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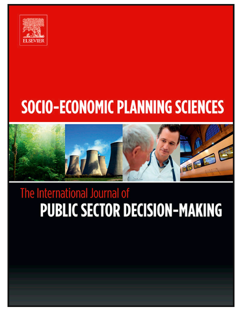

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Fei Zhao, Sujin Zhang, Quanda Du, Jieyu Ding, Guize Luan, Zhiqiang Xie

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Assessment of the Sustainable Development of Rural Minority Settlements Based on Multidimensional Data and Geographical Detector Method: A Case Study in Dehong, China

Fei Zhao[a], Sujin Zhang[a], Quanda Du[a], Jieyu Ding[b], Guize Luan[a], Zhiqiang Xie[a*]

[a]School of Earth Sciences, Yunnan University, Kunming, 650500, China
[b]School of Resource and Environmental Sciences, Wuhan University, Wuhan, 430079, China

Abstract: In a developing country, paying attention to the sustainable development of rural areas is conducive to the development of the entire country. Ethnic minority areas are an important part of China's economic and social development. Owing to a lack of relevant statistical data, most previous studies in this area have focused on the sustainable development of rural areas or the development of ethnic minorities, but have not studied the sustainable development of rural ethnic minorities. The development of rural ethnic minorities is worthy of attention. In this study, we took Dehong as the study area. First used toponyms to accurately identify the rural minority areas and then calculated a grid of settlement density. Second, we considered the digital number (DN) value of the visible infrared imaging radiometer suite (VIIRS) as a measure of the development of the region and digital elevation model (DEM), net primary productivity (NPP), normalized difference vegetation index (NDVI), and gross domestic product (GDP) data as the indicators of terrain, climate, ecological, and economic factors, respectively. Finally, linear regression and the geographical detector method were used to determine the weight of the factors for constructing a sustainable development index (SDI) to quantitatively analyze the sustainable development and influencing factors of each minority nationality. The factors evaluated using linear regression and the geographical detector method were ranked as follows: NDVI > elevation > GDP > slope > NPP > settlement density. The results demonstrate that of the five main ethnic minorities in Dehong, Dai and Jingpo have higher SDI, followed by Achang, Lisu and De'ang. In addition, we provide some suggestions for ethnic minorities in Dehong.

Keywords: Sustainable development index; Ethnic minority; Rural; Geographical detector; VIIRS; Toponym

1. Introduction[1]

The colorful cultural resources of ethnic minorities have enriched the treasure house of world civilization. Regarding the importance of national culture, all sectors of society have reached consensus. However, what is inconsistent with this cognitive consensus is that the development of ethnic regions and the protection of ethnic cultures is not harmonious [1]. With the foundation of the People's Republic of China in 1949, the Chinese government started to reclassify ethnic groups and autonomous areas. Fifty-five ethnic minorities, alongside the Han majority, have been classified since 1949 [2]. The standard of classification is that the same ethnic minority should have a common language, live in the same region, share a common economic life, and share the same culture. Owing to long-term and complex historical reasons, compared with the Han, there are many problems facing the development of

* Corresponding author.
E-Mail addresses: vwobai@163.com (F.Zhao); zsj@mail.ynu.edu.cn (S.J.Zhang); 530452049@qq.com (Q.D.Du); 951479366@qq.com (J.Y.Ding); luanguize@163.com (G.Z.Luan); xzq_2019@ynu.edu.cn (Z.Q.Xie).

1 Digital Elevation Model (DEM); Digital Number (DN); Earth Observation Group (EOG); Geographic Information Systems (GIS); Gross Domestic Product (GDP); Net Primary Productivity (NPP); Normalized Difference Vegetation Index (NDVI); Sustainable Development Index (SDI), Visible Infrared Imaging Radiometer Suite (VIIRS).

ethnic minorities. With the continuous development of society, ethnic areas are facing more and more problems regarding population, resources, environment, economy, and other issues.

