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Nexus between Ecological Conservation and Socio-Economic Development and its Dynamics: Insights from A Case in China

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Abstract: Achieving sustainable socio-economic development in areas designated for ecological conservation is a challenge for many developing countries. The nexus between ecological conservation and socio-economic development is particularly complex in these areas for the reason that most of them are located in poor regions and their resource utilization is constrained by ecological conservation practices. A conceptual framework was proposed for examining the nexus between ecological conservation and economic development in a social-ecological system to explain the pathways and mechanisms of influence between the ecosystem and the social system. We chose the Lashihai watershed in Yunnan Province, China, as the case study area to explore whether a positive feedback loop between ecological conservation and socio-economic development has been formed, as well as how to promote the positive evolution of socio-economic and ecological status. The ecosystem and socio-economic system in the Lashihai watershed closely interact and form a dynamic system with a positive evolutionary trend. If negative factors, such as an uneven distribution of income and new population pressures, are not appropriately managed, they are likely to break the positive feedback loop and trap the system in a negative feedback loop.

We discuss the main factors that contribute to the interactions between ecological conservation and livelihoods, and develop policy recommendations for governments in other countries and regions to promote conservation and better livelihoods in conjunction.

Keywords: ecological conservation; livelihood; social-ecological system (SES); China

1. Introduction

Ecological conservation and socio-economic development have always been the focus of academic research. In developing countries, the contradiction and conflict between ecological conservation and livelihood development are particularly prominent.

Ecological conservation and livelihood development are also urgent problems faced by China. In recent years, China has gradually formed a national vision called Ecological Civilization and Green Development, which represents the basic understanding of the relationship between ecological conservation and socio-economic development. However, there are still many difficulties in implementing this strategy. China’s unique natural and economic geography has created a strong correlation between ecologically important areas and undeveloped poor areas. About 72% of all 592 national poverty-stricken counties are distributed in the ecologically fragile zone, accounting for 74% of the poor population; 95% of the absolute poverty-stricken population live in the areas with an
extremely fragile ecological environment [1]. Studies have shown that it is a regional characteristic in most poor areas of China that poverty is caused by deterioration of the ecological environment and natural endowments [2]. The conflict between ecological conservation and socio-economic development is the fundamental reason for the unbalanced nature and inadequacy of development in these areas. If economic development is restricted due to the requirements of ecological conservation, this may lead to a local economic recession and affect the motivation of local residents to conserve nature; if economic development is pursued without concern for the thresholds of ecosystems, it may affect and even destroy ecological resources. The question regarding how to achieve a balance and positive feedback between ecological conservation and economic development is an urgent problem faced by China.

There is a complex relationship between ecological conservation and socio-economic development [3]. Relevant studies can be divided into three categories. The first type of research focuses on the impact of the environment on development. On one hand, for example, a benign resource and environment may not be conducive to socio-economic development, as expressed by resource curse theory [4–7]. Resource-dependent economic growth may only create short-term prosperity rather than sustained development, as described by the effects of the Dutch disease [8–11]. On the other hand, numerous studies show the impact of a deteriorated ecological environment, such as pollution on economic recession and drought on productivity or conflicts [12,13]. The second type of research focuses on the impact of development on the ecological environment in terms of, for example, the environmental Kuznets curve and “pollution heaven” theory. Economic growth may lead to a deterioration in environmental quality or pollution transfer but may in turn provide economic incentives to promote reductions in pollution [14–18]. The third type of research has tried to illustrate the environment–economy linkage by using the concepts of the “virtuous circle” and “vicious circle” and the “poverty trap” process [19], which is simplistic and has been criticized as being unable to capture the many-patterned nexus between the environment and development [20].

With the popularization of the concept of sustainable development, research has focused more on the interactions between ecosystems and socio-economic systems [21]. Researchers have established various frameworks for analyzing social-ecological systems (SESs), but these frameworks differ significantly with respect to the conceptualization and structural criteria of ecological and social systems and their interrelations [22,23]. SESs are systems in which ecosystems and human societies are integrated and exhibit reciprocal feedback and interdependence, or so-called complex adaptive systems, which are gradually becoming one of the tools used for understanding and measuring the interactions and dynamic relationships between humans and nature [24–26]. Ostrom proposed a framework for the analysis of SESs that includes resource systems, government systems, natural resources, resource users, and other systems to identify the variables that affect the likelihood that self-organization will result in a sustainable SES [27–30]. Nassl and Löffler established a causal sequence and a closed cycle of ecosystem service provision and societal feedback by merging the core elements of the cascade model and the driver–pressure–state–impact–response framework [31]. Walker et al. emphasized the impacts of flexibility, adaptability, and convertibility on the trajectory of social ecosystem development [32]. Studies increasingly tend to view sustainable development as a constant process of change or adaptation in human interactions with natural ecosystems to ensure the survival of both human societies and these ecosystems, instead of being a final objective or static status [33,34].

Based on the complex relationship between ecological conservation and socio-economic development, two basic feedback loops can arise, which indicate two directions in which an SES may evolve. One is a desired feedback loop in the form of “economic development \(\rightarrow\) improved environment \(\rightarrow\) sustainable development.” That is, a local livelihood can maintain or improve their own capacities and assets without destroying the natural resource system [35,36], and ecological conservation can also benefit local residents’ livelihoods [37,38]. The other feedback loop is an undesired feedback loop in the form of “poverty \(\rightarrow\) ecological deterioration \(\rightarrow\) poverty.” The over-utilization of resources leads to environmental degradation, whereby the inappropriate implementation of conservation policies further affects livelihoods and aggravates poverty [39].
Because complex adaptive systems have several essential features, such as nonlinear feedbacks, strategic interactions, individual and spatial heterogeneity, and varying timescales, and although the adaptive cycle heuristics are widely used, it is always difficult to model and estimate the trajectory of the dynamics of SESs [40,41]. A core challenge in diagnosing why some SESs are sustainable while others collapse is the identification and analysis of relationships within these complex systems [28]. Some emerging research aims to integrate SES with the Institutional Analysis and Development (IAD) framework to help overcome their individual limitations (SES framework being too static and the IAD framework being underspecified) to gain power in explaining the social and ecological processes that contribute to SES outcomes [42,43]. However, internal explanations of the patterns of interaction and triggers of change in complex SESs are still lacking [44].

