frontiers | Frontiers in Environmental Science

TYPE Original Research
PUBLISHED 22 March 2023
DOI 10.3389/fenvs.2023.1116742

OPEN ACCESS

EDITED BY
Fengtai Zhang,
Chongqing University of Technology, China

REVIEWED BY
Chao Zhang,
Institute of Geographic Sciences and Natural Resources Research (CAS), China
Gui Jin,
China University of Geosciences Wuhan, China

*CORRESPONDENCE
Siji Zhu,
zhusijiyn@163.com
Jun Sun,
tswwiththinkwithgp@126.com

SPECIALTY SECTION
This article was submitted to Environmental Economics and Management, a section of the journal Frontiers in Environmental Science

RECEIVED 05 December 2022
ACCEPTED 06 March 2023
PUBLISHED 22 March 2023

CITATION
Zhu S, Sun J, Wu Y, Yu B, Li H, Xia T, Zhang X, Liang X and Zhu G (2023), A rural revitalization model based on regional livelihood capital: A case study of Diqing, China.
Front. Environ. Sci. 11:1116742.
doi: 10.3389/fenvs.2023.1116742

A rural revitalization model based on regional livelihood capital: A case study of Diqing, China

Siji Zhu[1]*, Jun Sun[1]*, Yingmei Wu[1], Bohao Yu[2], Hong Li[1], Tianshun Xia[1], Xiaomei Zhang[1], Xuqi Liang[1] and Guifang Zhu[1]

[1]Faculty of Geography, Yunnan Normal University, Kunming, China, [2]School of Mathematics, Yunnan Normal University, Kunming, China

Improving livelihood capital is beneficial for implementing China's rural revitalization strategy (RRS); however, researchers have not focused on the regional attributes of livelihood capital. Thus, this study proposes a new concept of regional livelihood capital to guide RRS implementation. A comprehensive measurement method and official government statistics were used to analyze regional livelihood capital characteristics in Diqing. The results demonstrate that, from 1993 to 2020, Diqing's regional livelihood capital index increased steadily from 0.058 to 0.356, and its structure continued to diversify; however, its level remains low. The natural capital index fluctuated between 2.044 and 2.284 and always had absolute advantages. The financial capital index increased rapidly from 0.024 to 1.396 and is the core driving force for the growth of regional livelihood capital. The physical capital index increased steadily from 0.056 to 0.456. The growth of the social and human capital index was slow and weak, with an average annual growth rate of only 4.42% and 1.07%, respectively, which represents a weakness in regional livelihood capital. Based on regional livelihood capital characteristics and Diqing's economic circumstances, a targeted rural revitalization model was developed according to the dynamics of the organic system of regional livelihood capital, in which natural capital is considered the foundation, financial capital is the power, physical capital is the medium, and social capital and human capital are the ultimate goals. The main direction of energy is "natural capital → financial capital → physical, social, and human capital." Simultaneously, reverse energy feedback should also be emphasized to promote the sustainable operation of this system. This study provides a new theoretical perspective of regional livelihood capital for the implementation of RRS and guidance for the practice of RRS in Diqing and other similar areas.

KEYWORDS

livelihood capital, regional livelihood capital, rural poverty, rural revitalization strategy (RRS), Diqing

1 Introduction

Rural poverty is an objective phenomenon in the history of human socioeconomic development (Tania, 2009; Shcherbak et al., 2020). Particularly, in developing countries, increasing urban polarization has caused rural areas to fall into a more desperate situation (Wang and Wan, 2015), leading to various problems, such as pressure on agriculture (Venables, 2018), infrastructure shortages (Onitsuka and Hoshino, 2018), and low incomes

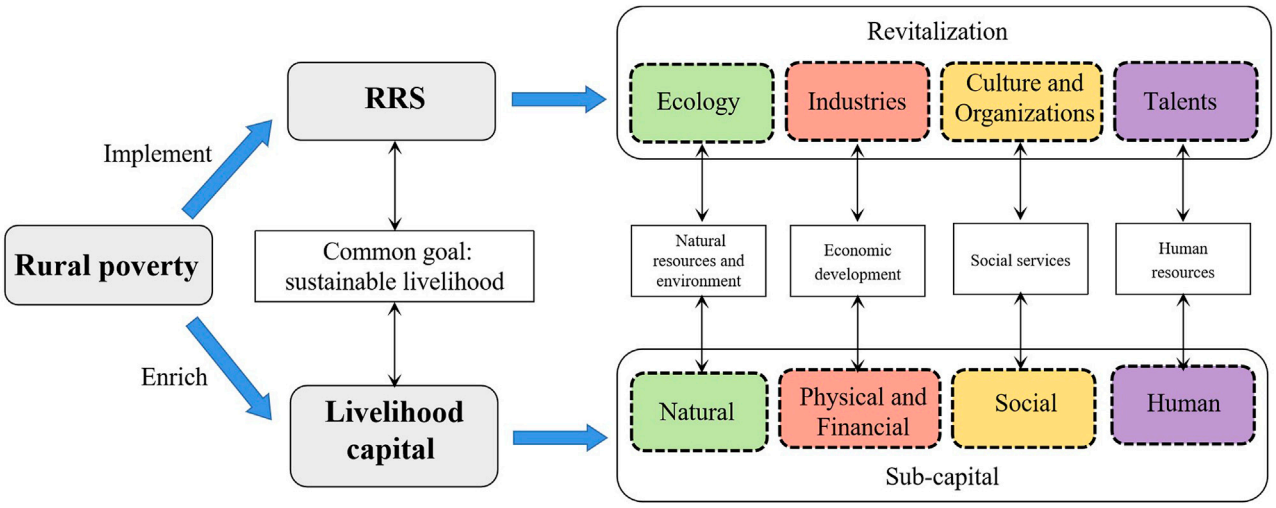

FIGURE 1
Links among rural poverty, the RRS, and livelihood capital.

for farmers (Africano and Collado, 2017). These problems have further exacerbated rural poverty. Subsequently, governments worldwide have implemented policies and measures to promote rural development (Marsden, 2010; Deng et al., 2022).

In China, the world's largest developing country, the government implemented policies that emphasized cities over rural areas to reverse the slow economic growth and low productivity that characterized the early days of China (Huang et al., 2020). Subsequently, the gap between urban and rural areas widened, and 80% of people living with long-term, large-scale, and intergenerationally transmitted poverty are concentrated in the vast rural areas (Liu M. et al., 2020). Although the Chinese government has made remarkable achievements in poverty alleviation, with 770 million people being lifted out of absolute poverty as of 2020, relative poverty persists in rural areas. To reduce poverty and promote the sustainable development of rural areas, the rural revitalization strategy (RRS), one of China's most important national development strategies (Liu, 2018), was first proposed at the 19th National Congress of the Communist Party of China in 2017. It aims to revitalize rural ecology, industries, culture, organizations, and talent to narrow the gap between urban and rural areas (Liu Y. et al., 2020). Compared with poverty alleviation focusing on poor rural areas, the RRS covers almost all rural areas and emphasizes positive interaction and integration between urban and rural areas at a macro-regional scale.

The RRS was proposed to solve the problem of rural poverty. The direct cause of poverty is the unsustainability of livelihoods (Scoones, 2009), which is fundamentally caused by the lack of livelihood capital (Roberts and Yang, 2003; Chowdhury, 2021). Livelihood capital is the sum of all available capital and conditions for people to make a sustainable livelihood (Wang et al., 2021a). It is the basis for resisting livelihood risks, choosing livelihood strategies, and achieving livelihood goals, as well as for policy intervention in rural development projects (Bhandari, 2013). Livelihood capital enrichment and RRS implementation are unified in value orientation, with the common goal of promoting the sustainability of people's livelihoods. In addition, the United Kingdom government's sustainable livelihoods approach (SLA) divides livelihood capital into natural, physical, financial, social, and human capital (DFID, 2000). These sub-capital forms are strongly linked to the RRS objectives (Figure 1). Both natural capital and ecological revitalization pertain to natural resources and the environment; physical capital, financial capital, and industrial revitalization focus on economic development; social capital and the revitalization of culture and organizations are aimed at social services; and human capital and the revitalization of talent focus on human resources (Liu M. et al., 2020; Chen et al., 2021). Therefore, livelihood capital can support the implementation of the RRS and provide a new theoretical perspective. It is an important theoretical basis for exploring the rural revitalization model.

As the core part of the SLA, livelihood capital has become the focus of many studies, mainly involving sustainable livelihoods (Marulanda et al., 2020; Yang et al., 2021; Azumah et al., 2022; Yan et al., 2022), poverty eradication (Zhang et al., 2020; Wang et al., 2021b), and public policy (Hua et al., 2017; Jin et al., 2021), and fruitful research results have been obtained. Subsequently, the five forms of sub-capital have become a popular research tool for quantitative measurement and an entry point for exploring relevant practical problems (Roberts and Yang, 2003; Chen et al., 2013; Zhang C. et al., 2019). However, most research has focused on micro-individuals (individuals or families) rather than macro-regions. Although the research on micro-individuals is significant for formulating personalized assistance measures for similar individuals, its instructiveness may be limited when implementing the RRS at a larger regional scale. Therefore, this study proposes the concept of regional livelihood capital to meet the practical needs of implementing the RRS and promote the use of livelihood capital in macro-regional research.

Diqing is one of the most representative and typical extreme poverty areas in China. Although Diqing has reduced absolute poverty (according to the poverty standard set by the Chinese

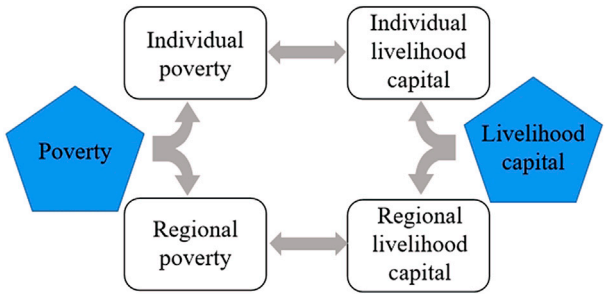

FIGURE 2
Basic contents of poverty and livelihood capital.

government in 2020), it still faces the risk of returning to poverty and the pressure of RRS implementation. Scientifically implementing the RRS to promote rural sustainability is a major issue for Diqing and urgently requires a response. Hence, this study uses the regional livelihood capital concept to develop a rural revitalization model for Diqing and provides a practical case for its use in RRS implementation. The main objectives of this study are as follows: 1) demonstrating the concept of regional livelihood capital; 2) using a reasonable evaluation index system, measurement method, and regional comparison to analyze the characteristics of regional livelihood capital; and 3) establishing a targeted rural revitalization model for Diqing as per the regional livelihood capital characteristics.

