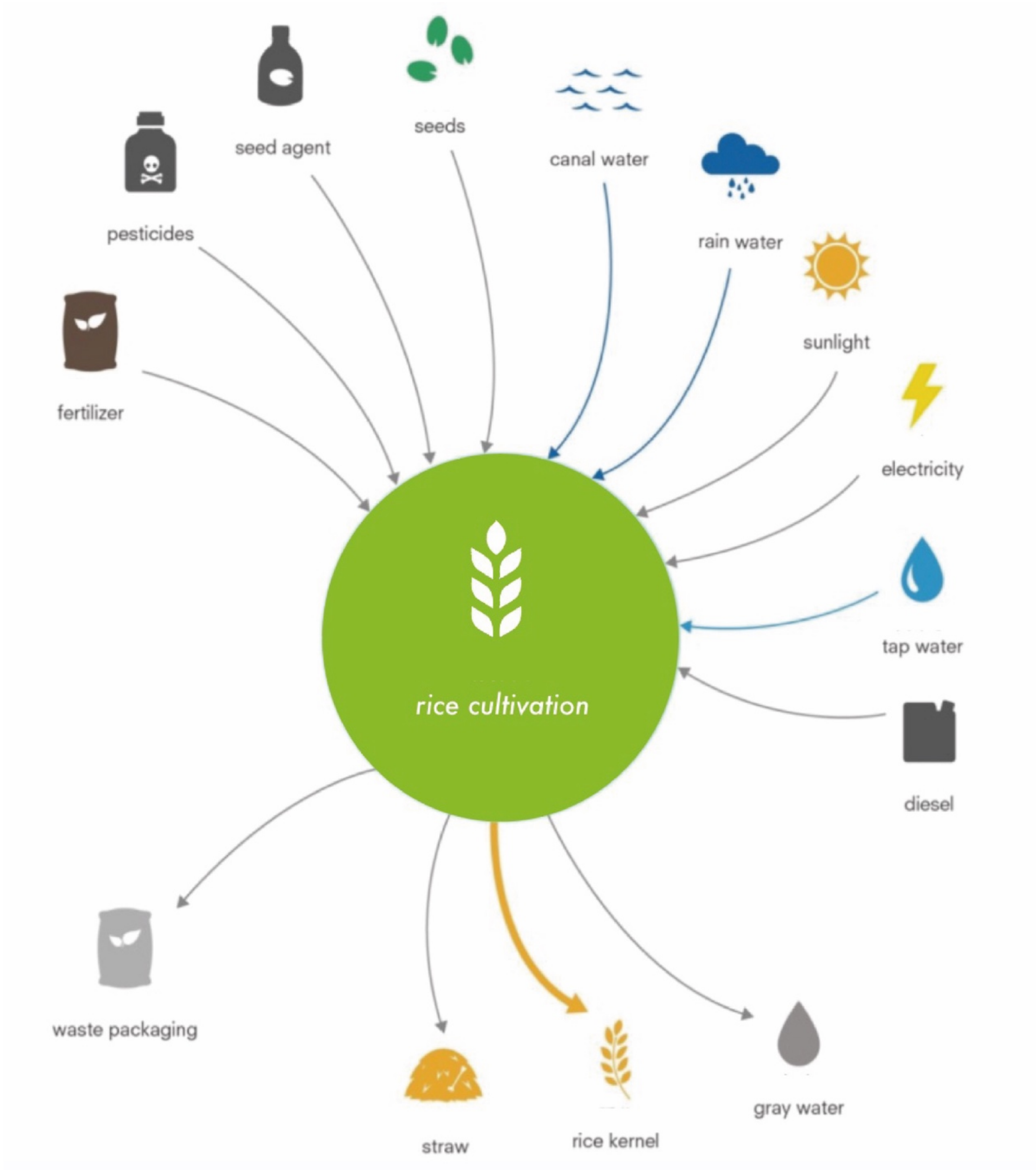


Figure 3.18 Input-output diagram of rice cultivation (Image credit: compiled by the author based on "Systemic design perspective of organic cultivation certification", Gao, Xiang, 2017, cultivation diagram)

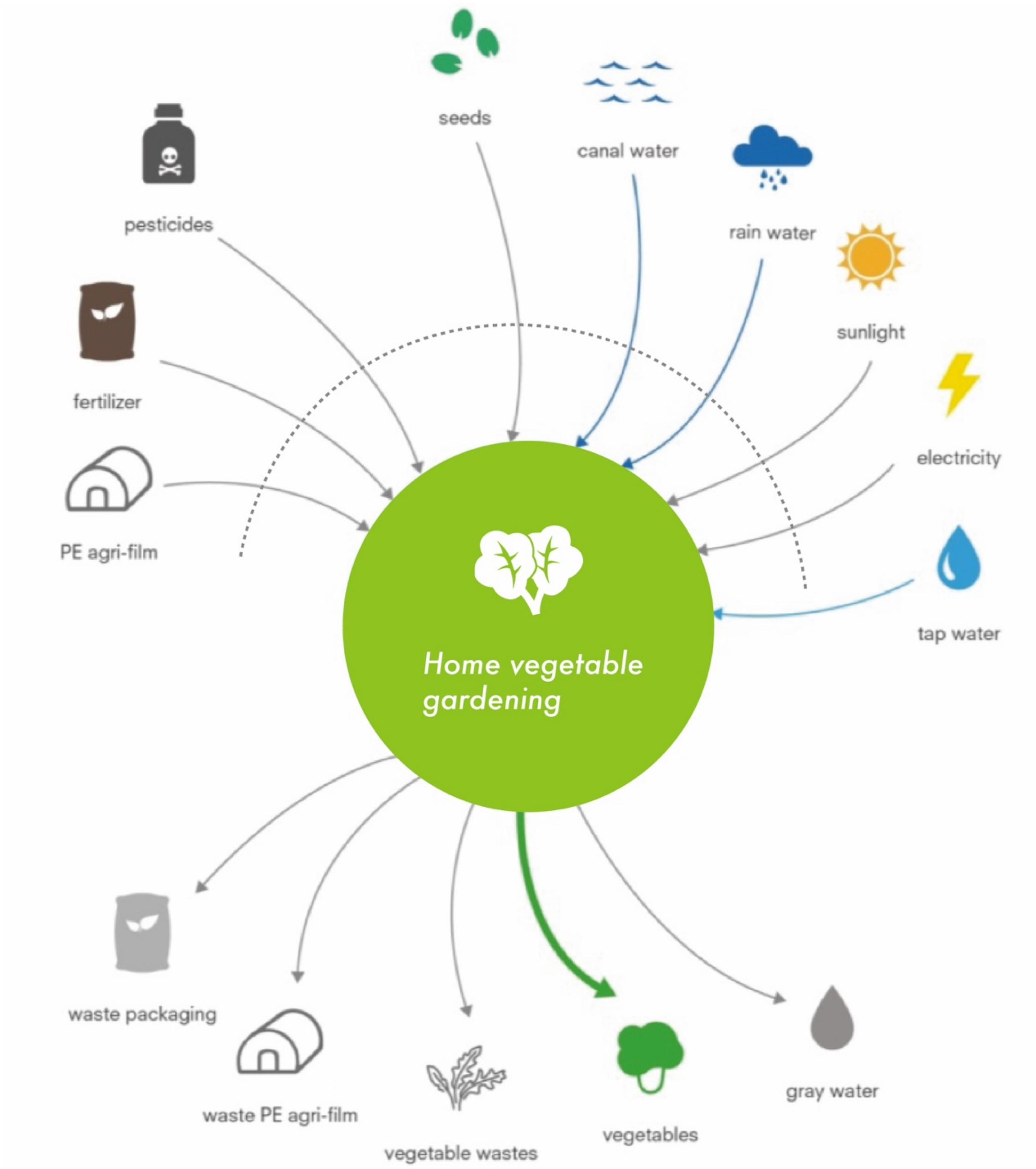


Figure 3.19 Input-output diagram of vegetable cultivation (Image credit: compiled by the author based on "Systemic design perspective of organic cultivation certification", Gao, Xiang, 2017, cultivation diagram)

Figure 3.18 and Figure 3.19 show the classification and analysis of the input and output substances of the main crops in the growing system. Combined with the author's observation and documentation of the typical user's daily dining process, Figure 3.20 visualizes and records the food cycle process in a system model (from cultivation to storage, cooking, dining process and disposal)

3.2.4 Linear food system modelling

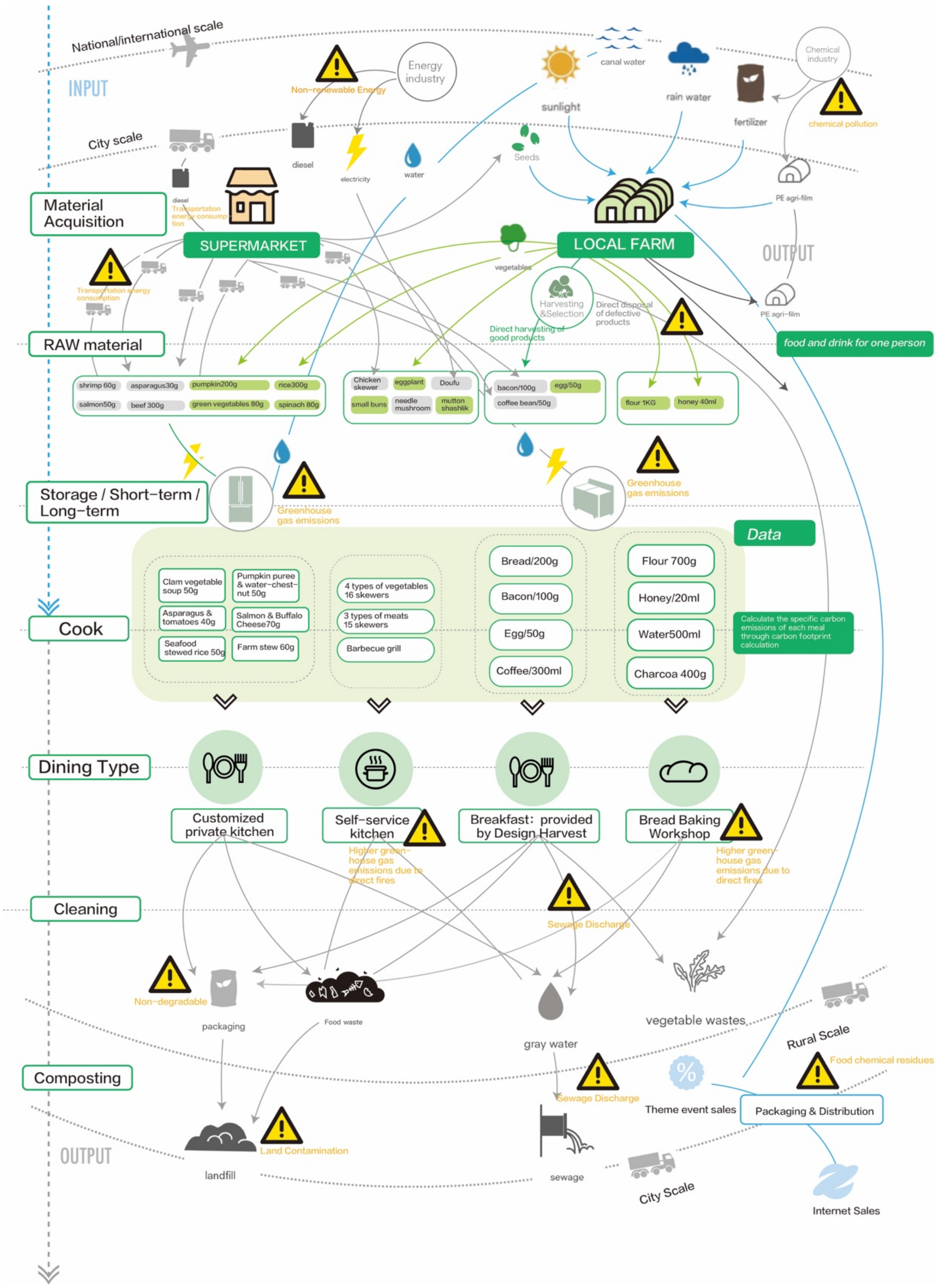


Figure 3.20 Linear food system modelling (Image credit: author's drawing)

3.2.5 System summary

The green part of the graph shows the controllable data, i.e. the data objectively recorded by the author - the food intake of a typical user over two days (weekend trip). Based on this benchmark of food quantity, the carbon emission formula can be used to derive the value of raw materials in reverse. After researching the eco-shed, the author has the essential data on the type of cultivation and growing practices. Then we can directly use the food intake of the "typical user" to derive the carbon consumption of the " eco-shed" growing industry for this intake.

The grey dashed lines indicate the boundaries in the system. From the inside to the outside: the boundaries of Design Harvest Farm, Xianqiao village, Shanghai and national, represent some of the ingredients sourced away from the local area. The yellow point in the diagram indicates system problems that need to be addressed through systemic design. The system shows a clear linear pattern in the representation of inputs and outputs, with an enormous need for external resources and poor management of the output waste.

3.3 Linear energy system modelling

3.3.1 Current energy use in urban and rural areas

The daily consumption of energy is a significant factor in the carbon footprint of Design Harvest. Tourism is one of the most representative sectors of the service industry. The energy consumption of the tourism industry depends on the individual behavioral restraint of the users on the one hand and the interior layout and service flow of the space up front on the other.

Design Harvest's B&B building space similar to the general household living space. Due to the lack of specific energy consumption data for the tourism industry, the author obtained a large amount of household energy consumption data from the China National Energy Network and the analysis results to serve as a reference for the Design harvest type of rural tourism energy consumption.

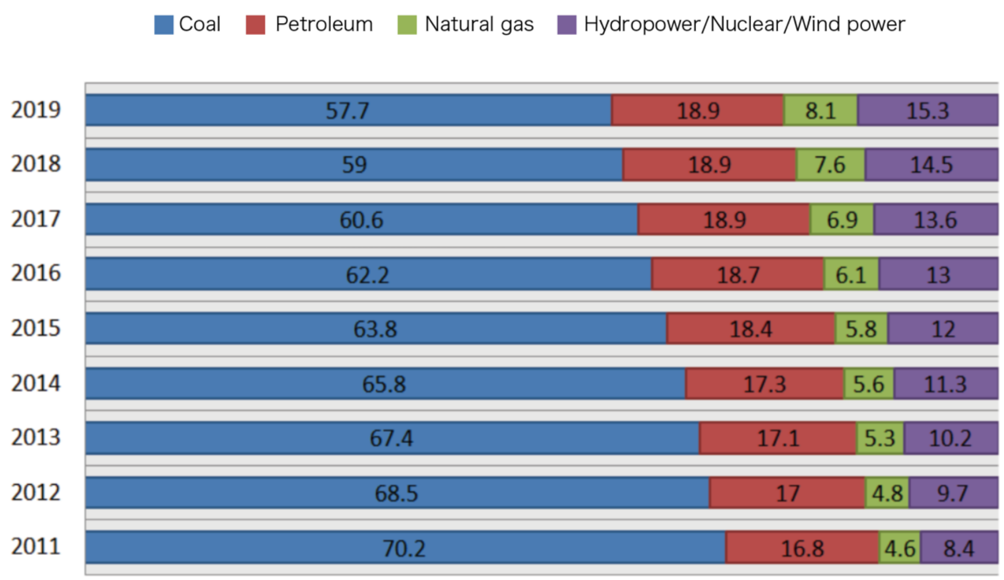


Figure 3.21 China's energy consumption structure (Image credit: China Energy Big Data Report, 2021)

The document states that "domestic research institutions, such as the Department of Energy Economics at Renmin University of China, conducted a questionnaire survey on household energy consumption among 1,340 households in 23 provinces across China during 2019-2020. The survey included six sections: household characteristics, dwelling characteristics, heating and cooling, residential transport, kitchen and household appliances, and fuel use." The survey results show that "an average household consumed 1,426 kilograms of standard coal (kgce) in 2019, with a per capita energy consumption of 612 kgce."[1] Analyzing the energy use structure, the proportion of energy used for cooking is significantly higher in China than in other countries. Heat, natural gas, electricity and firewood are the main energy supplies for households in China. There are significant differences in energy consumption and structure between urban and rural users. The average energy consumption of urban and rural households in 2019 was 1,503kgce and 1,097kgce, respectively. Natural gas and electricity are still the primary energy consumption structure for urban residents, while traditional biomass is still the primary energy consumption for rural households.

[1]Ways of Realizing Development, Sustainable Development Strategy Research Group, China Center for the Management of Agenda 21. research on all-round well-off society and sustainable development，2020（03）44-48

3.3.2 Energy consumption classification of Design Harvest

Based on the research and analysis of the energy structure and total energy consumption of Design Harvest, the author found that it is located in the surrounding districts and counties of Shanghai, so the rural development and construction is faster. Its primary energy consumption is electricity and a small amount of biomass, and its energy structure is significantly different from that of the inland and northern countryside. The B&Bs "Huami", "Tiangeng" and "Creative Shed" are all powered by electricity and are supplied by the village power station. In terms of water resources, groundwater is used for daily drinking and cleaning, natural precipitation is used for planting (paddy fields), and irrigation water is mainly used for the four greenhouses. The author obtained the monthly water and electricity bills of each B&B through the Design Harvest housekeeper and then combined this with a more rigorous follow-up research method in the hope of arriving at a more accurate average of individual energy use. The micro-survey data will help to understand current rural energy consumption patterns and urban-rural differences. They will also provide insight into whether sustainable design tourism, driven by 'design from the city', has the potential to damage the local ecology of the countryside.

3.3.3 Linear energy system model diagram building

The author conducted a detailed understanding and recording of the water and electricity bills for two B&Bs and one shed provided by the Design Harvest housekeeper (see appendix for details). The analysis yielded specific monthly energy usage for Design Harvest and was researched and recorded separately for each point in the specific low and high seasons. For example, the electricity consumption of Huami B&B in January 2019 was 2,468 kWh. Based on a unit price of 0.617, its electricity bill for the month amounted to ¥1,246.26. Based on the number of visitors received in a single month, 92, its per capita electricity consumption was 7.6 kWh. The author has calculated the annual electricity consumption (electricity bill) of the Huami, Tiangeng and creative greenhouses and obtained an average value of 2,100 kWh per month (525 kWh per week). Based on the average number of visitors received per week, the electricity consumption of a typical user was measured at 6.6 kWh per day and 15.2 kWh per 50-hour time unit. (The data is shown in the appendix)

Based on the current energy consumption within Design Harvest B&B and the Innovation Centre, the tourism accommodation model of Design Harvest, and the behavioral nodes of visitors and managers, the author uses typical users as carriers to string together and complete the modelling of the linear energy system through energy sources (water and electricity), as shown in Figure 3.22.