Therefore, with the inspiration of a combined IAD-SES model [42], we have developed a conceptual framework in this paper that focuses on explaining how interactions in actions generate certain outcomes in a SES. To open this box, we organize sets of intuitive diagnostic inquiries that can serve as a logic chain to understand the interactions between ecological conservation and socio-economic development, and to predict the outcome or sustainability of the SES change [43]. We then chose the Lashihai (or Lashi Lake) watershed in Lijiang City, Yunnan Province, China, as the study area to observe the nexus and dynamics of this coupled SES on the occurrence of external shocks and over a period with empirical data.

This article is organized as follows: Section 2 establishes the conceptual framework to explain the interactions between ecological conservation and socio-economic development; Section 3 describes the basic setting of the study area and empirical design; Section 4 analyzes the status and evolution of the socio-ecological system; Section 5 examines the interactions between ecological conservation and socio-economic development, and explores the pathways and mechanisms that support adaptive action; Section 6 summarizes the results and discusses the possible influencing factors that lead to different dynamic patterns; and Section 7 proposes policy recommendations for sustainable development.

2. Conceptual Framework

This study has constructed a conceptual model of the relationships between ecological conservation and socio-economic development to explain their interactions, pathways, and links, which constitute the dynamics of a SES (Figure 1).

![Figure 1. Interactions between ecological conservation and local livelihood.](image)

The figure shows a social-ecological system at a certain time. Such an SES may be subjected to some external perturbations that break the system status at time 0 (SES0), and generate a series of
interactions that drive the system to evolve to a new status or outcomes at time 1 (SES). The evolution of the SES can also be described as a two-phase destruction-creation process: due to the occurrence of non-absorbable disturbances, the SES becomes unstable; then, a release and a reorganization process pushes the SES toward a new stability domain [44]. As a dynamic system, a coupled human–natural system must evolve and adapt to any perturbations to survive [33]. Some perturbations may trigger the system to shift from its original state to a contrasting state [24]. Depending on whether the path that the system follows to evolve is in an adaptive or destructive direction, it will form different dynamic patterns.

In the SES, the decisions of actors are aggregated to constitute patterns of interaction that produce observable outcomes [43]. From a market perspective, externalities are the main causes of ecological damage [45]. Therefore, in theory, if ecological factors are included in the welfare function of local households (in terms of either producer welfare or consumer welfare), there will be incentives for local residents to protect the environment. In other words, if ecological conservation can bring net benefits to local residents, more ecological conservation actions will be carried out, which will thus form a desired feedback loop between ecological conservation and development. On the other hand, if ecological conservation limits the utilization of resources, or conservation provides extensive spillover benefits, the system may follow a path that involves competition for natural resources or the presence of free-riding incentives, which would lead to an undesired feedback loop between ecological conservation and development [46]. It is the feedback loops between these processes in the interdependent SESs that determine their overall dynamics [24].

On the basis of these understandings, the interactions can be described as two causal chains/links between ecological conservation and local livelihood: chain A (from ecological conservation to local livelihood) reflects the various ways in which livelihood development is influenced by the ecosystem, and chain B (from local livelihood to ecological conservation) represents the influences of livelihood development on ecological conservation. In each chain, the underlying factors that could drive the interaction and explain the outcome are listed. Positive factors (indicated with “+”) drive the desired feedback loops, and negative factors (indicated with “−”) promote undesired feedback loops.

Chain A: From ecological conservation to local livelihood.
A1. Ecological conservation provides a resource base for livelihood development (+).
A2. The benefits of ecological conservation are shared by the local community (+).
A3. Ecological conservation may constrain or prohibit activities that are detrimental to the ecosystem (−).

Chain B: From local livelihood to ecological conservation.
B1. Alternative livelihood reduces the pressure on the ecosystem (+).
B2. Local livelihood improves the motivation and capacity for ecological conservation (+).
B3. Local livelihood brings about new pressures on the ecosystem that are not effectively mitigated (−).

To overcome the limitations of a simple model, such as the one mentioned by Patterson et al. [47], this model addresses adaptation and mitigation simultaneously by incorporating system feedbacks such that we can observe the interactions and dynamics between conservation and livelihood. The positive influencing factors constitute a desired feedback loop as follows: ecological conservation → provides resource base for livelihood (A1) → development of alternative livelihood → alleviates the pressure on resources (B1) → improved ecosystem → the ecological benefits are shared by local residents (A2) → improved livelihood → enhances the motivation and capacity for conservation (B2) → more ecological conservation actions. The negative influencing factors constitute an undesired feedback loop, or vicious circle, as follows: ecological conservation → restrictions on resource utilization (A3) → livelihood difficulties (income loss) → ecological pressures (B3) → ecological degradation. With the existence of such feedbacks, we can observe the direction and dynamics of the SES evolution.

To be exact, the key to whether a conservation action can trigger a desired feedback loop is whether an alternative livelihood can be developed through adaptation to the implementation of
this conservation action. Similarly, whether the ecological pressure caused by livelihood
development can be mitigated or kept under control is also critical. If local residents can benefit from
ecological conservation without destroying the resource base, the motivation and capacity for
ecological conservation will continue to increase, and thus a desired feedback loop will be formed.

As Nadkarni has pointed out, a vicious circle can be transformed into a virtuous circle when the
poor become protectors of the environment [20]. In contrast, people may intend to carry out
intensified utilization of natural resources to obtain short-term economic benefits, which ultimately
destroys the ecological base, reduces the potential for sustainable development of the local economy,
and thus falls into a vicious circle [47,48].

