

Review

Telecoupled Sustainable Livelihoods in an Era of Rural–Urban Dynamics: The Case of China

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Abstract: Recently, increasingly sophisticated studies have investigated the relationship between agrarian livelihoods and the environment, as well as rural–urban interactions in developing countries. The policies developed to respond to these dynamics can constrain livelihood options or provide additional opportunities. In the present study, using a modified version of the telecoupled sustainable livelihood framework to generalize dynamic livelihood strategies in the context of rural–urban transformation and by focusing on recent research in China, we review important factors that shape rural livelihood strategies as well as the types of strategies that typically intersect with livelihood and environmental dynamics. We then examine telecoupled rural–urban linkages given that the dynamics of the livelihood strategies of farmers can cause flows of labor, capital, ecosystem services, and other processes between rural and urban areas, thereby placing livelihood strategies in a dynamic context, which has not been considered widely in previous research. We show that most previous studies focused on the reduction of environmental impacts via livelihood diversification and rural–urban migration. We propose several areas for future policy development and research.

Keywords: dynamic livelihood strategy; telecoupling; ecological effect; ecosystem service; rural household livelihood; rural–urban linkage; sustainable livelihood

1. Introduction

The livelihoods approach was pioneered in the late 1990s [1–4] as a holistic and people-centered analytical framework that increases our understanding of the complex and differentiated processes that construct livelihoods. The livelihoods approach also offers guidance regarding policy interventions that aim to foster sustainable livelihood strategies [5]. Livelihood strategies selected by households have important implications for exploring the relationships between the agrarian economy and the environment. In general, household livelihood strategies include a variety of choices, such as rural–urban migration, agricultural production strategies, biomass utilization, fertility decisions, and the use of land resources. These multiple livelihood strategies do not exist independently, but instead occur in combinations. Thus, households can pursue a combination of activities to assemble a diverse livelihood portfolio [3]. For example, due to advances in rural industrialization, urbanization, and agrarian development, the traditional farming options, such as cropping and livestock cultivation, are no longer the only ways to make a living, where aquaculture, forestry, seasonal

wage labor, and entrepreneurship are alternative options. In addition, these developments have changed decision-making processes regarding agricultural production and the utilization of natural resources in agrarian households, with impacts on nearby and downstream environments.

The present review considers the context of urbanization and rural–urban transformation in China. Since economic reform beginning in 1978, China has experienced rapid economic and social development, with accelerated industrialization and urbanization, increasing from 17.9% urbanized in 1978 to 57.35% in 2016 [6]. Urbanization can significantly transform the livelihoods of rural households [7]. Livelihood diversification and outmigration for work are increasingly important livelihood strategies that rural households employ to reduce the vulnerability and dependency on natural resources, and these decisions can directly impact agricultural production, rural economies, and local environmental conditions [8]. For example, changes in livelihood strategies in rural areas can lead to deforestation, soil erosion, biodiversity losses, the increased use of chemicals in crop production, and desertification [9,10], which all have subsequent impacts on communities [11]. These issues are complex, and livelihood strategy choices can also be driven by macro-level factors, such as national markets and policy, which may create opportunities and constraints at the local level [12]. In order to promote improvements in the quality of life while also supporting ecosystem health, we need a more nuanced understanding of the impacts of agricultural production, livelihood diversification, usage of natural resources, family planning strategies, and other livelihood strategies.

To date, numerous livelihoods frameworks usually focus on a particular place with little attention to the impacts of distant interactions in multiple places. The telecoupling framework, which refers to socioeconomic and environmental interactions over distances, has produced useful insights in sustainability studies [13,14]. Here, we regard rural and urban as two different socioeconomic and environmental systems, and this review contributes to our understanding of telecoupled rural–urban interactions of household livelihoods in three main areas. First, we focus on the dynamic relationships between livelihood strategies and rural–urban linkages. Second, we highlight the complexities that occur due to increasing urbanization and urban migration, as well as the telecoupling links and dynamic interactions between urban and rural areas. Urban livelihoods have been studied widely [15–18], but there has been little previous consideration of the subsequent rural–urban linkages that occur as consequences of changes in livelihoods and their links with sustainability. Finally, the majority of our empirical examples are based on a Chinese context, but we ground our review in international interdisciplinary livelihoods research, thereby highlighting the unique variety of livelihood conditions and rapid urbanization in China. In addition, a sufficient number of studies have now been conducted in China to warrant a dedicated review.

