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Abstract

Identifying the influence factors lie behind the livelihood choices of rural households are of crucial significance to improving the sustainable livelihoods of rural households in tourism regions. Five villages in Sa Pa District, Vietnam, were selected in this study, to conduct household surveys and interviews with 180 households. Based on this, a comprehensive approach, which includes multinomial/binary logistic regression, Ripley's function and geographical detector, is applied to understand the households' capital endowment and factors lie behind their livelihood choices. Results show that for rural households, tourism livelihood yields the highest income, but the lack of diversity of livelihood activities may make tourism livelihood household be more vulnerable to the external risk and shocks than balanced livelihood households. Different types of households are found to show clustering feature, with clustering degree ranking as: agricultural > balanced > tourism > labour. Households with more natural capital are less likely to choose livelihoods other than agriculture livelihood. And households with more financial capital are less likely engage in agricultural livelihood. Both financial capital and social capital can facilitate engagement in balanced livelihood. And financial capital is key to tourism livelihood, and a barrier impeding agricultural households to participate in other livelihood activities.

Keywords: *Livelihood strategy; livelihood capital; tourism; rural households; Sa Pa, Vietnam*

1 INTRODUCTION

The term livelihood is commonly defined as people's capacity for maintenance of living (Chambers and Conway, 1991). On many occasions, tourism is a key livelihood strategy for people from less developed countries and regions to escape from poverty (C. Ashley, Roe, & Goodwin, 2001; Mbaiwa, 2011; Nyaupane & Poudel, 2011; Sarmento, 2016). The livelihood strategies basically refer to the activities undertaken for households' survivals (Shen et al. 2008). In the last a few decades, many institutions (e.g. Food and Agriculture Organization of the United Nations (FAO), The United Nations Development Programme (UNDP), Department For International Development (DFID)) have focused on the analysis of livelihood sustainability. However, DFID emphasized a strong relationship between livelihood and livelihood capitals. Livelihood capitals are defined as different categories of household (FAO, 2005) and these categories are named as human, natural, financial, physical and social capitals (DFID, 1999; FAO, 2005). People generate the livelihood strategies through using the five capitals to achieve in livelihood objectives. Aside from engaging in tourism, the residents of impoverished areas have also multiple alternative livelihood strategies. For example, animal husbandry is the primary means of livelihood for rural households in the Upper Svaneti region of Georgia (Kemkes, 2015); agriculture is the source of livelihood for the majority of residents in the Upper Brahmaputra River Basin of the Assam State of India (Johnson & Hutton, 2014); and rubber planting is the main source of income for rural households in southern Thailand (Longpichai, Perret, & Shivakoti, 2011). People's ability to choose

livelihoods strategies is closely related to their capital endowments and accessibility to capitals. And improving access to capitals (e.g. education, social services) is a key to generate efficient opportunities for the poor to improved their life (Chambers, 1995). That also highlights the importance of exploring the impact of capitals on people's livelihood choices.

Among existing studies, multinomial logistic regression is commonly used to assess the impact of livelihood capital on livelihood strategies (Alemayehu, Beuving, & Ruben, 2018; Hua, Yan, & Zhang, 2017; Xi, Pouliot, & Walelign, 2017). However, the factors influencing the choice of livelihood strategies by rural households not only include livelihood capital, but also factors such as location conditions, natural environment, and socioeconomic level (Belay & Bewket, 2013; Mancini, Bruggen, A., & Jiggins, 2007; Tran & Walter, 2014). The investigation of the associated geographical strata should be involved when studying these types of factors that have spatial variability attributes between geographic units (Wang et al., 2010). Geographical Detector is able to compare the spatial consistency of livelihood strategies distribution versus the geographical strata (e.g. elevation, ethnicity, land type and population) to reveal the driving factors of the spatial stratified heterogeneity. It can be used to both analyse quantitative data and detect qualitative data, and hence has been widely applied in the identification of contributing factors (J. F. Wang, Zhang, & Fu, 2016). However, it has rarely been employed in studies of the factors influencing the livelihood strategies of rural households in tourism regions. To identify the useful livelihood strategies, firstly it is essential to investigate the influencing factors of livelihood capitals. In addition to this, currently, studies on the spatial distribution of rural households with different livelihood strategies are mainly focused on more developed urban areas, with comparatively fewer studies on rural tourism regions, and even fewer on the rural tourist destinations in Vietnam.

With reference to the Sustainable Livelihood Approach framework and considerations of the gap in tourism literature, this study aims to reveal the influence factors lies behind the livelihood choices of people in Sa Pa, Vietnam, and this is going to be based on understanding the capital endowments of local households. Five villages in Sa Pa District, Vietnam were selected for research, as there are substantial differences among different regions in the factors influencing the choices of rural households regarding livelihood strategies. A comprehensive application of multiple methods is applied to fully identify these influencing factors, which includes establishment of livelihood capital evaluation system, multiple logistic regression, geographic analysis techniques such as Ripley's function, nearest neighbour hierarchical spatial clustering and geographical detector method. The findings of this study aim to provide insight for government to optimize resource allocation and improve people's access to capital.

2 LITERATURE REVIEW

Tourism, as a livelihood activity, has attracted the attention of academia. Research on tourism livelihood in different countries and regions emphasise that tourism plays a significant role in reducing poverty and improving people's livelihoods. However, since each country has its own distinct development goals, economic level and tourism resources, it follows that rural households' livelihood strategy choices and the factors contributing to those choices vary considerably (Steel, 2012). According to the British Department for International Development's sustainable livelihoods framework, 'case-by-case analysis' should be conducted for the typical cases of different countries (DFID, 1999). In Vietnam, tourism shows development as an

important economic pillar. In 2018, Vietnam's tourism revenues amounted to approximately US$23,900 million, accounting for about 10% of the country's GDP. In addition to its economic effects, tourism is also considered to have a positive effect on reducing deforestation in Sa Pa village (Hoang et al., 2014). Despite if the positive role of tourism livelihood in poverty reduction and sustainable development is recognized, its impact on livelihood improvement varies greatly among different regions. In other words, in many places of Vietnam (even famous tourism destinations), tourism still cannot replace the dominance of other livelihood activities. For instance, Sa Pa gets a reputation as an attractive tourism destination, but there are still many people engaging in semi-subsistence agricultural livelihoods; which includes rice, maize and cardamom cultivation, livestock breeding and collecting forest products (Hoang et al., 2020; Tugault & Turner, 2009). Following the French colonial era, tourism has been revived again in Sa Pa (Michaud & Turner, 2006). Some of the local people contribute to the tourism business by working as trekking guides, running hotels or selling textile commodities to tourists (Turner, 2007). Despite the considerable economic growth that tourism brings to Sa Pa, tourism is not a panacea for everyone to improve their livelihood. Hoang et al. (2020) found that not all households can benefit from the development of tourism. Especially the households where are located in inaccessible places, lacking skills or assets are found it difficult to participate in tourism livelihood. Truong et al (2014) found that most of the local people in Sa Pa wish to become homestay owners or tourist guides, however the lack of capital and foreign language proficiency is identified as the most important barriers preventing this from happening. Some remarkable ethnographic research (e.g. Turner, 2012a, 2012b) suggested that, in addition to the capital restrictions, ethnic and cultural values have been closely related to the livelihood choice of the ethnic minority people. Tourism is seldom the only source of income for people in tourism development area. And local people generally combine a multitude of economic activities to make a living, especially in developing economies (Dahles & Susilowati, 2015). Thus, tourism livelihood is not abstracted from the local context in the present study, but embedded within the interactions with other livelihood activities.

Understanding the factors that lie behind people's livelihood choice is key to livelihood improvement (Nielsen et al., 2013; Mogaka et al., 2014; DFID, 1999). Factors contributing to people's livelihood choices vary from region to region. For example, in Wulingyuan scenic spot of China, human capital and financial capital were the significant capital factors that affect the tourism-based livelihood strategy (Wang et al, 2016), whereas Bhandari (2013) found that the "availability of family labour force" in human capital hindered farmers from engaging in non-agricultural strategies. Furthermore, for farmers and herdsmen in Kanas ecotourism scenic spot of China, financial capital was not significantly related to herdsmen's participation in tourism (Zhang et al, 2013). Moreover, different combinations of livelihood capital lead to different livelihood strategies. In the polders of Bangladesh, residents with rich financial capital are more likely to adopt financially-intensive forms of livelihood options such as purchasing cars for providing transportation services for tourists. And residents are able to pursue more appropriate livelihood strategies when access to social capital such as government subsidies for buying farm equipment (Nath et al., 2020). Households in the Inner Mongolian Grassland with less natural capital and more manufactured capital get a trend to adopt LS strategy (i.e. breeding mainly small livestock) (Liu et

al., 2020). Not only the livelihood capital, but also the geographical factors, social and cultural factors have impact on the livelihood strategy (Yoshito and Coomes, 2001; Oumer et al, 2013). For example, about 80% of Nepal's rural population adopt agriculture-based livelihood strategies, as about 77% of Nepal's land is covered by mountains and hills making it difficult to construct infrastructure and basic facilities (Paudel Khatiwada et al., 2017). However, there are still few studies focus on the impact of terrain and spatial distance of households on their livelihood choice.

The evaluation frameworks developed by some international agencies are effective tools for livelihood capital research. Frameworks that have currently been developed include: the Sustainable Livelihoods Approach (SLA) framework by the British Department for International Development (DFID) (C Ashley, Carney, Ashley, & Carney, 1999), the sustainable livelihoods approach by the United Nations Development Programme (UNDP) (Krantz, 2001), and the rural household livelihood security framework of the US Cooperative for Assistance and Relief Everywhere (CARE) (Frankenberger, Drinkwater, & Maxwell, 2000). Of these, the SLA framework by DFID is the most widely applied, and it divides livelihood capital into five categories: human, natural, physical, financial and social capital (Bebbington, 1999). Owing to regional differences, these frameworks must be adjusted according to the actual conditions of their application, that is, the index selection and weight need to be adjusted according to different research regions.. For example, in the selection of social capital, countries such as Benin and Mauritania in West Africa focused specifically on the strengthening of associations, whereas São Tomé and Príncipe in Central Africa emphasized the importance of gender (Allison & Horemans, 2006). Consequently, optimization of the livelihood indicators with the support of livelihood capitals is essential in performing different case studies. Moreover, indicator weights can differ according to the actual local conditions. Therefore, the indicator weights should be adjusted accordingly. Although existing studies in literature have contributed with the importance and identification of livelihood strategies in different rural areas, there is still a lack of diversity in indicators. Therefore, the study aims to contribute to with the gap through the identification of diverse indicators and determination of influencing factors on livelihood strategy choices.

The spatial distribution of rural household's livelihood reflects the result of interaction between household's livelihood strategy and natural environment, surrounding social economy and human land. It affects the scale, direction and possibility of regional economic development. Therefore, understanding the distribution of household s' livelihood, such as dispersion, distribution pattern, is conducive to accurately grasp the characteristics of households' livelihood, and helps us put forward more targeted planning suggestions for the optimal layout of households' livelihood. He (2014) revealed that the distribution of famers' livelihood capital was in strong coupling with the spatial position of geographical resources in Liangshan Yi autonomous prefecture of China, and the level of famers' livelihood capital stock of five counties and one city in Anning river basin is higher than any other county. Liu et al (2012) used the back propagation (BP) Neural Network to simulate the spatial distribution pattern of rural household livelihood capital risk index, the results showed that the villages' vulnerability index in Mountain District was bigger than in Middle-mountain and the Middle-mountain District was bigger than Dam District. It can be seen that the spatial pattern of households' livelihood often shows different forms and characteristics due to regional differences. In addition, in some articles, only one specific livelihood strategy was studied, which is not

comprehensive enough. For example, based on 2000 Uganda national household survey, You and Chamberlin (2015) presented a spatial distribution of households' cotton production by using the cartographic modelling, and suggested to expand cotton production area in feasible districts.