Following this logic chain, in order to empirically test whether the above hypothesis about SES
dynamics holds and whether a desired feedback loop between ecological conservation and
socio-economic development has been formed in Lashihai, we employed a questionnaire survey and
statistical analysis with the aim of answering the following questions: (1) Has the local livelihood
been changed by ecological conservation actions, and how? (2) What impact has the change in the
livelihood had on ecological system, and how? (3) What interactions and what type of feedback loop
has been formed between the local livelihood and ecological conservation? (4) What are the
underlying factors and concerns in the future evolution of the local livelihood and ecological
conservation?

3. Study Area and Empirical Design

3.1. Basic Setting of the Study Area

The Lashihai watershed, China, was selected as the study area (Figure 2). This watershed has a
drainage area of 24,100 ha, and consists of forests, lakes, and wetlands, forming a relative complete
and integral ecosystem. It is located on the western edge of the Hengduan Mountains in western
Yunnan Province, adjacent to the Yulong Snow Mountain. It is a typical plateau wetland ecosystem
and home to 100,000 migrant birds each year. To conserve this valuable piece of wetland, the
Lashihai Wetland Nature Reserve was established in 1998 and was designated as a national key
ecological function zone. With its rich biodiversity, endemic species, and unique ecosystem, its high
ecological significance and conservation values have also been internationally recognized, and it
was listed as a Ramsar wetland in 2004. Its ecological importance makes the Lashihai watershed a
key pilot site for implementing various conservation policies, including both national and local
policies, since 2000. Up to now, the change in ecosystem has been obvious and can be clearly
measured.
Figure 2. Map of Lashihai watershed and surveyed villages.

The Lashihai watershed belongs to the Lashi Township, Yulong County of Lijiang City in Yunnan Province. Yulong County is a province-level, poverty-stricken county. The minority population accounts for more than 98% of the total population and includes the Naxi, Yi, and Bai ethnic groups and other minorities. This watershed covers eight villages, but human activities are mainly concentrated in the six villages surrounding Lashi Lake, which consists of 65 village groups, 3194 households, and 13,031 villagers. In this area, the local economy has traditionally been dominated by agriculture, and people actively interact with the natural resources system (land, woods, and fish, etc.) to make their livings [49]. Meanwhile, each village has its unique characteristics in terms of natural endowments, levels of socio-economic development, the main sources of income, population mobility, public infrastructure, etc. For example, as shown in Figure 2, Meiquan Village has a good geographical location close to the lake and tourist market, such that it is favorable for tourism development, whereas Nanyao Village, which is located in a relatively remote mountain area, is still running traditional crop cultivation and animal husbandry [46].

These unique natural, cultural, and socio-economic characteristics provide a perfect setting for us to observe the complex nexus between ecological conservation and socio-economic development and its dynamics.

3.2. Empirical Design

Our conceptual model was set up based on a specific mode of reasoning, which allowed us to follow the logical chain of causation presented in the framework to figure out how some outcomes of SES are generated through certain interactions [42,50], such that we could observe the internal dynamic pattern between the ecosystem and human system. To adapt this conceptual model to our empirical study in the Lashihai watershed, we needed to first set up the spatial and temporal dimension to observe the change of both the ecosystem and human system, as well as the underlying interactions that help to explain those changes [44].

In terms of the time dimension, empirical cases of SES often face the challenge of defining a starting point and time length for observation of the evolution process. However, Lashihai watershed has a natural advantage in this aspect. As there were major conservation actions and economic booms in neighboring areas serving as external shocks for the Lashihai social-ecological system since around year 2000, we decided to focus on observations from 2000 to 2015. In terms of the spatial dimension, in order to observe the ecosystem change, we needed to consider the whole
watershed as an integral ecosystem. However, the human activities, including human reactions to the conservation policy, mainly concentrate in the surrounding area of the Lashi Lake; therefore, we focused our social-economic survey in villages surrounding the lake.

Under these time and spatial dimensions, we compared the ecosystem change over this period using biophysical measurements of the ecosystem services and biodiversity; comparing the human system change by mainly focusing on the local livelihood aspects, measuring the income level and income structure, etc.; and then to follow the conceptual framework to explore the interaction of the two systems by testing whether those causal chains work for the real case.

To implement this empirical strategy, we conducted a questionnaire survey to collect data. As we intend to observe how humans react to the external shocks by adjusting their behavior regarding the ecosystem, we need to collect socio-economic data about the behavior of decision-makers at the bottom level [51]. Through field investigation, we found that the village group is the ideal unit for the questionnaire survey in this area. In China, a village is the fundamental formal administrative organizational unit for a rural population, and a village group is a subordinate unit of a village. Rural households within a village group are normally geographically closer and share more similarity in terms of socio-economic and biophysical conditions. Especially in Lashihai watershed, partly due to the ethnic tradition, the behavior patterns within a given village group were highly homogeneous [46]. A village may consist of several village groups. The leader of each village group, normally the most informative person, was the direct respondent. Using this design, our survey covered all village groups in the core villages of Lashihai watershed, therefore we expect our data from the questionnaire to represent the whole population (all village groups in the core villages) rather than giving just a sample.

The questionnaire included questions regarding the basic socio-economic information of each village group, land use, total incomes, income structure, tourism scale, land area involved in ecological conservation, attitudes to conservation policies, environmental awareness, and so on. Based on this in-depth, bottom-up information, we conducted semi-quantitative analysis. For example, contingency analysis and ANOVA were applied to analyze the relationship between different types of variables, such as livelihood behavior and income level.

The earliest village-group-level survey data we collected was for the year 2005. Since the major shocks to the system happened around 2000, and it normally takes several years of lagging to view the outcome of conservation, as well as its impact on human side, we think it is acceptable to observe the livelihood change from 2005 to 2015. Furthermore, the 2005 survey only presents data from five out of six villages; therefore, to make a comparison with the same village groups in 2015, our observations finally included all village groups from the five core villages in the watershed. They were the Meiquan, Junliang, Nanyao, Hainan, and Jiyu villages, which consisted of 54 village groups (83% of all surveyed village groups), 2596 households (81% of all), and 10,686 villagers (82% of all). These villages covered the area where both economic and conservation activities were the most intensive in the whole watershed.