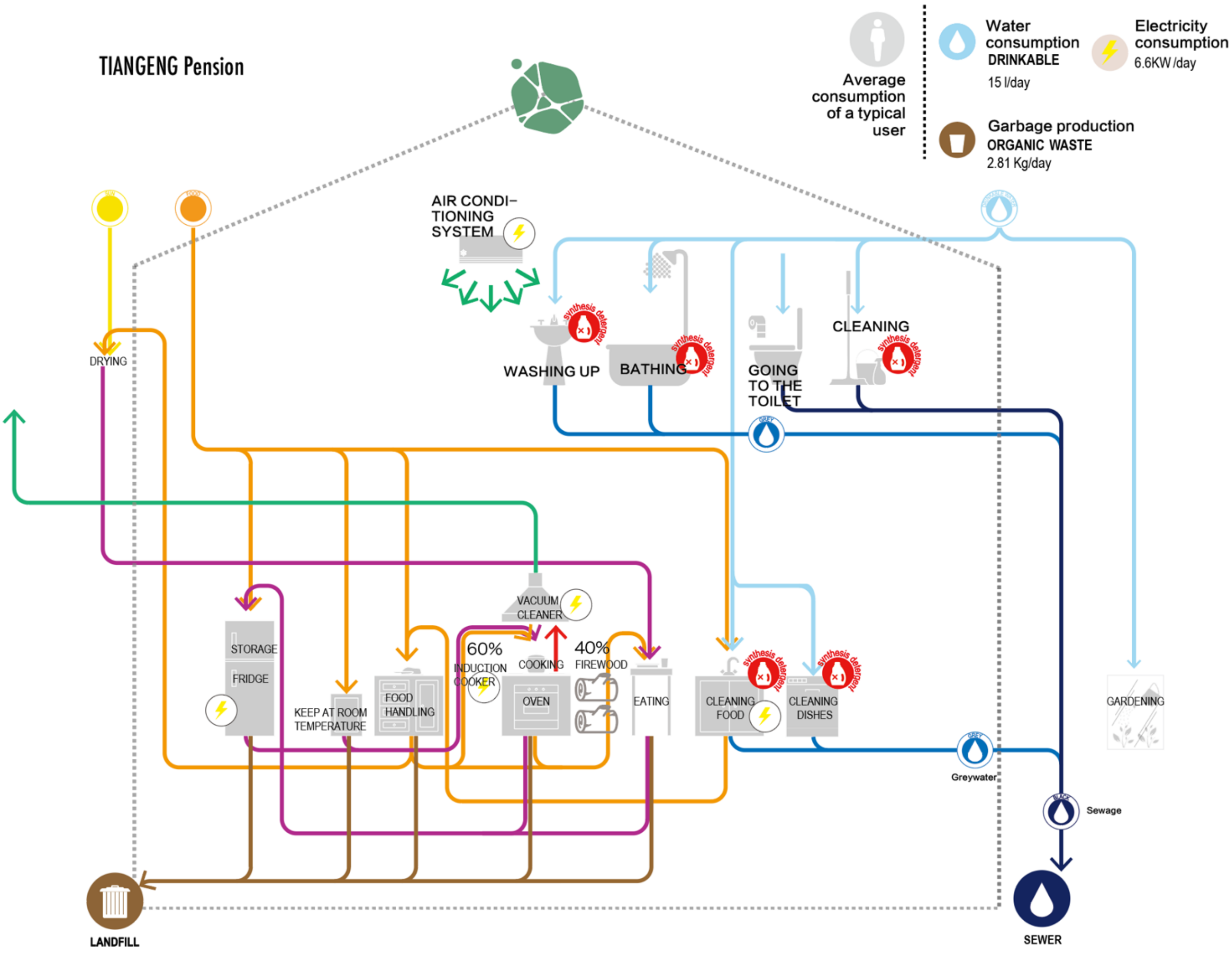


Figure 3.23 Diagram of a typical user's energy use system for Tian Geng B&B (Image credit: author's drawing)

3.4 Integration and Establishment of Linear Rural Tourism System Model

3.4.1 Linear Rural Tourism System Model

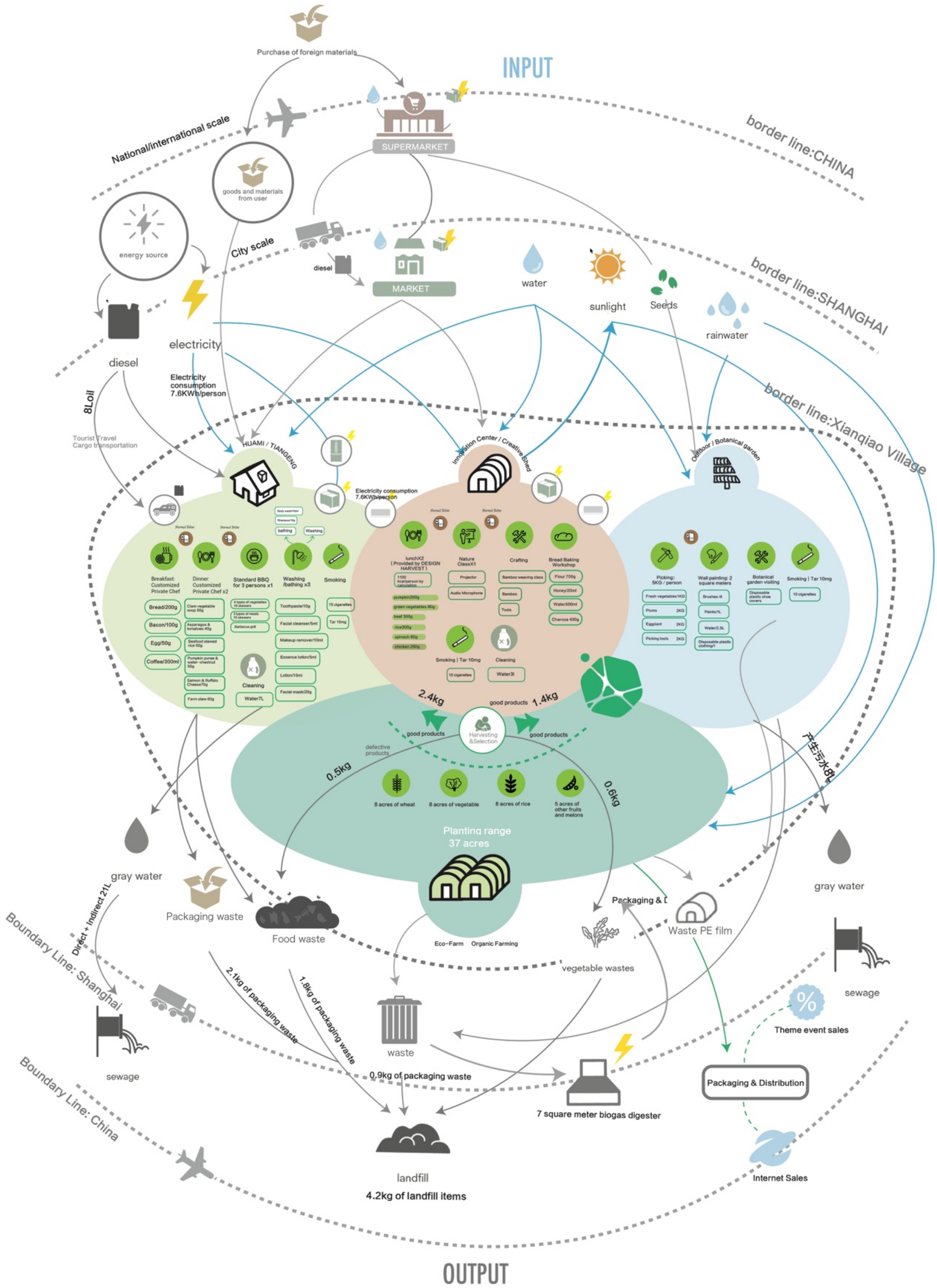


Figure 3.24 Linear Rural Tourism System Model Building (Image credit: author's drawing)

3.4.2 System summary

The previous subsections have modelled the elements of positive environmental impact separately due to the need for more accurate carbon emissions calculations. This summary requires the consolidation and generalization of the system model for the whole scenario vector, as shown in the figure, by regularizing each spatial node's immaterial behavior and material consumption and defining the carbon emissions of each spatial node in combination with the previous carbon emission calculations.

We can clearly learn from the above diagram that the system is linear and can be abstracted into the conceptual model in the diagram below. Firstly, the input resources of the system come partly from the industrialized global network and partly from the countryside itself. Secondly, the significance of waste utilization is weak due to the reliance on industrial resources to supplement some of the materials in the process of the tourism industry. This situation, the waste tourism industry, and the countryside itself waste human and financial resources costs. Thirdly, the linear system is mono-functional, efficient and rigid. Therefore, if this model is developed over a long period, as the flow of people continues to increase, carbon emissions increase and waste utilization decreases, the environmental load capacity of the countryside will reach a critical point, thus causing significant damage to the original ecological environment.

3.5 Ecological assessment of linear rural tourism systems

3.5.1 Assessment of global warming potential

Based on the above three elements of the linear system model, the main sources of carbon emissions can be found according to the problem nodes in the diagram, which are divided into indirect emissions - 'non-material behavior' and direct emissions - 'material consumption'. Detailed data is shown in the diagram below, and the sources and calculations are shown in Appendix A. Each important carbon emission node is extracted according to the scenario, and the corresponding detailed calculation and reasons are developed in detail in section 3.5.2.

3.5.2 Analysis and calculation of carbon emission nodes

According to the Design Harvest tourism system model, the corresponding application scenarios are "ecological/organic farms", "B&B", "creative greenhouses", and "outdoor/botanical garden". The classification of carbon emissions within each scenario will provide more accurate data on carbon emissions.

1. Eco-Farm

(1) Rice field methane

Methane from rice fields is another major source of greenhouse gas（GHG） emissions from farmland. Rice paddies account for 8% of total systemic GHG emissions. Methane from flooded rice fields creates an anaerobic environment where organic matter is fermented to produce methane. Studies have shown that tillage practices directly or indirectly affect methane emissions from paddy fields. In particular, no-till can reduce methane emissions overall compared to linear tillage. Linear tillage leads to the agitation of the upper and lower soil layers, promoting the decomposition of soil organic matter and providing more substrate for methane production. In addition, the use of nitrogen fertilizer can significantly increase methane emissions (Zheng, Tu-Ying, 2012)

2．B&B（Huami / Tiangeng）

(1) Catering

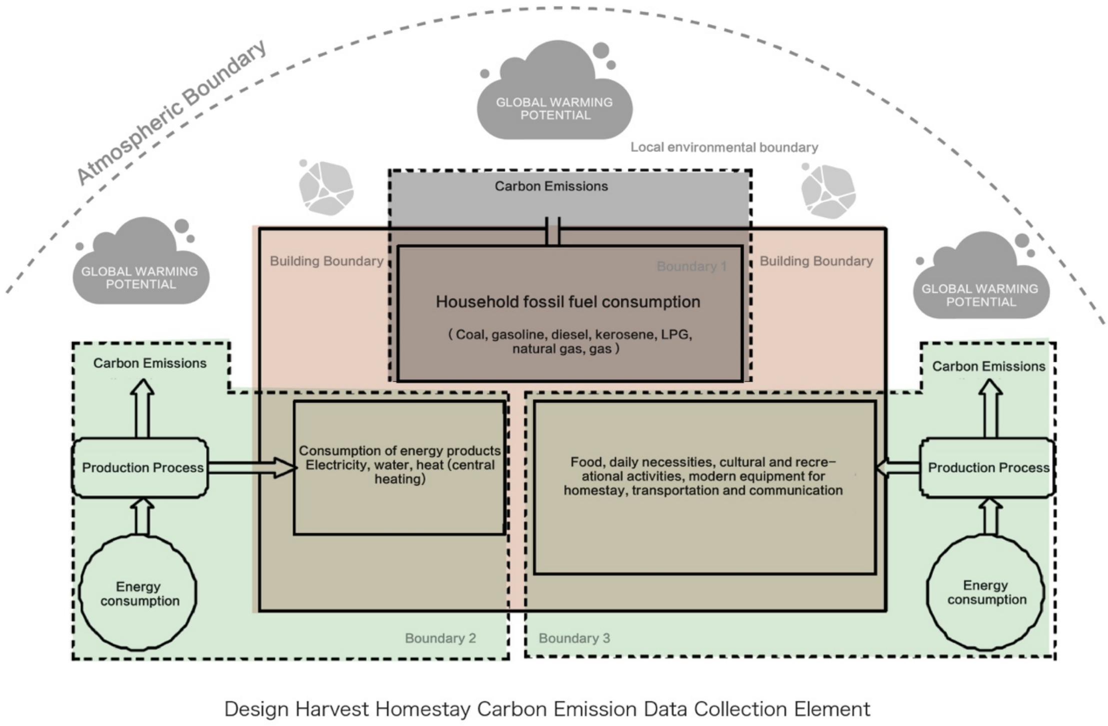


Figure 3.25 Factors influencing the consumption of carbon emissions (Image credit: author's drawing)

The act of catering in B&Bs is also a significant source of carbon emissions. From growing to picking, sorting, energy consumption for long-term or short-term storage, wood-burning for cooking and self-service barbecues generates high per capita carbon emissions. The average daily carbon emissions of a "typical user" of catering activities are calculated to be 27.25kg.

(2) Energy consumption

Energy produces carbon emissions directly during use and accounts for a certain proportion of overall emissions, with daily electricity consumption reaching 7.6 KWh per capita. CO2 emissions from domestic electricity use (kg) = 0.785 kWh consumed = 0.785kg. According to the author's statistics, the daily water consumption is 10L per capita, so the average daily carbon emission value for a typical user is calculated to be 22.84kg

(3) Visitor behavior patterns

The behavioral patterns of visitors show a higher proportion of male smokers and more random smoking locations. Due to the large number of carbon emissions generated during the smoking process, a packet of cigarettes emits 0.45kg of carbon. Female users use much water and, due to the high use of chemical lotions (face wash, conditioner, make-up remover, etc.), cause a higher level of effluent that is not easy to purify.

(4) Domestic waste

The Design Harvest B&Bs and the Innovation Centre waste mainly daily domestic wastes. The situation is confusing, with waste being sorted by the dichotomous method and the quadruple dichotomous method. However, the sorting is ineffective, and the waste is mixed together and disposed of in landfills by the waste disposal department.

Domestic waste generates a certain amount of greenhouse gases even before it is collected and transported. For example, most kitchen waste is organic, consisting mainly of food waste such as fruit and vegetable peels. Under linear storage conditions, these perishable food wastes undergo certain chemical reactions and produce large amounts of carbon emissions during the process of stacking. "In addition, the transportation of these wastes also emits a large number of carbon emissions."[1] The B&B generates about 3.8t of waste per week. The maximum frequency is 30 visitors per week. The distance to the township waste disposal center is 5km, transporting with a 15L per 100km fuel truck, so the carbon emissions generated are 15kg and 1.25kg per person per day.

The domestic waste still has carbon emission problems during the landfill process, which produces large amounts of methane, leachate, etc. Large amounts of nitrous oxide and other substances containing carbon are released in leachate conditioning ponds at domestic waste landfill sites. Furthermore, the landfilling of domestic waste requires a great deal of mechanical assistance because of the amount of work involved. It consumes a lot of electricity and fossil energy, leading to significant carbon dioxide gas emissions. According to calculations, the domestic waste in the Design Harvest B&B generates 4.25kg of carbon emissions per person during the incineration and landfill process. Combined with the waste itself, the carbon emissions from the transportation process are therefore calculated to be 9.05kg for the entire waste life

[1]Carbon emissions and emission reduction strategies for domestic waste disposal, Carbon Emissions Trading-China Energy Conservation Online, 2018, http://www.cecol.com.cn/news/

cycle.

3. Innovation Centre (Creative Shed)

(1) Selected thematic events

Themed catering activities such as bread baking workshops, for example, have their cooking space outdoors. The kiln also produces many carbon emissions, including 8.3kg per person from burning firewood. The most important experience of the bread kiln is baking handmade bread using farmhouse 'firewood' as fuel.

(2) Educational activities

This type of event is usually located in a scene with a high density of people within the unit and involves various production materials, which will generate a large amount of waste at a later stage. Based on the weight of waste from five events, the author calculates that 1.5kg of waste gas is generated per person, which amounts to 4.12kg of carbon emissions.

4. Outdoor /Botanical Garden

(1) External material inputs

The main sources of carbon emissions from petrol are the travel of tourists and the delivery of external materials. The "typical user" of a private car for travel is 9.36 kg of carbon emissions per trip, while the average daily emissions of a truck used to transport materials are 12.25 kg.

(2) Carbon-neutral

Carbon neutrality in the environment comes mainly from carbon dioxide uptake by some green plants, of which trees account for a large proportion. Trees absorb carbon dioxide by photosynthesis, converting it into $C_6H_{12}O_6$ and eventually into trunks, branches and roots (mainly cellulose $C_{22}H_{48}O_{22}$).

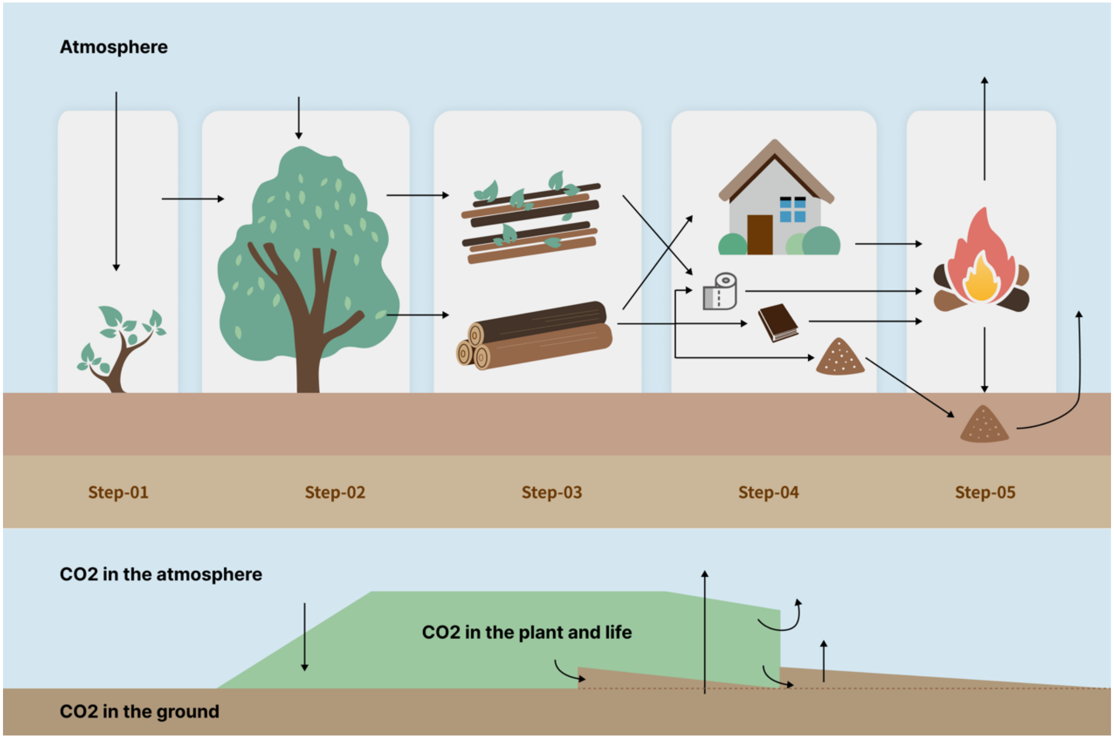


Figure 3.26 Carbon neutral schematic (Image credit: author's drawing）

So how do we calculate the average daily CO2 uptake of a tree? Firstly, we can calculate the amount of carbon dioxide absorbed by a tree by measuring how much mass it grows in a year. Of course, the amount of CO2 absorbed by photosynthesis is much more than this, but respiration releases a large proportion back into the air, so this method gives a net amount of CO2 absorbed in a year. Assuming a tree that grows to 10 meters high and half a meter thick in ten years, the tree's trunk is only two cubic meters. Assuming that the underground part of the tree is about the same size as the above-ground part, that would be a total of 4 cubic meters. The density of the tree is about 0.5, so the weight of the tree is two tones. Based on the CHO ratio of C22H48O22, C accounts for 0.8 tones. This translates into a CO2 mass of about 3t-4t, divided by ten years (about 3650 days), equating to about 1.3-1.8kg/day.

According to the China Carbon Emissions Trading website[1], a tree absorbs an average of approximately 1.66kg of carbon dioxide per day. Based on the effective absorption area of 30 square meters (10-15 trees) in the Design Harvest Botanical Garden, its average daily carbon dioxide absorption is 25.25kg, and its annual carbon absorption is

[1] China Carbon Emissions Trading Network， http://www.tanpaifang.com/

9216.25kg.

3.5.3 Carbon Emission Model Building for Linear Rural Tourism Systems

Based on the above distribution calculations, this summary integrates the carbon emissions of each emission node and establishes a carbon emission model for the linear rural tourism system. The nodes are classified as "energy consumption", "food", "agricultural cultivation", "travel", "activity materials", etc. The specific carbon emission values are shown in the figure below.