Sustainable development in rural areas is an important component of China's social and economic sustainable development, and the sustainable development of rural minorities is also an inevitable choice in China in the 21st century[3]. First, the realization of sustainable economic development in ethnic areas is of great significance to border security and national defense consolidation. Most of China's ethnic areas are located in the northeast, northwest, and southwest frontiers of the inland area, reaching Inner Mongolia in the north, Xinjiang and Tibet in the west, Yunnan and Guangxi in the south, and the neighboring 14 countries at the 8000 km land boundary. Second, the sustainable development of ethnic areas is the key link to ecological sustainability in China. China's ethnic areas are mostly located in fragile ecological environment zone. The ecological stability of these areas is poor, once it is destroyed, and the chance of restoration is small. In addition, the realization of sustainable development can greatly improve the quality of life of ethnic minorities.

In 1980, the International Union for the Conservation of Nature suggested that it is necessary to study the basic relations among natural, social, ecological, and economic factors, along with the process of using natural resources, to ensure the sustainable development of the world. Sustainable development is an important goal for the development of ethnic areas in China, and evaluation is a necessary means to define and clarify this goal [4]. Rural residential areas are the primary spatial hosts of rural populations while supporting multiple other functions, such as agricultural production and social succession. The spatial distribution and evolution of these areas reflect human adaptations to economic, geographic, environmental, and historical conditions and changes [5]. Settlement sites (villages) are the most basic units of culture and social organization [6]. The sustainable development of rural economies will directly promote the spatial reorganization of rural settlements and social and cultural changes. Therefore, it is necessary to make a quantitative evaluation of the sustainable development of minority rural settlements. However, the lack of a large amount of research data makes it difficult to quantitatively assess the development of these regions. Special living conditions, habits of locals, and regional economic and social development characteristics greatly differ between rural minority areas and developed areas [7]. The construction of a sustainable development index (SDI) for rural minority areas is therefore different from that of urban areas.

Minority populations are widely distributed, being either mixed into larger diverse populations or concentrated in small communities, making it difficult to clearly distinguish ethnic minority residential areas. However, the recent growth in geospatial big data has provided new opportunities to extract accurate information about minority populations. Place names or toponyms reflect the extensive geographic knowledge of ancient indigenous people, accumulated through generations of interactions with their environment [8]. Similar to point of interest data, toponym data contain the exact location information (i.e., latitude and longitude) along with other details, such as the name, category, and classification of the place [9]. Their point coordinates can be converted to raster layers with different grid sizes, thus allowing convenient and flexible combination with remote sensing data [10]. Toponym data have the stability of time and space, and can not only reflect the geographical environment and human characteristics in different historical periods, but also the natural factors influencing human civilization, such as environmental factors, terrain, and types of objects [11]. In the 21st century, modern research on toponyms tends to focus on quantitative and visualized analyses [12]. Some scholars analyzed the spatial distribution characteristics of toponyms based on a GIS approach, including rural toponyms and toponyms in ethnic minority languages [13, 14]. For example, Wang et al. used geographic information systems (GIS) visualization and multifactor analysis to deeply explore the structure of toponyms in Zhuang villages, taking the Guangxi Zhuang Autonomous Region as an example [15, 16]. Therefore, in this study, we used toponym data to identify ethnic minority areas.

The availability of artificial light is often associated with wealth and a more modern society [17, 18]. Remote sensing nighttime light data can be very useful for assessing development at broad scales, so we used these data to refer to the current development of ethnic minority areas. The visible infrared imaging radiometer suite (VIIRS) currently provides nighttime light imagery that is significantly superior to older DMSP-OLS data in terms of its wider measurement range, higher spatial resolution, and on-board calibration [19]. These data have been used to identify economic development status at the county level, demonstrating a close relationship between light levels and economic development [20]. In addition, remote sensing has the ability to record a variety of spatial and temporal data over land surfaces comprehensively, and can be applied to the evaluation of ecological environment quality [21]. For example, Yu et al. established a poverty assessment system at the county level in China using night light data, which demonstrated that night light remote sensing images can be used as an assessment tool to measure development levels [20]. Li et al. discussed the use of nighttime light data in assessing economic and social development, determining spatiotemporal dynamics of urban expansion, and estimating regional development quality [22]. Therefore, it is feasible to use VIIRS brightness to evaluate the development of a region.