Our overall goal is to provide a better understanding of how to foster telecoupled sustainable livelihoods in the context of urban–rural dynamics. To meet this goal, we have three specific objectives: (i) broadly summarize the context, opportunities, and constraints that affect household livelihood strategies in the context of urbanization; (ii) describe how livelihood activities on the landscape scale can influence the flows of labor, capital, ecosystem services, and other processes between rural and urban areas; and (iii) analyze the feedback between policy and household livelihood strategies.

2. Framework for Assessing Household Rural–Urban Dynamic Livelihood Strategies

Livelihood strategies comprise the activities and choices that people make in order to achieve their livelihood goals, which can include production activities, investment strategies, and reproduction decisions [19]. Livelihood strategies can also be understood more simply as ways of making a living [20]. Farming is still the main productive activity in rural areas [21,22], but rural households in poor countries are increasingly adopting a range of strategies to make ends meet because diversification helps to minimize risk [3,23], as well as serving as a response to changing markets, politics, or cultural identities [24–26].

Formal and informal organizational and institutional factors influence sustainable livelihood outcomes [4]. Here, we present a telecoupling framework for conceptualizing rural–urban dynamic

livelihoods in the context of rural–urban transformation and we then examine the rural–urban linkages given that dynamic changes in the livelihood strategies of farmers lead to dynamic flows of labor, capital, ecosystem services, and other processes between rural and urban areas [14].

Figure 1 provides an outline of the conceptual approach employed in this study. The left-hand side of the framework shows the effects of the rural system, whereas the right-hand side shows the main effects of the urban system. Arrows indicate the direction of interactions. From the bottom to the top, we first recognize causes that produce telecouplings between rural and urban systems, that is, the key factors that drive the dynamic changes in the livelihood strategies of farmers, which are mainly conditioned by the physical context, household assets, urbanization, institutions, and organizations. In the context of rural–urban transformation in developing countries, great changes have occurred in terms of the livelihood strategies of rural households, where non-farm employment and rural-to-urban labor migration have replaced traditional agriculture production as the two main routes that allow households to diversify their livelihood sources. These dynamic changes in livelihood strategies may induce telecoupled rural–urban interactions, which are reflected by flows in terms of the population, ecosystem services, finance and information, and job opportunities between urban and rural areas. We could consider these distant interactions as feedbacks. Furthermore, policies should also be useful feedbacks to guide rural–urban systems toward sustainability.

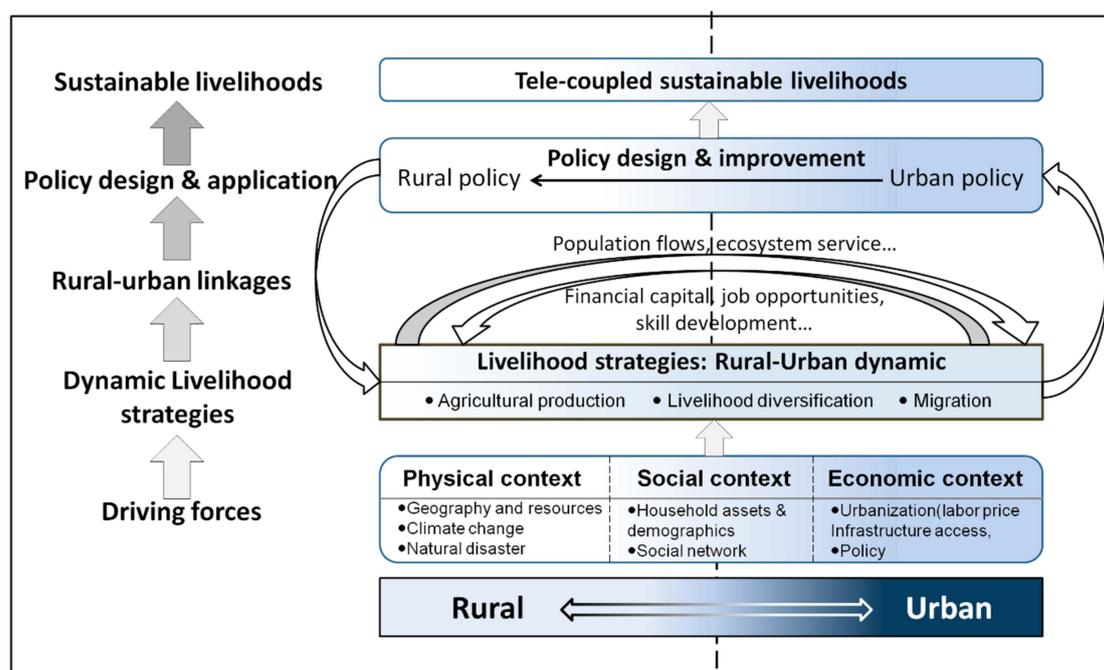


Figure 1. Telecoupled sustainable livelihoods in the era of rural–urban dynamic changes.