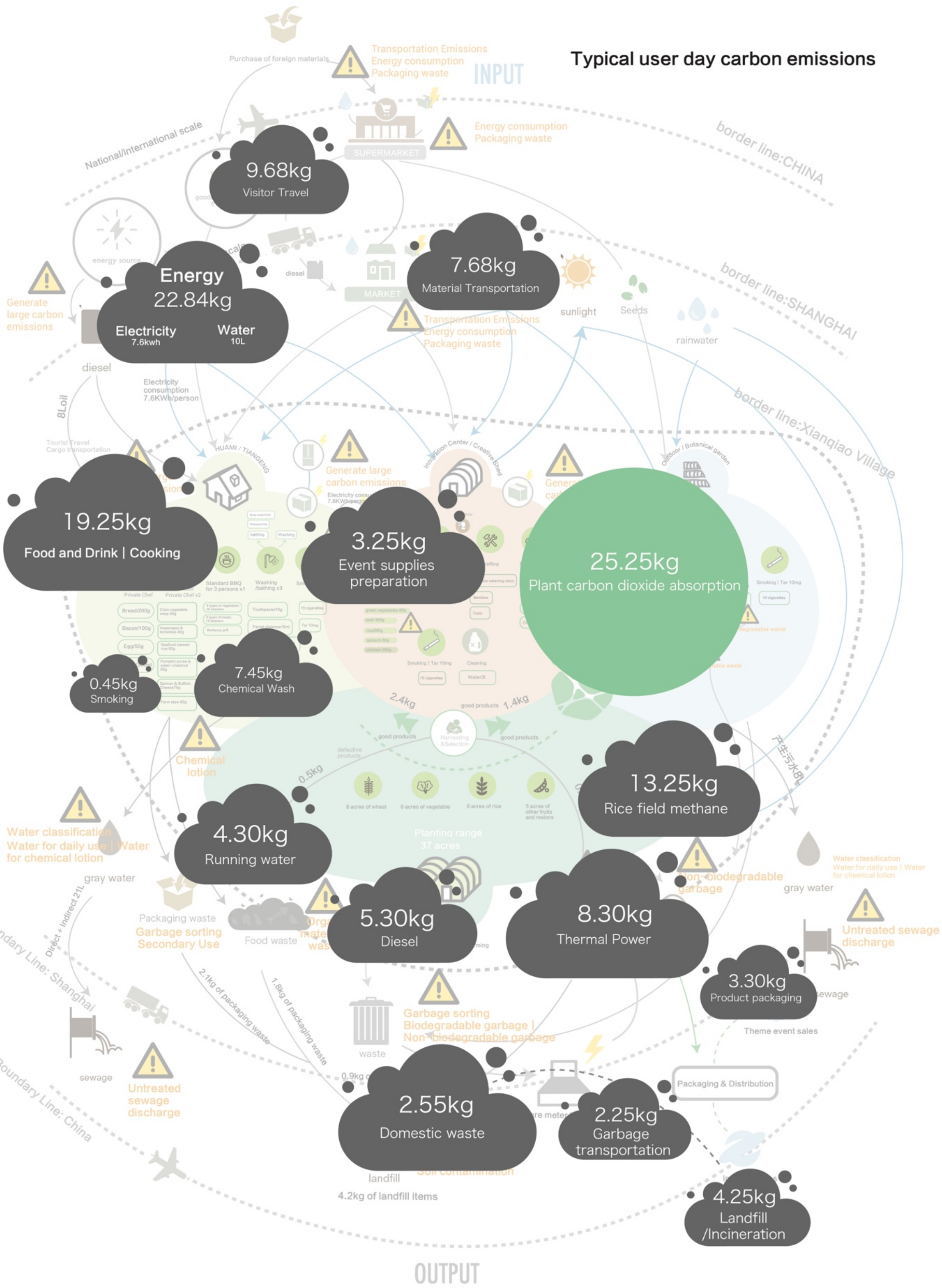


Figure 3.27 Map of carbon emissions of Linear rural tourism systems (Image credit: author's drawing)

3.5.4 Summary of the assessment

The carbon emissions visualization of the linear system is based on a quantitative analysis of the typical user's activity behavior during a day in the scenario carrier. These activity behaviors have a high frequency. Based on the typical user's behavior at each node, the carbon emissions are analyzed and calculated, resulting in average daily carbon emission for the typical user and a final carbon emission value of 76.77 kg/D for the "time unit".

The author compared the behavioral activities of the "typical users" of Design Harvest for several simulations and took the average of the final high-frequency activities. The data from each problem node has a large sample size and represents the daily carbon emissions per capita of Design Harvest, thus deriving the Design Harvest annual carbon emissions. Once specific carbon emission values have been derived, the global warming potential of the Design Harvest project is assessed through a comparative approach. The comparator is the carbon-neutral value for the area in which the Design Harvest is located, above which the Design Harvest project will have a relatively high environmental impact.

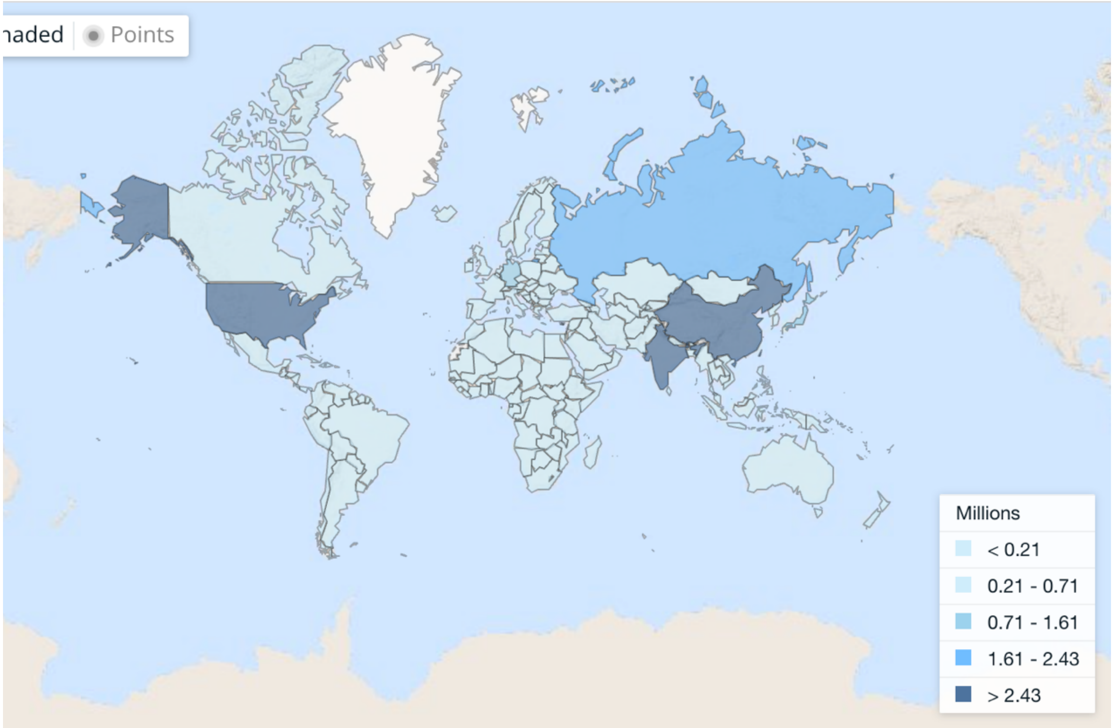


Figure 3.28 Map of carbon emissions by country in the world in 2018 (image credit: THE WORLD BANK)

A visual comparison of total carbon emissions by country in the world in 2018 can be observed in Figure 3.28. As the developing country with the largest economy, China is one of the countries with the highest carbon emissions. This is directly related to China's development model of achieving economic benefits at the expense of the environment. The data shows that carbon emissions in most developed countries are basically on a gradual downward trend, reflecting the gradual implementation of the low carbon development concept of energy conservation and emission reduction in developed countries after the explosive industrial development, while China is going in the opposite direction. The data shows that, in 2014, the total cumulative national carbon emissions were 9.116 billion tonnes, with a cumulative per capita value of 6.5 tonnes, or 17.17 kg per day. In 2018, this value became 21.25 kg per day, 30.21 kg for urban residents. As shown in Figure 3.29, Shanghai's cumulative per capita carbon emissions are 11.7 t, with a daily average of 32.05 kg.

Design Harvest visitors' average daily carbon emission is 76.77kg, and the average daily carbon emission of the whole Design Harvest project is 132.25kg. (See Appendix

B for detailed calculations) This is equivalent to 2 times the carbon emissions of urban residents and three times that of rural residents. Based on the number of 2,100 visitors received by Design Harvest in 2019, the average annual carbon emissions generated would be 58,254 tonnes, which seriously exceeds the local environmental loading capacity. In summary, the carbon emissions from the Design Harvest linear tourism system reflect that the ecological status of the system is not sustainable.

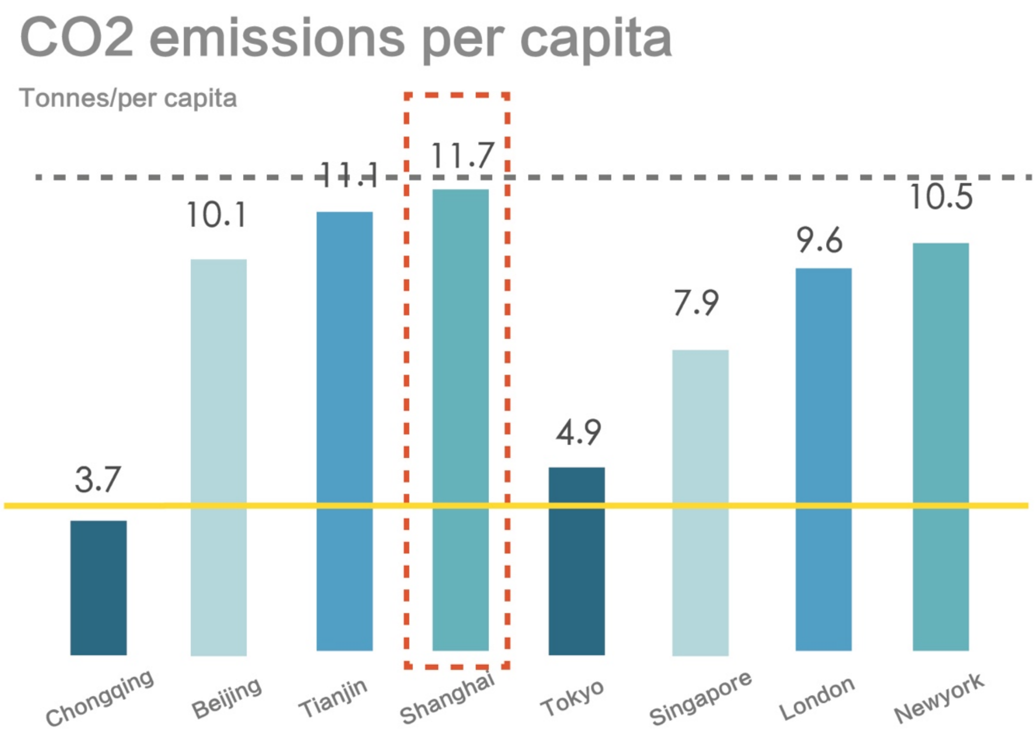


Figure 3.29 Average CO2 emissions per capita in 1997-2018 (Image credit: China Carbon Emissions Trading Network

3.6 Summary of this chapter

This chapter develops a linear rural tourism system model based on the current situation and data, using Design Harvest as a scenario carrier. The system is also described and analyzed in terms of inputs, behavioral processes/production processes and outputs, concluding that linear rural tourism systems are linear systems that deplete indigenous natural capital and waste resources. The system was then assessed for global warming potential and found unsustainable.

Chapter 4

From Linear to Sustainable Rural Tourism Cycle System Modeling

This chapter is divided into two parts. The first part integrates the three sub-systems of the existing rural tourism cycle system. The second part summarizes the strengths and weaknesses of the current standard systems. A model of a sustainable planting system is then constructed and ecologically assessed.

4.1 From linearity to sustainability

4.1.1 Linear systems

Based on the study of the linear rural system model in Chapter 3, it is known that the system is linear and can be abstracted into the conceptual model in the figure below. Firstly, the input resources of the system come partly from the industrialized global network and partly from the countryside itself. Secondly, the significance of waste utilization is weak due to the reliance on industrial resources to supplement some of the materials in the process of the tourism industry. This situation, the waste tourism industry, and the countryside itself waste human and financial resources costs. Thirdly, the linear system is mono-functional, efficient and rigid. Therefore, if this model is developed over a long period, as the flow of people continues to increase, carbon emissions increase and waste utilization decreases, the environmental load capacity of the countryside will reach a critical point. The "nature-friendly" countryside in the eyes of urbanites will gradually become the next tragedy of the "urbanized" countryside.

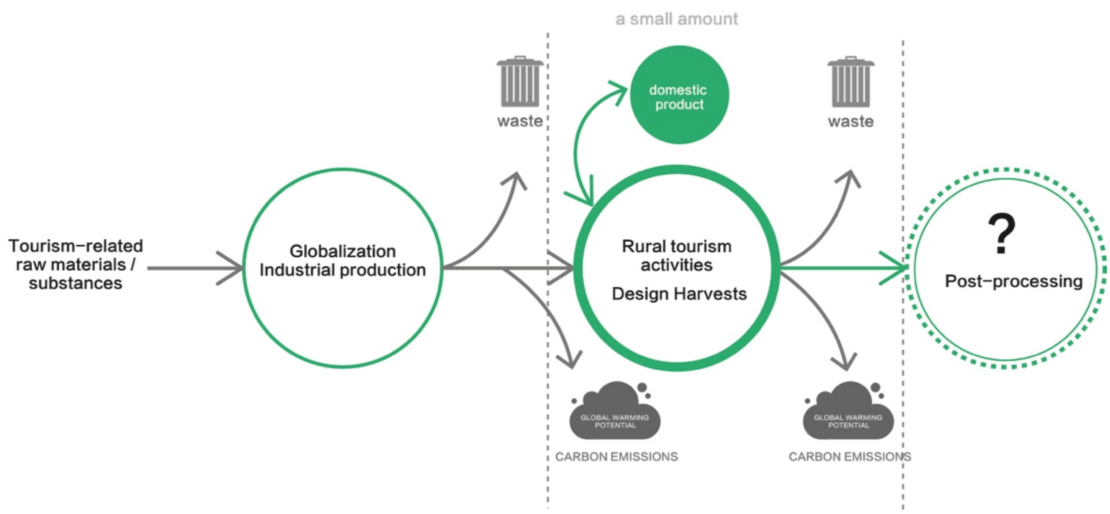


Figure 4.1 Linear Tourism System of Design Harvest (Image credit: author's drawing)

4.1.2 Sustainable Systems

Building sustainable systems start with a reversal of linear thinking and begin with the quality problems of the system's inputs and outputs. After determining what input qualities are required by the system and what output qualities are owned by the system, the search for possible sources of the substance begins. The characteristic of a sustainable system is that it can partially supply its own needs in order to maintain its sustainability. As shown in Figure 4.2, this process reduces additional unnecessary external inputs and allows for the full recycling of waste. When a system is not fully self-sufficient, it requires the cooperation of a nearby producer or a reliable seller of that resource.

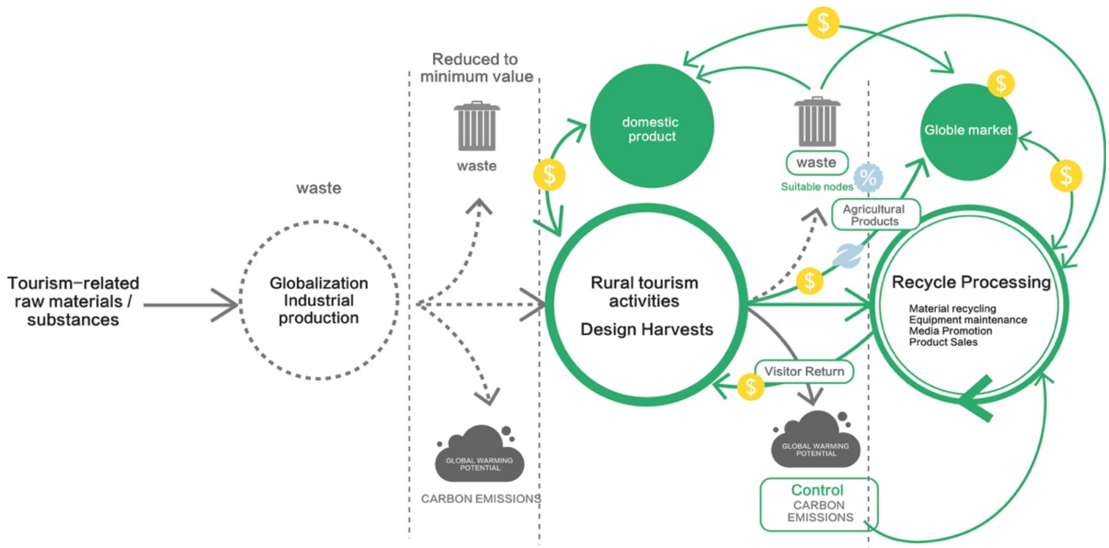


Figure 4.2 Sustainable Tourism System of Design Harvest (Image credit: author's drawing)

In Figure 4.2, the entire cycle system uses local production materials as much as possible to minimize the presence of outside industrial products and production materials. This reduces the geographical extent of the ecosystem from the source, thus reducing waste and carbon emissions while at the same time increasing the productivity and utilization of local materials and contributing to the transformation of the local economy.

4.2 Linear system model problem nodes

4.2.1 Problem nodes analysis of the linear system model

Based on the linear rural tourism system model developed in Chapter 3, the author analyses the three parallel dimensions: visitor behavior, food and energy. This study was conducted under the guidance of the concept of circular economy, which focuses on the '3Rs' (Reduce, Reuse, Recycle). Therefore, whether or not it can precisely guide the sustainable development of tourism activities and the ecological environment is also the basis for assessing the rationality of the circular economy in rural tourism. If this conceptual criterion is adopted, there are still many problems with the current recycling system within the scenario carrier. Finding the problematic points (yellow points) in the original linear system is the key to building a sustainable rural tourism model.

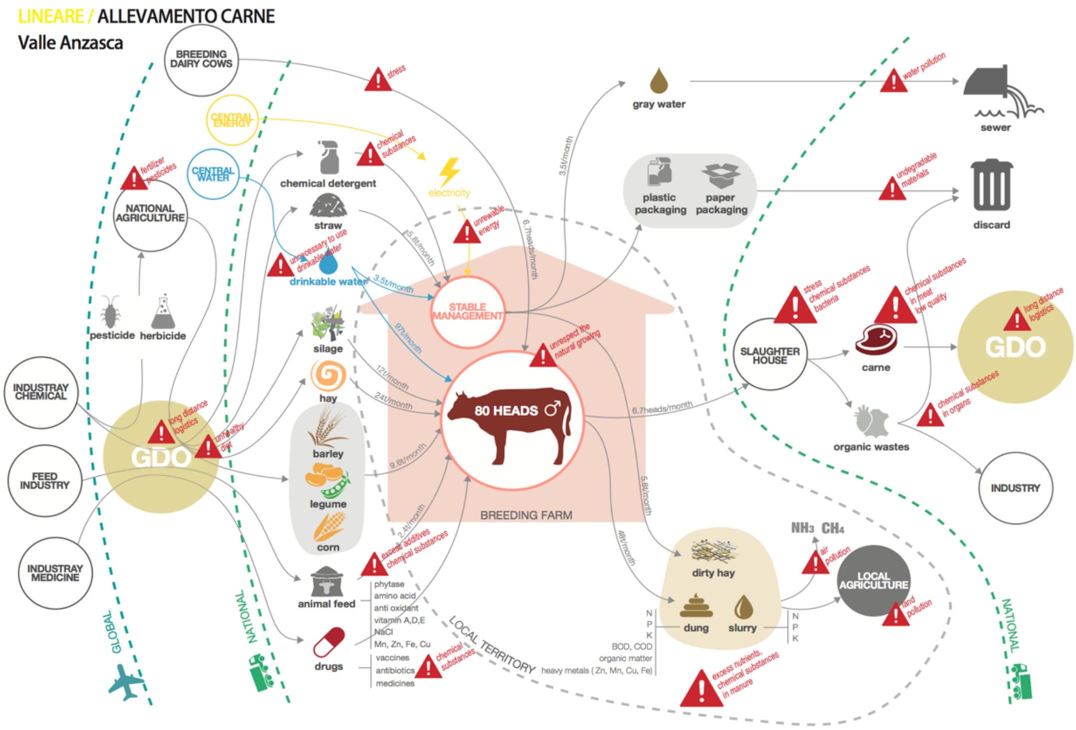


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Figure 4.3 Example of the meat production system diagram for Blackbirds Farm (Image credit: Politecnico di Torino)

In the systemic design approach, we often use YELLOW POINT to indicate that something is wrong with a node when there are many wasted resources, and it does not move on to the next stage of the circulation loop.

Figure 4.3 shows a linear cattle farming system diagram at the Blackbirds farm in Turin, Italy. Most of the outputs are not converted into input for the next cycle, resulting in higher carbon emissions and energy consumption in the whole system. The nodes in the diagram where there are potential improvements are marked with a red/yellow exclamation mark. The reason for the current problem is indicated, providing a basis for the next step of integrating these opportunities and proposing a solution strategy.[1]

Based on the linear model of the linear rural tourism system established in Chapter 3, the author visualizes and organizes the opportunity points that appear in the system diagram. The following diagram shows the system model of the problem node (Yellow point) based on the linear rural tourism system model.

