

## Impacts of snow disaster on rural livelihoods in southern Tibet-Qinghai Plateau



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### ARTICLE INFO

#### Keywords:

Snow disaster  
Rural livelihoods  
Impact  
Shigatse Prefecture

### ABSTRACT

Snow disaster is one of the most influential and devastating natural disasters with the serious losses in the Qinghai-Tibet Plateau, but its impact on rural residents' livelihood does not get enough attention from scholars. This study evaluates the index of snow disasters (SI) and multi-dimensional livelihood index (MLI), and constructs an assessment framework of the impact of snow disaster on the livelihood capital of rural residents. The results indicate that: (1) SI in Shigatse Prefecture presented a downward trend from 1980 to 2014, but the peak interval shrunk; the high disaster areas located in the north, west and south as well as the low in the center and east. (2) The livelihood capital of rural resident showed an upward trend with an average annual growth rate of 6%, and was in a state of spatial agglomeration. (3) The significant negative effects of SI on each capital from largest to smallest are financial capital, physical capital, human capital, social capital and natural capital. (4) The 18 counties were divided into four groups, namely the high-disaster high-capital group, the high-disaster low-capital group, the low-disaster high-capital group and the low-disaster low-capital group. According to the panel regression, agricultural and meteorological fiscal inputs, road construction and educational input have positive influence on livelihood capital, but the effects vary in different groups. Accordingly, we propose that more effective policies should be adopted to mitigate the negative effects of snow disasters.

### 1. Introduction

Livelihoods are based on the capacities, capital and activities, namely the combination of the resources that people use and the living activities [17]. The sustainable livelihood has been the hot spot of the academic circles in recent years, and the sustainable livelihood framework (SLF) established by Department for International Development (DFID) has been widely adopted and applied [25,28,31,32]. This framework mainly consists of 5 parts, which are vulnerability context, livelihood assets, transforming structures and processes, livelihood strategy and outcomes [35]. This framework regards livelihood assets as a livelihood pentagon [19,34,39,4,8]; there are the direct and indirect reinforcing or weakening interactions between vulnerability context and livelihood assets [3]; transforming structures and processes may improve or worsen the livelihood conditions through the impact on vulnerability context and livelihood assets [22,38]; individuals, however, can adopt the corresponding strategy in the case of synthesizing the assets that they can use, considering the vulnerability context and supporting or hindering the transforming structures and processes

[30,42], so as to obtain the outcome [14]; outcome directly affects the individuals' livelihood conditions, and will determine the individuals' further livelihood capital and the degree of availability as well [18]. The guiding significance of this framework is that livelihood is a dynamic and sustainable process, and how individuals can effectively deal with the impact of the vulnerability context according to their own livelihood assets as well as grasp the favorable factors of transforming structures and processes to adopt the correct strategy and produce the desired outcome, so as to achieve the purpose of improving the future livelihood conditions [24].

Natural disasters are the results of the comprehensive effect of risk, vulnerability, and exposure. In recent years, the influence of natural disasters on livelihood has gradually attracted considerable attention [23,27,33,9]. As the main disaster-bearing bodies, families are the main vulnerable groups in disaster risks. Their livelihood vulnerability mainly embodies as the sensitivity to the changes of the external environment and the limitation of the abilities to cope with natural disasters [40,41], and livelihood capital are a key factor for the families to cope with natural disasters and external pressures [26,7]. Compared

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with the urban families, the vulnerability of rural family livelihood capital to natural disasters is more prominent [1,10]: in natural disaster-prone areas, disasters can affect the accumulation of rural residents' livelihood capital; however, the lack of livelihood capital makes them have limited means to deal with natural disasters and other external shock, while the serious and frequent natural disasters force rural residents to sell limited resources to maintain the basic consumption, so that production materials can not be regained to engage in agriculture and animal husbandry activities after disasters, whereas the livelihood vulnerability is increasing, and poverty is even intensified.

Snow disasters have always been one of the most serious natural disasters in the world. Snow disasters may cause the obstruction of life and social panic. After snow disasters, it is easy to cause landslides, collapses, debris flows and other secondary disasters, leading to transportation and communication interruptions, soaring prices, etc. In recent years, due to the frequent occurrence of snow disasters and the wide range of influence, the research on the impact of snow disasters on social economy has attracted great attention. Since 1990s, the remote sensing technology has been widely used in the field of snow disaster judgment. The common method is to combine the meteorological observation data with the remote sensing monitoring data to construct the snow disaster risk rating model [36,37,45], which reflects the superiority and convenience of the remote sensing technology, but ignores the actual situation of snow disasters. Some scholars combine remote sensing data, meteorological data with historical data to consider the possibility and reality of snow disaster, and build a comprehensive risk assessment system for snow disaster [43]. When discussing the impact of snow disasters, numerous scholars mainly focus on the influence of snow disasters on social economy, using property losses, insurance data, etc. to estimate the snow disaster losses, and they do not lay emphasis on the impact on residents' livelihoods. Due to the comprehensive effects of the unique geomorphology and the complex climate change, snow disasters are the most frequent and influential natural disasters with the most serious losses in the Qinghai-Tibet Plateau, and different degrees of snow disasters almost occur every year [16,20]. The analysis on the influence of snow disasters on livelihoods of rural residents in the Qinghai-Tibet Plateau can more clearly understand the rural residents' livelihood vulnerability under the disaster risks. Meanwhile, it has important reference value for formulating and implementing policies and measures aiming at helping rural residents improve their abilities to deal with snow disaster, becoming the prerequisite and the useful tool for promoting the sustainable development of this area and even the entire society [2].