Many previous studies have investigated each of these components, but they are far too numerous to cover comprehensively. In this paper, we use the framework to highlight notable empirical studies that illustrate each of the components. First, we summarize multiple causes of telecoupling in Section 3, and then discuss the telecoupled rural–urban dynamics of livelihood strategies in Section 4. Next, we examine the effects of telecoupling processes as well as feedbacks between rural and urban areas in Section 5. Finally, in Section 6, we summarize our findings and provide conclusions regarding the potential paths for shaping sustainable livelihoods in rural China.

3. Factors that Drive Dynamic Changes in Livelihood Strategies

Household livelihood strategies and the individual availability of assets are fundamentally constrained by the context in which they are located. The basis of building sustainable livelihoods

is recognizing the key factors that drive the dynamic changes in the livelihood strategies of farmers. Changes in the physical context (such as climate, natural disasters, and natural resource endowment) determine the dynamic changes in the livelihoods of farmers. Thus, in addition to considering the effects of natural disasters and ecological degradation on household livelihoods, we also investigated how changes in the socio-economic context, such as large-scale urbanization, rapid economic growth, economic globalization, and population flow, might combine with the physical context to determine household livelihood strategies and resource utilization patterns.

3.1. Changes in the Rural Physical Context to Telecoupled Livelihoods

3.1.1. Geography, Resource Endowments, and Resource Constraints

The geographical locations of households determine the immediate resource endowments and constraints, and thus the possible livelihood activities that are available to households [4,27]. Most rural households depend on ecosystem services as the foundation of their livelihood activities, and the location tends to determine the supply of possible ecosystem services [28,29]. For example, a household located near the sea will adopt a very different set of livelihood strategies compared with a household in a mountainous area. In China, ecological migration policies have moved whole communities from areas that are considered dangerous (e.g., vulnerable to landslides) or ecologically sensitive to new rural, urban, or peri-urban housing, thereby combating poverty and protecting sensitive or important ecological areas, particularly in poor, remote, and environmentally fragile regions [30]. In general, households lack the skills required to find off-farm work in these new locations and economies, and social capital is often lacking. Migration generally improves the likelihood of ecological restoration in the area of origin, but, after migration, rural residents often find themselves in a vulnerable situation, at least in the short term, such as having no land or land of inferior quality. Thus, rural residents must face many difficulties when transitioning their livelihoods into a new economic environment [31]. New livelihood activities may even lead to net ecological damage in these destination areas and the environmental impacts of ecological migration can vary across different regions [32]. Studies have shown that the centralization of population and livestock due to these policies can increase the environmental pressure in the receiving areas [33].

3.1.2. Environmental Risks

The environmental risks imposed on household production factors, such as land, natural and financial capital, and labor are the main determinants of livelihood strategies [34,35]. These risks affect such decisions as where to locate a residence, whether to engage in agriculture, and the social relationships that need to be maintained.

In China, the eco-environmental deterioration in rural areas has not been controlled effectively. The main problems due to environmental risks comprise scarce water and cultivated land resources, climate warming, frequent natural disasters, soil erosion, and decreases in agricultural biodiversity, which can impose significant constraints and disrupt households, and thus these risks affect how households make decisions about their livelihood strategies. For example, the 2008 earthquake that occurred in Sichuan, China is a classic example of the impacts of these types of low-probability and high-risk events. Guo et al. [36] assessed how the 2008 earthquake affected a community in western Sichuan that experienced tremendous losses in terms of the livelihood resource base, including detrimental impacts on arable land, forests, and local mines, thereby resulting in great reductions in planting acreage and breeding stock, as well as severe job shortages.