2 Demonstration of concepts

2.1 Individual and regional poverty

The original meaning of poverty refers to the lack of material items, money, and ability required to make a living among individuals, families, or specific groups (Konkel, 2014). With the development of poverty research, defining poverty from a geographical perspective has gained traction in academic discourse. Poverty is increasingly considered the result of a lack of geographical capital (Misturelli and Heffernan, 2010). Therefore, by examining poverty from different perspectives, individual and regional poverty have gradually become leading poverty concepts (Nallari and Griffith, 2011; Michálek and Madajová, 2019; Zhou and Liu, 2019; Hou et al., 2022). Individual poverty is defined using a micro-perspective and refers to the definition outlined previously. It also includes the deprivation of the right and opportunity to earn a living (Lo Bue and Palmisano, 2020). Regional poverty is defined using a macro-perspective as the decoupling of people, environment, and industry, focusing on the place where poverty occurs and the relationship between poverty and the environment (Liu et al., 2017). Individual and regional poverty affect each other, as individual poverty has a positive amplification effect and its accumulation will lead to regional poverty. In contrast, regional poverty caused by geographical disadvantage will also disadvantage individuals and further aggravate individual poverty. An analysis of individual poverty cultivates the endogenous development ability of people living in poverty, whereas an assessment of regional poverty is conducive to creating favorable development conditions in poverty regions. Subsequently, individual and regional poverty should be addressed to alleviate poverty.

2.2 Individual and regional livelihood capital

Poverty is the direct consequence of the long-term lack of livelihood capital (Su et al., 2009). According to the logic that poverty includes individual and regional poverty, livelihood capital can also include individual and regional livelihood capital. Just as the lack of individual livelihood capital causes individual poverty, regional poverty is also caused by the lack of regional livelihood capital (Figure 2).

Individual livelihood capital is the sum of all resources and conditions available for livelihood owned by an individual or family, and it emphasizes the private attributes of livelihood capital (Oladele and Ward, 2017). Individual livelihood capital is the focus of most current research and has been widely recognized in academia (Gentle and Maraseni, 2012; Fang et al., 2014; Liu and Xu, 2016; Xu et al., 2019). However, people's livelihood is closely related to their geographical environment. Different geographical environments will inevitably lead to different livelihood strategies and results, ultimately caused by the differences in regional livelihood capital in different regions (Berchoux and Hutton, 2019). Regional livelihood capital can be considered the sum of all resources and conditions available for livelihood provided by a specific regional environment (Xu et al., 2018). It emphasizes the regional attributes of livelihood capital. Regional livelihood capital focuses on the relationship between livelihood and the environment (Horsley et al., 2015). The regional livelihood capital amount can reflect the difficulty in making a living in specific regional environments.

In conclusion, both individual and regional livelihood capital are people-oriented. However, there are differences in the "people" they target. For individual livelihood capital, the word "people" refers to individuals or families, whereas regional livelihood capital regards "people" as all people in a specific region (Ghosh and Ghosal, 2021). Research on individual livelihood capital can explore how to develop sustainable livelihoods for individuals or families living in poverty (Liu et al., 2021a). Research on regional livelihood capital can explore sustainable development approaches (Singh and Hiremath, 2010). Thus, this study divides livelihood capital into natural, physical, financial, social, and human capital and distinguishes between individual and regional livelihood capital (Table 1).

3 Materials and methods

3.1 Study area

Diqing is a representative area of extreme poverty in China, with a weak foundation for rural development, making it an ideal case for this study. Its geographical environment is complex. Diqing is near the southwest border of China in Yunnan Province (Figure 3). It has an average altitude of 3,380 m, with 5,254 m between its highest and

TABLE 1 Differences between individual livelihood capital and regional livelihood capital.

Sub-capital	Differences in connotations	
	Individual livelihood capital	Regional livelihood capital
Natural capital	Natural resources and conditions that individuals or families can use to make a living (e.g., privately owned arable land, irrigation water, pasture, trees, and timber)	Natural resources and conditions provided by the regional geographical environment for people to make a living; this can be considered the natural background of people's livelihood (e.g., agricultural land, water resources, forests, and regional topography)
Physical capital	Physical material privately owned by individuals or families to make a living (e.g., vehicles, agricultural equipment, water conservancy facilities, and daily necessities)	The physical material conditions in the region that can support people's livelihood (e.g., consumer goods level, living conditions, and traffic conditions)
Financial capital	Funds consumed and accumulated by individuals or families to make a living (e.g., cash, deposits, wages, allowances, and relief funds)	The economic and financial conditions provided by the region to support people's livelihood (e.g., economic conditions, industrial level, residents' income level, fiscal revenue, and expenditure)
Social capital	All actual or potential social resources owned by individuals or families that can be used to make a living (e.g., marital status, interpersonal relationships, social organization, and culture/religion)	Social resources and conditions provided by the region to support people's livelihood (e.g., the degree of social development, social security, educational resources, medical resources, and cultural atmosphere)
Human capital	The physical functions and abilities of individuals or families, and the opportunities and rights to create their own value (e.g., individuals' physical qualities, skills, knowledge, and health status)	The quantity and quality of human resources on which regional development depends (e.g., regional population, labor force, education level, and employment opportunities)

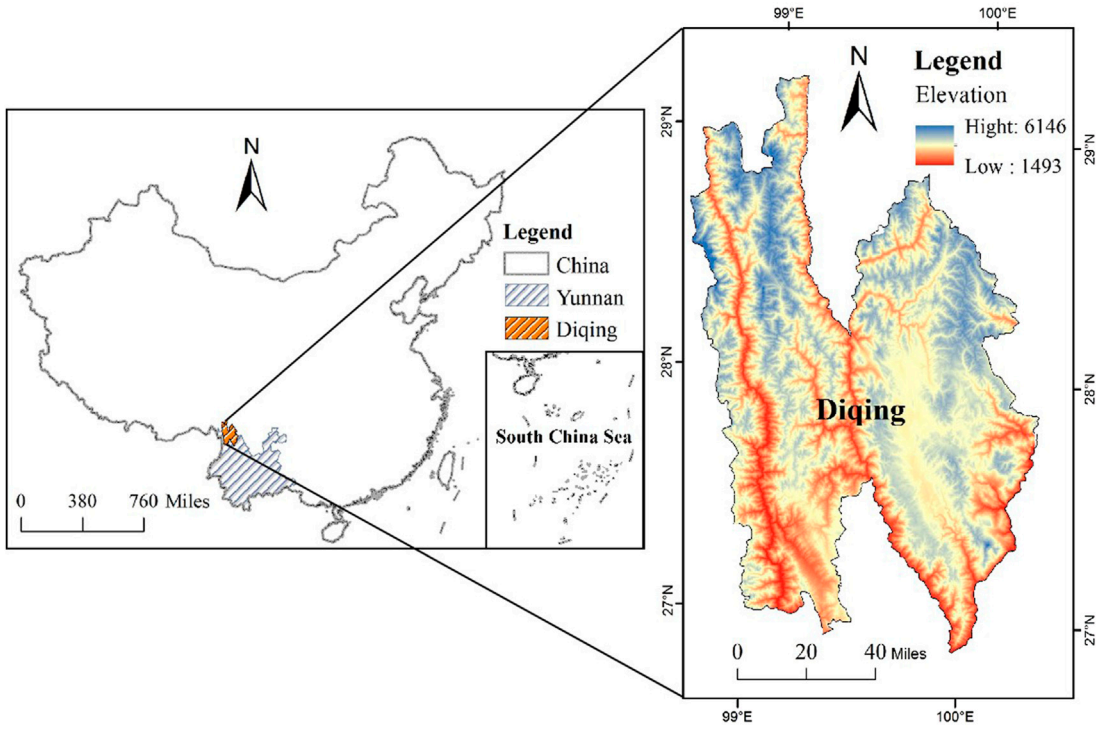

FIGURE 3
Map of Diqing in Southwest China.

lowest points; 94% of its area is mountainous, and 60% of the region has an area with a slope greater than 25°. It is characterized by surface fragmentation, vertical zonality, and a stereoscopic climate. The Lancang and Jinsha rivers run through Diqing from north to south, and most people living in poverty are scattered between more than 20 villages on both sides of these rivers. Mountainous natural conditions lead to a sparse population and a high cost of infrastructure construction and maintenance, which is one of the reasons for the lack of human and physical capital. In addition, the ecological security of Diqing is of great significance to China (Hillman, 2010), and the contradiction between ecological protection and economic development is prominent. However, the complex geographical environment is rich in natural resources, and owing to the location of the Hengduan Mountain

tectonic belt, Diqing is a famous metal, rare metal, and non-metal mineral area in China. Diqing is also rich in biological resources and has unique tourism resources. These elements together embody Diqing's natural capital.

Diqing's socioeconomic development is also underdeveloped, with a low starting point for such development. In 1950, Diqing was liberated from the feudal serfdom society, and in 1978, with economic reform and opening up, it shifted from a planned economic system to a market economic system. In 1993, marked by the Poverty Alleviation Office Meeting held by the People's Government of Yunnan Province in Diqing, development in Diqing accelerated. Nevertheless, socioeconomic development remains underdeveloped. In 2020, Diqing achieved a total GDP of 26.694 billion yuan, comprising only 1.09% of the GDP from 6.06% of the land in Yunnan Province, and was ranked 15th among the 16 regions in the province. This has led to a neglect of financial and social capital in Diqing, as there has been insufficient investment in social services, such as education, medicine, and culture.

3.2 Data source

The data used in this study were obtained from the official statistics of local governments using the *Statistical Yearbook of Diqing*, *Yunnan Statistical Yearbook*, and *Statistical Communique of National Economic and Social Development*, which can be obtained from the official websites of the Yunnan Provincial Bureau of Statistics (http://stats.yn.gov.cn/) and the statistical information network of China (http://www.tjcn.org/). The research team had been engaged in the rural development of Diqing for a long time, established a good cooperative relationship with the relevant departments of the local government, and visited Diqing for field investigation and data collection in September 2018, August 2019, October 2020, and September 2021. In addition, the 1:500000 DEM datum of Yunnan Province used to calculate the relief degree of land surface (RDLS) was obtained from the geospatial data cloud website of the Computer Network Information Center of the Chinese Academy of Sciences (http://www.gscloud.cn), and the geographic coordinate system is WGS_1984_Albers. Basic data, such as average altitude, average elevation difference, flat area, and regional area, were calculated and extracted using ArcGIS10.2.