[1] Systemic design, Politecnico di Torino

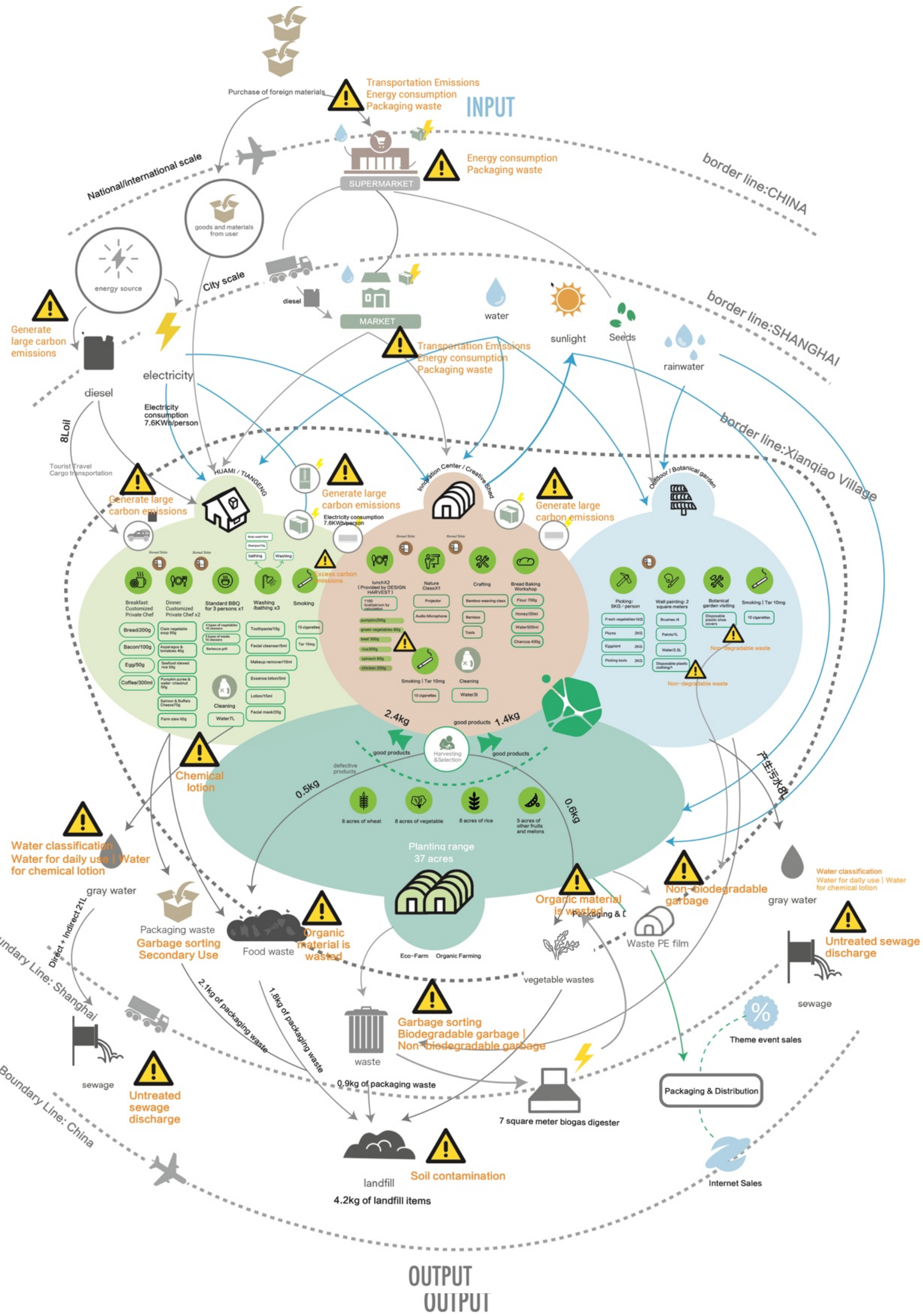


Figure 4.5 Yellow point analysis of Linear rural tourism system model (Image credit: author's drawing)

4.2.2 Classification and integration of opportunities for linear system model

This section focuses on analyzing the problematic nodes that currently exist within the system, looking for opportunities for improvement and classifying the problematic nodes in terms of system output.

As can be seen in Figure 4.6, the primary systemic problems currently exist in the areas of "external materials input", "excessive use of non-renewable energy", "waste disposal", "fuel use", "sewage disposal", and so on. But these issues are not sufficient to describe each step-in detail. Therefore, the author describes the current situation in detail of material sources and usage behavior of the linear rural system inputs and outputs, as shown in Figure 4.7. The author also solves the 'unsustainable' problems in a 'sustainable' way, providing the theoretical basis and technical means for the next sustainable rural tourism system.

Problem Nodes

Homestay (HUAMI/TIANGENG)		Creative Shed	
Description	Explanation	Description	Ex
Use of Externally brought items	Snacks, FMCG products, plastic packaging, large quantities of disposable items	**Use of foreign materials**	Ger and
Energy consumption	High and unreasonable energy consumption of water and electricity. Travel is mainly by private car, generating 0.36kg of carbon emissions per capita	**Energy consumption**	Hig
Combustible material use	Cooking with firewood produces large carbon emissions	**Daily water treatment**	Cra lot sep
Daily water treatment	Catering water, drinking water, and cleaning water are all discharged uniformly without secondary use.	**Waste disposal**	Was dire stat
Waste disposal	Organic waste, plastic waste and packaging waste are not reasonably separated		

Figure 4.6 Classification diagram of problem nodes in conventional systems (Image credit: author's drawing)

Eco-shed (Botanical Garden)

planation	Description	Explanation
nerate a variety of plastic packaging l non-degradable waste	**PE film use**	Non-biodegradable materials are discarded and buriedte
h energy consumption per capita	**Small amount of chemical fertiliz-er use**	Industrial fertilizers pollute land and water
ft classes, wall painting, etc. produce a of chemical waste water that is not parated from daily water use	**Agricultural products inferior products**	Classified as waste and landfilled directly by the township waste disposal station
ste is not segregated and landfilled ectly by the township waste disposal tion	**Agricultural water use**	Classified as waste and landfilled directly by the township waste disposal station

Tourist activity system input and output substances list of Design Harvest
Conventional systems VS sustainable systems

	Conventional system			
		Name	systemic process	Positive environmental correlation
INPUT	Externally brought items	Body wash and other toiletries for daily	large quantities of disposable items	✘
		Disposable gloves	Plastic disposable gloves are non-degradable prod-ucts	✘
		Frozen food / puffed snacks, etc.	Generates large amounts of plastic packaging and leftover puffed food	✘
		Cigarettes	High carbon emissions	✘
		Automotive Fuel	50% of visitors to Design Harvest come to Xianqiao Village by private car, generating a large amount of carbon emissions, which is calculated to be 9.63kg per capita in a single trip.	✘
	Daily Energy Consumption	Groundwater	It is divided into daily water, agricultural water. Water consumption is high and unreasonable.	✘
		Electricity	Electricity consumption is divided into B&B, creative greenhouse and ecological greenhouse.	✔
		Firewood	Mainly for the cooking method of "experience" self-service kitchen in the homestay, which will generate a lot of carbon emissions	✘
	Agricultural farming	PE film	Generate various plastic packaging and non-degradable waste	✘
		Seeds	Purchased from the internet and delivered by truck, generating large carbon emissions	✘
		Soil	Local Soil	✔
		Fertilizer	Purchased from the internet and delivered by truck, generating large carbon emissions	✘
		Agricultural energy consumption	Mainly groundwater irrigation method, elec-tricity consumption is also large	✘
	Catering	Foodstuffs / raw materials	Partly from outside the border (network or city), partly from local ecological greenhouses	✘
		Firewood /Natural Gas	Mainly for the cooking method of "experience" self-service kitchen in the homestay, which will generate a lot of carbon emissions	✘
		Food packaging	Disposable food, partly purchased from outside the border (network or city), generates a lot of packaging	✘
		Energy for cooking storage (water and electricity)	Energy consumption of water, electricity, coal, etc. during the cooking process	✘
Action + User be-havor	Education Classes	Handicraft Classes	Craft classes, wall painting, etc. produce a lot of chemi-cal waste water that is not separated from daily water use	✘
		Nature Class	The creative shed generates electricity and energy consumption and material wast	✘
	Artistic activities	Theme activities	Homestays and sheds generate water, electricity and energy consumption and some material waste	✘
		Flux-Artist Activities	Wall painting and other art activities use a lot of cheap inorganic pigments, which affect the air quality of the surrounding environment and produce a lot of chemical waste water, which is not separated from the daily water use	✘
	Sales	Agricultural prod-ucts sales	Mainly using OEM factories to produce packaging materi-als and packaged by DESIGN HARVEST staffs	✔
INPUT	Sewage	Daily Water Use	No classification, no grey water recycling, directly treated as sewage	✘
		Agricultural water treatment	No classification, no grey water recycling, directly treated as sewage	✘
	Waste	Packaging waste	No sorting, sent directly to the township waste disposal station for landfill or burning	✘
		Chemical pigments/wash	No sorting, sent directly to the township waste disposal station for landfill or burning	✘
		Agricultural waste	No sorting, organic items such as substandard agricultural products can be recycled twice	✘
		Food scraps	Organic waste, but the current situation is that there is no effective separation.Sent directly to the township waste disposal station for landfill or burning	✘
	Products	Agricultural waste	sent directly to the township waste disposal station for landfill or burning	✘
		Agricultural Products	Mainly using OEM factories to produce packaging materials and packaged by DESIGN HARVEST staffs	✔
		Handicraft Products	Such as bamboo weaving, leaf painting, etc., sold directly to tourists	✔
commu-nity	Cooperation	Catering	Customized farming dishes for visitors are all customized by Design Harvest's partner, the farming residents of Xianqiao Town	✔
		Planting	Design Harvest's ecological greenhouses are managed by Design Harvest's hired workers and villagers.	✔

Figure 4.7 List of inputs and outputs of the Linear tourism activity system (Image credit: author's drawing)

The diagram shows that there are 'unsustainable' nodes in the inputs and outputs and the behavioral processes. In order to build a sustainable tourism system, all tourism activities' inputs, processes, and outputs need to be re-analyzed and reconsidered. The problems in the standard model need to be rectified to arrive at a sustainable tourism system model. The following chapter proposes targeted solutions to the problematic nodes (yellow points) to provide the basis for constructing a sustainable model.

4.3 Sustainable planting system modelling

4.3.1 System input optimization

1. Out-of-boundary commodities

Figure 4.8 Various types of external commodities of rural tourism (Image source: Taobao)

As far as the tourists are concerned, more and more tourists are concerned about rural places' hygiene and food conditions, leading them to purchase large quantities of fast food, household goods, and disposable products before they visit. The input of these "foreign materials" from "outside the system boundary" has brought more pressure on countryside waste disposal, which already has environmental problems. Also, the inconsistent quality of tourists leads to some unreasonable behavior in using these goods, which increases the load on the environment.

As far as rural tourism operators are concerned, a large number of materials are printed, and souvenirs are produced during the various thematic events such as the "Flux-Artist Activities" and the "Countryside Fun Fair" by Design Harvest. The materials and products are made in factories outside the 'boundary' and transported over long distances to Design Harvest. The process generates excess carbon emissions and non-degradable waste after use.

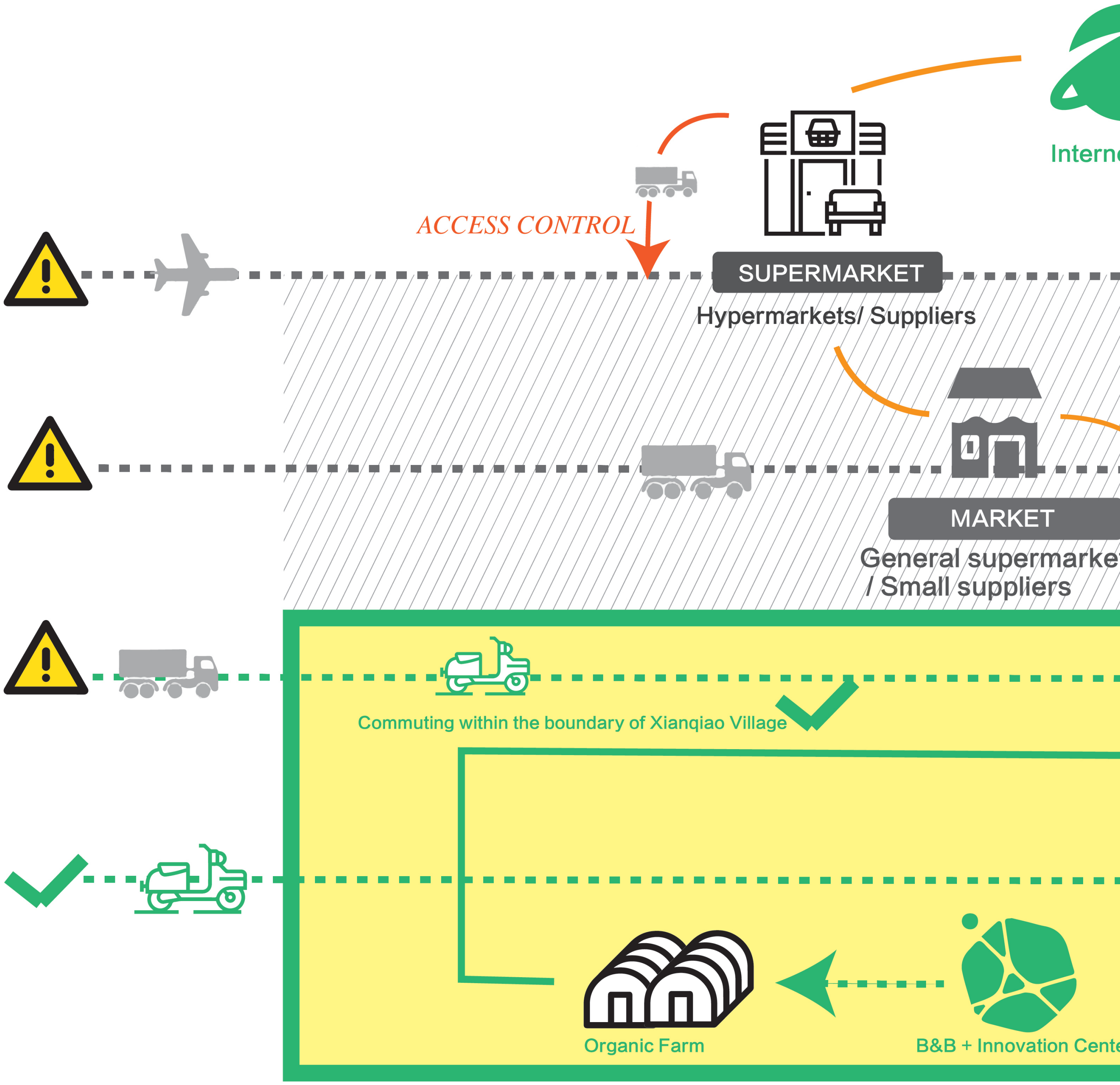
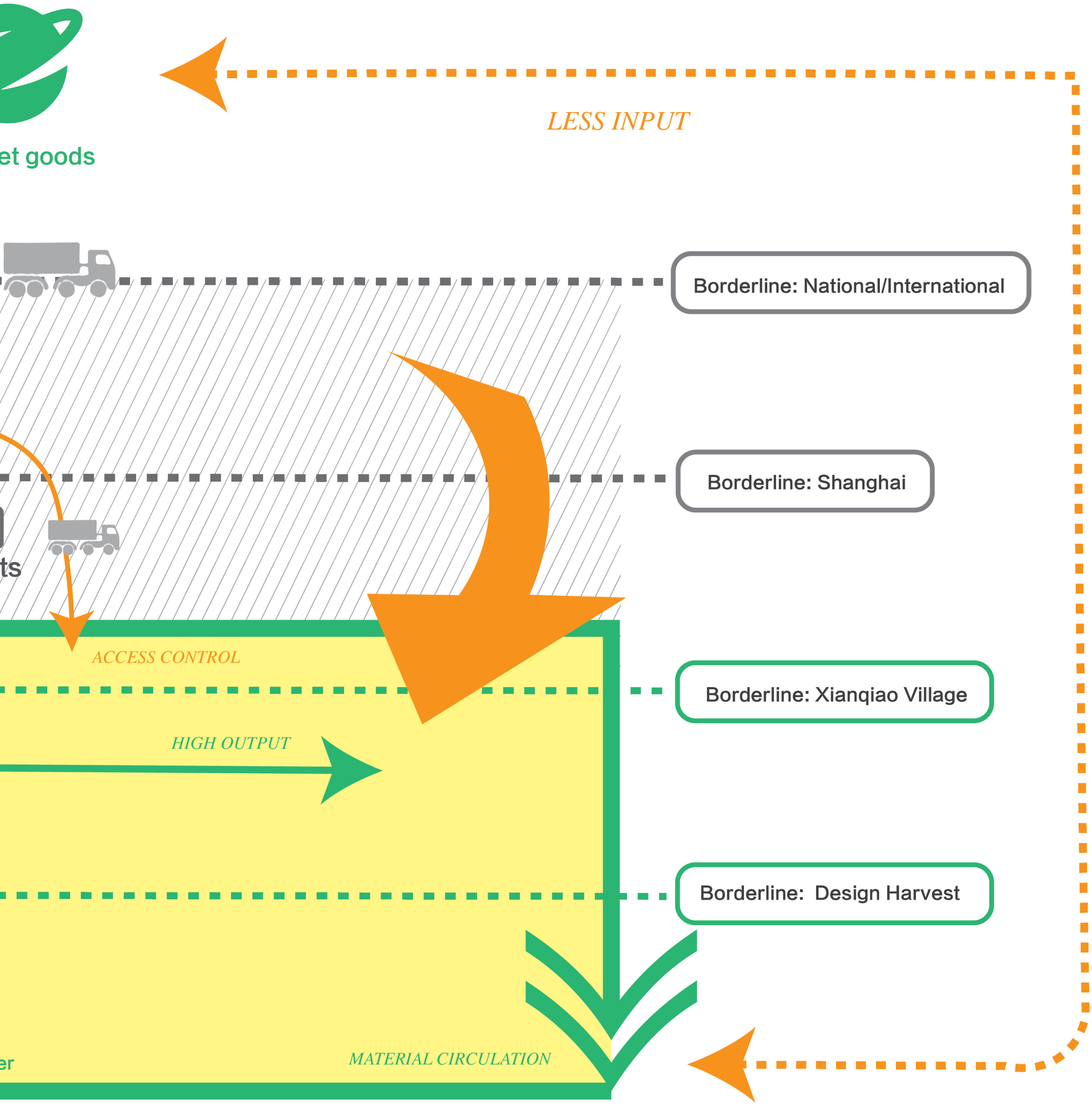


Figure 4.6 Classification diagram of problem nodes in conventional systems (Image credit: author's drawing)



et goods
LESS INPUT
Borderline: National/International
Borderline: Shanghai
ts
ACCESS CONTROL
Borderline: Xianqiao Village
HIGH OUTPUT
Borderline: Design Harvest
er
MATERIAL CIRCULATION

Therefore, in the sustainable systems model, as in Figure 4.9, the operator should first maximize the use of local raw materials to provide for the functioning of the system and control the brutal invasion of goods from outside the borders to create a positive circulatory system. When some materials need to be purchased from outside, they can cooperate with the local community or exchange within the village to minimize the inputs (or small quantities if necessary).

Of course, this is obligatory at the expense of part of the user experience, but in the long term, it is a matter of maintaining the sustainability of the local ecosystem. Existing means of production can be redesigned to create differentiation and personalization of local products, increasing visitors' interest and reducing dependence on commonly used urban goods on a psychological level.

2.Energy

(1) Strategies for optimizing the use of electrical energy

A brand-new solar power generation device is used for the electrical energy at the input side. Solar power systems use clean, clean, renewable natural energy - solar power - to generate electricity without greenhouse gas and pollutant emissions, in harmony with the ecological environment and in line with sustainable economic and social development strategies. In the United States, solar energy was developed and utilized relatively early, and many homes are actively choosing to install solar energy. Excess solar energy can be sold to the power company, saving energy and generating economic benefits.