Similar studies have focused on the risks and vulnerabilities associated with global climate change [37–39]. These fundamental risks also impact the incentives for adopting and investing in certain types of livelihood strategies, and climate change risks will vary between regions and populations [40,41]. For example, in rural mountain communities in Nepal, climatic risks are major hazards for livelihood resources, and households are often compelled to sell financial capital, such as

seed stock and livestock, or to sell their own labor in the local community (and seasonally in India) to cope with livelihood challenges [37]. Similarly, Liu et al. [42] showed that the climate change risks for communities in Inner Mongolia (China) shape the household livelihood strategies in a different manner in pastoral areas compared with farming areas. It was also shown that farmers in this region respond to climate change in different ways in terms of accessing credit, seeking non-farm employment opportunities, and alternating crop varieties. The findings of these studies demonstrate the role of the socio-economic context in livelihood strategy choices.

3.2. Changes in Socio-Economic Context

3.2.1. Household Assets and Demographics

The household structure, gender, and health play important roles in determining decisions regarding household livelihood strategies. Inherited factors, such as land and housing, may influence these factors, but they may also mediate the accessibility of public or private services, such as education and access to credit [43]. Household-level demographic factors can affect the distribution of household capital, such as land, resources, and labor, that are available for various livelihood activities, including production and child-rearing activities, thereby influencing the possible set of strategies that a household can employ to earn a livelihood [43]. For example, younger and better-educated household members have better access to off-farm opportunities, whereas those with limited education, skills, or social capital are more likely to engage in agriculture as a source of livelihood [44]. In addition, gender can play a significant role in family livelihood strategies, often via embedded cultural notions of what constitutes female work versus male work [45]. Furthermore, increases in female participation in household production activities generally reduce household birth rates, thereby affecting the nature and type of livelihood strategies undertaken by households [46].

3.2.2. Social Capital

Social capital comprises the resources (networks, social claims, social relations, affiliations, and associations) that people exploit when pursuing different livelihood strategies that require coordinated actions [4]. Social capital was first proposed in sociology as an important form of capital that affects economic behavior and performance, where there is a focus on the importance of social interactions between individuals or individuals and groups. According to previous studies of rural household livelihoods, social capital also has important effects on better livelihood outcomes, educational achievement, migration, and coping with natural hazards, disasters, and climate change. For example, local traders and migrant relatives with access to urban centers can provide more information regarding markets and job opportunities, thereby helping households to engage in multiple livelihood activities [47].

3.2.3. Urbanization (Infrastructure Access and Job Opportunities)

Increased rural development can help to create more non-farm employment opportunities, but small-scale operations must also be monitored to ensure their compliance with environmental regulations. Some recent studies indicate that urban growth, the related demand for service workers in urban areas, and the development of manufacturing industries in peri-urban areas are significant drivers of increases in off-farm employment, where they have strong effects on rural household livelihood strategies [48]. Infrastructure, such as roads and utilities, facilitates more complex forms of economic development. Households with access to infrastructure are also more likely to have opportunities to integrate with the market, adopt various forms of productive technology, and participate in commodity trading [49]. For example, in China, rural public investment in programs that promote infrastructure development, such as the “Open up the West” campaign [50], gives rural workers access to labor markets and opportunities for livelihood diversification.

3.2.4. Policy

Rural household livelihoods in China are affected by a variety of policy changes and institutional factors, which are often conducted to simultaneously alleviate poverty and further conservation objectives. In the following, we review several policies that aimed to mitigate environmental externalities by regulating or promoting different livelihood activities.

- Agricultural policy

In recent decades, world grain yields and the diffusion of agricultural technology in developing countries have improved greatly. However, modern agriculture also depends on large inputs in terms of labor, land, and nutrients, which also generate environmental issues [51]. Thus, the continued extension of agriculture into marginal areas is not sustainable, and an approach is required that can build new foundations for feeding the planet [52] while also improving local food security [53]. Food security and rural livelihoods are often supported through subsidies and assistance programs, which are usually designed to help farmers adjust their management of agricultural resources. In China, traditional price supports are in place [54,55], but the agricultural policies also include subsidies and incentives for farmers to help them transform abandoned cultivated land into timber-producing forest land, as well as encouraging agricultural land transfers, increasing the scale of agricultural operations, and adopting agricultural technology [56–58]. For example, China has implemented several large-scale national programs with the goal of improving rural livelihoods and mitigating environmental degradation, particularly the Grain for Green Program [59]. These types of policies can directly change land use, restore large quantities of marginal steep-sloped or sandy lands with severe soil erosion and low food production into forests and grasslands, and help free up the household labor that was previously applied in agriculture, thereby ultimately supporting livelihood diversification strategies [60]. These changes have resulted in dramatic increases in vegetation and forest cover to sequester carbon and help control soil erosion and nutrient losses [58–61].