3.3 Methods

3.3.1 Comprehensive measurement of regional livelihood capital

In this study, regional livelihood capital was divided into natural, physical, financial, social, and human capital. The specific elements reflecting their characteristics were selected as evaluation indicators based on the following principles: 1) rationality and accessibility: the indicators should objectively reflect the level of regional livelihood capital, ensure the scientific nature of the evaluation results, and be obtained from authoritative official channels; 2) comprehensiveness and perspicacity: the indicators should comprehensively reflect the stock and quality of regional livelihood capital at the present stage and predict its future development trend; and 3) particularity and universality: the regional particularity of Diqing and its universality in horizontal comparison with other regions should be considered. On this basis and referring to previous studies, the natural capital indicators were natural resources (mainly agricultural) and natural environmental conditions (Hu, 2014); physical capital indicators were regional daily consumer goods, infrastructure, transportation, and housing (Fang et al., 2014); financial capital indicators were economic development and people's income in the region (Kuang et al., 2020); and social and human capital indicators were regional social security and social services (Naithani and Saha, 2020) and the quantity, quality, and employment of people in the region, respectively. Therefore, 26 indicators were selected to establish a regional livelihood capital evaluation index. The calculation method of each indicator is described in Table 2. The measurement of RDLS will be described separately, and the weights will be calculated using formula (2).

The regional livelihood capital evaluation index system is a comprehensive evaluation index system including five dimensions and 26 specific indicators. At present, there are few measurement methods specifically for regional livelihood capital, but the weighted summation, vector summation, and polygon area methods have achieved good results in relevant fields (Liu and Xu, 2016; Lind, 2019; Liu et al., 2021b). Among them, the weighted summation method is commonly used in one-dimensional measurements. The polygon area method is more suitable for an evaluation index system with more positive indicators and reflects the indispensability of all dimensions. Therefore, the weighted summation method measures each sub-capital, and the polygon area method integrates regional livelihood capital. The steps are outlined in the following paragraphs.

First, the range standardization method compares indicators with different units and dimensions (Dong et al., 2021). The formula is as follows:

$$\begin{aligned} &\textit{Positive indicators}\colon\ Z_{ij} = (X_{ij} - X_{\min})/(X_{\max} - X_{\min}),\\ &\textit{Negative indicators}\colon\ Z_{ij} = (X_{\max} - X_{ij})/(X_{\max} - X_{\min}), \end{aligned} \tag{1}$$

where Z_{ij} is the standardized value of the jth indicator of sub-capital i, X_{ij} is the original value of the jth indicator of sub-capital i, and $X_{\min}$ and $X_{\max}$ are the minimum and maximum of all data of the jth indicator of sub-capital i, respectively.

Second, in order to avoid artificial subjectivity and the irrationality of the equal weight method, the entropy method is used to objectively determine the weight of 26 indicators. The entropy method determines the weight according to the amount of information entropy carried by each indicator, which has been widely used in many studies (Ding et al., 2016; Zhao et al., 2018). Its algorithm is as follows:

$$\begin{aligned} p_{ij} &= \frac{Z_{ij}}{\sum_{i=1}^{n} Z_{ij}},\\ e_{ij} &= -k\sum_{i=1}^{n} p_{ij}\, ln\left(p_{ij}\right), k = 1/ln(n),\\ d_{ij} &= 1 - e_{j},\\ w_{ij} &= \frac{d_j}{\sum_{i=1}^{n} d_j}, \end{aligned} \tag{2}$$

TABLE 2 Evaluation index system of regional livelihood capital.

Sub-capital	Indicator	Calculation method	Weight	Property
Natural capital	Per capita land for agriculture use	Land for agriculture use/land area	0.0314	+
	Per capita amount of water resources	Total amount of water resources/total population	0.0638	+
	Index of wastes air pollution	Statistical data	0.0311	−
	Forest coverage	Statistical data	0.0304	+
	RDLS	Alt/1000+{ralt·[1-p(a)/a]}/500	0.0335	−
Physical capital	Per capita retail sales of consumer goods	Retail sales of consumer goods/total population	0.0426	+
	Per capita rural investment in fixed assets	Rural investment in fixed assets/rural population	0.0441	+
	Per capita floor space completed	Floor space completed/total population	0.0335	+
	Highway density	Total length of highways/land area	0.0408	+
	Per capita private motor vehicles	Total private motor vehicles/total population	0.0352	+
Financial capital	Per capita gross regional product	Statistical data	0.0336	+
	Per capita gross agricultural output value of agricultural population	Gross agricultural output value/agricultural population	0.0420	+
	Average savings deposit balance of rural households at year-end	Balance of rural household savings deposits at year-end/number of rural households	0.0415	+
	Disposable income *per capita* of rural residents	Statistical data	0.0385	+
	Per capita final consumption expenditure of rural households	Final consumption expenditure of rural households/rural population	0.0403	+
	Per capita local government general budgetary expenditure	Local government general budgetary expenditure/total population	0.0339	+
Social capital	Urbanization rate	Statistical data	0.0390	+
	Coverage of rural subsistence allowances	Rural subsistence allowance population/rural population	0.0348	−
	Per capita expenditures on culture and cultural relics	Expenditures on culture and cultural relics/total population	0.0406	+
	Number of regular institutions of higher education	Statistical data	0.0405	+
	Number of hospital beds *per capita*	Number of hospital beds/total population	0.0377	+
Human capital	Total population	Statistical data	0.0409	+
	Proportion of non-agricultural population	Non-agricultural population/total population	0.0392	+
	Proportion of rural employed persons	Rural employed persons/rural population	0.0371	+
	Proportion of scientists and technicians	Scientists and technicians/total population	0.0352	+
	Average educational years of rural residents	Statistical data	0.0388	+

where p_{ij} is the proportion of the jth indicator value of sub-capital i, e_{ij} is the entropy of the jth indicator of sub-capital i, d_{ij} is the information entropy redundancy of the jth indicator of sub-capital i, and w_{ij} is the weight of the jth indicator of sub-capital i.

Third, the weighted summation method is used to measure the sub-capital index:

$$Nci, Pci, Fci, Sci, Hci = \sum_{i=1}^{n} w_{ij} \cdot z_{ij}, \quad (3)$$

where Nci is the natural capital index, Pci is the physical capital index, Fci is the financial capital index, Sci is the social capital index, Hci is the human capital index, w_{ij} is the weight of the jth indicator of sub-capital i, Z_{ij} is the standardized value of the jth indicator of sub-capital i, and n is the indicator quantity of sub-capital i.

Finally, the polygon area method integrates the regional livelihood capital index. This method is an approach for comprehensive measurements. It extends outward with multiple lines of common points to form a polygon, and the length of these lines is regarded as the value of each dimension. In contrast, the area of the polygon is regarded as the value of the comprehensive measure (Liu and Xu, 2016). The five sub-capital forms are drawn as five lines with common points to form a regional livelihood capital pentagon (Figure 4).

In Figure 4, O is a common point, and Nc, Pc, Fc, Sc, and Hc represent natural, physical, financial, social, and human capital, respectively. α is the included angle of five lines ($\alpha = 360^{\circ}/5 = 72^{\circ}$), and the area of pentagonal $NciPciFciSciHci$ is defined as the regional livelihood capital index (RLCI). According to the relevant geometric knowledge, the calculation is as follows:

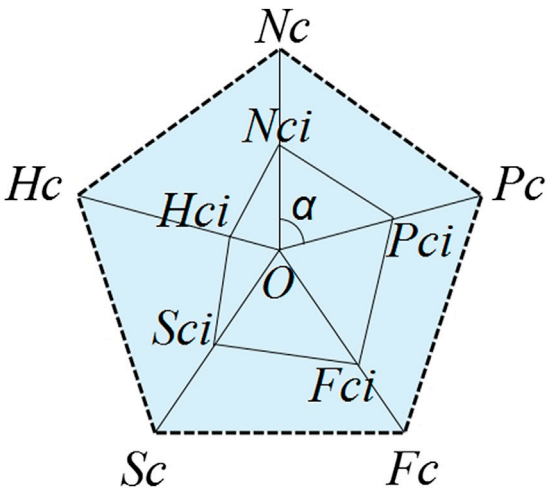

FIGURE 4
Regional livelihood capital pentagon.

$$RLCI = \frac{1}{2}\sin\alpha \left(Nci \cdot Pci + Pci \cdot Fci + Fci \cdot Sci + Sci \cdot Hci + Hci \cdot Nci\right). \quad (4)$$

3.3.2 Relief degree of land surface

RDLS comprehensively represents regional altitude and surface fragmentation and is one of the important indicators for geomorphological classification (Feng et al., 2008). Some extant studies have proven that there is a significant negative correlation between RDLS and regional socioeconomic development (Liu et al., 2015; Zhang J. et al., 2019). Particularly, in the mountainous Yunnan Province, the obstacles of land surface relief to regional socioeconomic development are more prominent (Zhu et al., 2020). As a natural geographical representation, large RDLS will inevitably lead to natural capital disadvantage, so it is considered an important indicator for evaluating natural capital. The formula is as follows:

$$RDLS = RAA/1000 + \{RAED \times [1 - FA/A]\}/500, \quad (5)$$

where RAA is the regional average altitude, $RAED$ is the regional average elevation difference, FA is the flat area of the region (according to the mapping standard of the China geomorphic map, an elevation difference of less than or equal to 30 m is regarded as flat (Feng et al., 2008)), and A is the area of the region.

3.3.3 Contribution degree of indicator

The contribution degree of indicator (CDI) is a quantitative evaluation of the effect of each indicator on the evaluation results to identify the importance of these indicators (Alkire and Foster, 2011a). It can also be used to quantitatively describe the impact of different dimensions on the measurement results (Alkire and Foster, 2011b). In this study, CDI is used to explore the impact of various indicators on regional livelihood capital to identify meaningful indicators and reflect the development trend of the contribution of natural, physical, financial, social, and human capital to regional livelihood capital. The formula is as follows:

$$CDI_{ij} = \frac{w_{ij} \cdot z_{ij}}{\sum_{i=1}^{n} w_{ij} \cdot z_{ij}} \times 100\%, \quad (6)$$

where CDI_{ij} is the contribution degree of indicator of the jth indicator of sub-capital i, w_{ij} is the weight of the jth indicator of sub-capital i, and Z_{ij} is the standardized value of the jth indicator of sub-capital i.