This paper analyzes the spatial characteristics and driving factors of the sustainable development of rural ethnic minorities. In general, sustainable development is not only evaluated unilaterally, but also constructed from multiple dimensions. Thus, based on the concept of sustainable development, this study employed linear fitting and the geographical detector method to explore five aspects of the rural minority areas: settlement density, the economy (measured by GDP), terrain (measured by DEM and slope), climate (measured by NPP), and the ecological environment (measured by NDVI). Dehong, a minority autonomous prefecture, is the research area. The geographical detector method is a statistical method used to detect spatial heterogeneity and reveal the driving force behind it; it was initially applied to study endemic diseases and their relevant geographic risk factors [23]. In recent years, as an essential method for detecting the spatial pattern and mechanism of certain elements, the geographical detector method has been extensively applied in social, economic, and natural science disciplines.

In this study, we first classified the toponym data. Second, the single-factor linear fitting method was used to fit the relationship between the five factors and the digital number (DN) value of VIIRS, thus exploring the relationship between current development and each factor. The DN value is the brightness value of each remote sensing image pixel. Third, the weight of each factor was determined using a geographic detector, and an SDI was constructed using linear modeling. Finally, based on statistical analyses of the obtained SDI values through single-factor and single-ethnic analyses, relevant measures were identified for the sustainable development of ethnic groups and resource development in the region. This research solves two problems. The first is the extraction of rural minority area locations where it is difficult to confirm the area using only toponym data and night light remote sensing data. Second, it quantitatively analyzes the influence of different factors on the ethnic minorities and the sustainable development of various minorities through SDI. Related policies and measures to help ethnic minorities achieve sustainable development can then be put forward.

2. Data and Preprocessing

2.1. Study Area

Dehong Prefecture is located in western Yunnan Province, China, with five county-level units: Mangshi, Ruili, Lianghe, Yingjiang, and Longchuan (Figure 1). The altitude of the whole prefecture is 210 to 3177 m. The northeast is higher than the southwest, forming seven altitudinal zones. Dehong has an area of 11,500 square kilometers. The urbanization rate is 47.53%.The government functions from Mangshi, with a planned urban area of 14 square kilometers. Dehong is one of the eight minority autonomous prefectures in Yunnan Province. More than 30 ethnic minority groups live in the region, of which the five main with the largest population are Dai, Lisu, Jingpo, Achang, and De'ang. According to the 2015 Dehong statistical yearbook of China, the total population of the whole prefecture is 1,279,000. Ethnic minorities accounted for 47.8% in 2015, of which the five main minorities accounted for 95.8%. The Dehong Government is currently implementing the ethnic policy and the system of regional ethnic autonomy[24], with the intention of achieving unity, progress, and development in border ethnic minority areas.

At present, Dehong's GDP ranks 13th among the 16 prefectures and cities of Yunnan Province. Primary industry, secondary industry, and tertiary industry account for 58.8%, 21.0%, and 20.2%, respectively. There is a large difference in levels of economic development among its counties. In 2019, Mangshi had the largest GDP and Lianghe had the smallest, with Mangshi's GDP approximately 4.5 times that of Lianghe. In terms of industry, Mangshi and Yingjiang are more developed than the other

counties in Dehong. The total industrial added value of these two counties accounts for three quarters of the entire prefecture. In terms of tertiary industry, Mangshi and Ruili are more developed.

Dehong's current level of urbanization is low as various national cultural industries remain underdeveloped, restricting the economic development of Dehong; at the same time, many aspects of national cultural heritage have not been fully utilized. Therefore, it is particularly important to evaluate the sustainable development of major ethnic groups in Dehong and implement relevant measures for development.

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Figure 1. Location of Dehong Prefecture within Yunnan Province and its five counties.

2.2. VIIRS Data

VIIRS nighttime light data were obtained from the Earth Observation Group (EOG), National Geophysical Data Center, at the National Oceanic and Atmospheric Administration. These are a suite of average radiance composite images that collect persistent human-generated lights from towns, cities, and other sites. So far, two types of temporal averaging NPP-VIIIRS data can be obtained from the EOG data, namely monthly and annual composite images [25]. We used the 2015 annual composites and referred to the algorithm of Elvidge and other researchers on night light data [26] after removing background noise. We then selected the dark areas in the images as the samples, such as the sea, mountain area, and farmland, and then calculated the average DN value of those samples. The pixels that were lower than the average value were replaced by 0 to remove background noise. After processing, using Dehong vector data for clipping, projection, conversion, and resampling, the resampling size obtained was 1 × 1 km.