- Natural resource management policies

Natural resource management policies can promote livelihood strategies that make direct use of resources, such as timber harvesting or clearing land for agricultural or other land uses. For example, in China, two main national policies have shaped the access of rural residents to forest resources: the National Forest Protection Program and the Forest Ecosystem Compensation Fund [62], which limit the use of forests mainly in the headwaters of the Yangtze River and provide compensation for communities to maintain large areas of intact forest, respectively. In northwest Yunnan, a logging ban imposed by the National Forest Protection Program dramatically changed the livelihood activities of local villagers [63,64], where many villages transitioned to heavier reliance on NTFPs (non-timber forest products), thereby highlighting the novel need for the proper management of these diverse resources [65,66]. NTFPs can promote sustainable livelihoods by improving incomes while also creating a system based on the sustainable harvest of natural resources, with minimal impacts on other regional or global ecosystem services [67,68]. Another main route that allows for livelihood strategies to intersect with natural resource policy is through the need for access to energy sources, particularly in rural areas. Transitioning fuel use from locally sourced biomass to cleaner burning energy sources is important for both health and sustainability [69,70]. Raw coal use has been greatly reduced in urban areas (and banned in some cases), but it is still the dominant form of fuel consumption in the rural regions of China [71,72]. In the most recent 11th and 12th Five Year Plans, China set targets with the aim of promoting a transition from heavy reliance on coal to pelletized biomass use [73,74]. Additional efforts have focused on the development of biogas, solar, and other types of clean energy production in rural areas, especially in ecologically fragile regions. These efforts could help facilitate a change in the structure of rural household energy use [75].

- Payment for ecosystem service programs

In China, the government has implemented a number of payment for ecosystem service programs, which are domestically referred to as eco-compensation programs. A previous review of these programs summarized numerous national and provincial level programs focused on water resources, forests,

soil, ecological agriculture, carbon, and other types of resources [62]. Some of these programs are best characterized as national-to-provincial government transfers that sometimes only indirectly impact household livelihood strategies. Others provide direct payments to households with the aim of changing decision-making through payments. These payments for ecosystem service programs have been studied widely [76,77]. Two of the largest and most well-known examples in China are the Natural Forest Protection Program and the Grain for Green Program [78]. These types of ecological policies change household livelihood capital and land-use patterns, thereby reducing livelihood activities that rely on land resources and promoting the transition of agricultural labor to non-agricultural sectors [59,60,79,80].

4. Dynamic Household Livelihood Strategies and Consequences

Based on the underlying physical, social, and cultural context where households are positioned, livelihood strategies are selected to maximize the utilization of the available options (see the base of Figure 1). In the context of urbanization in China, farming is still the main productive activity in rural areas, but livelihood diversification and outmigration for work are becoming increasingly important livelihood strategies for rural households, where they can reduce the vulnerability of livelihoods and the dependency on natural resources. These livelihood strategies have direct implications for how households accumulate or dispose of different types of “capital” [5,81], as well as the resulting changes in the local environment and ecosystem services (see the middle section in Figure 1), which are considered in the following.

4.1. Agricultural Production

Agricultural production processes ranging from primitive methods, such as slash-and-burn farming, to the development of modern agriculture have always been the focus of research into rural livelihoods and land use. In the broader physical, social, and cultural context, households adopt various agricultural production strategies, which can be broadly categorized as *extensive* or *intensive* agriculture. Extensive agricultural strategies are agricultural production systems that use low inputs in terms of labor, fertilizers, and capital relative to the farmed land area. Intensive agriculture strategies are characterized by a low fallow ratio and the higher use of inputs, such as capital and labor, per unit land area compared with traditional agriculture [82]. Potential environmental tradeoffs are embedded in each of these systems, which have been addressed in the land sharing versus sparing debate [83,84]. In the following, we focus on links with livelihoods.

4.1.1. Extensive Agriculture Strategies

In some regions, livelihood strategies aim to expand agricultural production at the extensive margin, especially in areas where the soil fertility or water availability is marginal, land rights are weak, or prices for agricultural products remain attractive [85]. For example, herdsman may not adopt intensive grazing strategies before forests have been depleted, even if pasture intensification is technically possible [86]. When expansion encroaches on marginal lands, extensive agricultural expansion can have negative impacts on the land quality and environment. For example, in China, much land is farmed on excessively steep slopes in order to decrease the amount of “wasted” land and increase the area under cultivation. This type of expansion increases soil erosion and exacerbates land degradation [87], and this also extends to grassland systems because herders grazing livestock on marginal lands can increase desertification and limit other ecosystem services provided by grassland [88], such as plant biodiversity and habitat maintenance [89].