3.3.4 Diversification index

The diversification index (DI) is used to quantitatively describe the diversification degree of regional livelihood capital, that is, the proportional relationship and equilibrium degree of each sub-capital that comprises regional livelihood capital (Yang et al., 2014; Shahzad et al., 2021). Because this study involves the five forms of sub-capital, the maximum DI is 0.8 (1–1/5 = 0.8), and the minimum is infinitely close to 0. DI depends on the inequality of different dimensions (natural, physical, financial, social, and human capital). The higher the DI, the stronger the stability of the regional livelihood capital structure. The formula is as follows:

$$DI = 1 - \sum_{i=1}^{5}\left[\frac{V_i}{Nci + Pci + Fci + Sci + Hci}\right]^2, \quad (7)$$

where DI is the diversification index of regional livelihood capital, V_i is the value of ith sub-capital index, Nci is the natural capital index, Pci is the physical capital index, Fci is the financial capital index, Sci is the social capital index, and Hci is the human capital index.

These methods consider the time series from 1993 to 2020 (the period of rapid development of Diqing). The raw data of each year need to be obtained and used to calculate the relevant index (except RDLS because 23 years is too short for RDLS, and its change can be ignored).

4 Results

4.1 Analysis of the development of regional livelihood capital

The measurement results of RLCI in Diqing are illustrated in Figure 5. From 1993 to 2020, Diqing's RLCI increased steadily from 0.058 to 0.356, with an average annual growth rate of 6.98%. During this period, the growth rate was relatively slow, with an average annual growth rate of 4.98%. From 2009 to 2020, mainly due to the rapid development of financial capital, the RLCI entered a period of rapid growth, with an average annual growth rate of 10.25%.

Natural capital fluctuates significantly. From 1993 to 2020, Nci fluctuated between 2.044 and 2.284, with a slight increase. This reflects that the ecological and environmental protection policies and measures in Diqing have, to a certain extent, succeeded in promoting natural capital. From the CDI, the change in the "per capita amount of water resources" is the key factor causing the fluctuation of natural capital, as illustrated in Figure 6A. In 2001, 2006, 2009, 2010, and 2016, Diqing suffered drought, resulting in water shortages; in 2010, the drought threatened the livelihood of some peasant households. Overall, the CDI of the five natural capital indicators is trending downward, with the "per capita amount of water resources" decreasing most significantly.

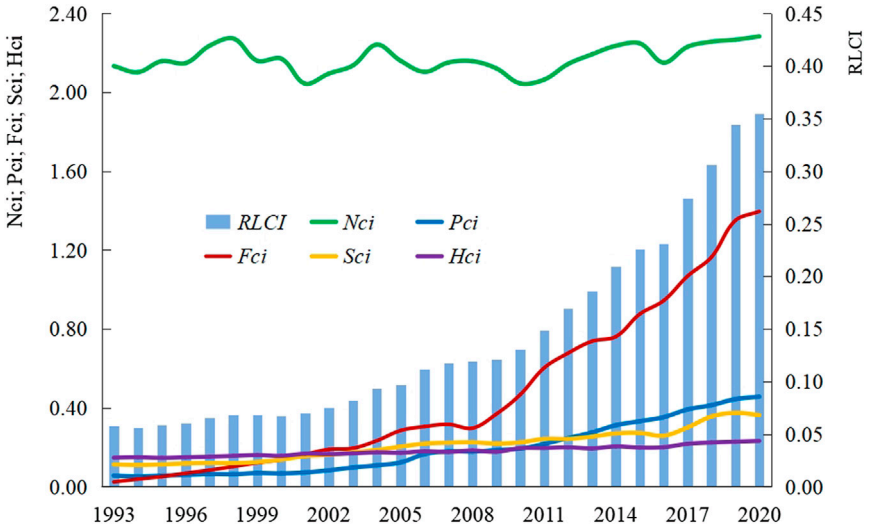

FIGURE 5
Development of regional livelihood capital in Diqing (1993–2020).

Physical capital grew steadily. From 1993 to 2020, *Pci* gradually increased from 0.056 to 0.456, with an average annual growth rate of 8.08%. Particularly, after 2010, the growth trend is more obvious. From the CDI, the five physical capital indicators are rising, as illustrated in Figure 6B, with the "per capita rural investment in fixed assets" and "per capita retail sales of consumer goods" increasing significantly, demonstrating that fixed assets and daily consumer goods are the key factors for the growth of physical capital. These findings indicate that, since 2010, the measures implemented to increase fixed asset investment and promote poverty alleviation have led to the rapid development of rural life and production infrastructure in Diqing, which are critical to the growth of physical capital.

Financial capital increased significantly. *Fci* increased rapidly from 0.024 to 1.396, with an average annual growth of 16.24%. Particularly, since 2003, *Fci* has maintained a high growth rate. Based on the CDI, the six financial capital indicators show a rapid growth trend, as illustrated in Figure 6C, with the "per capita gross agricultural output value of agricultural population" increasing the most, indicating that agriculture is key to the rapid growth of financial capital. In the past 40 years, Diqing has gradually transitioned from pure manual labor to semi-mechanization, and the rapid development of the agricultural economy has increased farmers' income. In addition, the CDI of each index fluctuated slightly in 2008, possibly due to the global financial crisis and frost disasters.

Social capital grew relatively slowly. *Sci* increased from 0.113 to 0.363, with an annual growth rate of 4.42%. From the CDI, the five social capital indicators have different trends, as illustrated in Figure 6D. The "per capita expenditures on culture and cultural relics" and "number of hospital beds *per capita*" increased significantly, the "urbanization rate" increased slightly, and the "coverage of rural subsistence allowances" decreased gradually. This demonstrates the continuous improvement of cultural, medical, and educational service capabilities and the steady growth of farmers' income. However, there is currently no regular higher education institution in Diqing, which is extremely unfavorable for the growth of social capital.

Human capital grew weakly; *Hci* increased slowly from 0.147 to 0.232, with an annual growth rate of only 1.70%. Based on the CDI, the five human capital indicators have different development trends, as illustrated in Figure 6E. "Total population," "proportion of scientists and technicians," and "average educational years of rural residents" decreased slightly, whereas the "proportion of non-agricultural population" and "proportion of rural employed persons" increased slightly. This suggests that the development of non-agricultural industries and farmers' employment increasingly impacts human capital. Much attention should also be paid to the introduction of talent and the extension of farmers' education.

4.2 Analysis of the structure of regional livelihood capital

The sub-capital indexes from 1993 to 2020 are illustrated in Figure 7A. The proportion of sub-capital gradually tends to be relatively balanced, and the structure of regional livelihood capital is developing toward diversification. From the CDI, natural capital has decreased significantly, from 86.25% to 48.28%, but still occupies an absolute advantage; physical capital increased steadily from 2.26% to 9.64%; financial capital increased rapidly and substantially from 0.97% to 29.51%; social capital was relatively stable and fluctuated slightly, increasing from 4.57% to 7.67%; and human capital decreased from 5.94% to 4.90% in slight fluctuations. These trends indicate that natural capital has always been the basic element in regional livelihood capital's continuous growth, and regional economic development cannot be separated from the dependence on natural capital. In addition, regional livelihood capital DI rose from 0.2498 to 0.6623, as illustrated in Figure 7B. This demonstrates that regional livelihood welfare has become more

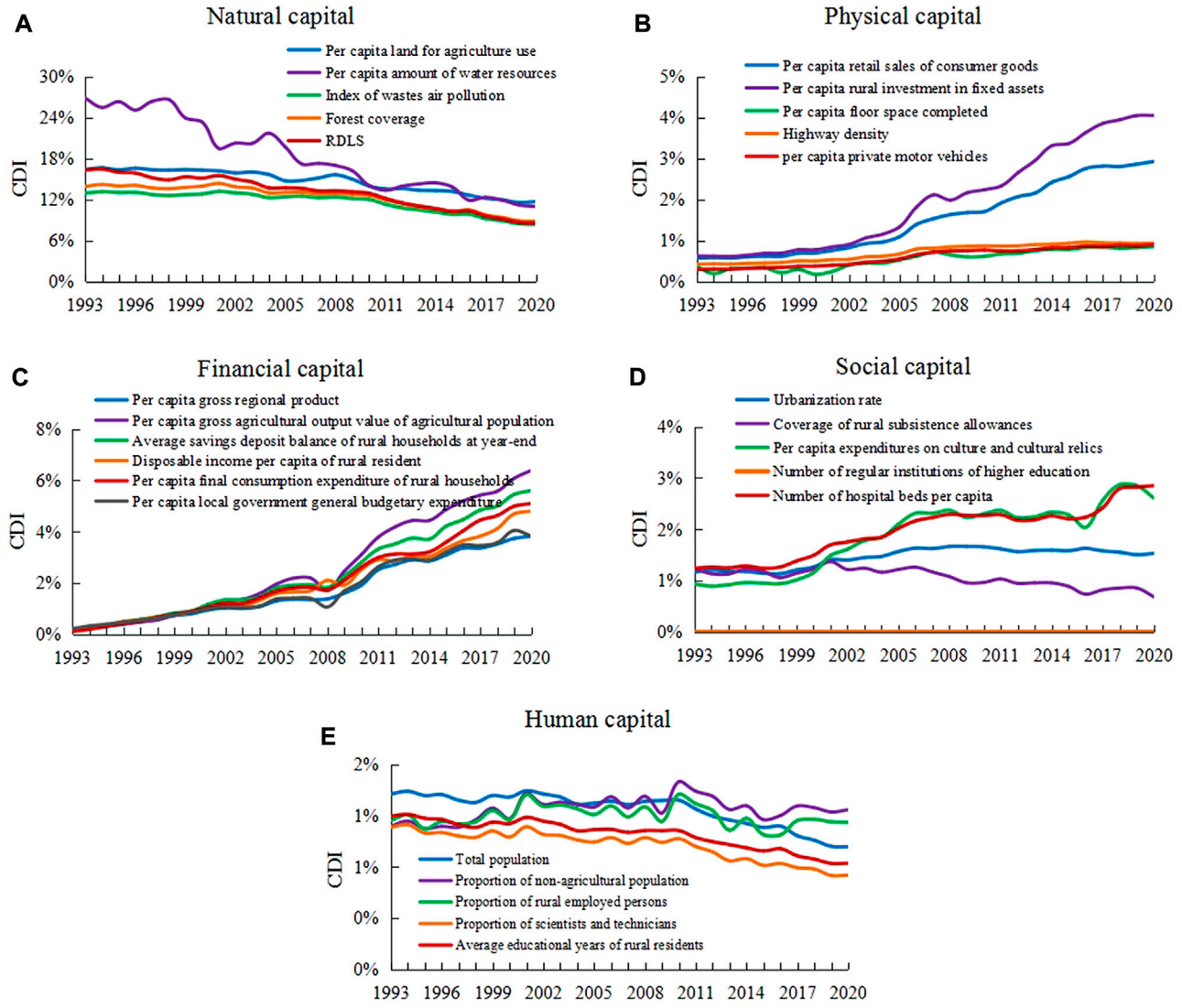

FIGURE 6
Development of CDI in Diqing (1993–2020). **(A)** Natural capital. **(B)** Physical capital. **(C)** Financial capital. **(D)** Social capital. **(E)** Human capital.

diversified, and the stability of the livelihood capital structure has improved.