Besides the survey data, this study was also supported by two other sources of information. One was in-depth interviews with local experts and officials of government departments, including the Statistics Bureau, Environmental Protection Bureau, Wetland Nature Reserves Bureau, Forestry Bureau, Agricultural Bureau, Water Resources Bureau, etc. The in-depth interviews provided us with rich data and anecdotal information about the history, culture, ecological, social and economic status and development, policy context, and so on. We also collected second-hand data, including land-use data, water quality monitoring data, bird monitoring data, economic and social development statistical data, etc., to support our case study.

4. Evolution of the Coupled Social-Ecological System

People and nature in the Lashihai watershed form a coupled SES. Each of these two subsystems in our framework has evolved over time. What changes have happened to the human society and the ecosystem over the period that we observed? In this section, we will try to measure the outcome
of those changes. Two prominent perturbations triggered the system to start the process and to evolve to a new state.

4.1. External Shocks

Before 2000, the main livelihoods in the Lashihai watershed were crop farming, forestry, and fisheries. Farming on steep slopes, clear-cutting of forests by the Yi minority people (following their traditional way of life), and overfishing posed serious threats to the fragile ecological environment, resulting in a reduction in forest cover, soil erosion, water loss, river siltation, and a significant reduction in species diversity, and also reduced the supply of basic ecosystem services such as water conservation, soil conservation, carbon sequestration, and biodiversity [52]. Unsustainable production and lifestyles, on the one hand, exacerbated this ecological deterioration. On the other hand, the increasing scarcity and declining quality of ecological resources in turn restricted the further development of the local socio-economic system and livelihoods. The SES’s internal controls locked the system into a pathway that reinforced undesirable outcomes [44,53].

At the turn of the 2000s, China initiated a series of national ecological conservation policies, which together with the booming development of tourism in the nearby city of Lijiang, altered the original social-ecological interactions and caused the SES in the Lashihai area to evolve into a new state.

External shock I: In 1998, after the great flood in the Yangtze River Basin, large-scale ecological conservation actions were initiated by the central government. The Lashihai watershed is an area where the country’s main ecological conservation policies and demonstration projects were implemented, such as the Sloping Land Conversion Program (SLCP), the Natural Forests Logging Ban, the Farmland to Wetland Conversion Program (FWCP), controls on the fishing season and fishing gear, compensation for crop damage due to wildlife, and pesticide bottle recycling (Table 1). Some of these conservation programs, such as SLCP, FWCP, etc., provided subsidies as a matching fund from the government for farmers or entities affected. Owing to the differences in their geographical location and natural endowments, the administrative villages that were involved in these projects varied. Meiquan, Junliang, and Hainan are near the lake and participated in the FWCP, whereas Jiyu and Nanyao are located in remote forested and mountainous areas and were mainly involved in the SLCP.

External shock II: The development of Lashi Township, as a small township with a specific geographical location, is deemed to be affected by the development of the nearby cities [39]. The Lashihai watershed is one of the sources of the water supply for Lijiang. With the rapid increase in the level of urbanization of Lijiang, especially with the rapid development of tourism in Lijiang, in order to guarantee the supply of water to the Lijiang area, the Lashi Lake and adjacent wetland were expanded for the first time in 1993. In December 1997, the Old Town of Lijiang, which is about 10 km north-east of Lashi Township, was designated as a World Cultural Heritage Site, which brought about a golden age of tourism in Lijiang and also caused explosive growth in the local tourist population from less than 3 million in 2000 to 46 million in 2018, and reach 200,000 per day during the peak season [54]. The Old Town of Lijiang is famous for its effective water system, which meets the needs of fire prevention, daily life, and industry in the town. Water also plays an important role in the Old Town’s unique architectural style, urban layout, and landscape. To ensure the supply of water to Lijiang, the Lashihai Water Regulation and Storage Project and a matching compensation

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**Table 1. Ecological conservation actions carried out in villages in the Lashihai watershed.**

| Ecological Conservation Action                          | Meiquan | Hainan | Jiyu  | Nanyao | Junliang |
|--------------------------------------------------------|---------|--------|-------|--------|---------|
| Natural Forests Logging Ban (1998)                      | √       | √      | √     | √      | √       |
| Sloping Land Conversion Program (2000)                  |         |        | √     |        |         |
| Crop damage subsidies (2003)                           | √       | √      | √     | √      |         |
| Farmland to Wetland Conversion Program (2006)           | √       | √      |       |        |         |
| Fishing season/gear control (2008)                      |         |        | √     |        | √       |
project as part of the abovementioned FWCP were implemented from 2006, which expanded the wetland area, but also inundated a large area of cultivated land surrounding the lake. At the same time, the boom in tourism in Lijiang also created a demand for tourism in Lashi Township, as it provided complementary attractions, such as the plateau wetland landscape, horseback riding on the Ancient Tea-Horse Road (also known as China’s Southern Silk Road), and ethnic cultural experiences for tourists in Lijiang. The tourist population in Lashi Township increased from about 20,000 in 2006 to over 2 million in 2015 (Figure 3). The decrease in farmland and the increase in the tourist population may, on the other hand, bring about new pressures on the conservation of the Lashihai watershed.

Figure 3. Development of tourism in Lijiang and Lashi Township.

Facing the above two shocks from the outside world, the SES in the Lashihai area was inevitably triggered to evolve to form a new interactive pattern. Will the Lashihai area fall into a positive or a negative feedback loop? How will this take place? We will answer these questions using observations for the period from 2000 to 2015.

4.2. Changes in Ecosystem

Since 2000, the ecological conservation of the Lashihai watershed has achieved great progress. Because the Lashihai area serves as an important habitat for migratory birds, the increase in its bird diversity provides sound evidence of improvements in the wetland ecosystem and its service functions. Bird monitoring statistics show that the number of migratory birds has reached more than 100,000 in 2015, which belong to 83 species, of which 34 species are listed as grade I and grade II state-protected birds. These numbers have increased by 100%, 8%, and 190%, respectively, in comparison with those in 2003 [55].