4.1.2. Intensive Agriculture Strategies

Agricultural intensification strategies increase the per-unit-area investment in agricultural land with the aim of increasing agricultural productivity [90]. These strategies are applied to a wide range of activities, including investing in farmland capital construction, developing irrigation, increasing

fertilizer application, increasing inputs to marginal lands, adopting new agricultural techniques, using improved crop varieties, and implementing mechanized farming. Agricultural intensification is a basic approach for improving food security and avoiding inefficiencies, and it is often considered one of the most effective approaches for improving environmental conditions [89]. However, excessive intensive agricultural practices generally have adverse effects on the rural environment. For example, China is now the world's largest pesticide producer and exporter and the largest fertilizer consumer in the world, where it accounts for 32% of the world's total consumption of synthetic N [91–93]. The overuse of pesticides and fertilizer creates many environmental problems, such as water pollution, nitrate pollution in agricultural products, soil hardening, biodiversity declines, and air pollution, all of which threaten sustainable development [94].

4.2. Livelihood Diversification Strategies

Livelihood diversification is defined as: “the process by which rural households construct a diverse portfolio of activities and social support capabilities in order to survive and improve their standards of living” [20]. Many studies have demonstrated that rural households in developing countries no longer depend on a single resource or type of asset for their income-generating activities but instead farmers tend to engage in a range of activities to meet their living needs, where this process is often referred to as diversifying their portfolio. Households often cope with adversity in terms of livelihood by employing strategies that aim to smooth consumption or asset use (i.e., maintaining levels of consumption and assets even if one's income stream receives a “shock” or fluctuates) [95,96], increasing income levels, and improving rural infrastructure and education in order to cope with deteriorating conditions [20]. In developing countries, rural households tend to diversify their livelihood sources via two main methods: local off-farm employment and rural–urban migration, which can have complex effects on the rural environment due to changes in land use, the energy structure, income, and consumption.

Increasingly, rural labor that was typically bound to the agricultural sector is being transferred to non-farm industries, such as manufacturing, services, and business [3]. In particular, China has a long history of this process through the development of “township and village enterprises” since the 1970s, which contributed greatly to economic growth and a more controlled pace of urban migration [97,98]. Non-farm employment is an important strategy that helps rural households to reduce the vulnerability of their livelihoods and the dependency on natural resources [99]. However, although non-farm employment tends to reduce the dependency on local environmental resources for livelihoods, the overall net impact on natural resources depends on the type of non-farm activity to which farmers switch and the type of farming in which they were previously engaged. For example, research has shown that the location of non-farm employment for farmers significantly affects ecological recovery on mountains in rural areas [100]. Local enterprises often improve the welfare of rural residents and have been credited with the early efforts that brought much of rural China out of poverty [101,102]. However, due to inappropriate policies and imperfect laws and management, studies have shown that the pollution emissions from townships and village enterprises accounted for more than 30% of the total national emissions [103], which has placed tremendous pressure on the rural environment.

4.3. Outmigration for Work

Outmigration for work where rural residents move to urban or other rural areas for jobs (permanent or temporary) has been a significant feature of China's economic development since the mid-1990s [104]. The effects of rural residents seeking opportunities on the local environment can be complex, but they are mainly conditioned by the responses of the family that remains on the land or the usage of natural resources after migration [46]. Some labor-migrant households will leave their land idle or transfer part of their land to other households or agencies [105]. Previous studies have shown that land transfer and abandonment can lower the production per capita of land, which may negatively affect the stability of agricultural production [106,107], and others have demonstrated that the return of land cover to forest

or grassland [108] can reduce the intensity of land utilization to ease the pressure on local ecosystems and help promote ecosystem recovery [109,110].

5. Rural–Urban Linkages and Dynamic Changes in Livelihoods

Due to the driving effects of the physical context and social-economic context, the living style of rural households has changed gradually from conventional agriculture to skilled non-farm employment. These dynamic changes in livelihood strategies may induce telecoupled rural–urban interactions, which are reflected by flows in terms of the population, ecosystem services, finance and information, and job opportunities between urban and rural areas.