From 1993 to 2020, the regional livelihood capital structure of Diqing evolved from "natural—human—social—physical—financial" to "natural—financial—physical—social—human." Although the stability of the regional livelihood capital structure was strengthened, it is still unreasonable and requires further optimization. The proportion of natural capital remains large, demonstrating that the natural environment can provide resources for people's livelihood, which is the foundation and advantage of Diqing. However, it also shows that people's livelihood depends too much on natural resources, which is unsustainable if not managed effectively. Additionally, the weakness of human, social, and physical capital are obstacles to the continuous optimization of the regional livelihood capital structure.

4.3 Comparative analysis of Diqing and other regions

This study compares Diqing with other regions in Yunnan Province to clarify the comparative characteristics of Diqing's regional livelihood capital. As illustrated in Table 3, in 2020, the RLCI of Diqing ranked 15th among the 16 regions in Yunnan Province at 0.355, indicating that the level of regional livelihood capital in Diqing was relatively low. For sub-capital, *Nci* ranked first in the province with 2.284, indicating that the comparative advantage of natural capital was significant. In particular, the *per capita* amount of water resources is as high as 28731.96 m^3, which is 7.5 times that of Yunnan Province and 12.7 times that of the country. *Pci* and *Fci* ranked 15th with 0.456 and 1.396, respectively, indicating a serious shortage of physical and financial capital. In particular, the *per capita* gross agricultural output value of the agricultural population in

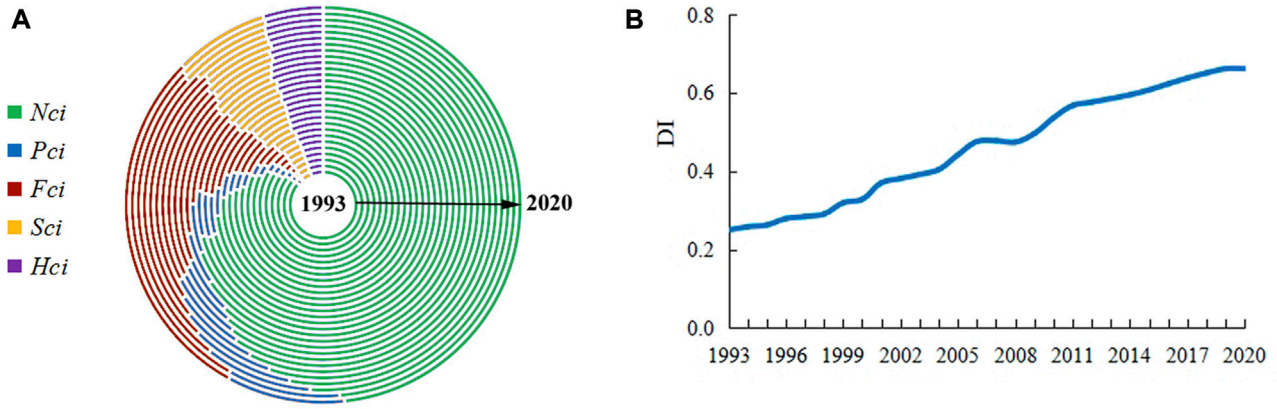

FIGURE 7
Development of the regional livelihood capital structure in Diqing (1993–2020). **(A)** Regional livelihood capital structure. **(B)** Regional livelihood capital DI.

TABLE 3 Regional livelihood capital of 16 regions in Yunnan Province in 2020.

Region	RLCI	Rank	*Nci*	Rank	*Pci*	Rank	*Fci*	Rank	*Sci*	Rank	*Hci*	Rank
Diqing	0.355	15	2.284	1	0.456	15	1.396	15	0.363	16	0.232	16
Kunming	5.462	1	0.923	11	3.230	1	4.901	1	2.872	1	2.672	1
Honghe	2.130	2	0.942	10	2.304	2	2.953	4	1.463	4	1.452	3
Yuxi	2.041	3	0.882	12	2.078	4	3.256	2	1.494	3	1.102	9
Qujing	1.872	4	0.386	16	2.157	3	3.015	3	1.518	2	1.494	2
Dali	1.838	5	1.235	3	2.018	5	2.604	6	1.310	5	1.306	5
Chuxiong	1.718	6	0.836	13	1.958	6	2.902	5	1.228	6	1.286	6
Wenshan	1.231	7	0.711	14	1.758	7	2.263	7	1.006	9	1.276	7
Baoshan	1.147	8	1.156	6	1.298	9	2.094	9	1.098	7	1.118	8
Zhaotong	1.057	9	0.505	15	1.537	8	2.164	8	1.026	8	1.310	4
Pu'er	0.840	10	1.161	5	1.112	10	1.951	10	0.681	11	0.992	11
Lincang	0.727	11	1.195	4	0.954	12	1.638	14	0.630	12	1.091	10
Xishuangbanna	0.679	12	0.982	8	1.083	11	1.711	13	0.774	10	0.630	13
Dehong	0.598	13	0.962	9	0.928	13	1.880	12	0.534	13	0.714	12
Lijiang	0.509	14	1.054	7	0.818	14	1.909	11	0.470	14	0.452	14
Nujiang	0.317	16	1.984	2	0.419	16	1.226	16	0.390	15	0.285	15

Diqing is only 11408.24 yuan, far less than 25101.76 yuan in Yunnan Province and 24607.14 yuan in the country. *Sci* and *Hci* ranked last with 0.363 and 0.232, respectively, indicating that the most serious problems were the lack of social and human capital. In particular, the number of hospital beds in Diqing is only 4.87 per thousand people, lagging behind 6.89 in Yunnan Province and 6.45 in the country. The total population of Diqing is only 38,751, the smallest of the 16 regions in Yunnan Province, and the quantity and quality of human capital are seriously insufficient.

5 The rural revitalization model for Diqing

The comprehensive measurement results indicate that, although Diqing's regional livelihood capital has steadily increased and the structure has been continuously optimized, the quality remains low and needs to be improved. Although natural capital fluctuates, its advantages remain significant. It is the foundation of Diqing's regional livelihood capital. The rapid growth of financial capital is the key to improving the quality and structure of regional

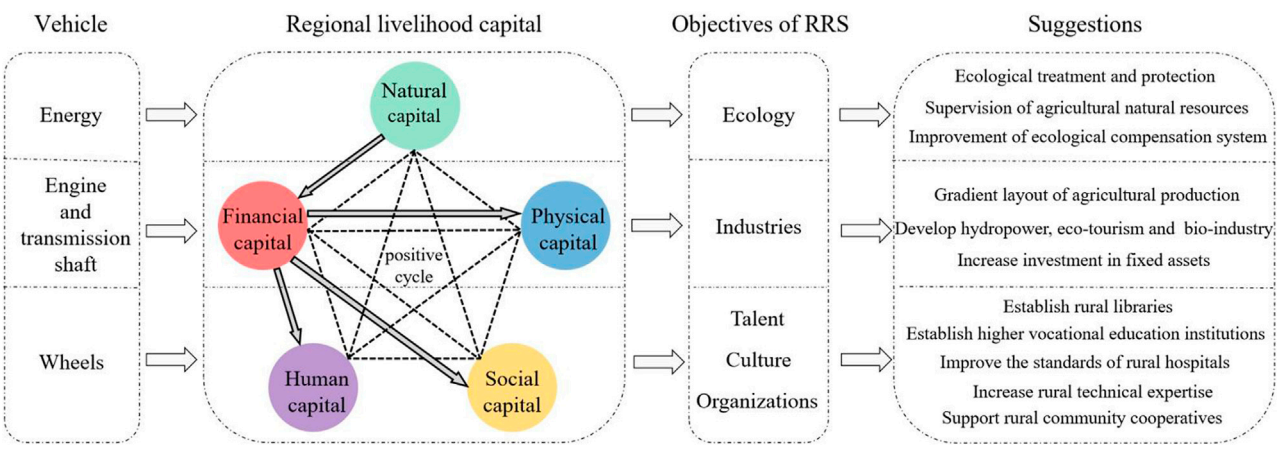

FIGURE 8
Rural revitalization model in Diqing.

livelihood capital, which is the core driving force for promoting the development of Diqing. However, there is a shortage of this compared to other regions. Physical capital is growing steadily, and its contribution to regional livelihood capital is also increasing. However, it remains insufficient compared with other regions. With their weak growth, social capital and human capital are at a disadvantage compared with other regions and are weaknesses in Diqing's regional livelihood capital. In terms of actual economic development, the proportion of primary, secondary, and tertiary industries in Diqing in 2020 was 6.2:37.9:55.9, which seems to contradict its underdeveloped economy. Furthermore, the advanced development of tourism has resulted in a single tertiary industry in Diqing. However, the role of the secondary industry, mainly manufacturing, in promoting socioeconomic development has not emerged yet. Meanwhile, the tertiary industry dominated by tourism cannot drive the primary and secondary industries. The high level of the tertiary industry in Diqing does not represent a developed economy but is the result of a "virtualization" of the industrial structure (Chen et al., 2016). Improving farmers' livelihoods fundamentally depends on the primary industry (agriculture), which is most closely related to their livelihood. The primary industry (agriculture) plays an important basic role in improving farmers' livelihoods. However, relying on agriculture is insufficient. It needs to form a joint force with other industries to promote the RRS implementation in Diqing. Fortunately, when other forms of sub-capital are at a disadvantage, abundant natural capital provides many possibilities to develop various industries. To sum up, RRS implementation in Diqing must rely on the development and utilization of natural capital.