2.3. Toponym Data

We searched for toponym data from the Chinese national database of geographical names (http://dmfw.mca.gov.cn/online/map.html) and gazetteers. Overall, we obtained 10,005 toponym records; they comprise 62 categories, including rural residential areas, urban residential areas, mountains, scenic spots, industrial areas, agricultural lands, forests, and others. We screened the toponym data to obtain 6671 rural toponyms. Then, we used the key words extraction method to identify the ethnic minorities of these toponyms. We established a key words database by consulting relevant documents. For

example, Dai, Lisu, Jingpo, De'ang, and other words were used as the key words in the database. Meng, Jing, Hui, and other words are Chinese translations of Dai and were also considered key words. Using this method, we determined nine minority groups (Table 1).

Ethnic minority

NPP is the fixed energy or organic matter produced by green plants per unit area and unit time through respiration; it is the total primary production minus the energy or organic matter left after plant respiration [26]. NPP is influenced by many variables, such as temperature, rainfall, altitude, soil, clouds, solar radiation, topography, and human land use [27] and is a key parameter used to evaluate the terrestrial ecological environment [28]. As there is a significant positive correlation between NPP and annual rainfall, NPP can be used as a proxy for climate [29]. Higher rainfall is generally associated with higher NPP within a region. We obtained NPP data for 2015 from the Resource and Environment Data Cloud Platform (http://www.resdc.cn/) and resampled these to a grid size of 1 × 1 km.

2.5. NDVI

NDVI can accurately reflect surface vegetation coverage. After processing, the values of NDVI data were in the range 0–1, where 0 means rock or bare soil and the values increase with higher vegetation coverage. Some scholars proposed that NDVI values should be combined with night light remote sensing data to determine community distribution because NDVI can reduce the influence of the saturation overflow of light data. The value is closely related to human activities, and NDVI is often negatively related to human distribution. For example, Levin and Zhang suggested that urban central areas have larger population densities, higher human non-agricultural activity intensities, and less vegetation cover [30]. In pastoral areas and grassland, vegetation is negatively correlated with human activities owing to the low intensity of human non-agricultural activity and large vegetation coverage [31]. Therefore, NDVI can help us judge the development ability of ethnic minorities. We obtained NDVI data for 2015 from the Resource and Environment Data Cloud Platform with a spatial resolution of 1 × 1 km.

2.6. GDP

GDP is an important indicator of social and economic development that is used for regional planning and resource and environmental protection in China, usually with administrative regions as the basic statistical unit. Several studies have proposed models for relating GDP and nighttime light data, such as the double logarithm correlation [32], natural index function relationship [33], linear model [34], and village-level linear model [35]. Nighttime light has been found to be positively correlated with GDP and Gross Regional Product at different spatial scales [36]. We collected spatial GDP data for 2015 from the Resource and Environment Data Cloud Platform in a 1 km × 1 km grid and used this data as the economic indicator.

2.7. Topographical Factors

Dehong’s terrain elevation ranges from 223–3177 m, being highest in the northeast and lowest in the southwest. Altitude affects the living environment. For example, the climate in the highest areas is cold and these areas are uninhabited, while lower areas are more suitable for habitation. The slope of the terrain affects its agricultural suitability; as most ethnic minorities in Dehong are engaged in agriculture, their settlements are more commonly located on gentler slopes. In addition, the population density is closely related to topographical factors [37]. Therefore, we collected DEM data from the geospatial data cloud (http://www.gscloud.cn/) and performed clipping, projection, and resampling for slope analysis.

3. Methods

This study used economic, topographic, and ecological data to assess the sustainable development ability of rural minorities from multiple perspectives. After preprocessing the data, the following flowchart was developed (Figure 3), showing the main methods used for analyses.

Figure 3. Methodological flow chart. Visible Infrared Imaging Radiometer Suite (VIIRS); Net Primary Productivity (NPP); Normalized Difference Vegetation Index (NDVI); Gross Domestic Product (GDP); Digital Elevation Model (DEM); Sustainable Development Index (SDI).