5.1. Urban to Rural Flows

5.1.1. Financial Capitals

In some cases, the migrating individuals who work in urban areas send remittances back to their household of origin, especially in the cases of temporary, periodic, or seasonal migration, where these financial capital inflows are important for rural areas. Migration and remittance payments contribute to improvements in the household income and the accumulation of family capital, but these changes in income and consumption activities can also affect the environment in the rural areas of origin. Thus, remittances may help to de-intensify the use of land and resources. Some studies also indicate that the income from remittances may finance household assets to improve the standard of living, such as electricity, food, and consumables, rather than funding productive investments, such as education [111]. Remittances may also help households invest more into conservation efforts, such as improving soil fertility [105]. However, the households that receive remittances may engage in investment activities that have negative impacts on the environment. For example, in grazing areas, cash may be “stored” in animals as wealth [112] and the herd sizes could increase above the levels that can be supported by the local environment [113–115].

In addition, social organizations for those from urban areas can provide microcredit services and information regarding market prices to farmers. A previous study showed that these rural–urban linkages can strengthen the financial capital for rural households and improve the rural economy, thereby facilitating the construction of healthy and orderly marketing environments [116].

5.1.2. Skills Development and Job Opportunities

Economic opportunities attract farmers toward urban areas to search for better paid non-agricultural jobs [117]. However, a phenomenon where “rural–urban migrant workers return to the countryside” has appeared in China since the beginning of the transfer of the rural labor force. Thus, some rural–urban migrant workers have returned home with the information, skills, and financial capital obtained from working in urban areas in order to start new ventures. Therefore, these production and operation activities facilitated the development of skills, as well as bringing employment to rural areas [118].

Thus, remittances from migrants, information regarding markets and consumer preferences, and the return of migrants with new skills have contributed significantly to economic development, as well as having environmental impacts and changing the style of livelihood in rural areas.

5.2. Rural to Urban Flows

5.2.1. Population Flows

Rural communities in developing countries are facing rapid population declines caused by the outmigration of youths [119] and China is no exception [120]. Population migration can relieve environmental pressures in the areas of origin but it may have less ambiguous negative impacts on the recipient locations. Migration changes the reliance on the environment from local rural dependency

to reliance on environmental resources through trade, spatial material flows, and interconnected globalization. According to the “ecology of cities” viewpoint [121], the marginal ecological impact of a person on a rural area must be assessed based on a comparison with the impact of adding that additional person in an urban area.

5.2.2. Ecosystem Service Flows

It is well-known that agricultural production activities in rural areas can provide ecosystem provisioning services to urban residents, such as food, raw materials, and medicinal resources. In addition, changes in rural household livelihood activities may influence the quality of the local environment via the utilization of natural resources, thereby feeding back from rural to urban areas in the form of ecosystem service flows.

Residents in rural areas tend to use natural resources directly for at least some of their livelihood. For many people, especially those in developing regions, their basic food and energy requirements are highly dependent on the supply of natural ecosystem services [122]. Other regional-level uses of natural resources might include the contribution of the landscape to safe and adequate water for agriculture and human or livestock consumption, amenity values derived from the landscape that contribute to tourism, or other livelihood uses. Livelihood strategies that depend on these regional landscape-scale goods suffer from a collective action problem [123–125] and a policy problem because the value of these services is often not recognized [126]. However, as incomes, non-farm employment opportunities, and migration increase, the cost of agricultural labor also increases. Thus, the supply of agricultural labor should decrease with a reduction in the intensity of land use. Agricultural land, especially marginal land, such as farmland on steep slopes, will be abandoned or rented to other labor-abundant families; therefore, only high-efficiency land will be intensively cultivated. Abandoned land is conducive to ecological restoration [109,127]. In addition, livelihood diversification and engagement in non-farm employment appear to generally decrease the usage of biomass. Diversification usually reduces the engagement in agricultural and livestock activities by farmers, as well as reducing the availability of crop residues and animal dung for fuel. Moreover, as regions develop rural labor markets, the opportunity costs for fuel wood collection may increase; however, due to market integration and increased income, the purchasing power for commercial energy may also increase for households. These factors enhance the opportunities for commercial energy and clean energy substitutes to replace traditional biomass sources in the daily lives of farmers, where this process may be a source of local ecological restoration [75]. This is also one of the underlying tenets of forest transition theory, which describes how forests undergo a period with a transition from net deforestation to net reforestation [128]. Moreover, the ecological protection policies implemented by governments have regulated household livelihood strategies and their environmental impacts, and yielded considerable environmental benefits, such as increasing vegetative cover, enhancing carbon sequestration, and protecting ecosystem services [129]. These changes will eventually lead to the flow of ecosystem services across space and time.