Based on the linkages between regional livelihood capital and the RRS objectives, the comprehensive measurement results and economic information analysis, the principle of system dynamics (Ravar et al., 2020), and the people-oriented concept, this study regards regional livelihood capital as an organic system formed by the coupling of natural, physical, financial, social, and human capital. For Diqing, if the organic system is compared to a vehicle, natural capital can be regarded as energy, financial capital as the engine, physical capital as the transmission shaft, and human capital and social capital as the wheels. Its goal is to make the car move fast and smoothly, that is, to make the wheels turn faster and more stably. Therefore, a targeted rural revitalization model was developed for Diqing according to the linkages between the forms of sub-capital and the RRS objectives (Figure 8).

The details of the model are based on several recommendations. First, continuing to consolidate the advantages of natural capital and promoting ecological revitalization are important. Natural capital is the foundation of Diqing's regional livelihood capital and socioeconomic development, just as a vehicle needs sufficient and high-quality energy to continue moving. Ensuring ecological security and sustainable utilization of natural resources are the primary tasks for RRS implementation. Ecological revitalization is the premise of rural revitalization. Therefore, this study recommends that ecological treatment and protection projects be carried out, with an emphasis on returning farmland to forest and grassland, protecting natural forests, and preventing and controlling environmental pollution. More attention should be paid to the supervision of agricultural and natural resources to ensure the supply of farmers' natural means of production. The ecological compensation system should be improved so that farmers can directly benefit from ecological protection.

Second, natural capital should be transformed into financial capital to promote industrial revitalization. This is the process by which the engine converts energy into kinetic energy. However, this does not mean seeking economic growth at the cost of environmental pollution and resource destruction. Instead, it follows the concept of sustainable development to emphasize the green utilization of natural resources and the development of industries according to local conditions. Moreover, the gradually enriched financial capital can provide more economic support for the consolidation of natural capital. Therefore, ecological and industrial revitalization can be promoted simultaneously, which is a key task for RRS implementation. Judging from the development of the regional livelihood capital structure, Diqing is possibly at this stage now. This study suggests that agricultural production should be distributed professionally according to the altitude of a given area: high-altitude agricultural industry (highland barley, potato, Tibetan

pig, yak, etc.) should be developed on plateaus; under-forest planting and breeding (medicinal materials, walnuts, cattle, sheep, poultry, etc.) and wild animal domestication (wild boar, Tibetan pheasant, etc.) should be developed in mountainous areas; and specialized planting (rice, corn, grape, tobacco, silkworm, etc.) and large-scale livestock and poultry breeding should be vigorously promoted in valleys. Green energy (hydropower), ecotourism, and agricultural bio-industry should be developed to increase income. Furthermore, investment in fixed assets should be increased to improve infrastructure, and priority should be given to irrigation and water conservation, transportation, factories, and other production facilities to improve economic efficiency and promote the growth of the real economy. More importantly, investment in natural ecological protection should be guaranteed.

Finally, financial capital, which is gradually enhanced, should be appropriately transformed into physical, social, and human capital to promote the revitalization of organizations, culture, and talent. The accumulation of financial capital is not the goal. However, its strong convertibility should be used to reasonably adjust the regional livelihood capital structure and enhance the ability to resist external risk shocks. This is how the engine transmits kinetic energy to the wheels, in which physical capital plays an important role. The support from physical materials, such as fixed assets and consumer goods, can greatly improve the output efficiency of financial capital and connect the channel of energy transmission from financial capital to social, human, and natural capital to increase the operational efficiency of the whole organic system. The accumulation of social and human capital is the goal of the operation of the organic system, but it is not the terminal of energy transmission. Social progress and the improvement of population quality complement each other, which produces positive energy feedback on natural, financial, and physical capital. Such a positive cycle will fundamentally strengthen the integration of regional livelihood capital and provide sustainable energy RRS implementation in Diqing. Therefore, this study recommends that actions be taken to establish rural libraries, launch higher vocational education institutions, improve the standards of rural hospitals, promote technical expertise in rural areas, and support rural community cooperatives. In this way, social progress and the improvement of population quality will, in turn, provide services for ecological protection and economic development.

In conclusion, in the organic regional livelihood capital system, the main direction of energy is "natural capital → financial capital → physical capital, social capital, and human capital," but at the same time, there is positive reverse return energy, which needs to be the focus. Therefore, it is necessary to promote the positive energy cycle among the five forms of sub-capital and ensure the efficient and stable operation of this organic system. In this way, the objectives of the RRS can also be achieved in this process.

6 Discussion

As one of the most representative poverty-stricken areas in China, Diqing is facing the practical problem of how to effectively implement the RRS. Many studies have provided solutions from different perspectives, such as improving the system construction (Lu et al., 2020), developing ecotourism (Bai and Ren, 2021), and enriching people's spiritual world (Coggins, 2019). Therefore, it is necessary to consider the RRS implementation from a more comprehensive perspective. Livelihood capital is composed of natural, physical, financial, social, and human capital, which is highly linked with the objectives of the RRS, providing an effective perspective for RRS implementation. Based on this, the model and relevant policy recommendations developed in this study have certain practical contributions for RRS implementation in Diqing and other similar areas.

Based on the current situation, in which livelihood capital research focuses on micro-individuals and ignores macro-regions, this study puts forward a new concept of regional livelihood capital to meet the practical needs of the RRS and creatively expounds its concept and connotation. Compared with the concept of individual livelihood capital pursued by mainstream studies, regional livelihood capital regards people in a specific region as a "whole" to emphasize the relationship between people's livelihood and the environment. However, some indicators with regional attributes have been included in the livelihood capital evaluation index system in some previous studies to reflect regional differences, such as "*per capita* mineral resource reserves," "regional fiscal revenue," "total regional population," "number of subsistence allowances," and "per capital area under culture" (Hu, 2014; Wu et al., 2019; Paul et al., 2020). These indicators reflect the inevitable connection between people's livelihood and the regional environment, demonstrating this study's theoretical contribution: livelihood capital is made up of both individual and regional livelihood capital. This can further enrich the connotation of livelihood capital and may also increase the understanding of livelihood capital in studies using a macro-regional perspective. It also provides new theoretical guidance for RRS implementation.

Based on the linkages between the forms of sub-capital and the objectives of the RRS, this study uses regional livelihood capital to develop a rural revitalization model for Diqing. It holds that the main direction of energy is "natural capital → financial capital → physical capital, social capital, and human capital" and that different sub-capitals play different roles. 1) Natural capital is the foundation. For Diqing, ecological revitalization is the premise of rural revitalization. This view is similar to a study in Iran, which demonstrated that natural capital plays a crucial role in the livelihood level and ecosystem function of residents in Zarivar (Aazami and Shanazi, 2020). 2) Financial capital is the core driving force of regional livelihood capital enrichment and should be the focus of the RRS. This is similar to a study in Sapa, Vietnam, which demonstrated that the convertibility of farmers' financial capital could better promote other forms of sub-capital to improve their livelihood strategies (Huang et al., 2022). 3) While physical capital plays a medium role, the development of other forms of sub-capital must include physical materials. This is similar to results from a study in Chiapas, Mexico, which demonstrated that when farmers adapt to climate change, physical capital guarantees that other sub-capital forms will play a more effective role (Shinbrot et al., 2019). 4) The improvement of social and human capital is the ultimate goal of RRS implementation. This is similar to the view of a study conducted in Bangladesh that demonstrated that the sustainability of social and human capital is fundamental to the protection of forest resources (Islam et al., 2019). In particular, many other studies have confirmed

the foundation of natural capital, the convertibility of financial capital, the intermediary nature of physical capital, and the intangibility of social capital (Karunarathne and Lee, 2019; Mbiba et al., 2019; Yang et al., 2021). Some studies hold different views from this study (Guo et al., 2019; Wang et al., 2021a); however, they should be interpreted in consideration of their specific situation.

Although most studies focus on individual livelihood capital, whether their findings are similar to this study largely depends on whether the study area is similar in the geographical environment and economic and social development. To take it a step further, livelihood capital has regional attributes, and the operation mode of the organic system of livelihood capital has spatial heterogeneity. Subsequently, the research on individual or regional livelihood capital should be based on a specific geographical environment. Therefore, the rural revitalization model developed in this study is not universal but is only effective for Diqing or areas similar to Diqing, which is one of its limitations. Other different types of regions need to be specifically analyzed according to the characteristics of their regional livelihood capital and geographical environment. In addition, this study uses prefecture-level regions as the research scale. Although some discoveries were made, other potential links may be found at the provincial, county, or village levels, and the research team intends to investigate this further. Moreover, most of the data in this study are based on official statistics, and the problems reflected may be relatively macro and even limited. More importantly, however, this study uses the linkages between livelihood capital, the RRS, and the principle of system dynamics to develop a rural revitalization model. This idea can be replicated in other regions to guide rural development. Following this idea, there are some possible research directions in the future, for example, performing quantitative analysis of the interaction of sub-capital forms, or examining how to comprehensively consider individual and regional livelihood capital, using statistics and field survey data to improve the livelihood capital evaluation index system, and formulating reasonable RRS policies according to the operation model of the regional livelihood capital organic system.

7 Conclusion

This study introduces a new concept of regional livelihood capital to develop an evaluation index system to analyze the characteristics of regional livelihood capital in Diqing. The results demonstrate that, from 1993 to 2020, Diqing's regional livelihood capital increased steadily, and the livelihood capital structure continued to diversify, but the level remained low. Although natural capital fluctuates in terms of sub-capital forms, it still has absolute advantages and is the foundation of regional livelihood capital. The rapid growth of financial capital is the core driving force for the growth of regional livelihood capital. The growth of physical capital is stable, but it is insufficient compared with other regions. The weak growth of social and human capital is the weakness of regional livelihood capital.