3.1. Linear Regression

Linear regression is often used to explore the relationship between factors and results [38]. We considered the following evaluation factors: settlement density, NPP, GDP, NDVI, elevation, and slope. Settlement density describes the spatial pattern of village concentration; NPP refers to climate factors; GDP is an economic indicator; NDVI indicates the relative amount of photosynthetic vegetation; and elevation and slope refer to livability. We extracted the central point data from the density grid and extracted the other variables to these points. The attributes of each center point included the DN value of VIIRS, the settlement density value, NPP, GDP, NDVI, elevation, and the slope value of each grid. MATLAB was then used to run the linear regression calculations between each of these six factors and the DN value of VIIRS to explore the correlation between each factor and the development of the region.

Linear regression of the six evaluation factors showed that NPP, NDVI, elevation, and slope had negative correlations with DN, but GDP and settlement density had positive correlations with DN values (Figure 4). A high DN value means high brightness, and an area with high brightness usually has greater population, better economic development, and a high degree of urbanization. In these areas, because of the high level of urbanization, the vegetation coverage is relatively low, which leads to lower NDVI values. Among the six factors, NDVI has the highest correlation with DN, followed by elevation, GDP, slope, NPP, and density.

(a)

(c)

in Dehong to classify the independent variables using the natural breaks method in ArcGIS (Table 2). The resulting data were then used with the geographical detector method.

Factor

geographical detector results showed that NDVI provided the highest contribution to the spatial distribution of brightness and settlement density provided the lowest contribution. The contributions of the pre-evaluation factors to the development of rural minority areas in the two methods showed similar trends, with the following order: NDVI> elevation> GDP> slope> NPP> density.

(a)

(e)

jewelry distribution center. It is an excellent tourism area with developed transportation and active trade. Therefore, we suggest that Ruili should continue to focus on the development of tourism in the future. Mangshi is the capital of Dehong Prefecture. The only airport in Dehong is located in this city. It is a major transit station and concentration area for tourists. Mangshi can also use its geothermal resources, ethnic resources, and beautiful scenery to increase publicity and develop tourism.

(a)

Figure 7. Distribution of SDI levels of ethnic minorities.

Figure 8. SDI levels by number of ethnic groups.

The Dai ethnic group is the most widely distributed ethnic group in Dehong. They are distributed in every county and city. Among the Dai ethnic groups (Figure 8), 6.21% of the ethnic settlements have SDI values at the first level; 64.47% of them have SDI values at the second level; and 29.32% of them are at the third level. The Dai has absorbed considerable levels of Han culture and have their own words and languages. Moreover, they lived with the Han for a long time, engaged in more commerce and agriculture, and have a high economic level. The Jingpo are mainly located in Longchuan, Yingjiang, and Ruili, with a few groups scattered in other counties. The first, second, and third levels of SDI account for 1.35%, 29.85%, and 68.80%, respectively. The Lisu are mainly distributed in Yingjiang in the north of Dehong, and scattered in other counties. Owing to the influence of the terrain, the SDI values of the Lisu are at the third level, accounting for 97.12%. The De'ang are distributed in all five counties. Mangshi and Ruili have the highest concentration, while most of the others live with the Jingpo, Han, Lisu, and other groups in the mountainous areas. Approximately 51.43% of them are in the second level and 48.57% are in the third level. The Achang mainly live in Lianghe and Longchuan, with a few of them in Mangshi, Yingjiang, and other places. Approximately 54.55% of the Achang are in the second level and 45.45% in the third level. Owing to the long-term mixed living with the Dai and Han nationalities, agriculture and handicrafts are relatively developed, and these can be effectively used for the development of the Achang in the future.

