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The Indicators of Construction Land Suitability Assessment (CLSA) for Quality of Rural Life (QRL) in Mountain Areas

Zhu Xiongbin[1,2,*], Sucharita Srirangam[1] & Tamilsalvi Mari[1]

[1]*School of Architecture Building and Design, Taylor's University, Malaysia*
[2]*School of Civil Engineering, Liupanshui Normal University, China*

* 651535742@qq.com

The global mountains cover about 1/4 of the surface, more than half of the population depends on water from mountain areass. Therefore, the construction of mountain areass is related to the global well-being. However, with the rapid expansion of rural construction land and unreasonable land layout, the ecological environment in mountain areass is deteriorating, and it has seriously affected the Quality of Rural Life (QRL). Construction Land Suitability Assessment (CLSA) is the premise of land selection and rational use. Although the research domain on CLSA has made significant progress in plain and urban areas, there is seldom work done for mountainous and rural areas, especially the factors affecting CLSA. Due to climate, terrain, cultural differences, the assessment factors must varied from plain areas. Therefore, the research aims to identifying the factors that affect the suitability of construction land and determining the indicators of CLSA from the perspective of improving QRL in mountain areass. Based on the theory of physical determinism, under the guidance of location theory and sustainable development theory, the study make a hypothesis that the QRL is affected by the spatial location indicators of villages. With document analysis method and theoretical research method to verify the relationship between CLSA and QRL, and deduced the 7 indicators (slope, slope direction, distance from water source, width of routes, distance from city, distance from cultivated land and aggregation degree of rural residential areas) for CLSA based on QRL in mountainous and rural areas. The outcomes can be developed as a toolkit for site selection of rural construction land. Finally, it is expected to mitigate the issues of the low QRL caused by a lack of rational land layout guidance and guide rational development and coordinate the contradiction between population growth and land resources shortage in mountain areas, and realize sustainable development of rural areas.

Keywords: Rural and mountain areas; Quality of rural life; Construction land suitability assessment; Assessment indicators

1. INTRODUCTION

In the face of globalisation, climate change, food security and development inequality, agricultural security, and unreasonable rural land development have swept developing and developed countries. As an essential basis for sustainable development, rational land use is a crucial research focus from regional to global. Improving land-use efficiency, alleviating the contradiction between man and land, and improving farmers' quality of life is essential to the world. Realising the importance of land resources engineering, the International Geographical Union Commission on Agricultural Geography and Land Engineering (IGU-AGLE) was formally established in December 2016. The commission aims to build an international platform to strengthen academic exchanges, promote international cooperation, and comprehensively advance the new pattern of global rural development and land capacity building. The inaugural IGU-AGLE Commission Conference on Global Rural Development and Land Capacity Building was successfully held on 26th-29th August 2017 in Yulin, China. The "global rural plan" proposed by the conference recommended that geographers should take positive action and provide suggestions for the effective implementation of rural revitalisation plans, mobilise resources to support villages in the least developed countries, and seek solutions for rural rehabilitation and sustainable development (Yang et al. 2018).

The global mountains cover about 1 / 4 of the surface, nearly one billion people live in mountain areass, and more than half of the population depends on water from mountain areass (Messerli et al. 2004). With the rapid development of the social economy and the acceleration of urbanisation, the demand for urban and rural construction land has increased significantly, and the land scale has expanded rapidly. In the process of spatial expansion and internal reconstruction of urban and rural construction land, there is often disorderly construction, blind expansion, inefficient development, scattered layout and occupation of cultivated land and forest land, which not only leads to inefficient development to the deterioration of the ecological environment but also lays a hidden danger for the sustainable use of land (Bi, A.P., 2014). Promoting urban-rural integration, maintaining rural livelihood stability, and upgrading Quality of Rural Life(QRL) have swiftly become societal focal points and research hotspots.

Countries have conducted a considerable number of suitability assessments of building land in urban and rural land planning and utilisation to alleviate the contradiction between man and land, protect the natural environment, and realise the rational and sustainable use of land. Construction Land Suitability Assessment (CLSA) is widely used in academic circles and the field of design and engineering. In the evaluation process, selecting evaluation indicators, constructing the index system and setting weight are the most key.