Among existing studies, multinomial logistic regression is commonly used to assess the impact of livelihood capital on livelihood strategies (Alemayehu, Beuving, & Ruben, 2018; Hua, Yan, & Zhang, 2017; Xi, Pouliot & Walelign, 2017). In Australia, it has been found using this method that cash income level and increasing access to finance were effective methods for local wheat households to cope with climate change and reduce their vulnerability to it (Huai, 2016). The Geographical Detector , initially proposed by Wang as a means of detecting the risk of local diseases and related geographical factors, was increasingly used in research studies of society, the economy, nature, etc. to detect and assess the mechanisms of various factors (Wang et al.,2010; Hu et al., 2011; Huang et al., 2014; Zhu et al., 2015).It can comprehensively analyse quantitative and qualitative data , however, it has been rarely employed in studies of the factors influencing the livelihood strategies of rural households in tourism regions although it has been widely applied by studies in different fields for the identification of contributing factors (Wang, Zang, & Fu, 2016). Therefore, this is the first study that investigates the influencing factors of livelihood strategies of rural households in tourism regions of Vietnam with application of the Geographical Detector method.

3 STUDY AREA AND DATA SOURCES

3.1 Overview of Study Area

The Sa Pa tourism region (Fig.1.), located in the west of Lao Cai Province (22°20´ N, 103°49´ E), is a mountainous area lies at the altitude of 1600m. Since the establishment of Lao Cai Province tourist area in 1991, it has received the government's attention, among which Sa Pa tourism region is the most obvious. In Sa Pa, the pro-poor potential of tourism is recognized by the local government and consequently tourism is included in the overall development strategy of Sa Pa (SPC, 2011; Truong et al., 2014). The government has invested special funds to renovate and improve the local infrastructure, lighting system and urban landscape, and upgrade the roads connecting different villages. A complete bus network and 15 taxi operators have been formed in Sa Pa District, which has greatly improved the tourism passenger transport capacity. In addition, the government offers language and tour guide training courses for local households free of charge, training a large number of tourism professionals and improving the level of local tourism services. The government also greatly increased the income of local households by organizing activities such as accommodation, catering and handicrafts. Sa Pa has become one of the most attractive vacation destinations in Vietnam as additional to its stunning rice terraces, it has also retained ethnic customs and strong traces of European colonial culture. Tourism development has significantly contributed much to the improvement of livelihood and poverty reduction. In 2018, the Sa Pa tourism region recorded 2.42 million domestic and foreign tourist arrivals, with a total tourism revenue of VNĐ 4 trillion (US$ 170,000,000). In recent years, the livelihoods of rural households in Sa Pa District have undergone constant changes. Some rural households have gradually abandoned agricultural production and have become reliant on good tourism resources by engaging in providing accommodation, catering and other hospitality services. Thus, tourism has become an important means of livelihood and source of income for rural households in Sa Pa.

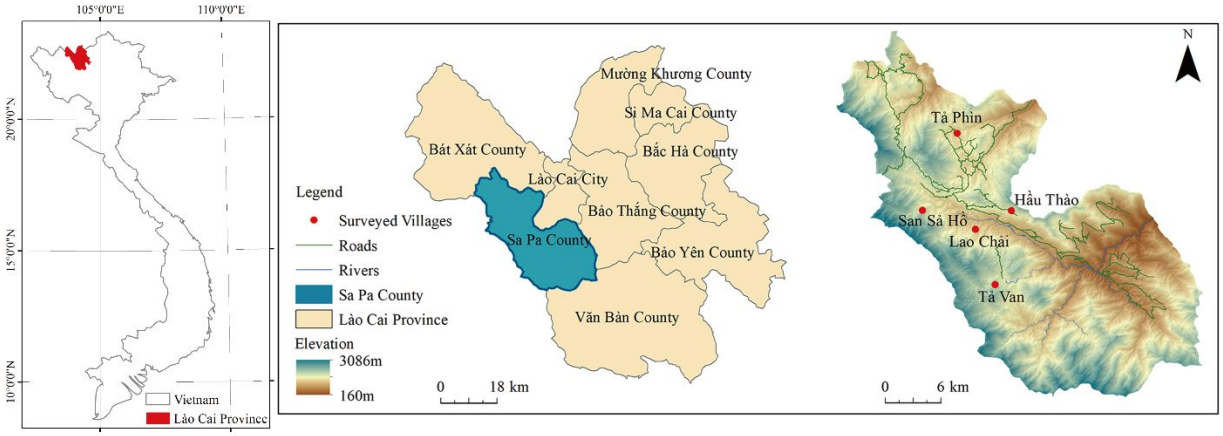

Fig. 1. The location of Sa Pa in Vietnam

3.2 Data Sources

The study data is composed of three parts, namely, field survey data, spatial data and socioeconomic data.

Field survey data. In July 2017, the survey team travelled to the Sa Pa tourism region to conduct a 30-day household survey. Firstly, the local government officials were interviewed to advance the understanding of the overall local situation. As a result of the initial interviews, five villages were selected in Sa Pa to conduct the survey. These villages were San Sả Hồ, Tả Phìn, Hầu Thào , Lao Chải and Tả Van. These villages were selected as they were a good presentation of the villages with growing tourism development in Sa Pa. A local was invited to introduce the interviewers to the villagers. Also, a Vietnamese researcher in our survey team carried out the survey along with 2 other Vietnamese volunteers. They are all native speakers and communicated with the local respondents in Vietnamese, which prevented potential misunderstandings due to language. Interviews and randomly sampled questionnaire surveys were conducted to investigate the head of each household, or someone who is familiar with the household. The average interview time per household was more than30 minutes. A total of 250 questionnaires were distributed and 185 were returned. Some of the returned questionnaires were not completed due to the busy schedules of the respondents or lack of motivation to cooperate. Furthermore, another 5 questionnaires were excluded as they contained respondent errors. In total, 180 questionnaires were used for the analysis. The questionnaire content included the following: basic characteristics of rural households (household size, ethnicity, gender, age, etc.); livelihood capital of rural households (natural capital, physical capital, financial capital, human capital and social capital); and livelihood means of rural households (industry that household members were engaged in, number of people, length and location of work). The variables obtained from the questionnaires are presented in table 2. Participatory interviews were conducted with local government staff and rural households to understand the basic situation of rural households' livelihoods and their influencing factors.

One of the researchers in our research team is Vietnamese, she carried out the investigation along with 2 more Vietnamese volunteers in the research places. They are all native speakers and communicate with the local respondents in Vietnamese, which

ensures the validity of communication and avoids the potential misunderstandings due to language.

Table 1

Indicators for Livelihood Capital of Rural Households

Primary indicator	Secondary indicator	Code	Description	Data source
Natural capital (N)	Woodland	N1	The actual woodland plantings per household (hm^2)	field survey
	Cultivated land	N2	The actual cultivated area per household (hm^2)	
	Paddy field	N3	The actual farmland planting area per household (hm^2)	
Physical capital (P)	Housing area	P1	Actual living area per household (m^2)	
	Housing structure	P2	Assignment: civil house = 0.25, brick and wood room = 0.5, brick and concrete = 0.75; concrete room = 1	
	Durable consumer goods	P3	Original value of household appliances, vehicles, agricultural machinery, etc. (VNĐ million)	
	Number of livestock	P4	Pig =1.5 sheep units, 1 cow = 5 sheep units, etc.;	
	Fish production	P5	Annual fish production per household (kg)	
Financial capital (F)	Household income	F1	Total annual household income (VNĐ million)	
	Household deposits	F2	Total household deposits (VNĐ million)	
	Income diversity	F3	Number of livelihood activities owned by household	
	Bank loan	F4	Including bank loans, loans from relatives and friends, etc.; Can the household get a loan from the bank? Assignment: no = 0, can get 1 or more = 1	
Human capital (H)	Number of family members	H1	Number of family members per household (person)	
	Family adult labour	H2	Non-labour = 0; semi-labour = 0.5; full labour = 1	
	Educational level of family members	H3	Assignment: illiteracy=0; primary school = 0.25; junior high school = 0.5; high school = 0.75; college and above = 1	
Social capital (S)	Number of civil servants	S1	Are there any township or village cadres in the immediate family? Assignment: yes=1, no=0	
	Government subsidies	S2	Does the government provide subsistence allowances, old-age insurance, etc? Assignment: yes=1, no=0	
	Project support	S3	Can the household get the project support? Assignment: yes=1, no=0	

Spatial data: Digital elevation model (DEM) data came from Google Earth, and ArcGIS was used to obtain information such as slope, aspect and elevation. Land data for the study area came from Global Land Cover (http://data.ess.tsinghua.edu.cn/), which was used to obtain data on major aspects of land transportation, major water bodies and land-use types. Following this, the

Distance command in the ArcGIS Spatial Analyst toolbox was used to obtain the corresponding distances.

Socioeconomic data: Government statistical data came from the official Sa Pa District website (http://www.sapa.laocai.gov.vn), which included factors such as GDP per capita, village population size and area. Data for Lào Cai Province were from the official website of the Ministry of Planning and Investment (http://www.mpi.gov.vn), which included information such as government policies, village development profiles and tourism resources. The nationality data was obtained from the government and field survey. The nationality concept plays a role in Sa Pa, with the culture and tradition of nationality impact the rural households' behaviour. Therefore, the nationality of the household is obtained to measure whether the nationality attribute impact the livelihood strategy choice of rural households. The values of 1 to 4 are used to indicate five ethnic affiliations for K

inh, Day, Dao, and Hmong of Sa Pa. And the value is determined according to the population of the ethnicity in Sa Pa.

Nine indicators, belonging to two dimensions of location conditions and socioeconomic development were selected as the independent variable (Table 2).

Table 2

Indicators of spatial data and socioeconomic data

Primary indicator	Secondary indicator	Code	Description	Data source
Location conditions	Slope	X1	Slope of household 's house	Google Earth/Global Land Cover
	Aspect	X2	Slope aspect of household 's house	
	Elevation	X3	elevation of household s house	
	Land type	X4	The main type of land within 2 km of peasant houses	
	Transport accessibility	X5	The closest distance from household's house to highways, first-class roads, secondary roads and main roads	Google Earth
	Distance from river	X6	The closest distance from household's house to river, stream, lake	
Socioeconomic factors	Population density	X7	The population density of the grid which household belongs to, representing the population level of the area where households live	Field survey data/Sa Pa County Government
	Economic level	X8	The GDP per capita of the grid which household belongs to, representing the economic level of the area where households live	
	Ethnicity	X9	The ethnicity of the household	

4 METHODOLOGY

In this section, first of all, the system evaluating the rural households' livelihood capital were introduced, and subsequently their livelihood capital stock was calculated in order to understand the current livelihood situation of households in Sa Pa. Subsequently, the spatial analysis methods - Moran's I index, the Nearest Neighbour Hierarchical Spatial Clustering analyses, and Ripley's K Function were used to explore the spatial distribution pattern of households with different livelihood types. Then, the multiple logistic regression was applied to reveal the impact of

livelihood capital on the livelihood choice of households in Sa Pa area. Finally, the geographical detector was adapted to assess the impact of geographical and socioeconomic factors on the livelihood choices.