Based on the results of the comprehensive measurement of regional livelihood capital and the economic information of Diqing, following the principle of system dynamics and the concept of being people-oriented, a targeted rural revitalization model was developed that regards regional livelihood capital as an organic system formed by combining natural, physical, financial, social, and human capital. Among these, natural capital is the foundation (energy), financial capital is the power (engine), physical capital is the medium (bearing), and social capital and human capital are the goals (wheels). The main direction of energy is "natural capital → financial capital → physical capital, social capital, and human capital." Moreover, the reverse feedback of energy should also be given much attention to promote sustainability and coordinate the efficient operation of this organic system. This model can provide significant guidance for RRS implementation in Diqing and other similar poor areas. Importantly, regional livelihood capital provides a theoretical perspective for sustainable rural development.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: Yunnan Provincial Bureau of Statistics (http://stats.yn.gov.cn/); the statistical information network of China (http://www.tjcn.org/); and Computer Network Information Center of the Chinese Academy of Sciences (http://www.gscloud.cn).

Author contributions

SZ: conceptualization, methodology, formal analysis, investigation, and writing—original draft. JS: supervision and funding acquisition. YW: investigation and writing—review and editing. BY: methodology. HL: investigation. TX: software and data collection. XZ: data collection. XL: data collection. GZ: data collection.

Funding

This work was supported by the National Social Science Fund of China (Grant Nos 17FZS047 and 20FZSB006) and the National Natural Science Foundation of China (Grant No. 41761037).

Acknowledgments

The authors thank the Agriculture and Rural Affairs Bureau, Poverty Alleviation Office, and Rural Revitalization Bureau of the People's Government of Diqing for their data support and full cooperation. The authors are very grateful to the editors and reviewers for their great efforts.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Aazami, M., and Shanazi, K. (2020). Tourism wetlands and rural sustainable livelihood: The case from Iran. *J. Outdoor. Rec. Tour.* 30, 100284. doi:10.1016/j.jort.2020.100284

Africano, A. C., and Collado, Á. C. (2017). Peasant economy sustainability in peasant markets, Colombia. *Agroecol. Sust. Food.* 41 (2), 204–225. doi:10.1080/21683565.2016.1266069

Alkire, S., and Foster, J. (2011a). Counting and multidimensional poverty measurement. *J. Public. Econ.* 95 (7-8), 476–487. doi:10.1016/j.jpubeco.2010.11.006

Alkire, S., and Foster, J. (2011b). Understandings and misunderstandings of multidimensional poverty measurement. *J. Econ. Inequal.* 9, 289–314. doi:10.1007/s10888-011-9181-4

Azumah, F. D., Onzaberigu, N. J., and Adong, A. A. (2022). Gender, agriculture and sustainable livelihood among rural farmers in northern Ghana. *Econ. Change. Restruct.* doi:10.1007/s10644-022-09399-z

Bai, H., and Ran, W. (2021). Construction and cultivation of rural tourism supply Chain from the perspective of poverty alleviation under the background of rural revitalization. *For. Chem. Rev.* 73–92. doi:10.17762/jfcr.vi.147

Berchoux, T., and Hutton, C. W. (2019). Spatial associations between household and community livelihood capitals in rural territories: An example from the Mahanadi Delta, India. *Appl. Geogr.* 103, 98–111. doi:10.1016/j.apgeog.2019.01.002

Bhandari, P. B. (2013). Ruralli velihood change? Household capital, community resources and livelihood transition. *J. Rural. Stud.* 32, 126–136. doi:10.1016/j.jrurstud.2013.05.001

Chen, H., Zhu, T., Krott, M., Calvo, J. F., Ganesh, S. P., and Makoto, I. (2013). Measurement and evaluation of livelihood assets in sustainable forest commons governance. *Land. use. Policy.* 30, 908–914. doi:10.1016/j.landusepol.2012.06.009

Chen, L., Zhu, X., and Li, X. (2016). Disparities of county at Yunnan Province in China base on the perspective of industrial structure. *Sci. Geogr. Sin.* 36 (03), 384–392. (In Chinese). doi:10.13249/j.cnki.sgs.2016.03.009

Chen, M., Zhou, Y., Huang, X., and Ye, C. (2021). The integration of new-type urbanization and rural revitalization strategies in China: Origin, reality and future trends. *Land* 10 (2), 207. doi:10.3390/land10020207

Chowdhury, T. A. (2021). Applying and extending the sustainable livelihoods approach: Identifying the livelihood capitals and well-being achievements of indigenous people in Bangladesh. *J. Soc. Econ. Dev.* 23, 302–320. doi:10.1007/s40847-021-00163-z

Coggins, C. (2019). Sacred Watersheds and the fate of the village body politic in Tibetan and han communities under China's ecological civilization. *Religions* 10 (11), 600. doi:10.3390/rel10110600

Deng, Q., Li, E., and Yang, Y. (2022). Politics, policies and rural poverty alleviation outcomes: Evidence from Lankao County, China. *Habitat. Int.* 127, 102631. doi:10.1016/j.habitatint.2022.102631

DFID (2000). *Sustainable livelihoods guidance sheets*. London: Department for International Development, 68–125.

Ding, L., Shao, Z., Zhang, H., Xu, C., and Wu, D. (2016). A comprehensive evaluation of urban sustainable development in China based on the TOPSIS-entropy method. *Sustainability* 8 (8), 746. doi:10.3390/su8080746

Dong, Y., Jin, G., Deng, X., and Wu, F. (2021). Multidimensional measurement of poverty and its spatio-temporal dynamics in China from the perspective of development geography. *J. Geogr. Sci.* 31, 130–148. doi:10.1007/s11442-021-1836-x

Fang, Y., Fan, J., Shen, M., and Song, M. (2014). Sensitivity of livelihood strategy to livelihood capital in mountain areas: Empirical analysis based on different settlements in the upper reaches of the Minjiang River, China. *Ecol. Indic.* 38, 225–235. doi:10.1016/j.ecolind.2013.11.007

Feng, Z., Tang, Y., Yang, Y., and Zhang, D. (2008). Relief degree of land surface and its influence on population distribution in China. *J. Geogr. Sci.* 18, 237–246. doi:10.1007/s11442-008-0237-8

Gentle, P., and Maraseni, T. N. (2012). Climate change, poverty and livelihoods: Adaptation practices by rural mountain communities in Nepal. *Environ. Sc. Policy.* 21, 24–34. doi:10.1016/j.envsci.2012.03.007

Ghosh, M., and Ghosal, S. (2021). Multidimensional rural livelihoods in Indian sub-himalaya: Regional analysis, households well-being and its determinants. *Int. J. Rural. Manage.* 0, 097300522110476. doi:10.1177/09730052211047639

Guo, S., Lin, L., Liu, S., Wei, Y., Xu, D., Li, Q., et al. (2019). Interactions between sustainable livelihood of rural household and agricultural land transfer in the mountainous and hilly regions of Sichuan, China. *Sustain. Dev.* 27 (4), 725–742. doi:10.1002/sd.1937

Hillman, B. (2010). China's many Tibets: Diqing as a model for 'development with Tibetan characteristics? *Asian Ethn.* 11 (2), 269–277. doi:10.1080/14631361003779604

Horsley, J., Prout, S., Tonts, M., and Ali, S. H. (2015). Sustainable livelihoods and indicators for regional development in mining economies. *Extr. Ind. Soc.* 2 (2), 368–380. doi:10.1016/j.exis.2014.12.001

Hou, X., Wu, H., and Wang, W. (2022). Identification and measurement of multidimensional relative poverty of Chinese rural adults considering climate factors. *Front. Environ. Sci.* 10. doi:10.3389/fenvs.2022.891077

Hu, Z. (2014). *The sustainable development of ecologically fragile zones from the perspective of livelihood assets*. Fuzhou, China: Fujian Normal University. (In Chinese).

Hua, X., Yan, J., and Zhang, Y. (2017). Evaluating the role of livelihood assets in suitable livelihood strategies: Protocol for anti-poverty policy in the Eastern Tibetan Plateau, China. *Ecol. Indic.* 78, 62–74. doi:10.1016/j.ecolind.2017.03.009

Huang, J., Rozelle, S., Zhu, X., Zhao, S., and Sheng, Y. (2020). Agricultural and rural development in China during the past four decades: An introduction. *Aust. J. Aga. Resour. Ec.* 64 (1), 1–13. doi:10.1111/1467-8489.12352

Huang, L., Yang, L., Tuyến, N. T., Nazan, C., and Liu, J. (2022). Factors influencing the livelihood strategy choices of rural households in tourist destinations. *J. Sustain. Tour.* 30 (4), 875–896. doi:10.1080/09669582.2021.1903015

Islam, K., Nath, T. K., Jashimuddin, M., and Rahman, M. F. (2019). Forest dependency, co-management and improvement of peoples' livelihood capital: Evidence from Chunati Wildlife Sanctuary, Bangladesh. *Environ. Dev.* 32, 100456. doi:10.1016/j.envdev.2019.100456

Jin, G., Chen, K., Liao, T., Zhang, L., and Najmuddin, O. (2021). Measuring ecosystem services based on government intentions for future land use in hubei province: Implications for sustainable landscape management. *Landsc. Ecol.* 36, 2025–2042. doi:10.1007/s10980-020-01116-3

Karunarathne, A. Y., and Lee, G. (2019). Traditional social capital and socioeconomic networks in response to flood disaster: A case study of rural areas in Sri Lanka. *Int. J. Disast. Risk. Re.* 41, 101279. doi:10.1016/j.ijdrr.2019.101279

Konkel, R. (2014). The monetization of global poverty: The concept of poverty in World Bank history, 1944–90. *J. Glob. Hist.* 9 (2), 276–300. doi:10.1017/S1740022814000072

Kuang, F., Jin, J., He, R., Ning, J., and Wan, X. (2020). Farmers' livelihood risks, livelihood assets and adaptation strategies in Rugao City, China. *J. Environ. Manage.* 264, 110463. doi:10.1016/j.jenvman.2020.110463

Lind, N. (2019). A development of the human development index. *Soc. Indic. Res.* 146, 409–423. doi:10.1007/s11205-019-02133-9

Liu, M., Feng, X., Wang, S., and Qiu, H. (2020). China's poverty alleviation over the last 40 years: Successes and challenges. *Aust. J. Aga. Resour. Ec.* 64 (1), 209–228. doi:10.1111/1467-8489.12353

Liu, M., Feng, X., Wang, S., and Zhong, Y. (2021a). Does poverty-alleviation-based industry development improve farmers' livelihood capital? *J. Integr. Agr.* 20 (4), 915–926. doi:10.1016/S2095-3119(20)63449-9

Liu, M., Qin, Q., Zou, Q., Wang, Y., and Wen, Y. (2021b). Natural resource dependence of communities around the giant panda protected land based on livelihood capital. *Agriculture* 11 (11), 1123. doi:10.3390/agriculture11111123

Liu, Y., Deng, W., and Song, X. (2015). Relief degree of land surface and population distribution of mountainous areas in China. *J. Mt. Sci.* 12, 518–532. doi:10.1007/s11629-013-2937-5

Liu, Y., Liu, J., and Zhou, Y. (2017). Spatio-temporal patterns of rural poverty in China and targeted poverty alleviation strategies. *J. Rural. Stud.* 52, 66–75. doi:10.1016/j.jrurstud.2017.04.002

Liu, Y. (2018). Urban and rural integration and Rural Revitalization in the new era of China. *Acta. Geogr. Sin.* 73 (04), 637–650. (In Chinese).