2. METHODOLOGY

This study adopts the three-phase methodological approach of PRISMA-2020 (Preferred Reporting Items for Systematic reviews and Meta-Analyses 2020) to conduct a systematic literature review (Page et al. 2021). That is, planning (including defining information sources; determining eligibility criteria; defining search strategies), discrimination (including specifying data management methods; determining selection process; developing data collection process; confirming data items; classifying and classifying), classification and summary (including determining deviation risk in individual research; conducting result analysis and discussion).

The first stage is planning. At this stage, the research objectives, keywords and inclusion and exclusion criteria were determined. The purpose of this study is to determine the CLSA evaluation index based on QRL. The papers used in this study are journal articles that can be searched through CNKI, Google Scholar and Scopus. In addition, the inclusion criteria also included books related to the research objectives edited in English. This study uses "land suitability evaluation" and "quality of life" as keywords to search, including relevant papers used in the title, abstract and keywords of the article. The search time was from January 1950 to January 2022. The search results are shown in Table 1. A total of 279 articles were retrieved (including 138 on CLSA and 141 on QRL) in Scopus, CNKI and Google Scholar platforms, Including 79 conference papers, 183 journal papers, and 17 books, and 37.6% of them were published after 2017(as shown in Table 1).

The second stage is discrimination. In this step, 27 duplicate papers on three search platforms and 18 papers that cannot provide full-text online were excluded, leaving 234 papers. After that, 65 articles on the suitability evaluation of agricultural production land and 71 articles on the quality of life of patients and special groups were excluded after browsing the specific contents of the articles, and 98 papers remained (including 51 papers on the suitability evaluation of construction land and 47 papers on the quality of life of urban and rural areas).

Table 1 Statistical table of systematic literature review

Theme	Source	Number				Type		
		Total	After 2017	2000-2017	Before 2000	Conference paper	Journal paper	Book
Quality of life	SCOPUS, CNKI, Google Scholar	141	42	41	57	41	92	8
Land suitability assessment	SCOPUS, CNKI, Google Scholar	138	63	39	36	38	91	9
Total		279	105	80	93	79	183	17

CNKI: China National Knowledge Infrastructure

The third stage is classification and summary. In this step, this study compares the similarities and differences of indicators adopted by scholars in various countries in CLSA and QRL, and puts forward the problems and defects in the existing indicators in combination with the characteristics of rural and mountain areass. Finally, through correlation analysis and comparative research, the indicators of CLSA based on QRL is determined.

3. FINDING

3.1. Construction land suitability assessment(CLSA)

CLSA is to meet the requirements of urban and rural development and conduct a comprehensive quality assessment on the natural environmental conditions that may be used as land for urban and rural development, as well as the possibility and economy of engineering technology, to determine the construction suitability of land and provide a basis for the rational selection of land for urban and rural development. Construction land suitability assessment is a specific application field of land suitability assessment. Different land-uses have different requirements for land quality.

3.1.1. Development of CLSA

Since The Athens Charter was issued in 1933, which had a far-reaching impact on planning, had the content to guide the selection of construction land, and proposed that the suitability of land should be discussed with the specific purpose and nature as the goal to determine the land selection of urban planning. At the beginning of land-use evaluation research, the research purpose is mainly for agricultural production (Bai et al. 2021). Comprehensively analyzing optical and polarimetric SAR features for land-use/land-cover classification and urban vegetation extraction in highly-dense urban area. International Journal of Applied Earth Observation and Geoinformation, 103, 102496.. The world’s first landmark land-use evaluation standard belongs to the land potential classification system issued by the Soil Conservation Bureau of the U.S (Gad, A.-A. 2015). Department of agriculture in 1961 to improve agricultural production. In 1969, Mcharg of the United States first put forward the concept of land suitability analysis that will have a far-reaching impact on the future. In 1969, the British soil survey issued the land-use potential classification system applicable to the U.K, which has a more accurate and detailed definition of land quality than the previous standards issued by the United States (Mary Silpa and Nowshaja, 2016). In the 1970s, the research on land-use evaluation began to change qualitatively, and the purpose of evaluation began to change from single-use to various special uses.