Generally, each square meter of solar panel can provide 100W of power. Based on two Design Harvest B&B buildings with an area of about 500 square meters and the vegetable shed with 1000 square meters (data in the appendix), the total monthly electricity consumption is 3200 kWh. If 200 square meters of solar energy is installed, the power generation will be 80KW/h per day and 29,200KW/h per year. In addition to supplying the original building with electricity, this saves a lot of money on electricity bills, and the surplus energy can be sold to the electricity supply system. According to the assembly cost of 15w (Solar Energy Official Website data), within five years to break even, the annual return rate is about 18%.

(2) Water cycle system strategies and methods

In system diagram 4.10, the water sources can be divided into drinking water sources and cleaning water sources. The water used for cooking, storage and drinking is classified as drinking water, and its later treatment is irrigation for the plantation industry. For cleaning water, all water-using such as room cleaning and toilets use secondary water, except for washing, bathing and dishwashing, which require a high degree of clean water (The specific circulation flow line is shown in diagram 4.10).

In addition to the wastewater treatment from a behavioral flow perspective, we can also explore technical solutions to this problem. Jun Yasumoto, Vincent van der Broeck, Olivier Pigasse and Alban Le Hun have developed a sustainable strategy for water purification that is positive both in terms of the technical means and the environmental effects. The principle is to use a natural filtration process that is 'plant-purified' so that the domestic bathroom can become a mini-ecosystem through the recycling and regeneration of wastewater. In this way, an attempt is made to combine the optimization of the bathing experience with the goal of achieving water recycling." (Jun Yasumoto, Vincent van der Broeck,2017).

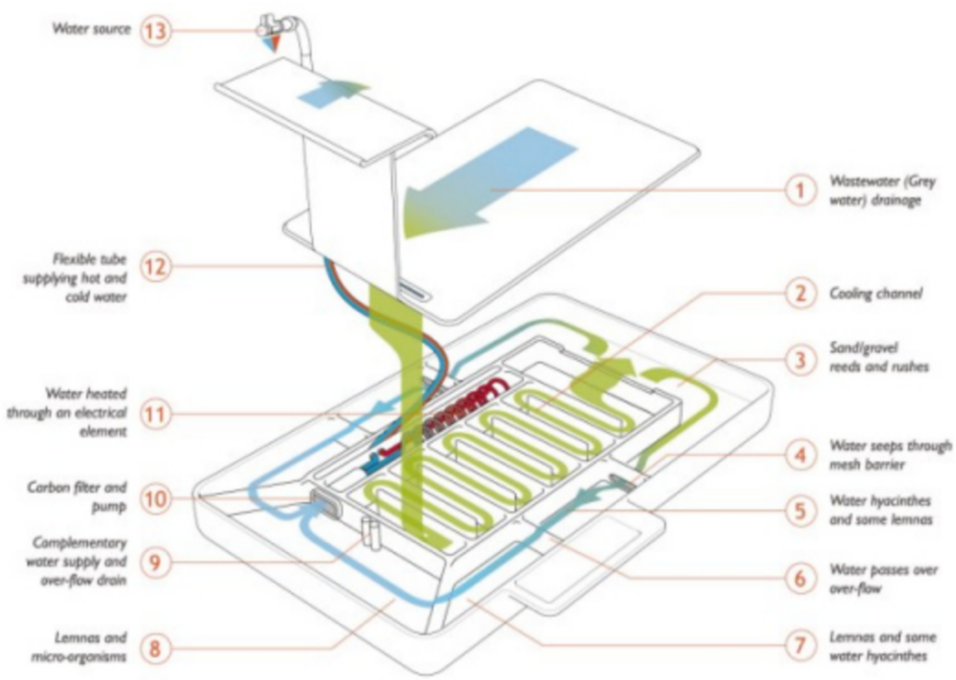


Figure 4.10 Conceptual diagram of a plant filtered water purification system
(Image credit: Jun Yasumoto,2017)

The plant-based water purification system works on the following principle: "The

Figure 4.11 Conceptual diagram of a plant filtered water purification system (Photo credit: Jun Yasumoto,2017)

wastewater from bathing enters a chamber under the bathroom floor, where it passes through a series of filters. This filter network consists of sand, reeds, a mesh filter, daffodils, floating duckweeds and a carbon filter.

Designing the more complex relationship between water circulation and bathing enables the user to reconsider the way water is used from another perspective."(Jun Yasumoto, Vincent van der Broeck, 2017) This design model for plant-based water purification is currently in the final stages of testing but could still be an essential tool in the next step of Design Harvest's solution to wastewater treatment.

(3) Sustainable Energy System Model

Based on the optimization of electrical energy use and the water recycling treatment strategy concluded in this chapter, the author optimizes the energy elements of the linear system diagram in a systemic way to establish a sustainable energy system based on the Design Harvest, as shown in Figure 4.12.

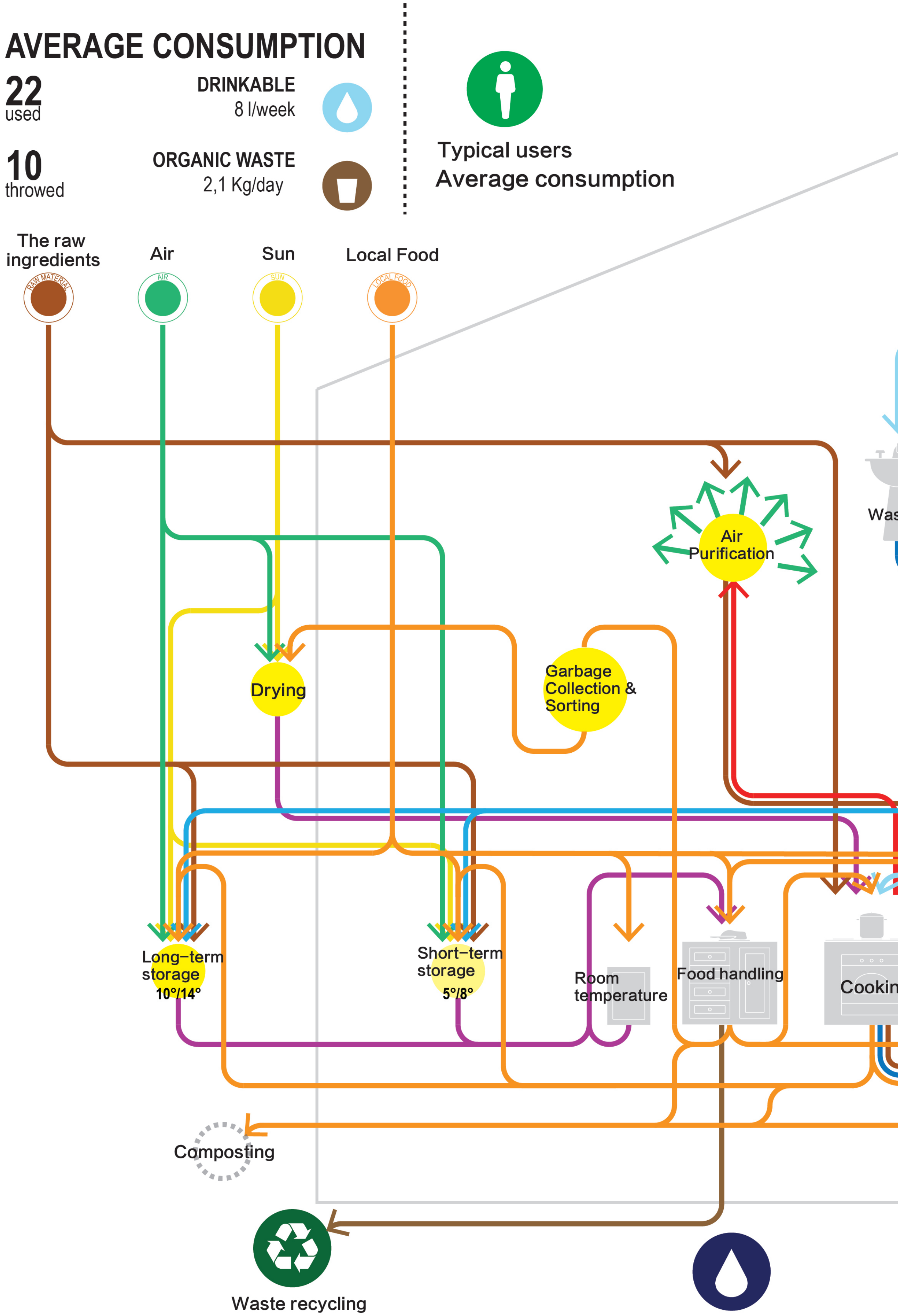
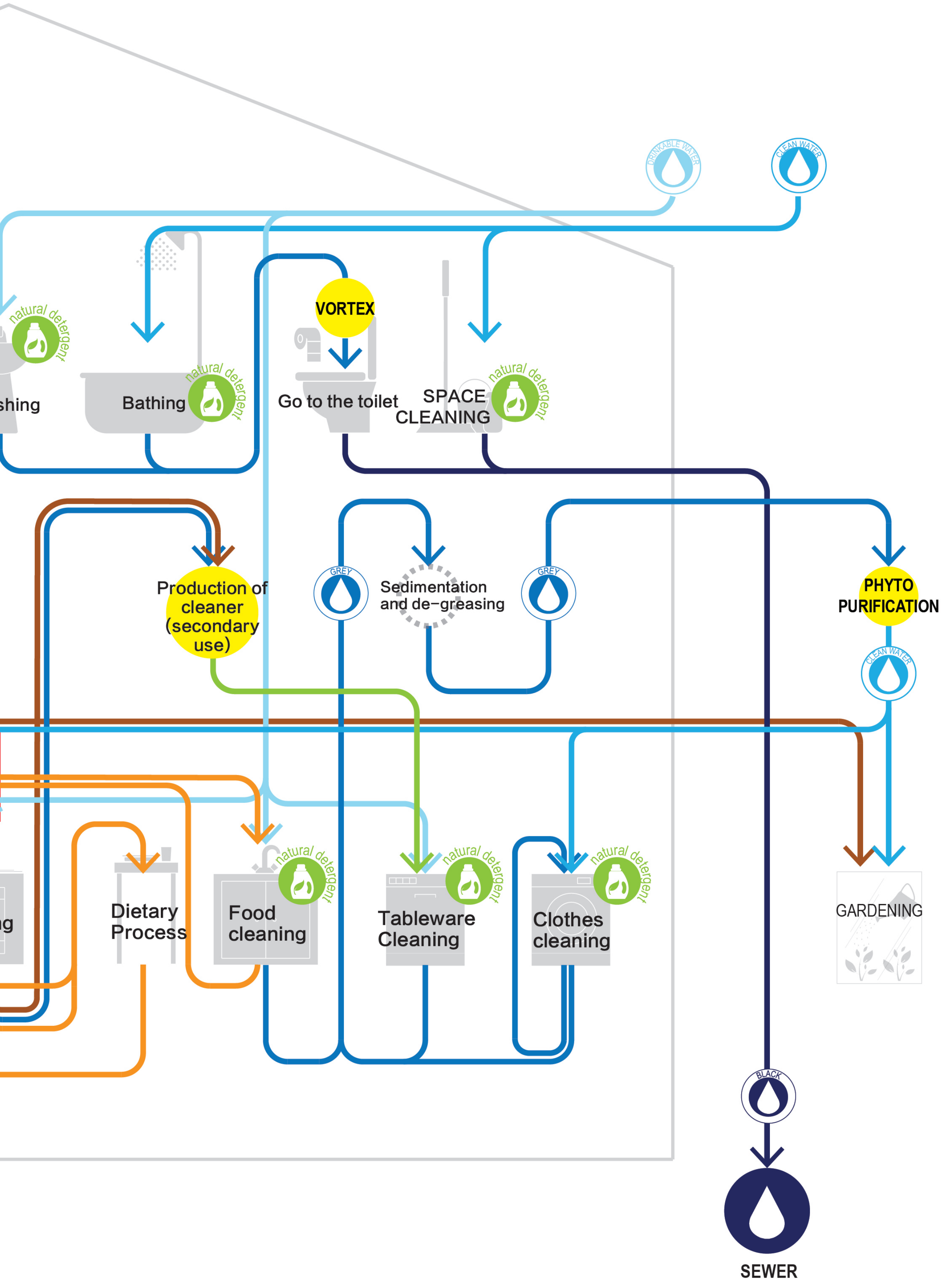


Figure 4.12 Sustainable Rural Tourism Energy System Model (Image credit: author's drawing)

Energy management



3. Food / Ingredients

Catering is one of the more important experiential components of rural tourism. The ingredient sources in the linear system come from the Design Harvest eco-farms and external purchases.

External food control

Figure 4.13 Puffed food, snacks and fast food (Image credit: Design Harvest official account)

External food is mainly snacks, puffed food and condiments, mainly brought by the visitors themselves or purchased by Design Harvest as part of their customized activity requests. This type of food is usually high in calories and pollution, which can be harmful to human health when eaten over a long period. Tourists bring in these foods mainly because 1. Tourists lack awareness of the basic environment of rural tourism. 2. The event organizers lack management awareness of information disclosure on tourism activities. Therefore, from the managerial level, it is essential to promote and publicize each rural activity, provide local ingredients and encourage tourists to experience the rustic food in-depth.

(2) Increasing the supply of local ingredients - optimizing ecological farming

In the sustainable system, the author assumes that most of the ingredients supply come from the ecological greenhouse and ecological paddy fields of Design Harvest. The planting types of ecological greenhouses are carried out according to the frequent ordering behavior of tourists, and more planting combinations are produced with the change of seasons. In this way, on the one hand, the quality of ingredients will be improved, and more distinctive catering services will be launched. On the other hand, it helps to protect the local farming environment by making the soil more active.

A small number of necessities can be obtained from other organic farms in the community, and the full localization of ingredients can be met through barter or monetary exchange within the community. A new production system perspective can also be an appropriate response to the new economic models and achieve significant results.

4.Agricultural cultivation

(1) Seeds

Seeds are the beginning of agricultural growing activities. Choosing a good, appropriate seed is a prerequisite for healthy crop growth and environmental optimization. Firstly, the seeds must be free from any artificially added chemicals, and secondly, they should come from our own farm or a neighboring organic farm and be of organic quality.

Figure 4.14 Some local ingredients of Designing Harvest (Image credit: Design Harvest official account)

(2) Fertilizer

-Crop straw returning to the field

Studies have shown that rice and wheat straw and the organic materials formed from rice and wheat straw contain N, P, K, Ca, Mg, S, and other nutrients required for crop growth and have significant benefits to the soil. It can significantly reduce the greenhouse gas produced by burning. (Yuan Dawei, Zheng Xianqing)

-Compost

Compost is an organic fertilizer made from various plant residues, mixed with human and animal faeces and urine, and decomposed by composting. Compost is rich in nutrients, has a long and stable fertilizing effect, and is also conducive to forming a solid soil structure.

3. Agricultural Water-Irrigation water

Crops rely mainly on their roots to absorb water from the soil. In the traditional linear planting system, water from the surrounding rivers is generally used for irrigation. If the polluted rivers are used for crop irrigation, it will have adverse effects on the growth of crops.

Typical pollutants in rivers include excessive nitrogen pollution, oil pollution, salt pollution and heavy metal pollution. Excessive amounts of each contaminant element can cause crops to grow stunted or even die. Another possibility for watering water in the new circulation system is from rainwater collection, which is much less polluted than the river but does not exclude the possibility that it is too acidic or carries heavy metal components.[1] Therefore, it is necessary to carry out preliminary purification

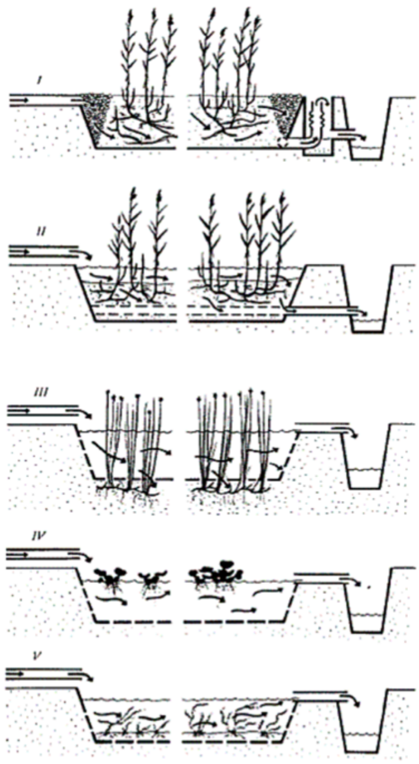


Figure 4.15 Plant water purification system (Image credit: www.lenntech.com/phytodepuration.htm）

1 Lou Jun, Irrigation Water Sources and Abstraction Hubs [M], China Water Conservancy and Hydropower Press, 2005, (02): 43-46

before irrigation to filter out the harmful substances, as shown in Figure 4.15.

4.3.2 Behavioral optimization + activity process optimization

1.Educational classes

Educational activities play an essential part in Design Harvest's activities, and nature classes are vital for the weekend activities. In terms of activity forms, the agricultural classes, traditional handicraft classes (led by local residents), and DIY classes are very typical and differentiated, combining local cultural characteristics and at the same time achieving value output. However, when observing its process, the author found that the educational activities generate a lot of paper, packaging and tool waste, which the manager does not sort and dispose of at the end of the day. Therefore, the author suggests that all waste generated after the class must be separated and disposed of. For example, salvaged handicrafts can be used as dismantling material for the next class, and some of the sticker signs can be recycled several times.

2. Artistic activities

Figure 4.16 Design Harvest's various educational classes (Image credit: Design Harvest's official account)

Artistic events are one of the core cultural outputs of the Design Harvest team, including a large themed event once a year and several smaller events every week.

Thematic events

Design Harvest's annual events, such as the Countryside Fun Fair, the Flux Art, and the Sustainable Ecology Gala (see Figure 4.17), fill the Design Harvest calendar throughout the year. Each time it is held, it attracts many people in a short period, but this is accompanied by high carbon emissions, noise pollution and the production of a large amount of waste material. For example, for the Sustainable International Party, two medium-sized trucks with 25L/100km fuel consumption were used to transport the stage equipment, which took 10 hours to set up and filled three large boxes with 20kg of promotional materials. These exterior materials and the event process placed a substantial environmental burden on the countryside.

A sustainable system of thematic events should, as far as possible, be supplied with local materials, adapted to the local context and with regional cultural characteristics. The event's location should be more appropriate in terms of fire protection, people safety, noise pollution and waste disposal.

Figure 4.17 2016 Chongming Global Eco-Fest (Image credit: Design Harvest's official account)

Smaller thematic activities

Smaller events such as bakery workshops, DIY workshops, Crab Season, etc., should be focused around the creative greenhouse. In a sustainable system, the number of participants and the precise number of materials needed for the activities should be better controlled so that no input material is wasted.

3. Sales activities

(1) Online sales

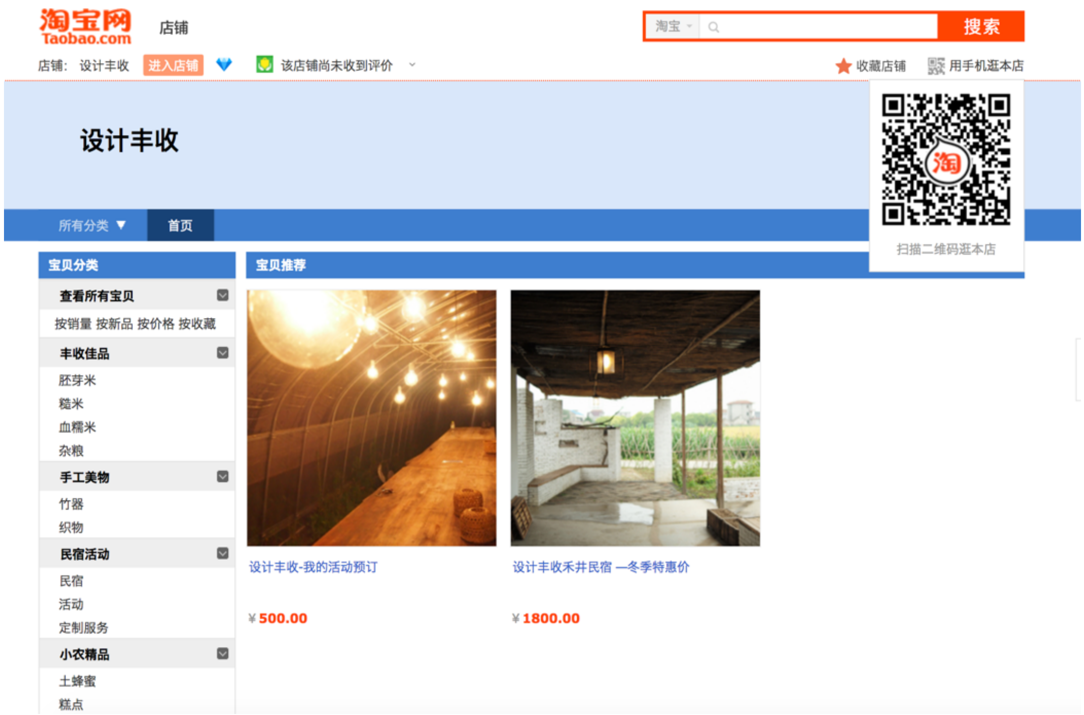


Figure 4.18 Design Harvest's sales data on Taobao (Image credit: Design Harvest official Taobao shop)

The current sales approach includes two main channels: online and offline. For the online channels, commodities are mainly promoted and sold on internet platforms - (Taobao, WeChat shops), etc., with relatively independent sales influence. However, based on the current situation according to the author's search, the official Design Harvest Taobao shop sales are dismal and fall into a semi-stagnant state. As shown in Figure 4.18, the Design Harvest Taobao shop has a rating of only one diamond. It does not sell more than five pieces of each product per month, which is a relatively unsuccessful business status. As a small high-quality agricultural products and handicraft sales shop, too much reliance is placed on their brand effect. The author believes that in the context of the economic development of the Internet+, such small high-quality agricultural products should cooperate with more mature fresh food e-commerce companies. For example, for Ali's Freshhema, Design Harvest can act as a supplier for its specific area, with lower-cost risk and rich promotional resources as well as customer volume compared to direct sales. The particular optimization system is shown in the diagram.