4.1 Construction of a Livelihood Capital Evaluation System for Rural Households

Based on the SLA framework and combined with the actual conditions of the Sa Pa tourism region, we constructed a livelihood capital evaluation indicator system. Its main content encompasses 18 indicators, covering the five aspects of natural, physical, financial, human and social capital (Table 1). Indicator weights were assigned based on the entropy weighting method. This method has been widely applied and is based on the 'difference driven' principle. After standardizing the data, optimal weights were constructed based on the actual data of each sample, which can reflect the utility value of indicator information entropy, thus showing strong objectivity, accuracy and feasibility (F. Wang, Yang, Wang, & Zhang, 2015). Given that there are m participating objects (180 rural households), the raw data matrix for n evaluation indicators (tertiary indicators) is . Taking into account the dimensional difference between the different indicators, the data was first standardized as follows:

$$X'_{ij} = \frac{X_{ij} - \bar{\bar{X}}_j}{S} \tag{1}$$

where $$X_j = \sum_{i \neq 1}^{n} x_{ij}/n, S^2 = \sum_{i \neq 1}^{n} (x_{ij} - \bar{x}_j)^2 \tag{2}$$

The standardized data was quantified, and the ratio of the indicator value for the i^{th} object to the evaluated under the j^{th} indicator was calculated as follows:

$$\alpha_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{m} Y_{ij}} \tag{3}$$

The entropy β_j of the jth indicator was calculated as follows:

$$\beta_j = -k \sum_{i=1}^{m} \alpha_{ij} \cdot ln\, d_{ij} \qquad j = 1,2,\cdots,n \tag{4}$$

where $k > 0$, $\beta_j \geq 0$. If x_{ij} is all equal for a given j, then $\alpha_{ij} = \frac{1}{m}$. Wherein

$\beta_j = -k \sum_{i=1}^{m} \left(\frac{1}{m}\right) \cdot ln\left(\frac{1}{m}\right) = k ln\, m$. If we specify $k = \frac{1}{ln\, m}$, then $0 \leq \beta_j \leq 1$.

The difference coefficient of the jth indicator is given by:

$$g_j = 1 - e_j \tag{5}$$

based on which, the weight of each indicator is given by:

$$w_j = \frac{g_j}{\sum_{j=1}^{n} g_j} \qquad j = 1,2,\cdots,n \tag{6}$$

The standardized data Y_{ij} and the weights of each indicator w_j were used to compose a weighted average composite mathematical model to calculate the livelihood capital of rural households, as shown below:

$$LC = \sum_{j=1}^{m} W_j Y_{ij} \qquad j = 1,2,\cdots,n \tag{7}$$

The entropy method was used to calculate the weight of each indicator (Table 3), then the scores for the five major types of livelihood capital and the total livelihood capital score (i.e. the sum of five scores) were calculated for the rural households in the Sa Pa tourism region.

Table 3

Evaluation Indicators and Weights for the Types of Livelihood Capital of Rural Households

Livelihood capital	Indicators	Weights
Natural capital (N)	Woodland	0.0591
	Cultivated land	0.0602
	Paddy field	0.0475
Physical capital (P)	Housing area	0.0332
	Housing structure	0.0527
	Durable consumer goods	0.0443
	Number of livestock	0.0631
	Fish production	0.0408
Financial capital (F)	Household income	0.0546
	Household deposits	0.0485
	Income diversity	0.0747
	Bank loan	0.0768
Human capital (H)	Number of family members	0.0647
	Family adult labour	0.0626
	Educational level of family members	0.0634
Social capital (S)	Number of civil servants	0.0515
	Government subsidies	0.0502
	Project support	0.0521

4.2 Multinomial logistic regression

The multinomial logistic regression model was employed for the quantitative analysis to determine the impact of the livelihood capital, location conditions and socioeconomic factors on the livelihood choices of rural households in Sa Pa. The individual scores of each livelihood capital (natural, physical, financial, human and social capital) and other contributing factors were set as independent variable X, and the four types of livelihood strategies were set as dependent variable Y.

Assuming that the non-ordinal dependent variables have K categories, and the Kth category is used as the base category, the multinomial logistic regression model can be expressed as K-1 binomial logistic regression models:

$$\text{logitP}[\frac{Y_1}{Y_k}] = \ln\left[\frac{P(Y_i =)}{P(Y_k)}\right] = \beta_{Y_10} + \beta_{Y_{11}}x_1 + \beta_{Y_{12}}x_2 + \ldots + \beta_{Y_{1j}}x_i$$

$$\text{logitP}[\frac{Y_2}{Y_k}] = \ln\left[\frac{P(Y_1)}{P(Y_k)}\right] = \beta_{Y_20} + \beta_{Y_{21}}x_1 + \beta_{Y_{22}}x_2 + \ldots + \beta_{Y_{2j}}x_i \quad (8)$$

$$\ldots$$

$$\text{logitP}\left[\frac{Y_{k-1}}{Y_k}\right] = \ln\left[\frac{P(Y_{k-1})}{P(Y_k)}\right] = \beta_{Y_{(k-1)}0} + \beta_{Y_{(k-1)1}}x_1 + \beta_{Y_{(k-1)2}}x_2 + \ldots + \beta_{Y_{(k-1)j}}x_i$$

wherein $x_i = [1, x_{i1}, x_{i2}, \cdots x_{ij}]^T$ refers to the explanatory variable of the ith object and $\beta_k = [\beta_{k0}, \beta_{k1}, \beta_{k2}, \cdots, \beta_{kJ}]^T$ refers to the parameters of the logistic regression model with K categories. This model has J explanatory variables, corresponding to J+1 parameter, of which the first parameter is the intercept term. The coefficient β_{kj} in the multinomial logistic regression model can be explained as follows: under the condition that other explanatory variables are controlled for, the impact of the unit number for the explanatory variable x_{ij} on the odds ratio of category k to the base category is $\exp(\beta_{kj})$.

4.3 Spatial Distribution Patterns of Rural Households

A series of spatial analysis methods were applied to explore the spatial distribution patterns of households with different livelihood types. The spatial autocorrelation was used to examine whether there is spatial autocorrelation in the distribution of households. The nearest neighbour hierarchical spatial clustering was applied to explore the cluster patterns of different types of households. And Ripley's K function was used to measure the distribution characteristics of households on different spatial scales.

4.3.1 Spatial Autocorrelation

Spatial autocorrelation was used to measure the spatial interdependence of geographic data. Its advantage is that not only can it discriminate between the spatial distribution types (clustered, random or dispersed) of point elements, but it can also characterize the spatial patterns of the rural household distribution in Sa Pa District, Vietnam, from the perspective of spatial correlation. The formula of the global spatial autocorrelation Moran's I index is given below:

$$I = n\Sigma_i^n\Sigma_j^n w_{ij}(y_i - \bar{y})(y_j - \bar{y})/(\Sigma_i^n\Sigma_j^n w_{ij})\Sigma_i^n(y_i - \bar{y})^2 \quad (9)$$

where n is the number of observed values; y_i and y_j are the observed values for the ith and jth regions, respectively; $\bar{y}$ is the mean of the observed values; and w_{ij} is the spatial weight based on the proximity criterion or distance criterion. When global Moran's $I > 0$, this indicates there is a positive spatial correlation among the research elements, i.e. the data values exhibit high-high or low-low adjacency. When global Moran's $I < 0$, this indicates there is a negative spatial correlation among the research elements, i.e. the data values show high-low adjacency.

4.3.2 Nearest Neighbour Hierarchical Spatial Clustering

Nearest Neighbour Hierarchical Spatial Clustering analyses the spatial clustering characteristics by calculating the Nearest Neighbour Index (NNI), which allows us to understand the degree of clustering among rural households with different livelihood strategies:

$$\mathrm{NNI} = \left[\sum_{i=1}^{n} \frac{\min(d_{ij})}{N}\right] \Big/ \left[0.5\sqrt{\left(A/N\right)}\right] \quad (10)$$

where $\min(d_{ij})$ refers to the distance between any point and its nearest neighbour and A is the total area of the study area. When NNI<1, this indicates the study objects follow a clustered distribution; when NNI>1, this indicates the study objects are uniformly dispersed; when NNI=1, this indicates the study objects are randomly distributed. The smaller the NNI value, the greater the degree of clustering.

4.3.3 Ripley's K Function

Ripley's K function can be used to analyse the spatial pattern changes of point data on any scale. It is one of the spatial analysis methods used most commonly, and can clarify the scale of spatial clustering (Ripley, 1981). Its calculation formula is as follows:

$$K(d) = \mathrm{A}\sum_{i}^{n}\sum_{j}^{n}\frac{w_{ij}(d)}{n^2} \quad (11)$$

where n is the number of point elements; $w_{ij}(d)$ is the distance between the ith and jth points within the range of distance d; and A is the area of the study area. $K(d)$ represents the ratio between the average number of sample points within distance d and the density of sample points within the area. By comparing the measured and theoretical values, we can determine the clustering of the study objects, hence the index $L(d)$ was constructed as follows:

$$L(d) = \sqrt{\frac{K(d)}{\pi}} - \mathrm{d} \quad (12)$$

When $L(d)>0$, this indicates the study objects show a clustered distribution; when $L(d)=0$, this indicates they follow a random distribution; when $L(d)<0$, this indicates they follow a dispersed distribution. The confidence interval (upper and lower envelopes) was calculated based on goodness of fit tests. When $L(d)$ is located above the upper envelope, this indicates that the spatial clustering of a certain distance is statistically significant; conversely, when $L(d)$ is located below the lower envelope, this indicates that the spatial dispersion of a certain distance is statistically significant. In addition, when the difference (Diff) between the observed value $L(d)$ and the expected value is greater than 0, this indicates the degree of random distribution is higher than the degree of clustering at the given distance; the degree of clustering is the highest when this value is at its maximum, whereas the degree of dispersion is higher when the opposite is true.

4.4 The Geographical Detector method

The Geographical Detector, which can be downloaded free of charge at http://www.sssampling.org/.GeoDetector, is a new statistical method to detect spatial stratified heterogeneity, reveal explanatory factors, and analyse the interactive relationship between variables (Hu et al., 2011; Wang et al., 2010; Shi et al, 2018). There are few restrictions on the statistical hypothesis of the Geographical Detector, such as normality, equal variance. The principle of Geographical Detector assuming that the study area is divided into several subareas. If the spatial distribution of the two variables tends to be consistent, there is statistical correlation between them. Compare to the regression technique, the Geographic Detector shows superiority in revealing the spatial causality, since the former measures spatial distribution characteristics on one-dimensional curves, while the latter measures on two-dimensional spaces thus being more reliable. Among four detectors of the Geographical Detector, which composed of risk detector, factor detector, interaction

detector and ecological detector, we used the factor detector to comprehensively assess the impact strength of external location factors on rural households' livelihood strategies in Sa Pa District.

The variables in table 2 is imported into the Geo-detector software, and the q value is used to measure the extent to which these factors can explain the spatial differentiation of rural households' livelihood strategies, the expression is shown as follows:

$$q = 1 - \frac{1}{N\sigma^2}\sum_{h=1}^{L} N_h \sigma_h^2 = 1 - {SSW}/{SST} \quad (13)$$

where N_h and N are the number of units in stratum h and the study area, respectively; L is the spatial density of rural households and number of impact factor classifications; σ^2 and σ_h^2 are the variances of stratum h and the study area, respectively; and SSW and SST are the sum of the intra-stratum variances and the total variance of the entire area, respectively. With $q \in [0,1]$, the larger the value, the stronger the explanatory power of the impact factor and vice versa. When q=1, this indicates the factor completely controls the spatial distribution of the study objects; when q=0, this indicates the factor is completely unrelated to the study objects.

5 RESULT

5.1 Basic Characteristics of Different Livelihood Strategies

According to the contribution proportion of different livelihood activities to household income, the rural households can be categorized to four types, and that is, agricultural, labour, tourism and balanced. Households with more than 60% of total income coming from agricultural activities were classified as agricultural livelihood households, and their livelihood activities are mainly composed of farming and animal husbandry. Households with more than 60% of the total income coming from tourism activities were categorized as tourism livelihood households. And their main livelihood activities include tourist guiding, handicrafts making or souvenirs selling and catering. The households having a labour livelihood mostly composed of migrant workers, and more than 60% of the family income comes from engaging in industrial or engineering work. Balanced livelihood household engage in a variety of livelihood activities, including agriculture, tourism, migrant work, employment in enterprises and institutions, and other similar activities. Their income comes from two or more livelihood activities, and the income of any one livelihood activity accounts for no more than 60%. Households with various livelihood activities engage in multiple livelihood activities at different periods of a year, and in different places. In other words, the temporal and spatial variation of livelihood are represented in the diversity of household income sources.

The distribution of livelihood strategies is shown in fig. 2. The agricultural households have the largest area of forest and cultivated land, but the lowest living space, household income and average household member education level. The labour households have the lowest area of cultivated land, area of forest land and household education level. Tourism households have the highest living space, original value of durable consumer goods per household, total annual household income and average household education level, but have the lowest income diversity. The balanced households have the highest income diversity and number of civil servants (Table 4).