Based on Dehong's current economic development foundation and according to the calculated SDI stratification of different ethnic groups, we further analyzed the development of ethnic minorities in different counties. In Ruili, there are mainly Dai at the first and second SDI levels and Jingpo at the second SDI level. The rural settlements of ethnic minorities in Ruili can rely on the local economic foundation, industrial structure, and the advantages of a foreign cooperation platform with Myanmar border. Through the regional preferential policies provided by the government, the cooperation between local leading enterprises and rural farmers can be promoted, agricultural production bases should be built, deep processing of agricultural products should be developed, and the export of agricultural products could be expanded. Simultaneously, by relying on the two-way tourism loop between China and Myanmar, rural ethnic minority areas can transform into a tourism industry and promote foreign trade, such as natural ecological sightseeing in border villages, providing ethnic cultural experiences, and developing into a site of port businesses.

The Mangshi are mainly distributed with the Dai with second and third SDI levels, while the Deang are at the second SDI level. Mangshi is a famous characteristic biological industry innovation base in Dehong and in China more generally, and is an important export-oriented industrial processing base for the entire province. On the one hand, ethnic minorities in this region can play their own advantages in terms of biological resources and the ecological environment by actively develop coffee, nuts, rubber, tea, and other characteristic crops. On the other hand, the government can guide local rural ethnic minorities' labor force to enter the local industry, so as to increase the skill level and income of the local labor force.

In Longchuan, there are mainly Dai at SDI level 2 and Jingpo at SDI level 3. Longchuan has a good biological and ecological resource base, but the development foundation of the industry and service industry is weak. Local rural ethnic minorities can develop characteristic agriculture around the local sugar industry as well high-quality tobacco, and actively develop rural tourism, sports, and a health care base in ethnic minority areas.

In Lianghe, there are mainly Dai at second and third SDI levels, and Achang at the third SDI level. Lianghe is the only one of the five counties under the jurisdiction of Dehong that is not in the border area, and its economic development is at the middle level among the five counties. Based on the natural resources advantages and industrial development foundation of Lianghe, the rural minorities in this area can focus on the development of sugarcane, tea, animal husbandry, forestry, and other advantageous industries.

In Yingjiang, there are mainly Dai at the second SDI level, while the Lisu and Jingpo are at the third SDI level. Yingjiang has a certain manufacturing base and biological and ecological resources. However, there are many geological disasters in Yingjiang, including earthquakes, landslides, and debris flows. Therefore, we should also pay attention to disaster prevention in the process of economic development. The rural ethnic minorities in this area can give full play to the function of the main grain producing areas in Yingjiang; they can consolidate the development of plateau characteristic agriculture such as grain and sugar industries, and reasonably and moderately gather in surrounding towns to promote industrial agglomeration.

5. Discussion

5.1 Measurement of Sustainable Development

The determination of an SDI is an enormously complex task that involves many aspects, including the economy, society, and environment, regardless of location. This means that it is difficult to assess regional multidimensional sustainable development accurately with all the components included, in addition to the limitations of data acquisition. Many indicators of sustainable development are determined by screening multiple indicators of different dimensions [46-48]. In some studies, the number of indicators even exceeds 15. An SDI determined by too many indicators will limit its application, which is suitable for assessment in this region but not suitable in other regions. In 1980, the International Union for the Conservation of Nature suggested that it is necessary to study the basic relations among natural, social, ecological, and economic factors, along with the process of using natural resources, to ensure the sustainable development of the world. Sustainable development of rural economies means long-term dependence on the natural environment and natural resources [46]. In this study, we selected six indicators related to the natural environment and natural resources: NPP, NDVI, GDP, slope, elevation, and settlement density derived from toponym data. The SDI integrated the climatic, ecological, economic, and terrain factors with a measure of human living environment. Although it cannot comprehensively and completely evaluate sustainable development, it has assessment value and significance for rural ethnic minorities.

5.2 Limitations and Prospect

To our knowledge, the SDI established in this paper is the first integrated index to evaluate the sustainable development of rural ethnic minorities from a multidimensional perspective. We not only identified the distribution rural ethnic minority areas using night light remote sensing and toponym data, but also analyzed the development of five ethnic minorities in Dehong through the SDI and put forward relevant suggestions. Furthermore, the method can also be applied to other areas of the population that require classification, for example, the assessment of ethnic minorities and Han people living in the same region. However, there were still many spaces that we were not able to analyze. First, the processing of nighttime light remote sensing data did not completely eliminate noise, which affects weight construction; however, the general trend was not significantly affected. Second, because of data availability limitations, the GDP data used was at the county level, which led to the same GDP value at many points, thus affecting accuracy. Third, after gridding the toponyms of ethnic minorities, the main ethnic minority in the grid was determined according to the proportion of each category of toponym data. In further research, we intend to consider combining the population data to determine the main ethnic minority within each grid.