(2) Offline sales

Offline sales usually being bundled with themed events. The advantage is that sales are significant within the time unit, but the disadvantage is that sales are not sustainable as the event's popularity decreases over time. Offline sales are largely limited by the number of themed events and the location where they are held. The author suggests that Design Harvest cooperate more with distributors and farm product brick-and-mortar shops. Through partial concessions to achieve thin profit with more sales, enhancing brand influence.

Business model innovation from a circular economy perspective

As one of the economic sources of the Design Harvest project, the ultimate aim of sales activities is not only to make a profit but also to represent an important local cultural output, a link of interaction between local rural culture and urban. The specific model is shown in Figure 4.19.

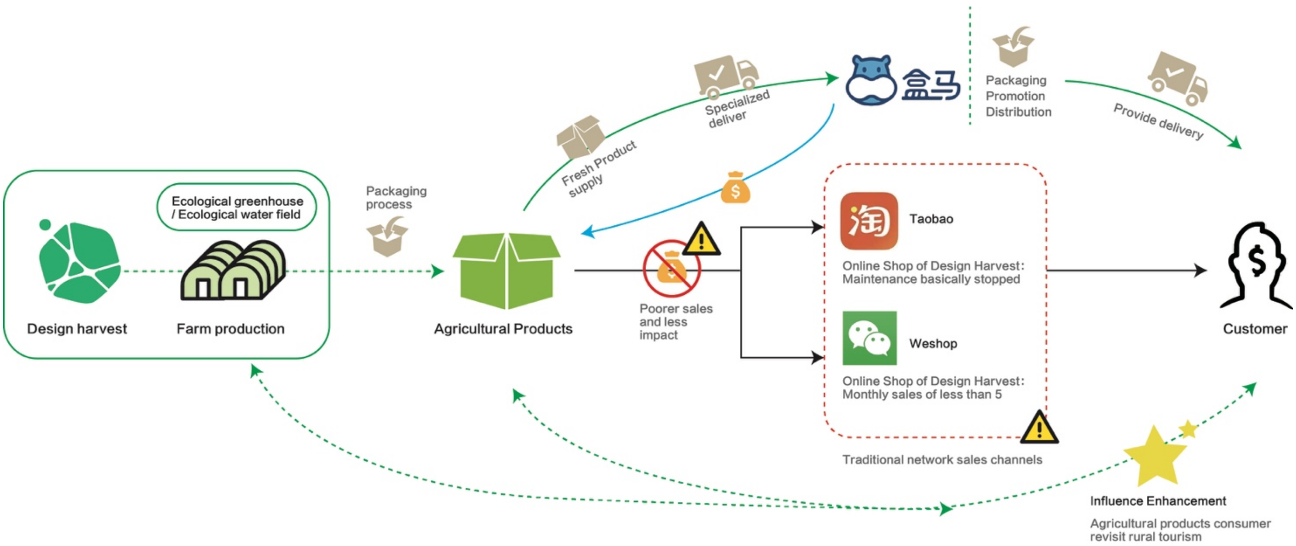


Figure 4.19 A new business model oriented towards the circular economy (Image credit: author's drawing)

4.3.3 System output optimization

1.Sewage

The sewage discharge within the design harvest is mainly divided into daily sewage and agricultural sewage. Daily sewage is water used by humans in their daily lives and contaminated by domestic waste. The volume and quality of water vary with the seasons. Generally, the daily sewage shows a large quantity and low concentration in summer. In winter, it's just the opposite. Daily sewage generally does not contain toxic substances. Still, it exists in conditions suitable for the multiplication of micro-organisms, so it includes many pathogens, which are hazardous from a hygienic point of view. [1] Daily sewage can be divided into two types according to the specific forms of the Design Harvest activities. Firstly, domestic sewage, the source of which is mainly concentrated in B&Bs. The second is the activity sewage, which is primarily focused in the creative greenhouses and those thematic, cultural and artistic activities outdoors, and whose source of pollution is mainly pigment, product packaging, etc.

Daily sewage treatment - B&B water recycling system

Generally speaking, daily sewage is divided into general greywater and chemically washed black water. The main sources of greywater are food washing, storage water and long-term surplus drinking water, which is later treated as irrigation in the cultivation sector. The chemically washed black water mainly comes from daily washing, bathing and dish cleaning. These actions require water with a high degree of cleanliness. Other water-using scenarios such as room cleaning and toilets use all secondary water that comes from greywater purification. Specific water recycling refers to section 4.3.1 Energy.

Agricultural sewage treatment - farmland runoff water treatment technology

Agricultural sewage is generally agricultural runoff water/farm tailwater. With the excessive and unreasonable use of chemical fertilizers in agricultural production, coupled with the diffuse irrigation of farmland and the scouring of rainwater runoff, a large amount of N, P and other elements enter the surrounding rivers, causing secondary pollution. It is also called rural non-point source pollution.

Ecological ditch system: Ecological ditch system is the initial aggregation site for agricultural non-point source pollutants and the export sources of nutrient salts to rivers and lakes. Its drainage capacity has an important impact on the ecosystem. Cash crops

[1]Liang Feiyu, A Brief Discussion on the Status of Sewage Treatment[J], Urban Construction Theory Research, (04):76--82

such as zizania aquatica (wild rice) and canna have a high N and P absorption capacity. If such plants are planted in ecological ditch systems, they can help the conversion of non-point sources of N and P in farm runoff and increase farmers' economic income.

2. Waste

(1) Waste classification and analysis

Figure 4.20 The classification standard of domestic garbage (Image credit: China's Ministry of Housing and Urban-Rural Development)

Waste is an important part of the entire output of tourism activities. Waste is classified by nature as hazardous waste, general waste; by the state as solid waste, liquid waste, gas waste; by composition as organic waste, inorganic waste; by the system in which it is located as domestic waste, industrial waste and agricultural waste. Design Harvest's current waste is unclassified and is transported directly to the town waste treatment factory for landfill or incineration, generating large amounts of harmful carbon emissions.

The method of waste collection and sorting is called "Quadratic quartering ". In other words, farmers primary sort their wastes at home into "rotten" and "non-rotten" wastes. The cleaners regularly collect these wastes and sort the "non-rotten" wastes into "saleable" and "unsaleable" wastes. About 70% of the wastes that will rot is composted on-site and returned to the land. 10% to 15% of the wastes that are “saleable” can be sold to recycling by renewable resource companies. Only 15% to 20% of the wastes that will not rot and cannot be sold are landfilled or incinerated. It is estimated that Jinhua City and its surrounding rural areas can reduce 760,000 tons of waste each year, saving about ¥200 million in removal and disposal costs. The economic and ecological benefits are significant. Scientific monitoring of the "cage trapping method" showed that the number of flies in Jinhua in 2015 summer was reduced by 60%." (Liu Xiangnan, Waste Kitchen Website, 2015)

Figure 4.21 Sustainable waste recycling 2+2 sorting method (Image credit: author's drawing)

Based on the operational model of Design Harvest and the current situation, we chose to divide the waste into domestic waste and agricultural waste according to the system. Next, domestic waste is further divided into organic and inorganic waste, and agricultural waste is also divided into organic and inorganic waste to facilitate our recycling process later. The previously popular waste-sorting method-the "Quadratic quartering "divides waste into "glass", "recyclables", "hazardous waste", and "other waste". This method is ineffective because some residents lack a subjective assessment of what to do before throwing away their rubbish. Due to the generally low level of education of rural people, only a small percentage of the population is able to complete the waste sorting.[1]

This is why we update the method into the "2+2 model", which is more proposed for the current situation of rural waste, as shown in Figure 4.20. The method is to first divide the waste into "wet waste" and "dry waste" according to the habits and perceptions of the local people, corresponding respectively to 'organic waste', which is easily perishable, and 'inorganic waste', which is not easily perishable (also difficult to degrade). Wet waste is then divided into 'food waste' and 'residual waste', while dry waste is divided into 'hazardous waste' and 'recyclable waste'.

(2) Agricultural waste

The organic waste from eco-farms, such as vegetable roots, straw and rice bran, can be used as animal feed or returned to the field or used as raw material for composting. The farm's wastewater contains more or less nutrients from the soil and should be purified before being discharged or reused.

(3) Daily waste

Daily waste is divided into everyday waste and event waste, including packaging waste, chemical paints and washes and food waste. The main sources of packaging waste are "foreign goods" and "event waste", including goods' packaging, disposable products and their packaging, materials from themed events and printed waste. However, the linear system is not designed to solve this problem properly. Rather, these wastes are landfilled or incinerated in the town waste treatment factory, which generates large amounts of excess carbon emissions and causes environmental pollution.

(4) Strategies

A "2 + 2" waste sorting mechanism is used, including "organic waste" - wet waste that is easily perishable; and "inorganic waste" - dry waste that is not easily perishable (also difficult to degrade).

Inorganic waste is mainly product and packaging waste, which is then sorted out by the

[1]Yuan Guiying, Research on the improvement of domestic solid waste distribution process [D], Nanjing University of Science and Technology, 2015,03:45-48

cleaners and Design Harvest staff to find recyclable parts. For example, if a creative artist needs some packaging waste or glass waste, he can be directly involved in sorting the inorganic waste. Or, if a craft class requires some paper materials, then the classroom staff can participate in sorting the relevant waste. Thus, the regularly sorted inorganic waste can be recycled at Design Harvest's internal events, saving resources on the one hand and having a sustainable artistic value on the other.

A large percentage of organic waste consists of food waste and peelings, of which the food scraps can be sorted and fermented to make organic fertilizer for use in eco-farms.

Method 1: HomeBiogas 2.0 - organic waste conversion system

HomeBiogas 2.0 is a device that converts organic waste into energy and fertilizer. It is small and easy to install. All you need to do is choose an open space within 20 meters of the kitchen (the area around the Design Harvest B&B is very suitable), and it takes about one hour to assemble the product. Once installed, just pour in your daily food waste, animal manure or bacterial reagents and wait for the new energy to be generated. After decomposition by bacteria in the pool, the organic material is transformed into biogas and liquid fertilizer.

On the one hand, the biogas can be used directly as a heat source for cooking when connected to a cooker. Each liter of food waste produces around 200 liters of combustible gas, and the entire gas bag can hold 700 liters of biogas for three hours of cooking. On the other hand, in addition to the biogas, liquid fertilizer can flow directly from the pouring pipe into the fertilizer tank. It is purely natural and free of any harmful substances and can be used directly as cultivation fertilizer. The specific flow pattern is shown in Figure 4.22.

Figure 4.21 HomeBiogas 2.0 waste conversion system (Image credit: HomeBiogas official website)

Figure 4.22 Waste conversion system workflow (Image credit: HomeBiogas official website)

Method 2: EnviroPure system

If direct biodegradation is desired, the commercially proven T&S company food waste recycling system can be used for biotechnological conversion or decomposition. The workflow is: high-pressure cleaning and filtration - activating the grinder pump -

running the compressor and oxygen diffuser to ensure aerobic treatment - shutting down the pump and grinder to allow solids to settle and reduce sludge. The whole process produces a small amount of carbon dioxide as well as greywater that can be recycled.[1]

Method 3: The last method of processing food scraps (organic waste) is to sort out food scraps with high nutritional content and convert them into raw materials for raising animals. It can be input to the small-scale animal farming industry in Design Harvest or cooperate with other animal farms.

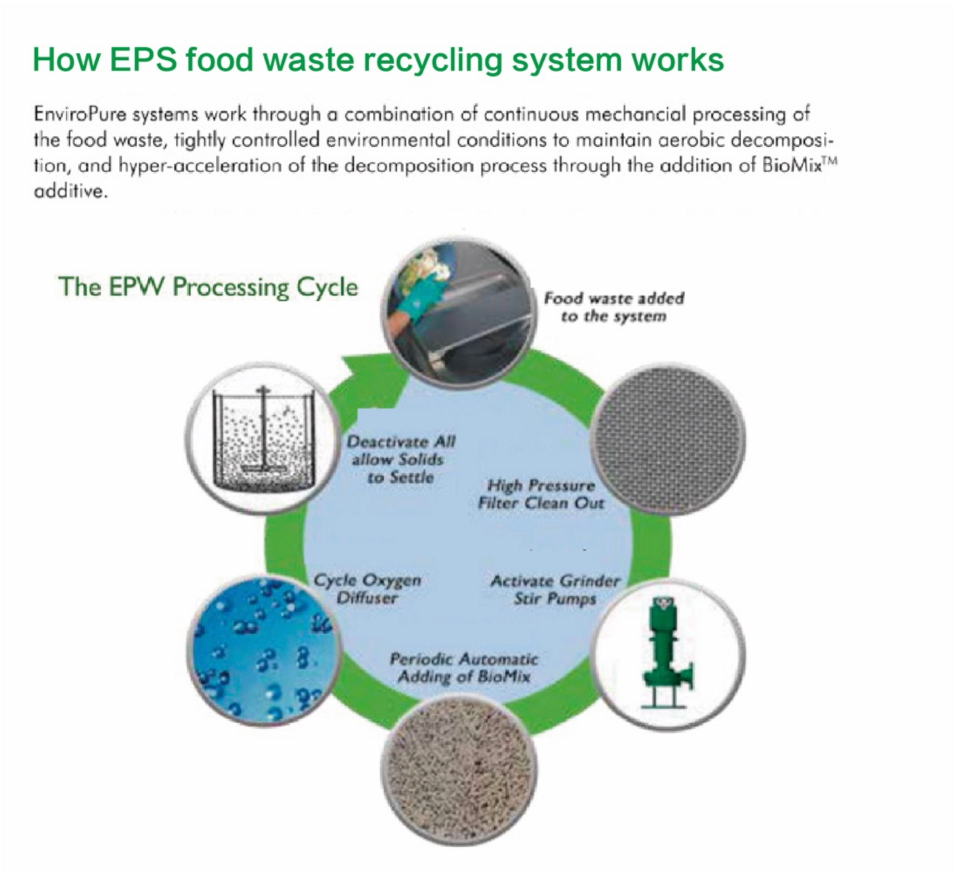


Figure 4.23 Food waste recycling system (Image credit: EPW website, 2016)

[1] EPW food waste recycling system, EPW official website

3. Products

Figure 4.24 New packaging of Design Harvest's agricultural products (Image credit: Design Harvest's official account)

The product output of Design Harvest mainly includes agricultural products and handicraft products. The following sections provide detailed explanations of sustainable strategies for them.

(1) Agricultural products

Agricultural products mainly come from planting. After harvesting, the crops are sorted into high, medium and low quality according to their parts and physical characteristics. High-quality agricultural products can be delivered to the catering industry and fresh market. Medium quality products can be processed into by-products such as vegetable juice, wine, etc. Lower quality products can be used to make plant protection products, converted into animal feed or sent to compost.

Design Harvest's agricultural products include: Grains: germ rice, brown rice, blood glutinous rice and miscellaneous grains. Agricultural by-products: local honey, pastries, handmade biscuits, handmade strawberry jam. Fruits and vegetables: strawberries and various vegetables. [1] As shown in Figure 4.24.

From the perspective of product packaging: The primary packaging materials should give up non-degradable materials and use pollution-free or environment-friendly packaging. Paper packaging can be used according to the actual situation and cost considerations. The raw materials of paper are mainly natural plant fibers, which will quickly rot and degrade in the ecological environment system, and can also be recycled to make paper again. From the design level, it can be considered to introduce the sustainable concept on the packaging, subtly influence the recycling habits of users and spread the sustainable concept.

(2) Handicraft products

As the export focus of local culture and the highlight of tourism activities, handicraft products are cheap to produce, but the quality and difficulty depend on the production method and the proficiency of the maker. The main products are local traditional handicraft bamboo wares and fabrics. The next strategy of Design Harvest is to use handicraft courses to build a mature handicraft production process system, combined with mature sales channels. Design Harvest should work with local craftspeople and modern artists and designers in an 'industry-academia-research collaboration' way, using modern methods to breathe new life into old traditional crafts.

[1] Design Harvest officialwebsite- agricultural products introduction, www.designharvests.com

4.4 Sustainable Rural Tourism Cycle System Modelling

4.4.1 Sustainable rural tourism system model diagram

The establishment of the sustainable rural tourism system model needs to refer to the circulation system standards of other industries on the one hand. On the other hand, it needs to re-analyze and consider the input, process and output of the entire system, revise the problems in the standard model, and finally get the result.