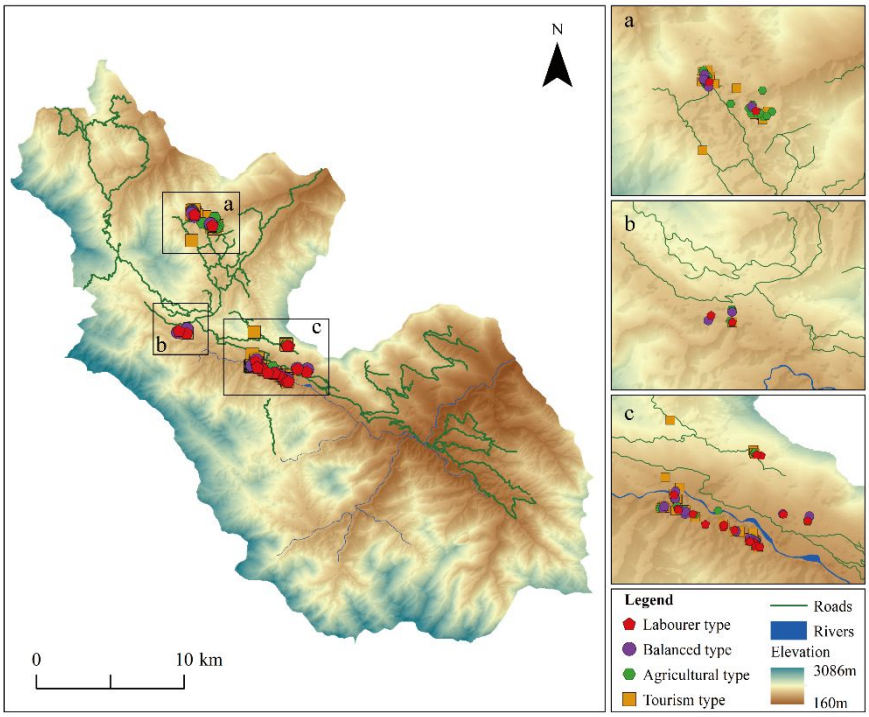

Fig. 2. The distribution of livelihood strategies

Table 4 Basic Characteristics of Rural Households with Four Types of Livelihood Strategies

Households type	Agricultural type	Labour type	Tourism type	Balanced type
Percentage of sample	32.22%	12.22%	38.89%	16.67%
Woodland (hectare)	1.70	0.39	0.86	0.97
Cultivated land (hectare)	2.84	1.06	1.44	1.72
Housing area (m^2)	93.59	121.82	205.00	103.87
Durable consumer goods (VNĐ million)	33.79	42.82	102.31	44.61
Number of livestock (sheep unit)	14.88	7.69	7.05	11.75
Household income (VNĐ million)	42.88	87.23	107.12	84.03
Income diversity	1.97	2.14	1.91	2.67
Educational level of family members	1.22	1.45	1.90	1.53
Number of civil servants (person)	0.02	0.00	0.06	0.43

5.2 Evaluation of Different Types of Livelihood Capital

The level of livelihood capital for the four types of tourism livelihood strategies among rural households in the Sa Pa region were ranked from high to low as follows: T4, balanced households (2.36) > T3, tourism households (2.33) > T1, agricultural households (2.26) > T2, labour households (2.18). The total value of livelihood capital increased in sequence from the labour households to the balanced households, with an especially significant increase for social capital (Fig. 3).

Of the five types of capital of rural households in the Sa Pa tourism region, financial capital scored the highest; this was followed by physical capital and human capital, whereas social capital scored the lowest. In terms of natural capital, rural households of the agricultural type

owned by far the most natural capital (0.45) compared to rural households adopting other livelihood strategies, whereas the labour households owned the least natural capital (0.31). The difference in physical capital was not substantial among the rural households, with the tourism households owning the most physical capital (0.55). In terms of financial capital, the balanced (0.63) and the tourism (0.61) households had more financial capital, while the agricultural households had the least (0.53). In terms of human capital, that owned by the tourism households (0.47) was far higher than rural households adopting other livelihood strategies. In terms of social capital, that owned by the balanced households (0.42) was higher than that of rural households adopting other livelihood strategies.

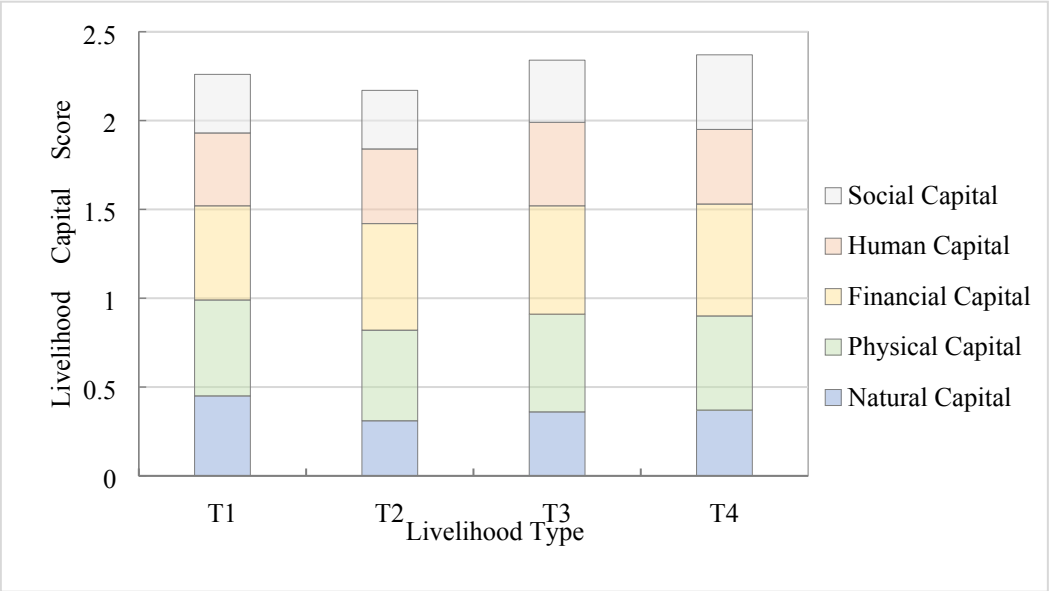

Fig. 3. Evaluation of Livelihood Capital Owned by Rural Households with Different Livelihood Strategies

5.3 Spatial Distribution Patterns of Rural Households

The global autocorrelation index Moran's I was 0.02, Z score=2.02＞1.96 for rural households adopting different livelihood strategies in Sa Pa District. Hypothesis testing at a significance level of =0.05 indicates that there was a significant positive spatial correlation among the rural households adopting different livelihood strategies in the Sa Pa study area, which exhibited a certain degree of clustering.

According to the NNI results, all the NNIs of rural households adopting different livelihood strategies in the Sa Pa tourism region were smaller than 1 and Z scores were all smaller than −2.56. Hypothesis testing at a significance level of 1% indicates that rural households adopting different livelihood strategies displayed a typical pattern of clustered distribution. Based on the NNI value, we can see that the degree of clustering for rural households adopting different livelihood strategies were as follows: agricultural households > balanced households > tourism households > labour households (Table 4).

Table 4

NNI Results of Rural Households Adopting Different Livelihood Strategies in the Sa Pa Tourism Region

Livelihood strategies	Agricultural type	Labour type	Tourism type	Balanced type	All the household

NNI	0.159	0.365	0.342	0.199	0.175
Z score	-12.259	-5.700	-10.534	-8.390	-21.163
P value	0.000	0.000	0.000	0.000	0.000

The analysis using Ripley's K function revealed that the L(d) of all rural households was greater than 0, which indicates that the clustered distribution of the rural households was statistically significant. Of these, the agricultural households showed significant clustering (L(d)>0) and exhibited the greatest clustering characteristics at 0.33km. The clustering characteristics gradually decreased with the increase in the distribution distance of rural households. At 2.93km, the Diff value of the agricultural-type rural households was nearly 0, thus indicating that they were beginning to display certain characteristics of dispersed distribution. The clustering trend of the labour households was significant, reaching a peak at 1.27km, i.e. where the Diff value was the greatest. The clustering characteristics of the tourism households showed an increase followed by a decrease, with inflection points appearing at 0.65km and 1km, with the peak value appearing at 0.65km. The balanced households showed significant clustering, which displayed a trend of increase followed by a decrease; the maximum clustering range was 0.64km. Overall, the spatial clustering ranges of the labour, tourism, balanced and agricultural households were 1.27km, 0.65km, 0.64km and 0.33km, respectively (Figure 3).

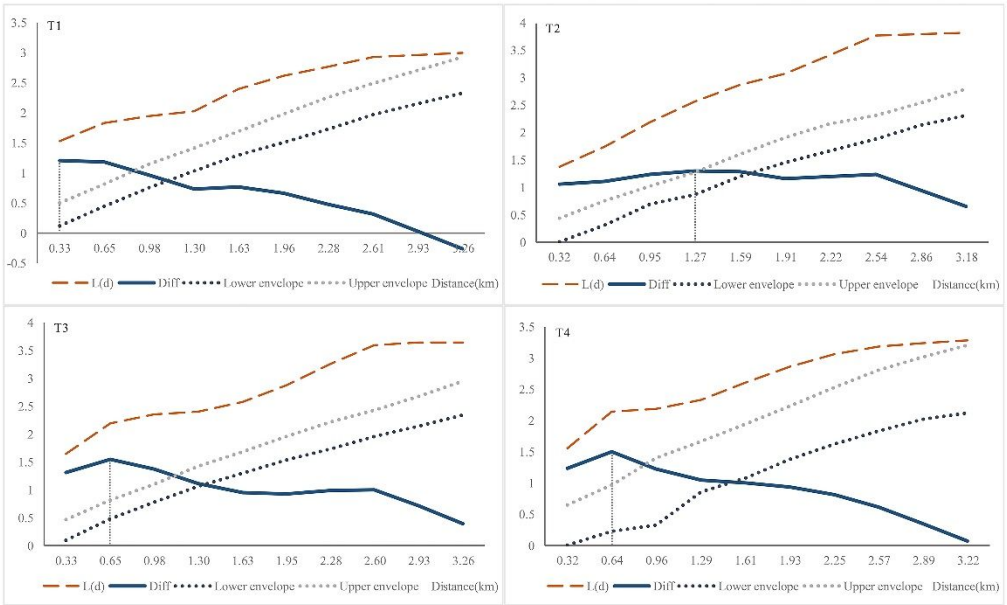

Fig. 4. Analysis of the Scale Characteristics of Clustering Among Rural Households Adopting Different Livelihood Strategies in the Sa Pa Tourism Region

5.4 Factors Influencing the Livelihood Strategies of Rural Households

5.4.1 Livelihood Capital and Livelihood Strategy Choices

To clarify the impact of livelihood capital on livelihood choice, multinomial logistic regression was used in the analysis. Labour type households (T2) and agricultural type households

(T1) were used as the base categories in two multinomial logistic models respectively, to explore which capital supports tourism livelihood (T3) and balanced livelihood (T4).

(1) Agricultural households as base category

Results show that natural capital has negative effect on the other three livelihood types, which suggests that with more natural capital, the households are less likely to choose livelihoods other than agriculture livelihood. On the contrary, financial capital has positive impacts on all of the three types of livelihood, which means households with more financial capital are less likely to engage in agricultural livelihood. Both financial capital and social capital can facilitate engagement in balanced livelihood, and financial capital is key to tourism livelihood (Table 5).