Liu, Y., and Xu, Y. (2016). A geographic identification of multidimensional poverty in rural China under the framework of sustainable livelihoods analysis. *Appl. Geogr.* 73, 62–76. doi:10.1016/j.apgeog.2016.06.004

Liu, Y., Zhang, Y., and Yang, Y. (2020). China's rural revitalization and development: Theory, technology and management. *J. Geogr. Sci.* 30, 1923–1942. doi:10.1007/s11442-020-1819-3

Lo Bue, M. C., and Palmisano, F. (2020). The individual poverty incidence of growth. *Oxf. B. Econ. Stat.* 82 (6), 1295–1321. doi:10.1111/obes.12362

Lu, Y., Yao, S., Ding, Z., Deng, Y., and Hou, M. (2020). Did government expenditure on the grain for green project help the forest carbon sequestration increase in yunnan, China? *Land* 9 (2), 54. doi:10.3390/land9020054

Marsden, T. (2010). Mobilizing the regional eco-economy: Evolving webs of agri-food and rural development in the UK. *Camb. J. Reg. Econ. Soc.* 3 (2), 225–244. doi:10.1093/cjres/rsq010

Marulanda, L. P., Patrick, L., Jepsen, M. R., Castro-Nunez, A., Francesconi, W., Camilo, K., et al. (2020). Farmscape composition and livelihood sustainability in deforested landscapes of Colombian amazonia. *Agriculture* 10 (12), 588. doi:10.3390/agriculture10120588

Mbiba, M., Collinson, M., Hunter, L., and Twine, W. (2019). Social capital is subordinate to natural capital in buffering rural livelihoods from negative shocks: Insights from rural South Africa. *J. Rural. Stud.* 65, 12–21. doi:10.1016/j.jrurstud.2018.12.012

Michálek, A., and Madajová, M. S. (2019). Identifying regional poverty types in Slovakia. *GeoJournal* 84, 85–99. doi:10.1007/s10708-018-9852-9

Misturelli, F., and Heffernan, C. (2010). The concept of poverty: A synchronic perspective. *Prog. Dev. Stud.* 10 (1), 35–58. doi:10.1177/146499340901000103

Naithani, S., and Saha, A. K. (2020). Social capital and livelihood strategies in response after 2013 Kedarnath disaster (India). *Prev. Manag.* 30 (2), 179–193. doi:10.1108/DPM-07-2019-0221

Nallari, R., and Griffith, B. (2011). *Understanding growth and poverty: Theory, policy, and empirics*. Washington, DC, USA: World Bank Publications - Books. 2281, 35–152. Available at: https://openknowledge.worldbank.org/handle/10986/2281.

Oladele, I., and Ward, L. (2017). Effect of micro-agricultural financial institutions of south Africa financial services on livelihood capital of beneficiaries in north west province south Africa. *Agric. Food. Secur.* 6, 45. doi:10.1186/s40066-017-0122-8

Onitsuka, K., and Hoshino, S. (2018). Inter-community networks of rural leaders and key people: Case study on a rural revitalization program in Kyoto Prefecture, Japan. *J. Rural. Stud.* 61, 123–136. doi:10.1016/j.jrurstud.2018.04.008

Paul, S., Das, T. K., Pharung, R., Ray, S., Mridha, N., Kalita, N., et al. (2020). Development of an indicator based composite measure to assess livelihood sustainability of shifting cultivation dependent ethnic minorities in the disadvantageous Northeastern region of India. *Ecol. Indic.* 110, 105934. doi:10.1016/j.ecolind.2019.105934

Ravar, Z., Zahraie, B., Sharifinejad, A., Gozini, H., and Jafari, S. (2020). System dynamics modeling for assessment of water–food–energy resources security and nexus in Gavkhuni basin in Iran. *Ecol. Indic.* 108, 105682. doi:10.1016/j.ecolind.2019.105682

Roberts, M. G., and Yang, G. (2003). The international progress of sustainable development research: A comparison of vulnerability analysis and the sustainable livelihoods approach. *Prog. Geog.* 22 (1), 11–21. (In Chinese).

Scoones, I. (2009). Livelihoods perspectives and rural development. *J. Peasant. Stud.* 36 (1), 171–196. doi:10.1080/03066150902820503

Shahzad, U., Doğan, B., Sinha, A., and Fareed, Z. (2021). Does export product diversification help to reduce energy demand: Exploring the contextual evidences from the newly industrialized countries. *Energy* 214, 118881. doi:10.1016/j.energy.2020.118881

Shcherbak, V., Ganushchak-Yefimenko, L., Nifatova, O., Fastovets, N., Plysenko, H., Lutay, L., et al. (2020). Use of key indicators to monitor sustainable development of rural areas. *J. Environ. Sci. Manag.* 6 (2), 175–190. doi:10.22034/gjesm.2020.02.04

Shinbrot, X. A., Jones, K. W., Rivera-Castañeda, A., López-Báez, W., and Ojima, D. S. (2019). Smallholder farmer adoption of climate-related adaptation strategies: The importance of vulnerability context, livelihood assets, and climate perceptions. *Environ. Manage.* 63, 583–595. doi:10.1007/s00267-019-01152-z

Singh, P. K., and Hiremath, B. N. (2010). Sustainable livelihood security index in a developing country: A tool for development planning. *Ecol. Indic.* 10 (2), 442–451. doi:10.1016/j.ecolind.2009.07.015

Su, F., Xu, Z., and Shang, H. (2009). An overview of sustainable livelihoods approach. *Adv. Earth. Sci.* 24 (1), 61–69. doi:10.11867/j.issn.1001-8166.2009.01.0061

Tania, M. L. (2009). Exit from agriculture: A step forward or a step backward for the rural poor? *J. Peasant. Stud.* 36 (3), 629–636. doi:10.1080/03066150903142998

Venables, A. J. (2018). Globalization and urban polarization. *Rev. Int. Econ.* 26 (5), 981–996. doi:10.1111/roie.12366

Wang, C., and Wan, G. (2015). Income polarization in China: Trends and changes. *China. Econ. Rev.* 36, 58–72. doi:10.1016/j.chieco.2015.08.007

Wang, W., Lan, Y., and Wang, X. (2021a). Impact of livelihood capital endowment on poverty alleviation of households under rural land consolidation. *Land. use. Policy.* 109, 105608. doi:10.1016/j.landusepol.2021.105608

Wang, W., Zhang, C., Guo, Y., and Xu, D. (2021b). Impact of environmental and health risks on rural households' sustainable livelihoods: Evidence from China. *Int. J. Environ. Res. Public. Health.* 18 (20), 10955. doi:10.3390/ijerph182010955

Wu, X., Qi, X., Yang, S., Ye, C., and Sun, B. (2019). Research on the intergenerational transmission of poverty in rural China based on sustainable livelihood analysis framework: A case study of six poverty-stricken counties. *Sustainability* 11 (8), 2341. doi:10.3390/su11082341

Xu, D., Deng, X., Guo, S., and Liu, S. (2019). Sensitivity of livelihood strategy to livelihood capital: An empirical investigation using nationally representative survey data from rural China. *Soc. Indic. Res.* 144, 113–131. doi:10.1007/s11205-018-2037-6

Xu, Y., Duan, J., and Xu, X. (2018). Comprehensive methods for measuring regional multidimensional development and their applications in China. *J. Geogr. Sci.* 28, 1182–1196. doi:10.1007/s11442-018-1549-y

Yan, D., Yang, X., and Sun, W. (2022). How do ecological vulnerability and disaster shocks affect livelihood resilience building of farmers and herdsmen: An empirical study based on CNMASS data. *Front. Environ. Sci.* 10. doi:10.3389/fenvs.2022.998527

Yang, X., Guo, S., Deng, X., and Xu, D. (2021). Livelihood adaptation of rural households under livelihood stress: Evidence from sichuan province, China. *Agriculture* 11 (6), 506. doi:10.3390/agriculture11060506

Yang, Y., Li, J., Sun, X., and Chen, J. (2014). Measuring external oil supply risk: A modified diversification index with country risk and potential oil exports. *Energy* 68, 930–938. doi:10.1016/j.energy.2014.02.091

Zhang, C., Fang, Y., Chen, X., and Congshan, T. (2019). Bibliometric analysis of trends in global sustainable livelihood research. *Sustainability* 11 (4), 1150. doi:10.3390/su11041150

Zhang, H., Wu, K., Qiu, Y., Chan, G., Wang, S., Zhou, D., et al. (2020). Solar photovoltaic interventions have reduced rural poverty in China. *Nat. Commun.* 11, 1969. doi:10.1038/s41467-020-15826-4

Zhang, J., Zhu, W., Zhu, L., Cui, Y., He, S., and Ren, H. (2019). Topographical relief characteristics and its impact on population and economy: A case study of the mountainous area in Western henan, China. *J. Geogr. Sci.* 29, 598–612. doi:10.1007/s11442-019-1617-y

Zhao, J., Ji, G., Tian, Y., Chen, Y., and Wang, Z. (2018). Environmental vulnerability assessment for mainland China based on entropy method. *Ecol. Indic.* 91, 410–422. doi:10.1016/j.ecolind.2018.04.016

Zhou, Y., and Liu, Y. (2019). The geography of poverty: Review and research prospects. *J. Rural. Stud.* 93, 408–416. doi:10.1016/j.jrurstud.2019.01.008

Zhu, S., Zhai, Y., and Wu, Y. (2020). Research on relief degree of land surface in Yunnan Province at county level and its correlation between population distribution and cconomic development. *J. Leshan. Norm. Univ.* 35 (04), 82–88. (In Chinese). doi:10.16069/j.cnki.51-1610/g4.2020.04.014