Several key ecosystem services (water conservation, water purification, soil interception, and carbon sequestration) were also assessed by applying biophysical models over the period 2000–2015, as shown in Table 2 [56,57]. The total amounts of nitrogen and sediment transported to the Lashi Lake decreased by 12.14% (7.93 tons) and 14.95% (16,300 tons), respectively. The annual amount of carbon stored in the basin increased by 119,900 tons. This means that through the implementation of conservation measures in the basin, the retention capacity for nutrients and soil increased, which helped to alleviate nutrient pollution in the lake and soil erosion in the basin. The increase in carbon storage is also a good sign for improvements in forest coverage. However, the water conservation capacity of the basin decreased by 29.32%, from 59,000 m³ in 2000 to 41,700 m³ in 2015; the reason for this is discussed in Section 5.2.3. When the overall status of the ecosystem is improving, this brings concerns regarding the emerging ecological pressure in this area.
Table 2. Changes in ecosystem services over the period 2000–2015.

| Ecosystem Service                             | 2000  | 2015  | Change | Proportional Change (%) |
|----------------------------------------------|-------|-------|--------|--------------------------|
| Water conservation capacity (1000 m³)        | 59.0  | 41.7  | −17.3  | −29.32                   |
| Nitrogen output (tons)                       | 65.34 | 57.41 | −7.93  | −12.14                   |
| Soil outflow (1000 tons)                     | 109.0 | 92.7  | −16.3  | −14.95                   |
| Carbon storage (1000 tons)                   | 9176.2| 9296.1| 119.9  | +1.31                    |

4.3. Changes in Livelihoods

Since 2005, local livelihood activities have also greatly changed in terms of both income levels and livelihood structures.

4.3.1. Income Levels

As shown in Table 3, the per capita income in all five villages in 2015 was significantly higher than that in 2005. The growth rate in Nanyao was the lowest, but the increase was greater than 80%. The per capita income in Meiquan and Junliang increased by 443.9% and 457.2%, respectively. These increases were much greater than the increases in rural per capita incomes in Lijiang (231%) and Yunnan Province (181%), and much higher than the inflation rate of 35.6% in the same period.

Table 3. Changes in per capita income in the surveyed villages in Lashi Township from 2005 to 2015.

| Village | Increase in Per Capita Income (RMB/yr) | Proportional Increase (%) | Standard Deviation | Minimum | Maximum |
|---------|--------------------------------------|--------------------------|--------------------|---------|---------|
| Meiquan | 9270.1                               | 443.9                    | 4689.0             | 6323.2  | 16,396.5|
| Jiyu    | 4911.4                               | 263.5                    | 1363.7             | 1389.6  | 7015.9  |
| Junliang| 4215.9                               | 207.2                    | 6875.0             | 1007.5  | 25,937.6|
| Hainan  | 3013.3                               | 207.2                    | 1112.0             | 1636.8  | 5380.9  |
| Nanyao  | 1425.0                               | 291.6                    | 882.3              | 1202.4  | 2388.1  |
| Total   | 4624.3                               | 291.6                    | 4173.9             | −1202.4 | 25,937.6|

4.3.2. Income Structures

In all five villages, the proportion of income derived from traditional crop farming, animal breeding, and fisheries declined during the period 2005–2015, while alternative livelihoods, such as tourism and fruit cultivation, contributed more to the increase of income. By 2015, in contrast with Nanyao, which was still dominated by crop farming, the major livelihoods in the four other villages have changed: tourism became the leading livelihood in Meiquan and Junliang, and fruit cultivation became the leading livelihood in Jiyu and Hainan. Meiquan was particularly prominent in that the proportion of income due to tourism had increased substantially. Tourism had replaced traditional agriculture, forestry, animal breeding, and fisheries overall. The income from tourism in Junliang and Nanyao had also increased to a certain degree in comparison with that in 2005 (Table 4).

Table 4. Changes in the income structures of the surveyed villages in Lashi Township from 2005 to 2015.

| Livelihood     | Meiquan | Jiyu | Junliang | Hainan | Nanyao |
|----------------|---------|------|----------|--------|--------|
| Crop farming   | −66%    | −42% | +2%      | −18%   | +8%    |
| Fruit cultivation | −8%   | +62% | −1%      | +15%   | +17%   |
| Fisheries      | −6%     | 0%   | −12%     | 0%     | 0%     |
| Animal breeding| −1%     | −25% | −19%     | −20%   | −11%   |
| Tourism        | +85%    | 0%   | +37%     | +1%    | +29%   |
| Subsidies      | +3%     | 0%   | −9%      | +8%    | −21%   |
| Other          | 0%      | 0%   | 0%       | 0%     | −5%    |

We also found that the villages were in different stages of the livelihoods transition, and the villages could be divided into three groups: Meiquan and Jiyu had completed the livelihood
transition, and the dominant income sources in their revenue structures were replaced by new livelihoods, namely tourism and fruit cultivation; Juliang was undergoing the transition, as its tourism revenue has grown rapidly in recent years; and Hainan and Nanyao had not changed significantly.

5. Interactions between Ecological Conservation and Livelihood

The above analysis presents an overall picture that both the ecological environment and livelihood in the Lashihai watershed underwent generally positive changes over the period 2000–2015. To understand why this has happened, we need to examine in more detail how ecological conservation and livelihood interacted in this transition process.

5.1. Chain A: From Ecological Conservation to Livelihood

According to the abovementioned analytical framework, to understand the impact of ecological conservation on livelihoods, we were concerned with whether ecological conservation actions limited traditional way of resource utilization, promoted the transformation of livelihoods, and promoted the abovementioned changes in economic status.

5.1.1. Have Conservation Actions Restricted the Utilization of Resources for Traditional Livelihoods?

Ecological conservation policies have restricted the use of land, water, forests, and other resources, and limited the development of traditional livelihoods. For example, the Lashihai Water Regulation and Storage Project raised the water level of the Lashi Lake to an elevation of 2447 m from the original level of 2442 m, expanded the wetland area, and inundated a large area of cultivated land surrounding the lake. A total of 343.2 ha of cultivated land was converted to wetland, which accounted for 25% of the total farmland in the villages surveyed, which directly affected the traditional crop farming activities of local farmers. The SLCP in mountain areas also reduced the area of cultivated land by 283.3 ha, which accounted for 46% of the total farmland in the village involved in this program. To protect migratory birds and the fish stock, fishing was prohibited for the whole winter, which was traditionally the peak fishing season; this greatly reduced the income from fishing.