6. Conclusions

The integrated telecoupled sustainable livelihood framework provides a new analytic approach to understanding the telecoupled rural–urban dynamics of livelihood strategies. The livelihoods of Chinese rural households are undergoing transformations due to urbanization. First, the rapid development of the urban economy had led to a wide prosperity gap between urban and rural areas. Thus, increasing rural income and reducing the rural–urban gap remains a major challenge for the Chinese government [130]. Second, the dynamic changes in livelihood strategies in China have caused multi-scale environmental issues, and it is necessary to reduce the environmental impacts of household livelihood strategies in rural areas. To achieve a “win-win” solution comprising the promotion of human well-being and ecological conservation, it is imperative that decision-makers

evaluate the sustainability of livelihoods at the household scale as well as assessing the sustainability of development activities at the regional scale [33].

Non-farm employment and rural-to-urban labor migration generally lead to improved revenues, a reduced dependency on natural resources, and decreased pressure on rural environmental conditions. Therefore, rural environment management policies should aim to provide favorable institutional conditions to promote diversification and migration. For example, non-farm activities are relatively rare in remote rural areas due to the poor transportation infrastructure and shortage of skills, so policies that promote infrastructure and skills development may reduce the pressure on rural areas. However, studies have also shown that the development of township and village enterprises may lead to severe pollution or the environmental burden may simply shift to new locations, where the net effect on various resources has not been assessed. Therefore, small-scale operations must also be monitored to ensure their compliance with environmental regulations [131].

In addition, the policies or rural development programs in China, such as “Building a New Countryside”, can enhance investment in rural infrastructure and promote a civilized social atmosphere, which plays an important role in tourism development in rural areas [132]. Recent developments in nature-based tourism have demonstrated the potential for attracting markets to rural areas, thereby helping to reduce poverty in areas with special environmental amenities. Ecotourism is ostensibly founded on the value of a natural landscape and this type of market generally has a positive effect on ecological protection, especially in nature reserves and biodiversity-rich areas [100], although negative examples are certainly known for sensitive areas [133,134]. However, it is hoped that nature-based tourism will not transform the way farmers use natural resources, as well as promote the sustainable use of resources and increase incomes for farmers.

The future research identified in our analysis of previous studies may consider the effects of livelihood strategies on the environment at different scales and locations. Previous studies have focused on the influence and dependency of household livelihood strategies on the local environment, but little attention has been paid to the ecological effects of these activities at different scales. Thus, more focus is needed on the teleconnections comprising the socio-economic and environmental interactions between distant geographic places [135], which require assessments of trade flows [136] and the relationships between micro- and macro-scales [4]. In the context of urbanization and growing rural–urban migration, we need a better understanding of where to invest in land conservation in order to support local livelihoods, and where development objectives can be achieved while minimizing the impacts on local communities [137]. For example, many studies have shown that migration to urban areas may reduce environmental pressure on the areas of origin. However, migration also transfers environmental pressure into the “labor inflow” areas. The net effects of these transitions from a regional perspective have not been well-studied.

Studies about rural–urban dynamics livelihoods in China have mainly focused on regions with high levels of urbanization, such as Beijing and its surrounding areas [138,139], the Cheng-Yu urban agglomeration [105], the Yangtze River Delta urban agglomeration [127], and the Pearl River Delta urban agglomeration [140], or regions where payments for ecosystem services (PES) programs are implemented [51,99]. It is necessary for decision-makers to consider the regional differences in the implementation of policies. For example, great regional differences have been reported in the changes in household livelihoods after the implementation of ecological compensation projects, where these differences were affected by many factors, such as the natural environment, resource endowments, socio-cultural practices, household livelihood capital, and the original livelihood style [79]. Moreover, it would be worth considering how to mark specific parts of telecoupled phenomena on the regional scale or national scale, and make geography-based classifications of Chinese regions by the association of causes and effects of telecoupling.

In conclusion, the research community should focus on the factors that influence household livelihood strategies and how they are related to the ecological and environmental conditions in the

current urbanization context. Policies that support positive rural–urban linkages are needed to inform rural sustainable development and to create a diverse set of sustainable livelihood activities.

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