Table 5

Impact of Livelihood Capital on Livelihood Strategy Choices

Livelihood strategies	Livelihood capital	Regression coefficient	Standard deviation	z	Significance	Relative risk
Balanced type (T4)	N	-0.784	0.313	-2.500	0.012	0.457
	P	0.061	0.317	0.190	0.848	1.062
	F	0.866	0.299	2.900	0.004	2.378
	H	-0.116	0.309	-0.380	0.706	0.890
	S	0.674	0.238	2.830	0.005	1.963
Tourism type (T3)	N	-0.929	0.245	-3.800	0.000	0.395
	P	0.211	0.248	0.850	0.395	1.234
	F	0.679	0.231	2.930	0.003	1.971
	H	0.258	0.220	1.170	0.241	1.294
	S	0.051	0.225	0.230	0.820	1.052
Labour type (T2)	N	-1.895	0.505	-3.750	0.000	0.150
	P	-0.117	0.339	-0.340	0.731	0.890
	F	0.794	0.309	2.570	0.010	2.212
	H	0.091	0.322	0.280	0.778	1.095
	S	-0.188	0.349	-0.540	0.589	0.828

(2) Labour households as base category

Natural capital shows a positive effect on balanced and tourism type livelihoods, when labour households are defined as the base category. Meaning that, among the four types of livelihood, households with more natural capital are the least likely to engage in labour livelihood activities. Social capital shows significant positive effect on balanced livelihood, which highlights the importance of social capital for households with balanced livelihood. Whilst, financial capital negatively influences agricultural livelihood, which indicates that agricultural households are the ones lacking most in financial capital. Financial capital is obviously a barrier impeding agricultural households to start engage in other livelihood activities (Table 6).

Table 6

Impact of Livelihood Capital on Livelihood Strategy Choices

Livelihood strategies	Livelihood capital	Regression coefficient	deviation	z	Significance	Relative risk

Balanced type (T4)	N	1.111	0.524	2.120	0.034	3.037
	P	0.177	0.347	0.510	0.609	1.194
	F	0.073	0.327	0.220	0.824	1.075
	H	-0.207	0.361	-0.570	0.566	0.813
	S	0.863	0.333	2.590	0.010	2.369
Tourism type (T3)	N	0.967	0.482	2.000	0.045	2.629
	P	0.327	0.280	1.170	0.242	1.387
	F	-0.115	0.266	-0.430	0.665	0.891
	H	0.167	0.285	0.590	0.558	1.182
	S	0.239	0.319	0.750	0.454	1.271
Agricultural type (T1)	N	1.895	0.505	3.750	0.000	6.652
	P	0.117	0.339	0.340	0.731	1.124
	F	-0.794	0.309	-2.570	0.010	0.452
	H	-0.091	0.322	-0.280	0.778	0.913
	S	0.188	0.349	0.540	0.589	1.207

5.4.2 Impact of Other Factors on Livelihood Strategy

The Geographical Detector results show that, the elevation and transport accessibility both passed the confidence test at the 0.05 level, while economic level and ethnicity both passed the confidence test at the 0.01 level. Therefore, elevation, transport accessibility, economic level and ethnicity have a significant impact on the livelihood strategy choices of rural households in the Sa Pa tourism region. Of these, the q value of economic level was the highest, at 0.182, thus indicating that it had the strongest explanatory power for the livelihood strategy choices of rural households in the study area; this was followed by ethnicity (q=0.106) and transport accessibility (q=0.077), whereas elevation (q=0.052) had the weakest explanatory power. Slope, aspect, land type and population density did not pass the confidence test at the 0.05 level, which implies that these factors currently do not have a significant association with the livelihood strategy choices of rural households in Sa Pa District (Table 7).

Table 7

The Geographical Detector Results

Factors	Slope	Aspect	Elevation	Land type	Transport accessibility	Distance from river	Population density	Economic level	Ethnicity
q value	0.012	0.047	0.052	0.041	0.077	0.016	0.058	0.182	0.106
p value	0.983	0.374	0.032	0.668	0.020	0.940	0.996	0.000	0.009

Binary logistic regression was performed to further analyse the impact of elevation, transport accessibility, economic level and ethnicity on the livelihood strategies of rural households. The results show that elevation, economic level and ethnicity are key factors influencing the choices of agricultural livelihood (T1); of these, elevation and ethnicity have significant positive effects, while economic level has a negative effect. Economic level and ethnicity are significant factors affecting rural households' choice of tourism livelihood, that is, the economic level of rural

households engaged in tourism is higher. Elevation, transport accessibility and ethnicity are important factors influencing the choices of the balanced livelihood (T4); all three factors have negative effects. This implies that the balanced-type rural households are frequently distributed in low-elevation areas near major trunk roads.

Table 8

Factors Influencing the Different Livelihood Strategy Choices of Rural Households

Livelihood type	Elevation	Transport accessibility	Economic level	Ethnicity
Agricultural type (T1)	0.004*	0.000	-0.038**	0.633**
Labour type (T2)	-0.003	-0.001	0.001	-0.081
Tourism type (T3)	0.001	0.001	0.008**	-0.444*
Balanced type (T4)	-0.007*	-0.003*	0.000	-0.085

Note: * and ** indicate that the results were significant at the 0.05 and 0.01 levels, respectively.

6 CONCLUSIONS AND DISCUSSION

6.1 Conclusions

This paper employed a comprehensive approach to understand the capital endowment of households and the influencing factors affecting their livelihood choices, and it is aimed to provide references for livelihood improvement as a result of the survey conducted on rural households in five villages of Sa Pa.

In this study a livelihood capital evaluation system for rural households based on the sustainable livelihood approach framework was constructed first. Then, the capital endowment of rural households was measured using this evaluation system. The results show that the livelihood capital endowment level of four livelihood types of households are ranked as: balanced livelihood households (2.36) > tourism livelihood households (2.33) > agricultural livelihood households (2.26) > labour livelihood households (2.18).

Next, the spatial analysis methods - Moran's I index, the Nearest Neighbour Hierarchical Spatial Clustering analyses, and Ripley's K Function were used to explore the spatial distribution pattern of different livelihood type households. It is found that the different livelihood types of households show clustering characteristics, with a degree of clustering ranking as: agricultural > balanced > tourism > labour. The clustering range of the labour households is the largest with a value of 1.27km, whereas the clustering range of the agricultural households is the smallest with a value of 0.33km; Furthermore, the tourism and balanced households have similar clustering range with a value around 0.6km.

Finally, in order to understand the factors lie behind households' livelihood choices, multinomial logistic regression and binary logistic regression were applied. The results show that households with more natural capital are less likely to choose livelihoods other than agriculture livelihood, and households with more financial capital are less likely engage in agricultural livelihood. Both financial capital and social capital can facilitate engagement in balanced livelihood, and financial capital is a key to tourism livelihood, and a barrier impeding agricultural households to participate in other livelihood activities. Besides capitals, elevation, transport accessibility, economic level and ethnicity are also found to be factors having an impact on livelihood choices.

Balanced households are frequently distributed at low-elevation areas near major trunk roads, whilst agricultural households mainly lie at high-elevation areas. Areas with higher economic levels are more likely to develop tourism livelihood Also, the results show that ethnicity has a significant influence on the choice of agricultural and tourism type livelihood in Sa Pa.

6.2 Discussion and Recommendations

A household's ability to choose livelihoods strategies that lead to higher incomes depends on their capital endowment and accessibility to resources. In general, the distribution of resources is unequal among rich and poor households. The households having rich resources to start with are more likely to participate in high return livelihood activities which requires high capital investment. On the contrary, the households with poor resources lack the ability to invest and are forced to continue their low-return livelihoods. Although off-farm livelihoods are encouraged to be promoted for livelihood improvement, without adequate regulation and intervention, off-farm diversification will exacerbate local wealth inequality (Gautam & Andersen, 2016). In order to utilize off-farm livelihood sectors as effective means of reducing poverty, the government needs to fully understand the characteristics of these sectors, the capital they require and the inequity in the distribution of capital. The present study attempts to reveal the capital required for different types of livelihood activities and the geographical factors affecting livelihood choices. These findings aim to improve the understanding of capital endowment and livelihood choices, and provide reference for the government to optimize the resources allocation and improve people's access to capital.

Identifying the capital combination required for different livelihood activities is an important part of livelihood improvement. Based on the Sustainable Livelihood Framework, the livelihood choices and capital endowments of Sa PA households were analysed, and the capital situation requirements of different livelihood choices were identified. In general, there is a general lack of social capital in this area, but the natural capital is relatively sufficient. This is because the government provides less subsidies and project support to rural households, and the social relationship between the rural households is relatively simple. Additionally, the long history of local agricultural production provides large cultivated land area for the households. Therefore, the government should vigorously strengthen the construction of social capital, give agricultural policy care and financial subsidies support, and provide more and more effective employment skills training for the rural households. Whilst, the households themselves should actively participate in rural affairs, strengthen social ties with others, and seek more opportunities for mutual assistance and development.

Among the four livelihood types of households in Sa Pa, the agricultural livelihood is found to contribute least to improve the households' income. It can be seen that single agricultural livelihood or excessively dependent on agriculture can hardly improve the living situation of rural households, which aligns with the previous literature (Rigg, 2006). Overall, the households engaged in tourism livelihood activities show higher average income levels, which suggests that tourism can improve the lives of Sa Pa rural households. Encouraging rural households to engage in tourism livelihood activities has been considered as an effective way to improve the livelihood of people in poor areas. This viewpoint has been confirmed by many livelihood studies about poor areas (Bires & Raj, 2020; Iorio & Corsale, 2010; Nyaupane & Poudel, 2011), and by some previous literatures on Sa Pa as well (Hoang et al., 2014; Hoang et al., 2020) Although tourism

livelihood has a good economic effect, but the seasonal variation and simple income structure bring uncertainty about income. Compared with the balanced livelihood household who have various income sources, the lack of diversity of livelihood activities may make tourism livelihood household to be vulnerable to the external risk and shocks. The social capital of the tourism households, especially minimum insurance and pension insurance capital, was the most lacking when compared to the balanced households. This is because the civil servants/government workers family members of balanced households benefit from the social and medical welfare system in Vietnam. To ensure the long-term and effective development of tourism in Sa Pa, it is necessary for government to establish a minimum livelihood guarantee scheme, improving the pension insurance system and promoting the development of the social healthcare system.

The factors affecting livelihood choices based on the constructed livelihood capital evaluation system were analysed further. It is found that financial capital facilitates off-farm livelihoods such as tourism and balanced strategies, which is consistent with some studies (Wang et al, 2014; Fang et al, 2014). The households with more social and financial capitals are more likely to choose balanced type livelihood, which suggests that diversified livelihood activities require mostly the support of social and financial capitals. Besides capital, the geographical location of household is also an important factor affecting livelihood choice. Analysing the distribution patterns of households with different livelihood types can help with the understanding of how geographical factors affect livelihood choices and serve scientific as evidence for government to plan a layout.

It is found that the location related conditions of rural households, such as elevation and transport accessibility, have a significant impact on their livelihood strategy choices. For instance, balanced households are often distributed in areas with good transport conditions and lower elevation. Thus, better accessibility can help people with engaging in more diverse livelihood activities, which highlights the importance of improving local transportation, strengthening village accessibility, and enhancing road capacity. Similarly, relocating households with high livelihood risk to places with low altitude or close to roads can also help with improving their livelihoods. The insight yielded as a result of the clustering characteristics of households with different livelihood strategies for government suggests that, policymakers can arrange more agricultural infrastructure, such as water conservancy facilities and sewage treatment facilities, to these gathering areas to form the clustering effect.