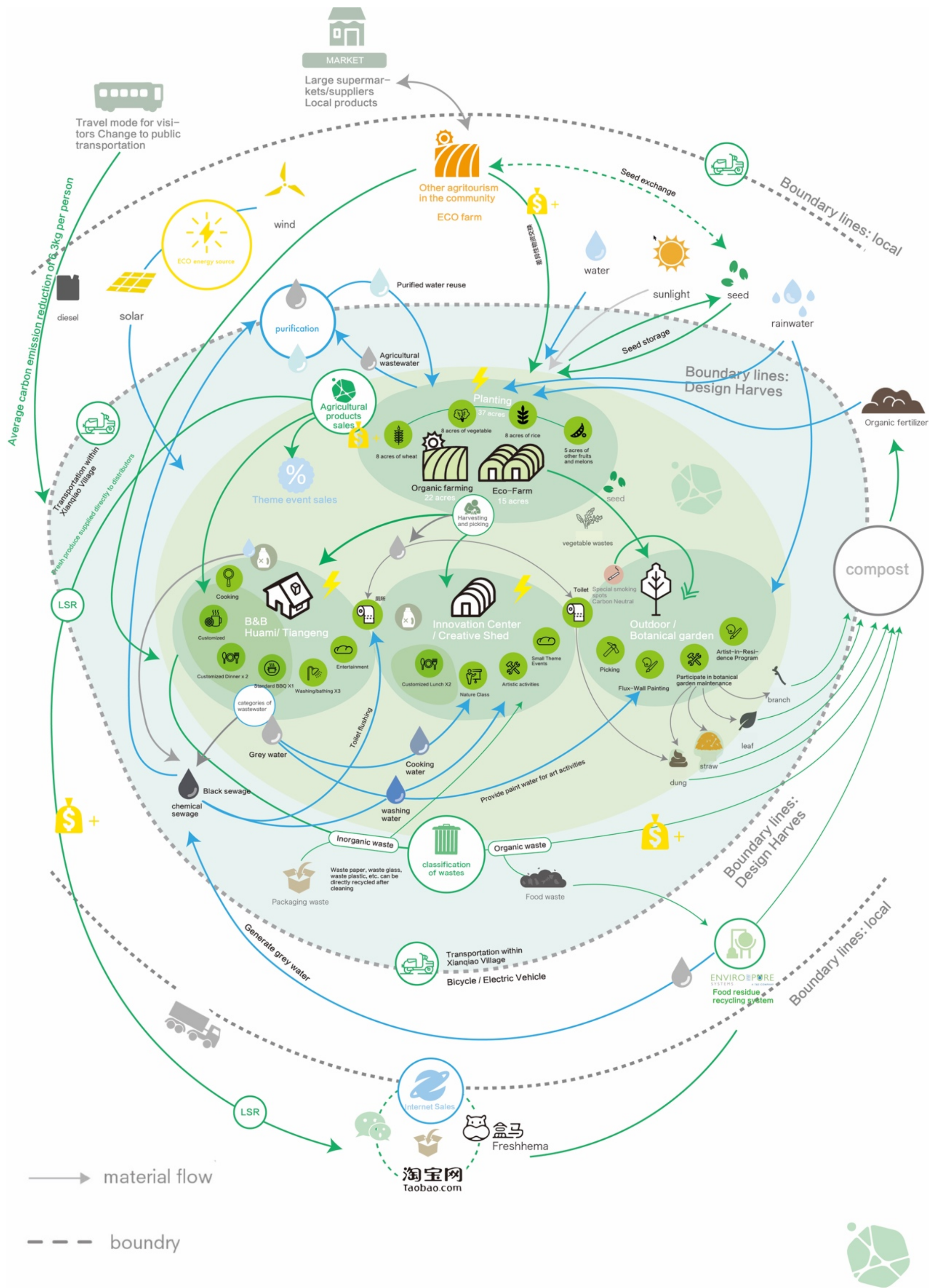


Figure 4.25 Sustainable rural tourism system model (Image credit: author's drawing)

4.4.2 Comparative analysis of linear and sustainable systems

4.4.3 System summary

Tourist activity system input and output substances list of Design Harvest
Conventional systems VS sustainable systems

		Conventional system			Sustainable system		
		Name	systemic process	Positive environmental correlation	Name	systemic process	Positive environmental correlation
INPUT	Externally brought items	Body wash and other toiletries for daily	large quantities of disposable items	✘		Hotels no longer provide disposable chemical lotions and encourage visitors to help themselves to take-away	✔
		Disposable gloves	Plastic disposable gloves are non-degradable products	✘		Eliminate the distribution of disposable gloves at themed events	✔
		Frozen food / puffed snacks, etc.	Generates large amounts of plastic packaging and leftover puffed food	✘	Small amount of externally brought items	Set specific waste classification for external materials and distinguish external materials that can be recycled twice. Encourage visitors to spend locally as much as possible	✔
		Cigarettes	High carbon emissions	✘	Cigarettes	Set up specific smoking spots to reduce carbon emissions by using (technical means) the carbon neutral capacity of green plants	✔
		Automotive Fuel	50% of visitors to Design Harvest come to Xianqiao Village by private car, generating a large amount of carbon emissions, which is calculated to be 9.63kg per capita in a single trip.	✘	Automotive Fuel	Encourage visitors to travel by public transportation and use walking or bicycles in Senbashi Village	✔
	Daily Energy Consumption	Groundwater	It is divided into daily water, agricultural water. Water consumption is high and unreasonable.	✘	Groundwater	Classification of water use and secondary classification of wastewater. Gray water recycling technology to improve water utilization	✔
		Electricity	Electricity consumption is divided into B&B, creative greenhouse and ecological greenhouse.	✔	Electricity	Use of green and clean energy	✔
		Firewood	Mainly for the cooking method of "experience" self-service kitchen in the homestay, which will generate a lot of carbon emissions	✘		Eliminate firewood burning where possible. "Experiential" kitchens can use electrical energy instead of firewood, allowing visitors to experience a country kitchen while reducing carbon emissions.	✔
	Agricultural farming	PE film	Generate various plastic packaging and non-degradable waste	✘	Biodegradable Eco-Membrane Technology	Greenhouse film produced with uniform double-degradable eco-membrane technology	✔
		Seeds	Purchased from the internet and delivered by truck, generating large carbon emissions	✘		Except for the first purchase, the farm keeps seeds every year and exchanges them with other organic farms	✔
		Soil	Local Soil	✔	Soil	Local Soil	✔
		Fertilizer	Purchased from the internet and delivered by truck, generating large carbon emissions	✘	Organic manure/green manure/manure	Purchase organic fertilizers, green manure, and make full use of farm animal manure and eco-toilet manure in the countryside	✔
		Agricultural energy consumption	Mainly groundwater irrigation method, electricity consumption is also large	✘	Agricultural energy consumption	Mainly groundwater irrigation method, electricity consumption is also large	✘
	Catering	Foodstuffs / raw materials	Partly from outside the border (network or city), partly from local ecological greenhouses	✘	Foodstuffs / raw materials	As much as possible, food ingredients can be sourced from local eco-farms, and some missing ingredients can be exchanged within the community	✔
		Firewood /Natural Gas	Mainly for the cooking method of "experience" self-service kitchen in the homestay, which will generate a lot of carbon emissions	✘		Eliminate firewood burning where possible. "Experiential" kitchens can use electrical energy instead of firewood, allowing visitors to experience a country kitchen while reducing carbon emissions.	✔
		Food packaging	Disposable food, partly purchased from outside the border (network or city), generates a lot of packaging	✘		Local ingredients are cooked directly after harvesting or short-term storage, without generating packaging waste	✔
		Energy for cooking storage (water and electricity)	Energy consumption of water, electricity, coal, etc. during the cooking process	✘	Energy for cooking storage (water and electricity)	Just use it normally	✘
Action + User behavor	Education Classes	Handicraft Classes	Craft classes, wall painting, etc. produce a lot of chemical waste water that is not separated from daily water use	✘	Handicraft Classes	Handicraft items can be separated and disposed of, while finished handicraft products can be sold twice.	✔
		Nature Class	The creative shed generates electricity and energy consumption and material wast	✘	Nature Class	Separate disposal of material waste (stickers, printed items, etc. be recycled and reused after treatment)	✔
	Artistic activities	Theme activities	Homestays and sheds generate water, electricity and energy consumption and some material waste	✘	Theme activities	Reduce the printing of materials for activities, mainly electronic information display, distribution of materials (stickers, printed items, etc. for recycling and secondary use after processing)	✔
		Flux-Artist Activities	Wall painting and other art activities use a lot of cheap inorganic pigments, which affect the air quality of the surrounding environment and produce a lot of chemical waste water, which is not separated from the daily water use	✘	Flux-Artist Activities	The pigments used in the art activities can be organic pigments, made of pigments extracted from plants, which do not contain elements harmful to human body and are environmentally friendly.	✔
	Sales	Agricultural products sales	Mainly using OEM factories to produce packaging materials and packaged by DESIGN HARVEST staffs	✔	Agricultural products sales	Use of waste packaging secondary processing into agricultural packaging for sales, mainly using online sales channels, and can be combined with the role of suppliers to reduce carbon emissions and waste generated by field sales	✔
INPUT	Sewage	Daily Water Use	No classification, no grey water recycling, directly treated as sewage	✘	Daily Water Use	Water classification, divided into general gray water (food washing, daily cleaning) chemical washing solution gray water and unusable black water, and targeted recycling	✔
		Agricultural water treatment	No classification, no grey water recycling, directly treated as sewage	✘	Agricultural water treatment	Can be stored centrally for subsequent sewage treatment according to national sewage treatment technology (one, two, three levels)	✔
	Waste	Packaging waste	No sorting, sent directly to the township waste disposal station for landfill or burning	✘	Packaging waste	Can work with resident artists to create secondary art from sorted packaging waste on a regular basis	✔
		Chemical pigments/wash	No sorting, sent directly to the township waste disposal station for landfill or burning	✘		Organic pigments can be used, and the wastewater should be treated according to the wastewater grade rating with wastewater treatment technology	✔
		Agricultural waste	No sorting, organic items such as substandard agricultural products can be recycled twice	✘	Agricultural waste	Organic items such as secondary agricultural products can be recycled	✔
		Food scraps	Organic waste, but the current situation is that there is no effective separation.Sent directly to the township waste disposal station for landfill or burning	✘	Food scraps	Organic waste can be biotechnologically transformed or decomposed with the help of commercially proven T&S company Food scraps recycling system	✔
	Products	Agricultural waste	sent directly to the township waste disposal station for landfill or burning	✘	Agricultural waste	Specific classification, such as agricultural products and other organic materials can be secondary use	✔
		Agricultural Products	Mainly using OEM factories to produce packaging materials and packaged by DESIGN HARVEST staffs	✔	Agricultural Products	Use of waste packaging secondary processing into agricultural packaging for sales, mainly using online sales channels, and can be combined with the role of suppliers to reduce carbon emissions and waste generated by field sales	✔
		Handicraft Products	Such as bamboo weaving, leaf painting, etc., sold directly to tourists	✔	Handicraft Products	Such as bamboo weaving, leaf painting, etc., sold directly to tourists	✔
community	Cooperation	Catering	Customized farming dishes for visitors are all customized by Design Harvest's partner, the farming residents of Xianqiao Town	✔	Catering	They can expand the scope of cooperation	✔
		Planting	Design Harvest's ecological greenhouses are managed by Design Harvest's hired workers and villagers.	✔	Planting	They can expand the scope of cooperation	✔

✔ The system follows this item ✘ The system does not follow this item

Figure 4.26 Comparative analysis of Linear and sustainable systems (Image credit: author's drawing)

The sustainable rural tourism system first optimizes the linear system in input, behavioral, and output. Then, the circulatory system model is established according to the important nodes in the rural tourism system, such as tourist activity behavior, food life cycle and energy. Finally, a sustainable rural tourism system that tends towards zero emissions is depicted, as shown in Figure 4.25.

The carbon emissions of this system are significantly lower than those of the linear system. Since the carbon emissions source is largely controlled, the yellow point in the previous linear system is improved through behavior guidance and green technology intervention. Due to the maximum use of local products, the entire system forms a complete ecological closed loop based on locality, thereby maximizing the reduction of the local environmental load. Matter moves from the input of one node to the output to the input of the next node, forming a sustainable closed loop. At the same time, community collaboration is added to the system, which closes the door to external commodities but puts forward the goal of collaboration and cooperation for the local community. It builds a sustainable system closed in the organization but opens in structure.

4.5 Ecological Assessment of Sustainable Rural Tourism System

4.5.1 Global Warming Potential Assessment

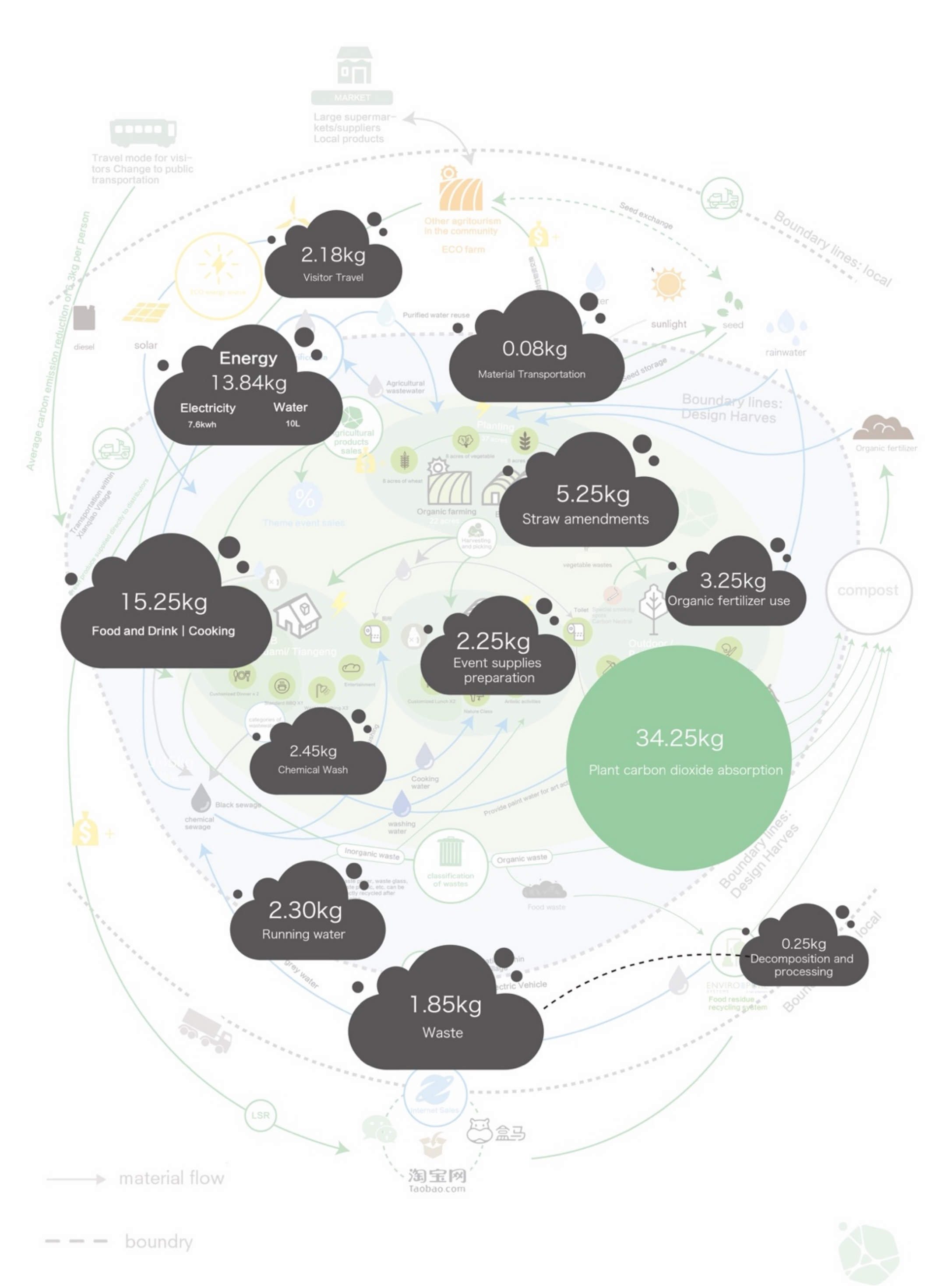


Figure 4.27 Carbon emission model of the sustainable tourism system (Image credit: author's drawing)

4.5.2 Analysis and Calculation of Carbon Emission Nodes

Figure 4.27 shows the carbon emissions generated by the sustainable rural tourism system. Please refer to Appendix B and Appendix C for calculation methods for detailed data sources. The final calculation shows that the per capita carbon emissions of the sustainable system model dropped to 39.70kg/d. By expanding the area of arable land and increasing the amount of indoor vegetation in the B&B, carbon absorption rises to 34.25kg/d, basically reaching a balanced state.

The graph shows that the carbon emissions of the sustainable system have decreased significantly compared to the linear system, from 76 kg/d to approximately 39 kg/d. This is mainly due to the control of input materials, the treatment of waste and sewage, the upgrading of the plantation industry and the optimization of the catering process.

1. Management of input materials

This part of the change in carbon emissions is due to the control of external commodities at the input side, such as reducing disposable items, packaging and material construction supplies required for activities, and various ingredients and foods. The input of these commodities generates a lot of carbon emissions, including four steps: packaging, transportation, unloading, and storage, resulting in a total of 7.68kg/d per capita. However, in the sustainable system, due to the promotion of localized production and the cooperation of local communities, we have greatly reduced the quantity of external goods to less than 10kg per week, and the corresponding carbon emission per capita is only 0.08kg/d.

2. Waste disposal

This part of carbon emissions mainly comes from the carbon emissions generated by the waste itself and the indirect transportation and disposal processes. As a result of controlling the external goods input and optimizing energy use, the amount of waste per person is calculated to be 1.65 kg/d (see appendix for calculation data), which corresponds to a carbon emission of 1.85 kg/d from the waste itself. With the "2+2 waste sorting model", food waste and manure are technically transformed into gas energy and liquid fertilizer, and inorganic waste and packaging are recycled in collaboration with artists and craft classes so that carbon emissions of transportation are reduced to zero indefinitely. However, the decomposition and conversion of organic waste generate 0.25 kg/d, so the total waste per capita is 2.10 kg/d, which is a significant reduction compared to the 9 kg/d per capita of the linear system.

3. Planting industry

First, the increase in the use of clean energy has led to a decrease in carbon emissions from the planting industry. Secondly, in terms of fertilizers, carbon emissions have been greatly reduced due to changes in fertilization methods and the biological conversion of organic waste into liquid fertilizers for plant nutrients.

4. Catering process

Throughout the catering process, the entry of ingredients outside the boundary is reduced at the input side, thereby reducing carbon emissions from transportation and packaging waste. Selecting the appropriate storage method according to the characteristics of the food saves some energy. On the output side, the use of technology to convert food waste into clean energy and liquid fertilizer leads indirectly to a significant reduction in carbon emissions, about 6.3 kg/d per capita.

To sum up, in the sustainable rural tourism system, the average daily carbon emission of typical users is 39.70kg/d. With regular replenishment of greenery and optimization of organic farming as described above, the average daily carbon absorption can reach 34.25kg/d. The carbon dioxide equivalent is ultimately 5.45kg/d per capita, resulting in an infinite approach to zero emissions, and the construction of a sustainable system is basically successful.

4.6 Chapter Summary

This chapter proposes targeted solutions to the yellow point in the linear rural tourism system. It reconstructs the organizational streamlined solution strategy and the technology-oriented solution strategy, thereby establishing a sustainable rural tourism system. Subsequently, carbon emissions are calculated for each component using input, behavior + using process and output as the basic framework. An ecological assessment of the entire sustainable system is also carried out. The sustainable tourism system improves the self-sufficiency defects in the linear system by coordinating the different functions of its subsystems, such as food, energy, and activity behavior. The advantages of a sustainable recycling system for rural tourism can be summarized as follows:

1. System level

(1) The system theoretically has almost no unilateral output, with each node's output becoming another node's input, forming a closed-loop ecosystem prototype.

(2) New waste classification methods and treatment methods are adopted, combined with the unique cultural attributes of Design Harvest, to provide new flow channels for waste.

(3) Strictly control the purchase (input) of fast-moving consumer goods from outside the local area, make maximum use of localized products. The crops of the plantation industry are produced naturally and selected naturally.

(4) There is no waste in the system, and resources are used efficiently.

(5) The stability of the system is enhanced through community cooperation.

2. Ecological level

(1) By increasing indoor green vegetation and expanding the planting industry, gradually increase the effective carbon absorption vegetation, form carbon sinks, and slow down global warming from a micro perspective.

(2) The water recycling system improves the utilization of water resources from both technical and strategic levels and alleviates the problem of rural water pollution.

(3) The establishment of waste sorting and recycling systems reduces the environmental pollution caused by landfills, incineration and hazardous waste on the one hand and increases the recycling rate on the other. The combination with the cultural industry can also enhance the brand effect.

(4) Using new energy sources such as solar and wind power will further reduce traditional energy consumption.

3. Economic level

(1) The purchase of external goods is reduced, and the operating cost is further compressed.

(2) The new operating model that fully cooperates with the local community, based on the concept of sharing, will also reduce operating costs.

(3) A new business model oriented towards a circular economy is established by optimizing the organic farming industry. Through the sales of agricultural products and handicraft products, the brand influence is enhanced, and the economic returns are relatively considerable.

Chapter 5

Guidelines for Sustainable Rural Tourism Circular Systems

5.1 How to establish guidelines

This paper presents an in-depth analysis and systemic design from linear to sustainable rural tourism activities. It proposes the principles of sustainable rural tourism systems oriented to the circular economy. Based on this, the existing recycling and green ecological technology tools have been further investigated, and the rural tourism production activities have been evaluated with carbon emission as the criteria.

In order to make this study more meaningful and to provide guidelines for all stakeholders (tourists, tourism managers and employees, designers and local rural residents) in the development of rural tourism, this paper refines the previous research results and summarizes the sustainable recycling system guidelines for small and medium-sized rural tourism industries. In the context of the growing conflict between rural tourism and the local ecological environment, we hope to provide a reference for scholars and practitioners who are truly concerned about the rural environment, agro-tourism and urban-rural interaction.

The guidelines are divided into two levels. The first level is for the rural tourism manager, where the guidelines are developed in carbon emission monitoring and management, waste disposal, catering, energy management, organic farming, and community collaboration. The second level is the design level. The author will conclude each aspect by suggesting possible roles that design can play in this direction, building a bridge between rural tourism construction and planning & design.

5.2 General Provisions

The present guidelines do not replace any existing standard circular standards for places but rather provide a quantitative analysis of the current rural tourism status from the perspective of controlling carbon emissions. The guidelines proposed by the author are intended only as a reference for scholars in related fields, operators in the rural tourism industry, and tourists.

(1) Independence and Systematicity

The rural tourism system should be seen as a circular organism that uses the resources needed for its production to maintain the system's natural functioning. From the input point of view, the planting system should be optimized to provide a richer source of material and achieve a model in which several types of production work together and support the independent functioning of the parent system. From the output point of view, the waste, effluent and other outputs should be recycled through technical methods and behavioral norms.