The year 1976 was a milestone year, the Food and Agriculture Organization of the United Nations (FAO) issued the outline of land evaluation, which defined land suitability assessment as the process of estimating the characteristics of land when it is used for particular purposes, and formally put forward the method of land suitability classification and a complete evaluation system. The suitability criterion based on multi-foundation and multi-index synthesis has gradually taken shape. With the acceleration of research progress, subjective judgment can no longer meet the scientific requirements of land-use evaluation. Scholars began to study the quantitative analysis means of natural geographical elements to enrich the connotation of land-use evaluation. The evaluation of construction land has experienced a long time of development and research and has been maturing with the continuous practice and exploration of urban planning (De Feudis et al. 2021).

In the approach of CLSA, the development of science and technology makes 3S technology widely used in land evaluation, especially bringing a qualitative leap to land suitability assessment. Its powerful function in data acquisition, processing and analysis not only greatly improves the work efficiency but also makes it possible to conduct investigation and evaluation based on a wide range, evaluation is more comprehensive, quantitative, and intelligent, and its application fields are more and more extensive. In terms of evaluation methods, it tends to use mathematical methods to quantify the evaluation indicators, which effectively avoids the subjective conclusions caused by relying solely on expert experience. The combination of qualitative and quantitative greatly improves the accuracy of urban construction land suitability assessment.

3.1.2. Policy formulation on CLSA in China

CLSA has gone through three processes in China. Early term (1986-2000): from the perspective of urban development, it is a development oriented pressure assessment, focusing on the bearing capacity of single elements such as land resources, water resources, atmospheric environment and soil; Medium term (2000-2018): from the dynamic perspective of the interaction between human activities and environment change, emphasize the comprehensive carrying capacity of the region, and achieve effective feedback and regulation of human activities by evaluating whether natural resources are overloaded; At this stage (after 2018): from the perspective of maintaining ecosystem health, highlight the inherent system characteristics of resources and environment, and emphasize the extensional functional evaluation based on system characteristics(as shown in Table 2).

Table 2: Time table of relevant policies formulation on CLSA in China

Year	Policy	Guideline And standard
1986		Technical regulations for county level land evaluation for urban
1999	Put forward the strategy of Western Development	
2009		the evaluation standard for urban and rural land (cjj132)
2013	Decision of the CPC Central Committee on several major issues concerning comprehensively deepening reform to establish a spatial planning system	
2015		The general plan for the reform of ecological civilization system establishes a land space development and protection system
2017	Rural Revitalization strategy proposed in the report of the 19th National Congress of the Communist Party of China	
2019	Several opinions on establishing a land spatial planning system and supervising (No. 18)	
2020		Guidelines for evaluation of resource and environmental carrying capacity and land spatial development suitability (No. 127)

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3.1.3. The indicators for CLSA

Indicator is the concept of explaining the overall quantitative characteristics and the synthesis of its values, so it is also called a comprehensive index. In the actual statistical work and statistical theory research, the concept of explaining the overall quantitative characteristics is often directly called indicators [9]. A complete indicator is generally composed of index name and index value, which reflects the characteristics of material and quantity (Habibie, M. I., et al. 2020). . CLSA is a specific application field of land suitability assessment. Different land-uses have different requirements for land quality. The requirements for land quality of construction land are mainly topographical and geological conditions but are also affected by transportation, location, social economy, ecology, policy, culture, etc (Chen-jing, F. A. N., et al. 2011). The differences are mainly reflected in the evaluation purpose and the construction of the index system. Even for the same construction land suitability assessment, there are significant differences in the selection of evaluation indexes due to different evaluation purposes, emphases and angles.