Besides the above mentioned factors, the economic level and ethnicity are also found to be influencing factors on livelihood choice. Areas with higher economic levels are more likely to develop tourism livelihood, which in turn can continue to increase the local income and to form a positive feedback. Ethnicity has a significant influence on the choice of agricultural and tourism type livelihood, which confirms the findings of other studies on the livelihood of ethnic minority in Sa Pa district. For instance, the Hmong are more likely to be engaged in farming. While some Kinh people come to Sa Pa and engage in tourism business, they are more likely to improve their well-being through non-agricultural livelihood such as tourism since they get a capital superiority. In addition to the lack of capital, ethnographic research on the livelihood of Hmong also points out that, the rooted cultural values and endogenous knowledge of Hmong make them to refuse to abandon their original agricultural livelihood and involve in economic capitalist market (Turner,

2012a, 2012b). The Hmong both embrace and resist the new livelihood opportunity brought by the growing market, and pursuing their livelihood in a way that appropriate to local cultural values and knowledges (Tugault, 2009). Despite favourable money returns, they are less likely to change completely to a higher income livelihood. For instance, young Hmong females who work as trekking guides in Sa Pa are expected to back to hamlet during the periods with intensive agricultural demand, even though they can earn more money via supplying guide service. Such cultural value leads to the wide existence of agricultural livelihood in Sa Pa, and the findings of this study that Hmong are more likely to engage in agricultural livelihood confirms this fact empirically. Understanding how livelihood choices interact with class, caste, gender, ethnicity, religion and cultural identity is vital (Scoones, 2009), which should be further explored combining empirical with qualitative analysis such as ethnography in the future.

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Response to reviewers

We gratefully thank the editor and all reviewers for their time and all constructive suggestions, which have significantly helped us to improve the manuscript. We have studied comments carefully and have made all required revisions. Comments of the reviewers have been responded point by point with the indication of our revisions in below.

Referee: 1

Comments to the Author

I have reviewed the revisions that the authors made and I am confortable with the result.

1. Some of the references are in caps lock (He, Liu, etc).

Thanks for pointing out this mistake. We have checked all the references throughout and made revisions.

2. Replace "Sao Tome and Principe" by "São Tomé and Príncipe"

It has been replaced. (line 21-22, page 4)

3. While questions of language have been explained, they were not (briefly) included in the paper. Could they? [One of the researchers in our research team is Vietnamese, she carried out the investigation along with 2 more Vietnamese volunteers in the research places. They are all native speakers and communicate with the local respondents in Vietnamese, which ensures the validity of communication and avoids the potential misunderstandings due to language.]

Thank you for your suggestion! The following text has been added as recommended:

"Also, a Vietnamese researcher in our survey team carried out the survey along with 2 other Vietnamese volunteers. They are all native speakers and communicated with the local respondents in Vietnamese, which prevented potential misunderstandings due to language" (line 20-24, page 6)

Referee: 2

Comments to the Author

The authors have seriously responded to the reviewers' concerns.

Thanks again for your precious time spent for making the constructive remarks.

Referee: 4

Comments to the Author

I'm afraid my overall verdict on this article is somewhat less positive than the previous reviewers. This may reflect my background in qualitative livelihood research. However, a well-written quantitative article should be able to make a contribution to livelihoods research. In this case I struggled to see what the contribution of the article to the field was. I did not really feel that I

learned anything substantial about the livelihoods of people in these five villages, nor how their livelihoods were contributing to or detracting from a more sustainable tourism.

If this article is to make a contribution to what we know about tourism contributions to sustainable rural livelihoods, I think it needs to more clearly articulate what that existing literature already says. I also think that a more clearly articulated aim and research questions are needed to identify the scope and contribution of this article.

If the main contribution of this article is related to original statistical or spatial methods then it should perhaps be re-written and re-focused with that in mind (and directed towards a more relevant journal).

Livelihoods research conventionally focuses on understanding the everyday lived experiences of the people whose livelihoods are being studied. Such understandings can generate categories and hypotheses that can then be used in quantitative studies. Here I did not get any sense of that occurring. The concept of stability seemed to be central to the argument, but it was never defined, and I did not understand why some livelihoods were considered more "stable" than others. How is "stability" related to established livelihood terms such as "coping" or "adaptation" or "diversity"?

I think that this article needs a major revision in order to better articulate its central concerns, what existing literature says about those concerns, and then what contribution this article has made to our understanding of those concerns. If its central contribution is a methodological one, relating to quantitative methods and spatial data then perhaps it should be re-written as a method article in a journal other than JOST. Some more specific comments follow.

Thank you very much for taking your time to review this manuscript. We really appreciate all your comments and suggestions! Please find our itemized responses in below and revisions/corrections in the re-submitted files.

1. A more clearly articulated aim and research questions are needed to identify the scope and contribution of this article.

The following paragraphs have been added to provide clarification of the scope and contribution of this article:

"With reference to the Sustainable Livelihood Approach framework and considerations of the gap in tourism literature, this study aims to reveal the influence factors lies behind the livelihood choices of people in Sa Pa, Vietnam, and this is going to be based on understanding the capital endowments of local households. Five villages in Sa Pa District, Vietnam were selected for research, as there are substantial differences among different regions in the factors influencing the choices of rural households regarding livelihood strategies. A comprehensive application of multiple methods is applied to fully identify these influencing factors, which includes establishment of livelihood capital evaluation system, multiple logistic regression, geographic analysis techniques such as Ripley's function, nearest neighbour hierarchical spatial clustering and geographical detector method. The findings of this study aim to provide insight for government to optimize resource allocation and improve people's access to capital." (line 25-35, page 2)

"Although off-farm livelihoods are encouraged to be promoted for livelihood improvement, without adequate regulation and intervention, off-farm diversification will exacerbate local wealth inequality (Gautam & Andersen, 2016). In order to utilize off-farm livelihood sectors as effective means of reducing poverty, the government needs to fully understand the characteristics of these

sectors, the capital they require and the inequity in the distribution of capital. The present study attempts to reveal the capital required for different types of livelihood activities and the geographical factors affecting livelihood choices. These findings aim to improve the understanding of capital endowment and livelihood choices, and provide reference for the government to optimize the resources allocation and improve people's access to capital." (line 17-25, page 20)

2. The concept of stability seemed to be central to the argument, but it was never defined, and I did not understand why some livelihoods were considered more "stable" than others. How is "stability" related to established livelihood terms such as "coping" or "adaptation" or "diversity"?

The households are classified to different livelihood types according to their family income structure. Among four types households, the balanced households combine more diversified livelihood activities, and have more income sources than agricultural, labour and tourism households. Balanced households with a greater diversity of livelihood activities are more resilient to economic and environmental shocks and threats, and this kind of strength is described as "stability" here may be inaccurate. We have removed this phrase and rephrased the comparison of different types of livelihood:

"Among the four livelihood types of households in Sa Pa, the agricultural livelihood is found to contribute least to improve the households' income. It can be seen that single agricultural livelihood or excessively dependent on agriculture can hardly improve the living situation of rural households, which aligns with the previous literature (Rigg, 2006). Overall, the households engaged in tourism livelihood activities show higher average income levels, which suggests that tourism can improve the lives of Sa Pa rural households. Encouraging rural households to engage in tourism livelihood activities has been considered as an effective way to improve the livelihood of people in poor areas. This viewpoint has been confirmed by many livelihood studies about poor areas (Bires & Raj, 2020; Iorio & Corsale, 2010; Nyaupane & Poudel, 2011), and by some previous literatures on Sa Pa as well (Hoang et al., 2014; Hoang et al., 2020). Although tourism livelihood has a good economic effect, but the seasonal variation and simple income structure bring uncertainty about income. Compared with the balanced livelihood household who have various income sources, the lack of diversity of livelihood activities may make tourism livelihood household to be vulnerable to the external risk and shocks." (line 39. Page 20 to line 10, page 21)

3. Literature.

The literature review lacks structure, so it is not clear which literature is supposed to be being reviewed.

(1) Existing work on tourism and rural livelihoods in Sa Pa should surely be reviewed. There has been extensive work done on livelihoods and tourism in Sa Pa district, none of which is cited in this article – Turner (2007), Tugault & Turner (2009), Turner (2012), Truong et al (2014), Hoang et al (2018). The assertion on p17 line 50 that these livelihoods and the factors influencing them have not been researched seems particularly inapt in the circumstances.

The literature review has been rephrased, and relative remarkable works have been reviewed. The assertion on p17 has been removed.

"Tourism, as a livelihood activity, has attracted the attention of academia. Research on tourism livelihood in different countries and regions emphasise that tourism plays a significant role in reducing poverty and improving people's livelihoods. However, since each country has its own distinct development goals, economic level and tourism resources, it follows that rural households' livelihood strategy choices and the factors contributing to those choices vary considerably (Steel, 2012). According to the British Department for International Development's sustainable livelihoods framework, 'case-by-case analysis' should be conducted for the typical cases of different countries (DFID, 1999). In Vietnam, tourism shows development as an important economic pillar. In 2018, Vietnam's tourism revenues amounted to approximately US$23,900 million, accounting for about 10% of the country's GDP. In addition to its economic effects, tourism is also considered to have a positive effect on reducing deforestation in Sa Pa village (Hoang et al., 2014). Despite if the positive role of tourism livelihood in poverty reduction and sustainable development is recognized, its impact on livelihood improvement varies greatly among different regions. In other words, in many places of Vietnam (even famous tourism destinations), tourism still cannot replace the dominance of other livelihood activities. For instance, Sa Pa gets a reputation as an attractive tourism destination, but there are still many people engaging in semi-subsistence agricultural livelihoods; which includes rice, maize and cardamom cultivation, livestock breeding and collecting forest products (Hoang et al., 2020; Tugault & Turner, 2009). Following the French colonial era, tourism has been revived again in Sa Pa (Michaud & Turner, 2006). Some of the local people contribute to the tourism business by working as trekking guides, running hotels or selling textile commodities to tourists (Turner, 2007). Despite the considerable economic growth that tourism brings to Sa Pa, tourism is not a panacea for everyone to improve their livelihood. Hoang et al. (2020) found that not all households can benefit from the development of tourism. Especially the households where are located in inaccessible places, lacking skills or assets are found it difficult to participate in tourism livelihood. Truong et al (2014) found that most of the local people in Sa Pa wish to become homestay owners or tourist guides, however the lack of capital and foreign language proficiency is identified as the most important barriers preventing this from happening. Some remarkable ethnographic research (e.g. Turner, 2012a, 2012b) suggested that, in addition to the capital restrictions, ethnic and cultural values have been closely related to the livelihood choice of the ethnic minority people. Tourism is seldom the only source of income for people in tourism development area. And local people generally combine a multitude of economic activities to make a living, especially in developing economies (Dahles & Susilowati, 2015). Thus, tourism livelihood is not abstracted from the local context in the present study, but embedded within the interactions with other livelihood activities." (line 37, page 2 to line 29, page 3)

(2) Sustainable Livelihoods approaches became fashionable twenty years ago. Literature on that period is cited, but not the more critical literature by the same authors as they began to review experiences of livelihoods approaches (eg Chambers 2005, Scoones 2009). This is surely a deficiency.

Thank you for underlining this deficiency. The viewpoints of Chambers and Scoones have been reviewed in the text:

"Despite favourable money returns, they are less likely to change completely to a higher income livelihood. For instance, young Hmong females who work as trekking guides in Sa Pa are

expected to back to hamlet during the periods with intensive agricultural demand, even though they can earn more money via supplying guide service. Such cultural value leads to the wide existence of agricultural livelihood in Sa Pa, and the findings of this study that Hmong are more likely to engage in agricultural livelihood confirms this fact empirically. Understanding how livelihood choices interact with class, caste, gender, ethnicity, religion and cultural identity is vital (Scoones, 2009), which should be further explored combining empirical with qualitative analysis such as ethnography in the future." (line 8-16, page 22)

"People's ability to choose livelihoods strategies is closely related to their capital endowments and accessibility to capitals. And improving access to capitals (e.g. education, social services) is a key to generate efficient opportunities for the poor to improved their life (Chambers, 1995)." (line 2-5, page 2)

(3) The literature that is reviewed is not treated reliably. Fabinyi is cited as an author who gives evidence that tourism is a promising livelihood activity. This is surely a misreading of Fabinyi's article, which mainly portrays fishing people as avoiding tourism because of their fear that they will be tricked by corrupt local authorities, and therefore they continue to pursue unsustainable fishing practices. Biddulph's work on livelihoods and tourism in Cambodia is in the reference list, but is not mentioned in the text.

Thank you for pointing out this mistake. This incorrect citation of Fabinyi's work has been removed. And all references have been checked and modified throughout.