5.1.2. Has Conservation Provided a Resource Base for the Transition to New Livelihoods?

Ecological conservation also provided a new resource base. In particular, the improved environment provided unique wetland landscape resources for tourism, as well as a good production environment for the high-quality and high-value-added forestry and fruit industries.

Taking tourism as an example, there was a significant relationship between village groups that were involved in the FWCP and village groups that had developed tourism (Table 5). Of the 22 village groups that were involved in the FWCP, 14 (63.6%) had developed tourism, whereas only 9 (28.1%) of the 32 village groups not involved in the FWCP had developed tourism. This shows that the village groups within the scope of the FWCP were more likely to have developed tourism. The analysis of the contingency table showed a significant relationship ($\chi^2 = 6.724, p = 0.01$) between the FWCP and tourism.

| Whether village was involved in FWCP | Whether tourism was developed | Total |
|-------------------------------------|------------------------------|-------|
| Yes                                 | 8                            | 14    | 22    |
| No                                  | 23                           | 9     | 32    |
|                                     | Total                        | 31    | 23    | 54    |

Table 5. Contingency table of the Farmland to Wetland Conversion Program (FWCP) groups and tourism.
Large-scale fruit cultivation emerged from 2005 as it brought higher profits in comparison with traditional crop farming. The unique environment and climate in the Lashihai watershed provided excellent conditions for the cultivation of high-quality fruit. Since 2005, when new fruit species were cultivated in this watershed, together with the improvements in the environment and land condition as a result of conservation, the famous reputation of local fruit brands was successfully established. At the same time, the rise in tourism also increased the demand and added value to the fruit products, which made fruit cultivation a profitable business in the Lashihai area.

5.1.3. Have the Local People Shared the Benefits of Conservation?

There are two ways in which local residents share the benefits of ecological conservation: directly, via receiving conservation subsidies, and indirectly, via an increase in income as a result of resource-based livelihood development. The former is paid by the government, whereas the latter is paid via the market. Most ecological conservation actions, such as the SLCP and FWCP, are subsidized to compensate for the direct loss of income caused by the restrictions on resources utilization, although the opportunity cost and welfare loss cannot be fully compensated for, especially in a fast-growing economy.

However, if local people could generate income from livelihood supported by an improved ecological environment, this might become a main channel whereby local residents could share the benefits of ecological conservation. Our survey showed that the village groups involved in the FWCP had a per capita income of 8159.7 yuan in 2015, which was significantly higher \( (p = 0.003) \) than that of the groups not involved in the FWCP (6327.3 yuan per year). Among the village groups involved in the FWCP, the per capita income of those involved in tourism (8742.8 yuan) was significantly higher than the per capita income of those not involved in tourism (2847.8 yuan) \( (p = 0.027) \). Furthermore, a one-way analysis of variance showed that the 14 groups with tourism businesses had a per capita income growth rate of 470.9% from 2005 to 2015, which was significantly higher than that of the 8 groups without tourism businesses (226.2%) \( (F \text{ value} = 3.99, \ p = 0.004) \). This implies that, although conservation exacerbates human–nature conflicts, if village groups affected by conservation actions can successfully develop substitute businesses, the pressure caused by conservation can be mitigated, and people can capture the value of conservation and share the benefits via the market.

However, it should also be noted that the benefits of conservation shared by the village groups were unevenly distributed. That is, as incomes increased after the livelihood conversion, the income gap also increased. According to the income data for the village groups, The Gini coefficient was calculated using an open-order cumulative method. The Gini coefficient for the surveyed village groups was 0.40 in 2005 and rose to 0.49 in 2015; the Gini coefficient for the administrative villages was 0.23 in 2005 and rose to 0.30 in 2015. These results indicate that some villages or village groups may not really benefit from conservation actions, although they may have suffered the same pressure or potential welfare loss from the conservation restrictions. It is easy to understand that as the conditions that are required to boost livelihood conversion, such as endowments for tourism, capital, skills, or other resources, may vary greatly among villages, the capacities of villages to capture the benefits of conservation via alternative livelihoods will differ significantly.

5.2. Chain B: From Livelihood to Ecological Conservation

To understand the influence of livelihood development on ecological conservation, we investigated whether a new livelihood can alleviate the pressure on resources. Furthermore, does livelihood development increase local people’s willingness and capacity to protect the environment? Have changes in livelihoods brought about new ecological pressures, and are these pressures effectively controlled and managed?

5.2.1. Have the New Livelihoods Alleviated the Pressure on Resources?
In comparison with traditional agricultural livelihoods, new livelihoods have significantly eased pressures on resources. For example, the transition to tourism will release the natural resources occupied by traditional livelihoods, such as farming, fisheries, logging, etc. Tourism represents an opportunity toward a non-consumptive use of natural resources if the tourism resources are used sustainably and the tourism scale is controlled within the ecological capacity limits. Although fruit cultivation still directly uses land and woodland resources, it allows farmers to use marginal land or use fewer chemicals, such as fertilizers and pesticides, due to its special climate and fruit species. These new livelihoods are generally eco-friendly if they are managed in a sustainable way.