In order to find out the common indicators for CLSA, this paper makes statistics and comparison on 12 top cited papers in the past 10 years. From Table 3 we can see that the main assessment factors include manmade indicators and Natural indicators. Manmade indicators mainly include distance to urban and town, access radius of primary schools, accessibility to public amenities, distance to haighway intersection, distance from public transportation, etc. Natural indicators are mainly include elevation, slop, Terrain, slop direction (as shown in Table 3). Due to different land-uses and evaluation standards, the selection of indicators also changes at different times and places, espatially in mountain areass, after long-term development, the land that is easy to develop continues to decrease, land resources are scarce. In this case, the contradiction between land demand, land supply, cultivated land protection and ecological environment protection is increasingly prominent. At the same time, the role and function of rural areas are more as the basis of ecological stability, agricultural production base, mode of rural life style and carrier of rural consciousness culture, the convenience of agricultural production and the improvement of the quality of life should be fully considered in the evaluation of land suitability in mountain areass. Therefore, the indicators for CLSA in mountain areass should include the following 8 themes: elevation, slope, topographic height difference, water supply accessibility, traffic accessibility, public service accessibility, distance from work place and building density.

3.2 Quality of Rural Life

3.2.1. Development of QRL

The term ″quality of life″ (QOL) was first put forward by Galbraith in《The Affluent Society》, and its evaluation criteria mainly include self-realisation, inner satisfaction, and social life satisfaction (Galbraith, 1958). To obtain considerable and comprehensive evaluation results, many calculation and evaluation indicators have been adopted by many scholars. For example, Canada and the United States have fully considered personal feelings and evaluated the quality of life through satisfaction, wellbeing, and other subjective factors (Mccrea et al. 2011). On the contrary, Europe pays more attention to the evaluation of objective factors that meet peopleʹs needs, such as the quality of the ecological environment, the level of public service facilities and social cohesion (Knight and Gunatilaka. 2010). In recent years, more and more objective indicators and subjective indicators have been combined, such as the availability of healthcare, education,

Table 3: The theoretical framework for factors of CLSA

	Natural indicators			Man-made indicators				
Themes	**Elevation**	**Slope**	**Topographic height difference**	**Distance from work place**	**public service accessibility**	**water supply accessibility**	**traffic accessibility**	**Building density**
(Chen-jing, Shi-guang et al. 2011)	Elevation	Slope	Topography		Distance to urban and town	Distance to tributary	Distance to Highway Intersection	Built-up area
(Javadian, Shamskooshki et al. 2011)		Slope direction			Access radius of primary schools		Width of routes	Ppopulation density
(Bathrellos, Skilodimou et al. 2017)	Elevation					Distance from streams	Distance from roads	
(Tian, Kong et al. 2018)			Terrain	Cultivated land accessibility	Serving areas of daily life circles	Access to water body	Accessibility of rural settlements to main road	
(Habibie, Noguchi et al. 2020)	Elevation	Slope				Distance from river	Distance from road	
(Ustaoglu and Aydınoglu 2020)	Elevation	Slope		Distance from industry/ commerce	Blue and green amenities	Distance from water sources	Distance from metro stops	
(Dong, Ge et al. 2021)		Slope	Geological hazard susceptibility		Distance to city		Distance to main road	Aggregation degree of rural residential areas
(Dong 2021)	Elevation	Slope	Slop direction					
(Tarmidi, Maimun et al. 2022)				Mobility distance from the workplace	Healthcare and education facility		Distance from public transportation	
(Wu, Luo et al. 2022)	Elevation	Slope		Distance to center of administration		Distance to rivers	Distance to railway	Population density
(Bamrungkhul and Tanaka 2022)			Topography		Accessibility to public amenities		Accessibility to transportations	Population
(Velumani, Priyadharshini et al. 2022)				Distance to Industries	Distance to Educational Institution		Distance to Access Transport	

economic opportunities, environmental conditions, human pressure, the accessibility of the areas (Boncinelli et al. 2015), and the individual perceptions concerning economic condition, security, environmental quality, and educational opportunities (Leonardo Casini. 2021).