6. Conclusions

In this study, we used multi-source data to construct a precise multi-ethnic population development analysis method. This was used to solve two problems.

(1) Owing to the expansion of urbanization and the influence of the geographical environment, the boundaries between rural and urban areas are becoming increasingly blurred, which means it is increasingly difficult to accurately identify rural areas. In this study, we showed how toponym data can be used to filter and extract rural place names, and how the key word extraction method can then be used to obtain accurate data on ethnic minority areas.

(2) During global sustainable development, we should not only focus on the development of big cities, but also recognize and pay attention to the sustainable development of areas that have not received adequate attention in the past. Rural areas, especially rural ethnic minority areas in remote regions, suffer from a lack of accurate statistical data, which makes it difficult to carry out accurate assessments. By employing widely used remote sensing data, including night light remote sensing, NPP, and NDVI combined with terrain data and GDP data, this study showed how the spatial distribution and development of rural ethnic minorities can be evaluated using a case study of Dehong, Yunnan Province, China.

Finally, the following conclusions can be drawn:

(1) The linear regression method can be used to explore the relationship between various factors and the brightness of night light remote sensing. In this study, the factor with the highest correlation with DN was NDVI, followed by elevation, GDP, slope, NPP, and settlement density.

(2) The contribution of each factor to the spatial distribution of remote sensing brightness can be obtained using the geographical detector method. NDVI contributes significantly to brightness distribution, followed by elevation and GDP, slope, NPP, and settlement density.

(3) Based on results 1 and 2, the weights of the six factors were determined. We used a multifactor weighting model to calculate the SDI values for rural ethnic settlements in Dehong based on six factors and classified the results using the natural breaks method. We found that among the five main ethnic groups in Dehong, the Dai and Jingpo are the most widely distributed, with the highest SDI level, followed by the Achang. We found that the SDI levels of the Lisu and De’ang are very low. Furthermore, we put forward some suggestions for the five counties and five major ethnic minorities in Dehong.

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Conflicts of Interest: The authors declare no conflict of interest.

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- Sustainable development indicator (SDI) was developed using six evaluation factors
- Keyword extraction and gridding methods were used to identify ethnic minority areas
- Linear regression and geographical detector method determined factor weight
- Areas with better ecological and topographical environments have higher SDI levels

Zhao Fei is a master's supervisor of school of Earth Sciences, Yunnan University. He holds a Ph.D. in cartography and geographic information engineering. Mainly engaged in research and teaching in the field of geographic information system. The main research directions are cartography theory, geographic information visualization, geographic information artificial intelligence application and national basic geographic information data update.

Zhang Sujin is a student of the school of Earth Sciences, Yunnan University. Her background is tourism management and geographic information science. Her research interests comprise sustainable development, ecological environment and natural resource utilization. Her main interest is to study the application of night light remote sensing in energy and economy.

Du Quanda is a graduate student in the school of Earth Sciences, Yunnan University. His professional background is regional economics, and his research direction is regional economic policy and land space planning. He has interdisciplinary background of economics and geography. At present, the main focus is regional high-quality development and regional coordinated development.

Ding Jieyu will go to school of resource and environmental sciences of Wuhan University to study for master's degree in 2020. She is working on application of night light remote sensing in the fields of economics, power generation, energy and sustainability issues, etc.

Luan Guize is a graduate student of the school of Earth Sciences, Yunnan University. He majors in cartography and Geographic Information System. His research interests geospatial data analysis and Geographic information data mining.

Xie Zhiqiang is a professorate senior engineer. He holds a Ph.D. in Mapping and Geographic Information Systems. He has successively worked in Yunnan Mapping Institute, Kunming surveying and Mapping Research Institute and Kunming urban underground space planning and management office. Published 50 papers in different fields, of which 2 were retrieved by SCI. The main research directions are cartographic theory, geographic information visualization in the field of resources and environment, the informationization of underground space (pipeline).