The main objectives of this study are to construct the assessment framework for the impact of snow disasters on livelihoods of rural residents in the Qinghai-Tibet Plateau based on the sustainable livelihood framework (Fig. 1), explore the temporal and spatial patterns of snow disasters occurred in the southern Qinghai-Tibet Plateau, evaluate the rural residents' livelihood conditions objectively and unbiased, identify the effects of snow disasters on rural residents' livelihood and put forward the targeted disaster response policy recommendations.

The framework structure of this study is as follows: Section 1 makes the literature review of the livelihood, the impact of disasters on livelihood, the measure of snow disasters and the impact of snow disasters on social economy; Section 2 describes the measurement methods of snow disasters and livelihood capital, constructs the influence model for livelihood capital and introduces the data sources; Section 3 analyzes the temporal and spatial patterns of snow disasters and rural residents' livelihood, gives the panel regression model results in southern Qinghai-Tibet Plateau, and puts forward the policy implications; Section 4 draws the conclusions and points out the significance and deficiencies of this study.

## 2. Research methods

### 2.1. Description of the study area

We take the Shigatse Prefecture as a case. With an area of 182,000 km<sup>2</sup> and a national border of 1753 km, it is located in the south of Tibet Autonomous Region. As the frontier area of China's southwest border, it is also the political, economic and cultural center of Tibet (Fig. 2). The terrain in this region is complex and diverse, and the average altitude is over 4900 m. Located at the junction of Shigatse Prefecture and Nepal, Mount Qomolangma is the highest peak in the world. Shigatse Prefecture belongs to the typical plateau climate, and the annual average temperature is 3.9 °C, while the annual average precipitation is 346 mm [13]. There are many rivers in the region: the Yarlung Zangbo River originates here, and the Pengqu flows into the Koshi River in Nepal and eventually reaches the Ganges River. Grassland is the main type of vegetation, accounting for about 93% of the land area, and it includes alpine meadow and mountain meadow.

The population of Shigatse Prefecture is about 783,300, of which 95.6% are Tibetans; with an average of 4.3 persons/km<sup>2</sup>, and the population density in the western high-altitude area is less than 3 persons/km<sup>2</sup>. Restricted by the natural conditions, the industrial structure is relatively single, and the agricultural population accounts for more than 86% of the total population. The traditional agriculture and animal husbandry are not only the traditional industries but also the main sources of economic and material welfare for rural residents. In 2015, the total output value of agriculture, forestry, animal husbandry and fishery in this region was 4.1 billion yuan, accounting for 24.63% of the GDP; the per capita net income of rural residents was about 7402 yuan, which was 89.79% of the average for Tibet Autonomous Region and 33.70% of the national average in the same period. Shigatse Prefecture is one of the two high-frequent snow disaster centers in the Qinghai-Tibet Plateau, and snow disasters have serious effects on the production of agriculture and animal husbandry here [15,44].

### 2.2. Variable selection and description

#### 2.2.1. Vulnerability context—the index of the snow disasters (SI)

Snow disaster is a meteorological disaster which has serious damage

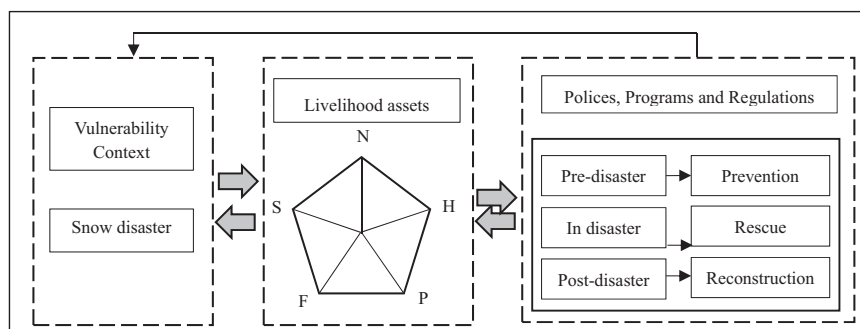


Fig. 1. Research conceptual model. Note: N, H, P, F and S denotes natural capital, human capital, physical capital, financial capital and social capital, respectively.

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