(4) The literature review needs to be better organized so that the reader knows which literatures are being reviewed, and also has a sense of why some literature is mentioned and not others (why is Fabinyi relevant, but not Dahles for example?)

The literature review has been restructured and rephrased. And Dahles's work has been reviewed.

"Tourism is seldom the only source of income for people in tourism development area. And local people generally combine a multitude of economic activities to make a living, especially in developing economies (Dahles & Susilowati, 2015). Thus, tourism livelihood is not abstracted from the local context in the present study, but embedded within the interactions with other livelihood activities." (line 25-29, page 3)

4.Conceptualisation of livelihoods

(1) My understanding is that a livelihood strategy is something rather flexible and dynamic, consisting of a combination of different activities which vary seasonally and according to various opportunities and crises that may arise. "Tourism" or "agriculture" are not livelihood strategies, but rather activities within a broader livelihood strategy. The authors give high priority to "stability" which to me is a rather novel term in livelihood studies, and its meaning in this context is not at all clear to me.

Thank you for underlining this deficiency. Livelihood strategy is a much broader concept which not limited to a single livelihood activity. We have modified the expressions for livelihood activities.

(2) Arguably, the main contribution of livelihoods research has been to shed light on processes of deagrarianisation. It is therefore somewhat incongruous on page 5, line 51 when the authors begin to refer to "farmers" and "farmers' livelihoods". This at least needs to be explained and justified so that the reader does not gain the impression that the authors assume that people who live in the countryside are by default farmers.

Thank you for the suggestion. The phrase "farmers" has been modified to "residents" or "people" or "households" in the text according to the comment.

(3) On page 6, line 46 the authors suggest that "Identifying the factors that affect livelihood strategies is the key to help residents optimize their livelihood strategies and achieve positive livelihood outcomes". I do not understand the logic here. If you tell me what factors affect how I organize my livelihood, how will this in practice help me to optimize my livelihood strategy? Why do you assume that I do not already know the factors that affect my livelihood strategy? Much of the original impetus behind livelihoods approaches was related to the valuing of local knowledge and de-prioritising external expertise. There does not seem to be any reflection on the politics of knowledge (again, see my comment above on the selection of literature relating to livelihoods). This sentence is supported by reference to Nielsen et al, but their conclusion is that the factors that obstruct people from better renumerated livelihood strategies are education, "ethnic affiliation and land".

The relationship between livelihood choices and capital found using multivariate logistic regression aims to show, that the probability of households with different capital to choose different livelihood. In other words, it aims to reveal which factors promote or inhibit the choice of a particular type of livelihood. The analysis findings can help to identify what combinations of 'capitals' are required for different livelihood strategy, and provide insights for livelihood improvement. Thanks for underlining that the phrase "to help residents optimize their livelihood strategies" is inappropriate. Since the barrier that prevents rural households from optimizing their livelihood is not the lack of awareness about affect factors. Additionally, we have modified this incorrect phrase.

In fact, identifying the impact factors of livelihood choice is useful for government (policymaker) to optimize resource allocation and improve people's accessibility to capitals. With an unequal distribution of resources, households who dominate more capital can engage in high-return livelihood easier than poor households. Moreover, the poor households are forced to continue their original low-return livelihood. It is expected that the government regulation can help with poor households by optimizing the resource allocation in poor areas, and reducing costs and extending accessibility to capitals. To achieve this, knowledge about characteristics of different livelihood sectors, and the capital they require is needed, which is what this study aims to provide. The following text has been added to provide clarification:

"A household's ability to choose livelihoods strategies that lead to higher incomes depends on their capital endowment and accessibility to resources. In general, the distribution of resources is unequal among rich and poor households. The households having rich resources to start with are more likely to participate in high return livelihood activities which requires high capital investment. On the contrary, the households with poor resources lack the ability to invest and are

forced to continue their low-return livelihoods. Although off-farm livelihoods are encouraged to be promoted for livelihood improvement, without adequate regulation and intervention, off-farm diversification will exacerbate local wealth inequality (Gautam & Andersen, 2016). In order to utilize off-farm livelihood sectors as effective means of reducing poverty, the government needs to fully understand the characteristics of these sectors, the capital they require and the inequity in the distribution of capital. The present study attempts to reveal the capital required for different types of livelihood activities and the geographical factors affecting livelihood choices. These findings aim to improve the understanding of capital endowment and livelihood choices, and provide reference for the government to optimize the resources allocation and improve people's access to capital." (line 12-25, page 20)

As pointed out, people take local knowledge into account, and de-prioritising external expertise when choosing their livelihoods, and both of them are encompassed by the Sustainable Livelihoods Framework. The key factors, education, ethnic affiliation and land, pointed out by Nielsen et al (2013), are included in the Livelihood Capital Evaluation System which was also constructed in this study. Education and land are subordinate to human capital and natural capital respectively, thus their separate analysis results are not shown. In addition to this, ethnicity is included in the socioeconomic factors. Results show that land has a significant impact on the households' choice of agricultural livelihood, and ethnicity has a significant impact on the choice of agricultural and tourism livelihood. While the effect of education is not significant in our results, probably due to that other capitals dominate here.

We totally understand the reviewer's concern that local knowledge has a prominent influence on livelihood choice. For example, Kinh people get a capital superiority, being more likely to improve their well-being through non-agricultural livelihood such as tourism. While the ethnographic research on the livelihood of Hmong points out that, the rooted cultural values and endogenous knowledge of Hmong make them refused to abandon their original agricultural livelihood and involve in economic capitalist market. We have added the discussion on the impact of local knowledge, especially ethnicity, on people's livelihood choice in the text:

"Besides the above mentioned factors, the economic level and ethnicity are also found to be influencing factors on livelihood choice. Areas with higher economic levels are more likely to develop tourism livelihood, which in turn can continue to increase the local income and to form a positive feedback. Ethnicity has a significant influence on the choice of agricultural and tourism type livelihood, which confirms the findings of other studies on the livelihood of ethnic minority in Sa Pa district. For instance, the Hmong are more likely to be engaged in farming. While some Kinh people come to Sa Pa and engage in tourism business, they are more likely to improve their well-being through non-agricultural livelihood such as tourism since they get a capital superiority. In addition to the lack of capital, ethnographic research on the livelihood of Hmong also points out that, the rooted cultural values and endogenous knowledge of Hmong make them to refuse to abandon their original agricultural livelihood and involve in economic capitalist market (Turner, 2012a, 2012b). The Hmong both embrace and resist the new livelihood opportunity brought by the growing market, and pursuing their livelihood in a way that appropriate to local cultural values and knowledges (Tugault, 2009). Despite favourable money returns, they are less likely to change completely to a higher income livelihood. For instance, young Hmong females who work as trekking guides in Sa Pa are expected to back to hamlet during the periods with intensive

agricultural demand, even though they can earn more money via supplying guide service. Such cultural value leads to the wide existence of agricultural livelihood in Sa Pa, and the findings of this study that Hmong are more likely to engage in agricultural livelihood confirms this fact empirically. Understanding how livelihood choices interact with class, caste, gender, ethnicity, religion and cultural identity is vital (Scoones, 2009), which should be further explored combining empirical with qualitative analysis such as ethnography in the future." (line 40, page 21 to line 16, page 22)

(4) Overall, I find it very odd that rather than trying to identify livelihood strategies through gathering information about the different combinations of livelihood activities pursued by different households at different times, the authors choose instead to ask local elites to develop categories for the study: "According to the interview with the local government, the rural households with clear livelihood strategy in the Sa Pa tourism region can be divided into four types: agricultural, laborer, tourism and balanced".

Our interpretation may be misleading. In fact, the livelihood types situation of households was identified through the field survey, in which the questionnaire surveys and interviews were carried out with the local households. In addition to investigating the households, we also communicated with government officials to further supplement our overall picture of the local situation. The following text has been added to provide clarification:

"Firstly, the local government officials were interviewed to advance the understanding of the overall local situation. As a result of the initial interviews, five villages were selected in Sa Pa to conduct the survey. These villages were San Sả Hồ, Tả Phìn, Hầu Thào , Lao Chải and Tả Van." (line10-13, page 6)

"According to the contribution proportion of different livelihood activities to household income, the rural households can be categorized to four types, and that is, agricultural, labour, tourism and balanced. Households with more than 60% of total income coming from agricultural activities were classified as agricultural livelihood households, and their livelihood activities are mainly composed of farming and animal husbandry. Households with more than 60% of the total income coming from tourism activities were categorized as tourism livelihood households. And their main livelihood activities include tourist guiding, handicrafts making or souvenirs selling and catering. The households having a labour livelihood mostly composed of migrant workers, and more than 60% of the family income comes from engaging in industrial or engineering work. Balanced livelihood household engage in a variety of livelihood activities, including agriculture, tourism, migrant work, employment in enterprises and institutions, and other similar activities. Their income comes from two or more livelihood activities, and the income of any one livelihood activity accounts for no more than 60%. Households with various livelihood activities engage in multiple livelihood activities at different periods of a year, and in different places. In other words, the temporal and spatial variation of livelihood are represented in the diversity of household income sources." (line 22-37, page 13)

5.Sa Pa

I do not in any way understand the assertion that Sa Pa is one of the most representative, vacation destinations in Vietnam (p8, line 52). Why is Sa Pa more representative than (say) Da Nang or

Hanoi? The data that is used to describe what the different categories of livelihood look like in Sa Pa at the top of page 10 is provided without sources and therefore it is difficult for the reader to assess its legitimacy.

Sa Pa is one of the most attractive tourist destinations in Vietnam, while Da Nang and Hanoi are also well-known tourist destinations in Vietnam. The reason why Sa Pa is representative is, first, Sapa is a mountainous town lies at the altitude of 1600m, where agricultural livelihood exists widely; Second, the pro-poor potential of tourism is recognized by the local government and tourism is included in the overall development strategy of Sa Pa. We consider the livelihood situation in Sa Pa is of great significance for research, not stating that the tourism development of Sa Pa is more representative than Da Nang or Hanoi. We have modified the phrase to avoid ambiguity:

"The Sa Pa tourism region (Fig.1.), located in the west of Lao Cai Province (22°20′N, 103°49′E), is a mountainous area lies at the altitude of 1600m. Since the establishment of Lao Cai Province tourist area in 1991, it has received the government's attention, among which Sa Pa tourism region is the most obvious. In Sa Pa, the pro-poor potential of tourism is recognized by the local government and consequently tourism is included in the overall development strategy of Sa Pa (SPC, 2011; Truong et al., 2014). The government has invested special funds to renovate and improve the local infrastructure, lighting system and urban landscape, and upgrade the roads connecting different villages. A complete bus network and 15 taxi operators have been formed in Sa Pa District, which has greatly improved the tourism passenger transport capacity. In addition, the government offers language and tour guide training courses for local households free of charge, training a large number of tourism professionals and improving the level of local tourism services. The government also greatly increased the income of local households by organizing activities such as accommodation, catering and handicrafts. Sa Pa has become one of the most attractive vacation destinations in Vietnam as additional to its stunning rice terraces, it has also retained ethnic customs and strong traces of European colonial culture. Tourism development has significantly contributed much to the improvement of livelihood and poverty reduction. In 2018, the Sa Pa tourism region recorded 2.42 million domestic and foreign tourist arrivals, with a total tourism revenue of VNĐ 4 trillion (US$ 170,000,000). In recent years, the livelihoods of rural households in Sa Pa District have undergone constant changes. Some rural households have gradually abandoned agricultural production and have become reliant on good tourism resources by engaging in providing accommodation, catering and other hospitality services. Thus, tourism has become an important means of livelihood and source of income for rural households in Sa Pa." (line 23, page 5 to line 2, page 6)

6.Method

(1) This very long section on method did not succeed in explaining to me what the research questions were, and how the methods were enabling those research questions to be answered. On the contrary, very basic questions that I had about the method were not answered. For example, in livelihoods research the importance of temporal variation, for example seasonal variations or coping strategies in response to economic downturns, are always important. I could not understand from the method section how temporal variation was taken into account. Were people asked about

their activities on the day of the interview? Or about their activities in the course of a year? Or the past three years?