5.2.2. Have Farmers’ Motivation and Capacity for Conservation Been Improved?

A good ecological environment is crucial for new livelihoods, such as tourism and the cultivation of high-quality fruit. Therefore, local residents could share more benefits from an improved ecological environment and hence may show stronger motivations for ecological conservation. Our survey shows that of the 32 village groups that explained the reasons for the improvement in their conservation awareness, 11 (78.6%) of the 14 groups that had developed tourism believed that getting benefits from conservation was the main reason for the improvement in farmers’ conservation awareness. This proportion was significantly higher than the total of 3 (16.7%) village groups among the 18 village groups that had not developed tourism ($\chi^2 = 12.26, p = 0.001$). Among the village groups without tourism, the increase in conservation awareness was largely attributed to environmental publicity and education (83.3%), which are the traditional ways of raising awareness (Table 6). The results indicate that the development of tourism enabled local residents to share the benefits of conservation and therefore to have incentives that are compatible with ecological conservation.

| Whether village groups had developed tourism | Yes | No | Total |
|--------------------------------------------|-----|----|-------|
| Environmental publicity and education      | 3   | 15 | 18    |
| Getting benefits from conservation         | 11  | 3  | 14    |
| Total                                      | 14  | 18 | 32    |

Ecological conservation requires not only motivation, but also capacity, which is mainly related to income levels. The increase in income brought about by new livelihoods, such as tourism, has increased the ability and potential of villagers to protect the environment in many ways. For example, the increase in income has directly changed the way of life of local residents, which has reduced the consumption of natural resources, such as wood for fuel. At the same time, the increase in income has enabled village groups to pay for environmental cleaning and sanitation. In the long run, the construction of environmental infrastructure, such as sewage treatment and garbage collection facilities, has also been included in the development plans of some administrative villages.

5.2.3. Have the New Livelihoods Brought about Negative Impacts on the Ecological Environment?

It is undeniable that the new livelihoods and corresponding socio-economic development have also brought about pressure on the environment. As noted in Section 4.2, we observed trade-offs among different ecological services driven by human activities in the process of pursuing livelihoods. Changes in the type of land use caused by a change in livelihoods may give a clear explanation. Spatial statistics for land use types in 2000 and 2015 are presented in Table 7.
Table 7. Land use changes from 2000 to 2015.

| Land Use Type      | 2000 Area (ha) | 2000 Proportion (%) | 2015 Area (ha) | 2015 Proportion (%) | Change (%) |
|--------------------|----------------|---------------------|----------------|---------------------|------------|
| Horse paddock      | 0              | 0                   | 0.47           | 0.002               | -          |
| Road               | 674.68         | 2.83                | 725.47         | 3.05                | +7.53      |
| Forest land        | 14319.43       | 60.13               | 14818.48       | 62.24               | +3.49      |
| Grassland          | 1442.09        | 6.06                | 1055.66        | 4.43                | -26.80     |
| Dry land           | 2375.15        | 9.97                | 2216.22        | 9.31                | -6.69      |
| Residential land   | 299.03         | 1.26                | 644.62         | 2.71                | +115.57    |
| Irrigated land     | 3399.96        | 14.28               | 3014.49        | 12.66               | -11.34     |
| Shoals             | 378.35         | 1.59                | 367.33         | 1.54                | -2.91      |
| Lake               | 925.10         | 3.88                | 922.05         | 3.87                | -0.33      |
| Park               | 0              | 0                   | 45.61          | 0.19                | -          |

It can be seen from Table 7 that from 2000 to 2015, residential land increased by 115.57%, which was the largest increase in all type of land coverage. The land use types that exhibited the greatest decreases were grassland and irrigated land, which were reduced by 26.8% and 11.34%, respectively. Although the local water conservancy project expanded the water storage capacity, the areas of lakes and tidal flats did not increase, but actually decreased by 0.33% and 2.91%, respectively, owing to a decline in rainfall and the expansion of human activities.

The rapid rise in tourism can explain these changes in land use patterns, which cause certain potential threats to the environment. First, the trampling of horses along the lakeside destroyed the surface vegetation of the lakeside and the original landscape. Second, when the rainy season came, horse excrement flowed into the lake with rainwater, which caused a decline in the water quality and affected the type and quantity of aquatic species. Third, the increasing number of tourists brought more waste and noise, and interfered with bird habitats, but no effective action has yet been taken to mitigate these impacts.

Although the fruit forestry has not become a big concern as a negative impact in observed period, large-scale fruit cultivation could also be an unsustainable extractive activity that brings higher profits for a few years until the soil is exhausted, unless sustainable farming practices are adopted.

6. Results and Discussion

The above analysis shows that the SES in the Lashihai watershed exhibited a clear dynamic pattern. Historically, the Lashihai watershed was a traditional agricultural area with low productivity. The impacts of traditional agriculture, forestry, animal husbandry, and fishery products were low, and the pressure on the ecological environment was relatively slight. The society was self-sufficient at a low level, and the balance between the ecosystem and livelihoods was fragile. External perturbations in the form of conservation policies and economic growth triggered the evolution of the Lashihai SES along two causal chains.

As we have observed, in general, a virtuous circle between ecological conservation and socio-economic development has taken shape in some villages in the Lashihai watershed. On the one hand, the national and local ecological conservation policies have driven the livelihood transition by directly restricting the traditional way of resource utilization, while at the same time, they have stimulated the development of alternative livelihoods by providing a new resource base. The transformation of livelihoods has enabled farmers to share the benefits of ecological conservation directly and indirectly. Therefore, positive feedback has occurred ranging from ecological conservation to livelihood development. On the other hand, the substitution of traditional livelihoods by tourism and the cultivation of high-value-added fruit has released resources that were traditionally used for crop farming, which has mitigated ecological pressures. At the same time, these new livelihoods strongly rely on a good ecological environment, which enhances residents’ motivation to protect the ecosystem. The growth in income brought about by the new
livelihoods has increased farmers’ capacity for ecological conservation. Positive feedback has thus occurred from livelihood change to ecological conservation. The combination of positive feedback from both sides constitutes a complete virtuous circle between ecological conservation and livelihood development.

Whether such a virtuous circle can be initiated and the SES will evolve along this track depends on many deeper underlying factors that drive the feedback loop. We found that factors such as population, location, natural endowments, matching policies for conservation actions, governance structure, and social capital all had important impacts on the formation of the interactions between ecological conservation and livelihoods.