In summary, any resource or energy that enters the system or is exported from the system must be analyzed objectively and qualitatively, taking into account all possible sources, methods of production and secondary use, and treatment methods. (Author)

(2) Localization and cooperation

Developing an appropriate tourism system should be based on a basic understanding of the local environmental conditions, climatic conditions and cultural background. The activity forms, food and drink, and, if included, ecological cultivation should be in accordance with the objective local conditions. The materials used in the cultivation process should be sourced from the local area as much as possible. It is advisable to enter into cooperative and mutually beneficial relationships with other local producers.

(Author)

(3) Naturalness and Ecology

If organic farming is included in rural tourism, artificial actions and synthetic chemicals that pollute or negatively affect soil, water quality, plants, and animals should be prohibited. The management and design of the planting system should be based on the comfort and health of the soil, plants and animals. We should create reasonable and suitable habitat conditions for plants and animals, establish wild ecosystems within and at the edges of farms, preserve the integrity and diversity of wild ecosystems, and protect the connections and boundaries between different microecological circles. (Author)

5.3 Carbon Emission Monitoring and Calculation Management

5.3.1 For rural tourism managers

(1) Carbon footprint calculation software can be set up within their system through a concise visual interface at important nodes of rural tourism activities. Tourists are encouraged to consciously calculate their carbon emissions for the day and record the final values.

(2) Develop a low-carbon incentive mechanism for tourists. The visitor with the lowest daily carbon emissions is selected to be rewarded.

(3) Popularize the knowledge of carbon emission, stop the visitor behavior activities that generate high carbon emissions and develop ecological behavior guidelines (high carbon emission activities are in Appendix C)

5.3.2 For designers

(1) Online: The carbon footprint calculator's service design and visualization design, including the PC and mobile terminals.

(2) Offline: Carbon emission VI design for activity sites and activity behaviors in rural tourism (e.g., the amount of carbon emission generated by each cooking is posted in the kitchen, and the amount of carbon emission generated by a cup of coffee is posted next to the coffee machine, etc.)

5.4 Waste Management

5.4.1 For rural tourism managers

(1) Waste collection using the "2+2" waste separation model (recyclable/hazardous/perishable/other waste) （Shanghai Municipal Greening and Urban Management Administration, author)

(2) Set up segmented waste separation and recycling facilities and guidelines to promote long-term waste separation. For example, particular recycling bins for plant waste can be placed at locations where flowering plants are more concentrated. While recycling bins for material waste can be set up in craft classes (author)

(3) Build a waste treatment and transformation system using technical means to manage the recycling of pre-sorted waste. For example, material waste from handicrafts can be given directly to resident artists as creative materials. Food waste can be re-generated into energy by technical means (e.g., composting) (author)

5.4.2 For designers

(1) Develop garbage cans with an intelligent identification system. The collection end has always been the pain point of the garbage disposal system. Users' subjective judgment and living habits can lead to confusion in the pre-collection of garbage. Designers can add intelligent recognition modules to garbage cans to monitor the type of garbage commonly used and calculate daily carbon emissions. (Author) For example, Professor Zhu Rong's group in the Department of Precision Instruments at Tsinghua University had developed a robot garbage recognition system. Based on thermal and pressure sensing elements, it can accurately recognize objects of different shapes, sizes and materials, and the recognition rate of seven kinds of garbage items can reach 94%.

(Rong Zhu)[1]

(2) Post waste type identification signs throughout the B&B system at various points. In the storage areas, toilets, kitchens, and the activity area of the creative shed, signs are posted to identify the type of garbage generated after the items are used. For example, the "handicraft materials" storage area can be marked with the graphic of "garbage generated by activities - recyclable". The graphic's visual style can be consistent with the intelligent garbage cans so that users have a preliminary knowledge of garbage classification. (Author)

5.5 Catering

5.5.1 For rural tourism managers

(1) Maximum localization of the source of ingredients. By optimizing the local organic farming industry, we can provide a constant supply of ingredients for the local restaurant industry. The surplus ingredients can be processed into organic agricultural products for sale, generating economic benefits and supporting the tourism industry. (Bisitanino, slowfood, author)

(2) Establish a suitable storage mode for ingredients. According to ingredients' characteristics, choose short-term storage, long-term storage or fermentation treatment to avoid unnecessary energy waste, and maximize the attributes of ingredients to achieve the best use. (Bisitanino, the author)

（3）Establish a bio-conversion system for food waste. Using HomeBiogas 2.0 - Organic Waste Conversion Unit to convert food waste and output new combustible gas energy and organic liquid fertilizer, reducing chemical fertilizer input to the farming industry and overall energy input to the tourism industry.

[1] Li G， Liu S， Wang L , et al. Skin-inspired quadruple tactile sensors integrated on a robot hand enable object recognition[J]. Science Robotics, 2020, 5(49):eabc8134.

5.5.2 For designers

(1) Experiential rural kitchen design

(2) Foodservice design

(3) Storage systemic design

5.6 Energy management

5.6.1 For rural tourism managers

(1) Classify existing energy use, evaluate the energy consumption nodes with the highest carbon emissions, and target norms to change visitor use habits. (Author)

(2) Use clean energy instead of linear energy. For example, rural B&Bs can install solar panels to generate economic benefits while being self-sufficient. Use Biogrom 2.0 (proven composting technology) to convert organic waste into combustible gas and liquid fertilizer. (Author, Biogorm2.0 team)

(3) Establish a comprehensive water recycling system. The innovative technology "Plant Filtration Water Purification System" and "Village Water Purification Program", combined with the optimization of water use patterns (see Sustainable Energy System Model for details), will significantly reduce water use. (Author)

5.6.2 For designers

(1) Solar panel intelligent service system design

(2) Energy management interaction design/visualization design

(3) Energy management service design

(4) Plant water filtration and purification system

5.7 Organic farming

5.7.1 For farm managers

(1) Select plant species that are adapted to local soil and climate, as well as resistant to pests, diseases and weeds. The selection of species should be consistent with biological genetic diversity. (Gao Xiang, IFOAM, author)

(2) The preferred choice of seed or plant propagation material should be organic seeds from the farm's previous harvest. If sufficient organic seeds are not available, we can cooperate with other local organic farms or exchange seeds with them. If we cannot get enough organic seeds locally, we can choose organic seeds from the market. (Author, Gao Xiang)

(3) It is forbidden to treat seeds and plant propagation materials with any artificial chemical substances. It is essential to maintain their natural organic nature. It is also prohibited to subject seeds to technological treatments such as radiation, genetic modification, etc. (IFOAM, DEMETER)

(4) Tillage methods are preferred to replenish, maintain, and enhance the fertility of the soil. (Author)

(5) Crop rotation must be used in the farming process, and green manure, legumes or deep-rooted crops should be included in the rotation process. (19630. IFOAM, DEMETER)

(6) In fields, intercropping or relay intercropping should be used to create a habitat for beneficial animals or insects. (19630, IFOAM, DEMETER)

(7) The farm should establish a natural environment protection zone for about 10% of the farm area. Such protected areas include, but are not limited to, grasslands, wilderness, reed marshes, orchards, shrublands, ponds, wetlands, fallow lands, native woodlands, boulevards, rock piles, etc. (Gao Xiang, IFOAM, DEMETER)

5.7.2 For designers

(1) Organic seed offline market platform: planning, communication, activities, market layout, service design.

(2) Organic seed online trading platform: interaction design, service design.

(3) Farm planning and design

(4) Wildland landscape protection design

(5) Waterfront wetland ecological landscape design

(6) Agricultural landscape design, farmland intercropping pattern and space design

(7) Aquatic plant purification systems, devices and landscape design

5.8 Community collaboration

5.8.1 For rural tourism managers

(1) First of all, we need to establish the basis of cooperation and adhere to an environmentally friendly development model. Collaboration is only possible when the partners agree on the interests, philosophy, purpose, and development direction. (Author)

(2) Only after the foundation of cooperation is established can we exchange resources, such as ingredients, fertilizers, and materials. (Author, Bisitanino)

(3) In rural communities, each cooperative system can establish local collaborative management organizations for mutual supervision and production management. (The author, Bisitanino)

(4) Rural tourism managers should actively cooperate with other local production and service units, such as agricultural sideline product processors, suppliers, or bee farms. (Author)

5.8.2 For designers

(1) Rural and village planning and design

(2) Systemic design: for the material input and output relationships between different cooperation units

(3) Tourism cooperation platform construction and service design

5.9 Chapter Summary

This chapter is about the establishment of sustainable rural tourism system guidelines. Based on the quantitative research and analysis of the rural tourism system in Chapters 3 and 4, we summarize the guiding principles of a circular economy-oriented rural tourism system from six aspects: carbon emission monitoring and calculation, waste management, catering, energy management, organic farming, and community collaboration. We also propose design directions and opportunities for establishing the system from a design perspective and provide references for rural tourism managers, farm designers, and rural planners.

Chapter6

Summary and Prospect

The environmental crisis has gradually become one of the biggest crises of human survival and has been receiving more and more attention in recent decades with the progress and development of science and technology. On the one hand, it is due to human activities' excessive consumption of environmental resources. On the other hand, the mentality of dominating nature has led humans to ignore the negative environmental impact of many production activities.

The importance of the countryside, as the closest area to the natural environment, is self-evident, and the impact of the rough development of rural tourism on the environment will be gradually magnified in the future.

A sustainable rural tourism system can reshuffle the chaotic rural tourism model. Therefore, a correct and accurate sustainable system standard is significant to rural tourism. If there are loopholes in the criteria, it will mislead the production behavior, and sustainable rural tourism will lose its meaning.

Therefore, this study develops a sustainable rural tourism model with the help of a systemic design approach and reviews the existing linear rural tourism system, which has high carbon emissions. Meanwhile, the life cycle assessment method is applied to ecological assessment of the system.

This study establishes a prototype framework for Design Harvest projects based on scenario carriers in Chapter 2. Then we sort out the logic of system model building and ecological assessment system. On this basis, the construction of the rural system model at different levels with different elements is started.

This study first built a prototype of a linear rural tourism system. We established a quantitative assessment of the global warming potential of the elemental nodes in the system using the life cycle assessment approach. The system was also assessed qualitatively from the perspective of diverse tourism forms.

Based on this, two system iterations, from linear to sustainable, were conducted.

The first level is a linear rural tourism system model based on the current situation. Due to the complexity and variability of the tourism system, in order to assess the global warming potential quantitatively, the author classifies and defines the elements within the scenario carriers that have a significant environmental impact. Based on the behavior patterns of tourists, we modeled the "human behavior" "food/growing" and "energy" systems with high environmental relevance. We then extracted the high-frequency environmental correlates and build the final linear rural tourism system model.

The second level is the sustainable rural tourism system model. We propose opportunities and solutions for each node of the carbon emission problems of the linear system model from input to output, find the correlation between subsystems, and finally, integrate the sustainable rural tourism system model.

Finally, based on the Sustainable Rural System Model, we propose a balanced solution that satisfies both environmental friendliness and user experience. A sustainable rural tourism system guideline is established to provide a reference for other stakeholders, such as rural tourism managers and designers.

6.2 Prospect

Design Harvest is one of the most representative projects of the innovative model of sustainable urban-rural linkage development in China. We are proud to be deeply involved in it. There are many scholars who have studied this project, but our study is the first to intervene in the problem from a systems design perspective. There are still some shortcomings in this study, but we hope to provide a more diverse perspective and methodological reference for more sustainable development innovation projects across China. Here are other aspects of the study that we believe are important for rural tourism development and sustainable design.

6.2.1 Community Collaboration

In this study, the operation mode of the individual organizations in rural tourism system is compared to the operation mode within a single cell. However, it is clear that individual cells do not yet have the capacity to form a living whole. Similarly, although this study explores the self-sufficient ability of individual systems, it is difficult for independent producers to make great progress and sustainable development in the market. Therefore, based on the study of a single system, we should study and design the integration of the various production subsystems from a more macro system perspective. For example, there are differences between farms due to geology, climate, and even the character of the producers. The collaboration of these farms complements each other and greatly increases the richness and possibilities, contributing to environmental sustainability and regeneration.

Therefore, the author suggests that the exploration of collaborative producer systems and service models can be carried out from a community perspective. And based on this, scholars can further explore the linkages between producer cooperatives in different regions and the complementary relationships between cooperatives and cities.

6.2.2 The balance of user experience orientation and environmental-friendly orientation

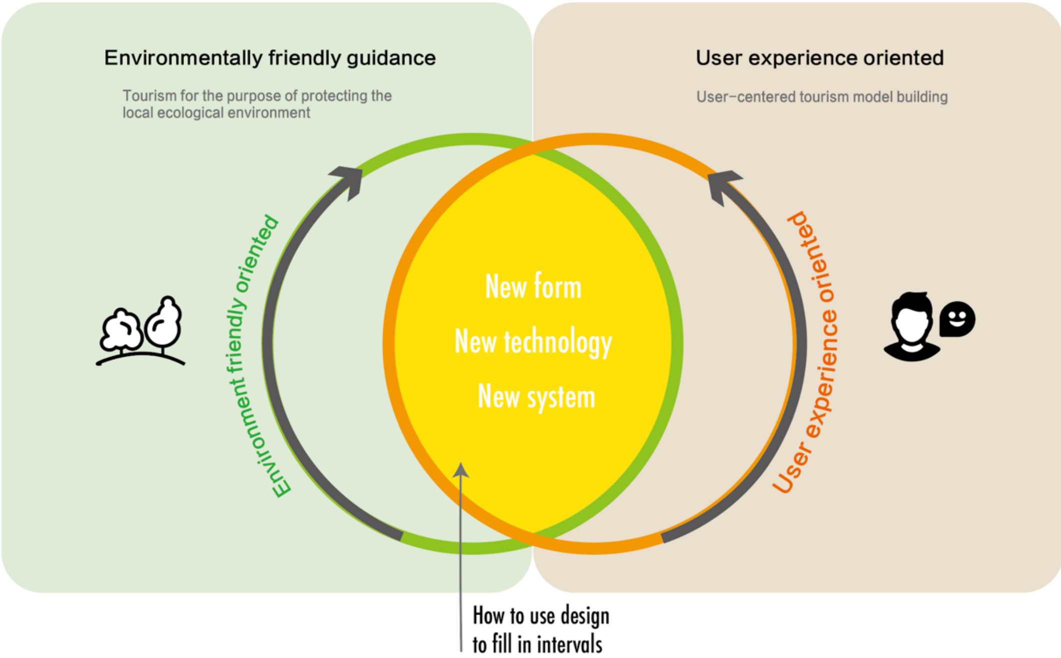


Figure 6.1 Complementary diagram of the relationship between rural tourism systems based on two orientations (Image credit: author's drawing)

In the sustainable rural tourism model building process, we found that the solution strategy for the problem nodes in linear rural tourism is environmentally oriented, the "user experience" orientation is abandoned in the process, and all criteria are aimed at a low carbon emission circular economy. However, linear tourism is a very experience-oriented activity, and a good user experience has been the primary consideration in tourism activities for a long time. All rules and models are designed with the "best experience" of the visitor in mind. But a good user experience is in conflict with or isolated from environmental friendliness in most cases. The sustainable guidelines and environmentally oriented concepts prohibit or restrict behaviors that make visitors feel "good". Domestic tourists' personal quality levels and educational levels are hard to control. China is late in promoting the concepts and applications of "recycling", "environmental protection" and "low carbon". Therefore, finding a balanced solution for the tourism system between user experience and environment-friendly is a problem that needs to be solved in the future.

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Appendix

Linear energy system data sources and calculations

Figure1 Electricity bills of B&Bs in Design Harvest (Image credit: Manager of Design Harvest)

Figure2 Electricity bills of B&Bs and creative center in Design Harvest (Image credit: Manager of Design Harvest)

Figure3 Electricity bills of B&Bs in Design Harvest (Image credit: Manager of Design Harvest)

Figure4 Electricity bills of B&Bs in Design Harvest (Image credit: Manager of Design Harvest)

Linear system visitor behavior research questionnaires

Design Harvest-Sustainable Behavior Pattern of Rural Tourists-Questionnaire

Dear Tourists: Hello! We are master graduate students from Tongji University's School of Design and Innovation. We are doing a survey on tourist behavior patterns in Design Harvest rural tourism. The purpose is to better balance the tourism experience of rural tourism and environmental friendliness. I hope you can fill in this survey with your truly tourism behavior in Design Harvest. This survey is only for academic research and is anonymous. We will keep all your information confidential. Thank you for your participation!

1. Do you know about sustainable tourism? (Single Choice * Required)

○ Understanding

○ No idea

○ Never heard of it

2. The transportation for you to Design Harvest is ( ) (Single Choice * Required)

○ Walking or cycling

○ Public transport

○ Self-driving

○ Other

3. How long do you spend to arrive at the design harvest? (Single Choice * Required)

○ Half an hour

○ 1 hour

○ 1-2 hours

○ 2-3 hours

○ 3 hours and above

4. The main purpose of your coming here is ( ) (Multiple Choice * Required)

□ Experience Rural Culture

□ Participate in thematic activities

□ Attend Nature Class

□ Feel Nature

5．How long does it usually take you to visit here? (Single Choice * Required)

○ Half a day

○ A day

○ Two days

○ Resident

6．How often do you spend your day outdoors? (Single Choice * Required)

○ 1 hour or less

○ 1-2 hours

○ Half a day

○ Almost all day long

7. How many disposable goods do you use in one day? Such as towels and toothbrushes provided by the design harvest (single choice * Required)

○1 piece

○ 2 pieces

○ 3 pieces or more

○ Do not use, bring my own

8. How often do you bathe every day in Design Harvest? How long for once? (Multiple-choice * Required)

□ once

□ less than 10 minutes

□ twice

□ 10-20 minutes

□ twice or more

□ 20 minutes or more

9. What do you eat for lunch and dinner? (Multiple-choice * Required)

□ Self-help cooking

□ Private Kitchen Customization

□ Bring my own fast food

□ Take-out

□ I Don't eat

10. Do you use disposable tableware in the dining? (Single Choice * Required)

○ Regular

○ Occasionally

○ Never

11. How much do you eat per meal? (According to Baidu's Meal Estimation Method) (Multiple-choice * Required)

□ 100-300g

□ 300-500g

□ 500-800g

□ 800g－1.2kg

□ 1.2kg and above

12. Have you ever paid attention to the impact of your travel behavior on the environment? (Single Choice * Required)

○ Regular attention

○ Occasional attention

○ Never pay attention

○ I don't know how to pay attention to that

13. Which behaviors do you think will reduce environmental impact in the tourism process? (Single Choice * Required)

○ Catering

○ Bathing

○ Smoking

○ Waste disposal

○ Commuting

○ Other

14. What kind of consumption will you have in Design Harvest? (Multiple-choice * Required)

□ Catering

□ Agricultural Products

□ Handicraft products

□ Design activities

□ Supermarket Commodities

15. Where do you stay the longest in Design Harvest? (Awakening Time) (Single Choice * Required)

○ B&Bs-Tiangeng and Huami

○ Innovation Center

○ the botanical garden

○ The artist pig shed

○ Other regions

16. Gender: (Single Choice * Required)

○ Male

○ Women

17． Age (Single Choice * Required)

○ Under 18

○ 18-25 years old

○ 26-35 years old

○ 36-45 years old

○ 46-55 years old

○ Over 55 years old

18． Your occupation: (Single Choice * Required)

○ Public servants

○ Enterprise manager

○ Professional/cultural, educational and scientific personnel

○ Designer/Artist Practitioner

○ Workers

○ Soldiers

○ Farmers

○ Retired personnel

○ Students

○ Other

19．Your education level: (Single Choice * Required)

○ High School \ Technical Secondary School or Below

○ Junior college

○ Undergraduate course

○ Master's degree

○ Doctoral and Postdoctoral

20. Your personal monthly income: (students don’t need to answer this question) (Single Choice * Required)

○ Under CNY¥5000

○ CNY¥5,000- CNY¥7,000

○ CNY¥7,000- CNY¥10,000

○ CNY¥10,000- CNY¥20,000

○ More than CNY¥20000

21．You come from: (Single Choice * Required)

○ Shanghai

○ Other parts of the country

○ Foreign countries

22. What is your ideal sustainable rural tourism? Are you satisfied with the sustainable tourism in Design Harvest?

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23. Which do you prefer, the user experience-centered pattern or the environment-friendly pattern of rural tourism? Why?

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