The following text has been added to provide clarification of the questions each method attempts to solve:

"In this section, first of all, the system evaluating the rural households' livelihood capital were introduced, and subsequently their livelihood capital stock was calculated in order to understand the current livelihood situation of households in Sa Pa. Subsequently, the spatial analysis methods - Moran's I index, the Nearest Neighbour Hierarchical Spatial Clustering analyses, and Ripley's K Function were used to explore the spatial distribution pattern of households with different livelihood types. Then, the multiple logistic regression was applied to reveal the impact of livelihood capital on the livelihood choice of households in Sa Pa area. Finally, the geographical detector was adapted to assess the impact of geographical and socioeconomic factors on the livelihood choices." (line 24, page 8 to line 7, page 9)

"The multinomial logistic regression model was employed for the quantitative analysis to determine the impact of the livelihood capital, location conditions and socioeconomic factors on the livelihood choices of rural households in Sa Pa." (line 1-3, page 10)

"A series of spatial analysis methods were applied to explore the spatial distribution patterns of households with different livelihood types. The spatial autocorrelation was used to examine whether there is spatial autocorrelation in the distribution of households. The nearest neighbour hierarchical spatial clustering was applied to explore the cluster patterns of different types of households. And Ripley's K function was used to measure the distribution characteristics of households on different spatial scales." (line 22-27, page 11)

Instead of specifically describing the difference of livelihood activities during the year, we focus more on whether a household combines various livelihood activities, and the temporal variation of livelihood activities is measured by the diversity of income sources. The households were investigated about their family income structure and the livelihood activities contribute to their income. Thus, the temporal variation is represented by the diversity of income sources, since if a household performs different livelihood activities in different seasons, its income structure is more diversified than households who only engage in one livelihood activity during a year. We have added the following text to explain how the temporal variation is included in the measurement of this study:

"According to the contribution proportion of different livelihood activities to household income, the rural households can be categorized to four types, and that is, agricultural, labour, tourism and balanced. Households with more than 60% of total income coming from agricultural activities were classified as agricultural livelihood households, and their livelihood activities are mainly composed of farming and animal husbandry. Households with more than 60% of the total income coming from tourism activities were categorized as tourism livelihood households. And their main livelihood activities include tourist guiding, handicrafts making or souvenirs selling and catering. The households having a labour livelihood mostly composed of migrant workers, and more than 60% of the family income comes from engaging in industrial or engineering work. Balanced livelihood household engage in a variety of livelihood activities, including agriculture, tourism,

migrant work, employment in enterprises and institutions, and other similar activities. Their income comes from two or more livelihood activities, and the income of any one livelihood activity accounts for no more than 60%. Households with various livelihood activities engage in multiple livelihood activities at different periods of a year, and in different places. In other words, the temporal and spatial variation of livelihood are represented in the diversity of household income sources." (line22-37, page 13)

(2) Similarly, the geographical distribution of household members is a key interest in livelihoods research. In this sense the GIS component in this study is very interesting as it potentially could provide ways to describe multi-local livelihood strategies. However, I could not from the method understand how locations had been plotted. I was not even sure whether the authors were referring to the household location (which would therefore conceal the multi-locality and distribution of different activities) or whether they were referring to the locations of different household members (and again, if so, how was seasonal variation accounted for. If a man is at home and farms rice during the wet season, and is in town operating as a motorcycle taxi in the dry season, how do the spatial data capture this?)

The geographical factor we studied here is the household location, and the spatial analysis methods have been applied to explore whether the geographical location of the household affects their livelihood choices. The households' livelihood situation can be seen from their income structure. For example, if a man farms at home in the wet season and works for factory in the dry season, then his household income source will be more abundant than others, thus his income source consists of migrant work and agriculture. The fact this man is able to carry out such diverse livelihood activities is related to the location of his family, and we attempt to reveal how the household location affect the livelihood choice and whether there is there a pattern in the livelihood choice of household with different geographical locations.

We have provided further clarification on how the spatial variation is represented in this study:

"Households with various livelihood activities engage in multiple livelihood activities at different periods of a year, and in different places. In other words, the temporal and spatial variation of livelihood are represented in the diversity of household income sources." (line 34-37, page 13)

(3) I am not qualified to comment on the technical quality of the spatial and statistical procedures employed in this study. However, there is perhaps a need to better define the scope of the article (which should perhaps be two articles). If what is of interest here is the technical methods, and the authors feel that they are making an original contribution to spatial science, then perhaps the article should be re-written with that in mind, and the focus and contribution be to do with the technical innovations in the method. On the other hand, if this is an article which seeks to contribute to our understanding of tourism's role in the livelihoods of rural people in Sa Pa, then the method should be described in such a way as it better explains the research activities in relation to the research aims and questions. My feeling at the moment is that the article does not really succeed in doing the latter.

We have made a major modification on this paper, with the research questions and contributions to the existing knowledge of this study have been further clarified. Especially, the following text

have been rephrased or added in the paper, and how does each technical method contributes to solving research questions is clearer now.

"With reference to the Sustainable Livelihood Approach framework and considerations of the gap in tourism literature, this study aims to reveal the influence factors lies behind the livelihood choices of people in Sa Pa, Vietnam, and this is going to be based on understanding the capital endowments of local households. Five villages in Sa Pa District, Vietnam were selected for research, as there are substantial differences among different regions in the factors influencing the choices of rural households regarding livelihood strategies. A comprehensive application of multiple methods is applied to fully identify these influencing factors, which includes establishment of livelihood capital evaluation system, multiple logistic regression, geographic analysis techniques such as Ripley's function, nearest neighbour hierarchical spatial clustering and geographical detector method. The findings of this study aim to provide insight for government to optimize resource allocation and improve people's access to capital." (line 25-35, page 2)

"In this section, first of all, the system evaluating the rural households' livelihood capital were introduced, and subsequently their livelihood capital stock was calculated in order to understand the current livelihood situation of households in Sa Pa. Subsequently, the spatial analysis methods - Moran's I index, the Nearest Neighbour Hierarchical Spatial Clustering analyses, and Ripley's K Function were used to explore the spatial distribution pattern of households with different livelihood types. Then, the multiple logistic regression was applied to reveal the impact of livelihood capital on the livelihood choice of households in Sa Pa area. Finally, the geographical detector was adapted to assess the impact of geographical and socioeconomic factors on the livelihood choices." (line 24, page 8 to line 7, page 9)

"The multinomial logistic regression model was employed for the quantitative analysis to determine the impact of the livelihood capital, location conditions and socioeconomic factors on the livelihood choices of rural households in Sa Pa." (line 1-3, page 10)

"A series of spatial analysis methods were applied to explore the spatial distribution patterns of households with different livelihood types. The spatial autocorrelation was used to examine whether there is spatial autocorrelation in the distribution of households. The nearest neighbour hierarchical spatial clustering was applied to explore the cluster patterns of different types of households. And Ripley's K function was used to measure the distribution characteristics of households on different spatial scales." (line 22-27, page 11)

(4) Page 10 line 52 I was not clear what a "participatory interview" meant, nor how it differed from a "group interview" or an "interview"

The term "participatory interview" is misused, and it has been modified to "interview". (line 18, page 6)

(5) Page 10, line 60. Notwithstanding the authors' response to previous reviewer comments, the authors continue to refer to survey forms being "not returned", and it is still not clear why if these are face to face interviews, why seventy of them should not yield any data.

During a 30-day field survey in Sa Pa, we visited the households, had conversations with them, and invited them to fill out questionnaires. To understand the livelihood status of households in

various aspects, questionnaire was designed with many questions, which takes more than 30 minutes to fill in. Thus, some questionnaires were sent out but not completed due to the time limitation of the respondents or their unwillingness to cooperate. And these uncompleted questionaries are described as "not returned". The following text has been added to clarify why some questionnaires were not returned:

"A total of 250 questionnaires were distributed and 185 were returned. Some of the returned questionnaires were not completed due to the busy schedules of the respondents or lack of motivation to cooperate. Furthermore, another 5 questionnaires were excluded as they contained respondent errors. In total, 180 questionnaires were used for the analysis." (line 20-24, page 6)

(6) Page 12 line 51. The categorization of "nationalities" appears wrong here. What are referred to are ethnic affiliations and not nationalities.

Thank you for pointing out this mistake. It has been modified.

7. Results, Discussion and Conclusions

(1) The lack of clarity in the method made it difficult to evaluate the significance of the results. For example, the results suggested that a "labor" household is likely to be poorer than a "balanced" household. Without knowing how these categories have been defined and operationalized it is difficult to understand what this means. If people with greater incomes have been categorized as "balanced" and people with lower incomes have been categorized as "labour" then this becomes a self-fulfilling prophecy.

Based on the survey of households, information of their family income was collected, and the households are categorized according to the household income structure. Households with more than 60% of total income from agriculture were classified as agricultural livelihood households. And households whose income is more than 60% from tourism activities were categorized to tourism livelihood households. More than 60% of the family income of labour livelihood households is from engaging in industrial or engineering work. And balanced livelihood households engage in a variety of livelihood activities, their household income comes from two or more livelihood activities, and the income of any one livelihood activity accounts for no more than 60%.

The balanced and labour households are not defined by whether they have higher or lower income, but by their income sources. It is an objective situation found through the descriptive statistical analysis that the balanced households have higher income level on average, which is partly due to their more various income sources. However, from the perspective of individual household, there are also cases where labour household has higher income than balanced household.

The following text has been added to provide clarification on the definition and classification standard of different types households:

"According to the contribution proportion of different livelihood activities to household income, the rural households can be categorized to four types, and that is, agricultural, labour, tourism and balanced. Households with more than 60% of total income coming from agricultural activities were classified as agricultural livelihood households, and their livelihood activities are mainly composed of farming and animal husbandry. Households with more than 60% of the total

income coming from tourism activities were categorized as tourism livelihood households. And their main livelihood activities include tourist guiding, handicrafts making or souvenirs selling and catering. The households having a labour livelihood mostly composed of migrant workers, and more than 60% of the family income comes from engaging in industrial or engineering work. Balanced livelihood household engage in a variety of livelihood activities, including agriculture, tourism, migrant work, employment in enterprises and institutions, and other similar activities. Their income comes from two or more livelihood activities, and the income of any one livelihood activity accounts for no more than 60%. Households with various livelihood activities engage in multiple livelihood activities at different periods of a year, and in different places. In other words, the temporal and spatial variation of livelihood are represented in the diversity of household income sources." (line 22-37, page 13)

(2) The relative poverty of "agriculture" households compared to others fits with much existing literature (like Rigg's classic 2006 article in World Development) but the results are not discussed in relation to that existing literature. Rather other issues such as government policies to build infrastructure etc are discussed, but these do not seem to have been the focus of the method or the analysis. Neither, overall, did I see a clear contribution to the journal's main focus on sustainable tourism.

The following text has been added to discuss with the correlative literatures:

"Among the four livelihood types of households in Sa Pa, the agricultural livelihood is found to contribute least to improve the households' income. It can be seen that single agricultural livelihood or excessively dependent on agriculture can hardly improve the living situation of rural households, which aligns with the previous literature (Rigg, 2006)" (line 39-42, page 20)

8. Additional formalia:

Items in the list of references are not in alphabetical order, making them difficult to locate.

The references have been checked and re-sorted throughout.

Dear Editor:

Thank you for giving us enough time to revise the manuscript “Factors Influencing the Livelihood Strategy Choices of Rural Households in tourist destinations” (JOST-4981). We appreciate the reviewers for the time and effort that they have put into reviewing the previous version of the manuscript. Suggestions and comments from all reviewers have been carefully considered, which helped us to improve our work greatly.

Each suggested revision and comment, brought forward by the reviewers was accurately incorporated and considered. The changes in the revised manuscripts are highlighted in red. And we also provide a point-to-point response to the reviewers’ comments.

We appreciate for Editors and Reviewers’ warm work earnestly, and hope that the revised manuscript will meet with approval.

Sincerely,

Corresponding author