First, population pressure, especially external population pressure due to the development of tourism in Lijiang, was the main driving factor that initiated the continuous evolution of the causal chain between ecological conservation and livelihoods in the Lashihai wetland. The rapidly increased number of tourists exacerbated the scarcity of water resources, which directly led to the establishment of the water conservancy project and the FWCP. This project reduced the area of cultivated land and resulted in conflicts between the population and the land. Therefore, the original balance between the ecosystem and livelihoods in the Lashihai area was broken. The conversion of traditional agriculture to tourism acted as a way to seek a new balance between the ecosystem and livelihoods, which reduced the demand for land resources for cultivation on the one hand, but on the other hand, further stimulated the development of tourism in the Lashihai area, which posed new threats to the ecosystem of the Lashihai wetland.

Second, whether a virtuous circle can be established largely depends on whether the affected communities can successfully convert their livelihoods from vulnerable traditional livelihoods to emerging eco-friendly livelihoods. If no successful conversion is achieved, conservation policies are likely to restrict the utilization of resources and therefore lower income levels. In contrast, if the conversion is successful, ecological conservation may have a positive impact on income levels. Whether a suitable livelihood can be developed is further determined by natural endowments, as well as the capacity for conservation. As mentioned before, in the case of the villages near the lake and closer to the tourist market, although the area of farmland was reduced as a result of conservation, the recreational value of the wetland increased significantly due to the tourist market, and the potential for developing tourism is very high. However, in the remote areas affected by the SLCP, it was difficult for farmers to convert the pressure from land loss caused by conservation into opportunities for the development of tourism, and the benefits of ecological conservation cannot be captured by the affected groups.

Third, favorable matching policies for conservation actions will mitigate the negative impact of conservation and further boost livelihood development. For various conservation actions, different matching policies have been introduced to mitigate the negative impact on farmers’ incomes. For example, in the Lashihai watershed, the FWCP was a local compensation policy that paid about 10,500 RMB/ha, with a 750 RMB increase every five years, to farmers who lost cultivated land due to the expansion of the wetland. Local government has signed land leases with farmers to guarantee this commitment, which can compensate farmers for direct losses of income caused by reduced land and release redundant labor to develop alternative businesses. Another compensation policy was introduced as part of the national SLCP, with a subsidy of RMB 3750 RMB/ha in 2003–2011 and 1875 RMB/ha after 2012, which is far less than the income loss experienced by farmers, and there was no mention of boosting a smooth transition to new livelihoods. It is difficult to adapt such a top-down policy design to the local situation and make it an integral part of an adaptive management system.

Finally, the formation of a virtuous circle depends on the local governance structure and the amount of social capital. The Lashihai area is a region where ethnic minorities have gathered. Its tourism organizations employ a typical model of self-governance, which is supported by abundant social capital and highlighted by the cooperative operation of their tourism businesses and co-management of common pooled resources within the village groups. Our previous study found that if villagers’ organizations are relatively complete or more highly developed, it will be easier for villagers to use natural resources effectively to achieve sustainable development [38]. Our survey
statistics from 2015 also provide supporting evidence that about 60% of the village groups that had formed villagers’ organizations within the villages had developed tourism, whereas only 22% of the village groups without such organizations had developed tourism. The societies self-organize, learn, and adapt after perturbations, and increase their capacity to adjust to disturbances and reorganize while undergoing change [44,58].

In addition, it should be noted that the virtuous circle between ecological conservation and socio-economic development in the Lashihai area also faces some potential threats, of which one is the imbalance in the distribution of income. The villages in Lashi Township near the lake have already formed a virtuous social-ecological circle, while the villages far from the Lashi Lake are not yet in a positive feedback loop and need the government or other agencies (such as NGOs) to provide support to boost their livelihood transitions. A second threat is that the rapid development of new livelihoods has brought about some new pressures on the ecosystem, which requires appropriate regulatory interventions to ensure they are run in a sustainable way. Third, with the increase of income, the lifestyle of local residents is also changing from a traditional pattern to a high-consumption and high-discharge pattern, which also poses a potential threat to the ecosystem. In other words, the current virtuous or vicious cycle is a short-term one rather than a long-term one.

7. Conclusions

The main contributions of this paper are to propose a conceptual framework for examining the nexus and its dynamics between ecological conservation and economic development in a SES, and to explain the pathways and mechanisms of influence between these two processes in the real case of the Lashihai watershed. With this semi-quantitative empirical analysis, we observed trade-offs among different ecological services driven by human activities in the process of pursuing livelihoods, as well as transformations of livelihoods driven by conservation practices. Some insights can be derived such that other countries and regions may promote conservation and better livelihoods in conjunction.

First, the ecosystem and socio-economic system closely interact with each other and form a dynamic evolution. Both conservation practices and economic growth can act as perturbations that drive the evolution process, but the interactions between the ecosystem and socio-economic system may determine the direction of evolution of a SES along a virtuous or a vicious feedback loop.

Secondly, although conservation actions have limited the utilization of resources, in general they have also provided a resource base for the development of alternative livelihoods, which generated income for the local communities, enabled them to share the benefits of ecological conservation, and motivated them to invest more in conservation. This indicates that the SES in the Lashihai watershed underwent a generally positive evolution. However, such trends are still fragile and unstable. If negative factors, such as an uneven distribution of income or new ecological pressures, cannot be effectively alleviated or controlled, they would be very likely to break the positive feedback loop and start a vicious circle.

Third, the key mechanism in the establishment of a positive feedback loop in a SES largely depends on whether the affected communities can successfully convert their livelihoods from vulnerable traditional livelihoods to emerging eco-friendly livelihoods. Ecological conservation practices have restricted traditional livelihoods, but such pressure could be converted into an impetus for future development if adaptive changes in livelihoods could be successfully promoted.

Fourth, government should play an important role in balancing the multiple objectives of managing the complex SES by promoting conservation actions to guarantee that environmental targets are met, facilitating communities in capturing the benefits of conservation, and providing a clear regulatory base to ensure that the development of local communities’ livelihoods will not exceed the limits of the ecological capacity.

Finally, each system and each state of a SES is unique, and hence there is no one-size-fits-all “win-win” solution. It is worthwhile carrying out long-term monitoring and observations of changes in both the ecosystem and the social system to understand the interactions between them and their evolutionary trends.
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