Some studies show that the choice of residential land is closely related to residents′ quality of life. For example, in 2016, Chen and Cerin analysed the characteristics of urban land-use and compared the urban life quality of different cities and their communities based on GIS as a simple, direct and objective method (Chen et al. 2016). Xiong and Zhang used the data collected from 539 young people in Japanese cities in 2010 to estimate the structural equation model. They found that youths living in compact, mixed, and bus-oriented cities such as Tokyo, Nagoya and Osaka are happier and more satisfied with their lives (Xiong and Zhang. 2016). In 2021, Li and Managi studied the relationship between spatial background, land cover, and human wellbeing. They found that urban land, water, and grassland were positively correlated with human wellbeing, while bare land in Japan was negatively correlated with human wellbeing (Li and Managi. 2021). In previous studies, the perspectives of CLSA tend to be diversified, and the rational layout and optimisation of rural settlements have achieved fruitful research results, which provides a reference for the layout and optimisation of settlements. Still, there are few studies based on the QRL perspective.

3.2.2. The indicators for QRL

The QOL is affected by many complex factors, such as psychological state, cognitive level, physical health, environmental adaptability, ideology, social, interpersonal relationship, etc. It reflects individuals′understanding and evaluation of themselves in their cultural and social background and their relationship with personal goals, life attitudes and values (Shi et al. 2021). The quality of life has become the focus of many research fields, including geography, economics, sociology, medicine, psychology, and city planning. and the corresponding evaluation indicators have been proposed by different scholars. In recent years, more and more studies have been devoted to the evaluation of the quality of life, but different people have different requirements for quality of life, so the indicators of QRL is multifaceted and uncertain. In order to find out the common indicators for QRL, this paper makes statistics and comparison on 8 top cited papers in recent 10 years.

From the Table 4 we can see that the evaluation indicators for QRL can be divided into subjective indicators and objective indicators. The subjective indicators mainly include psychological and physical health, social interactions, human pressure, vulnerabilities and other indicators. Objective indicators mainly include quality of environment, harmless treatment rate, per capita disposable income, availability of healthcare and education, and other indicators (as shown in Table 4). The evaluation of urban life quality pays more attention to the evaluation of objective living conditions, while rural areas tend to evaluate farmers’ subjective consciousness. Due to the living habits and lifestyles in rural areas are different from those in cities, the evaluation of the quality of life in rural areas is different from those in cities. With the narrowing of the gap between urban and rural areas, the material living conditions in rural areas have reached a certain level, the evaluation indicators of QRL should fully consider the role of subjective indicators. The evaluation indicators for QRL should be adjusted according to the characteristics of rural areas. The Wellbeing should be adjusted to Satisfaction with living in the village, the Spiritual life should be adjusted to Cultural activities. Therefore, The indicators for QRL should include the following 8 themes: wellbeing, spiritual life, public service, job opportunities, infrastructure conditions, income, environment, life expectancy.

Table 4: The theoretical framework for indicators of quality of life

	Subjective indicators			Objective indicators				
Themes	**Wellbeing**	**Spiritual life**	**Public service**	**Job opportunities**	**Infrastructure conditions**	**Income**	**Environment**	**Life expectancy**
(Bérenger and Verdier-Chouchane 2007)	Material well-being		Quality of education				Quality of environment	Life expectancy
(Boncinelli, Pagnotta et al. 2015)		Human pressure	Availability of healthcare and education	Economic opportunities	Accessibility of the areas		Environmental conditions	
(Bhatti, Tripathi et al. 2017)	Psychological and physical health	Social relationships	Access to services		Access to facilities	Economic condition	Environment	
(Biagi, Ladu et al. 2018)		Social interactions	Education	Employment		Income	Environmental amenities	
(Ma, Liu et al. 2020)			Public services			Per capita disposable income	Harmless treatment rate of pollutants	
(Fang, Ma et al. 2020)	Satisfaction with living	Cultural activities	Public services and social security		Infrastructure	Income and expenditure	Ecological environment	
(Shi, Zhu et al. 2021)			Number of buses and theatres		Road density	Month income	Annual mean concentration of PM2.5	
(Viccaro, Romano et al. 2021)	Economic wellbeing	Social relationships and vulnerabilities	Mobility and quality of services	Work	Mobility and quality of services		Environment	

3.3. The relationship between CLSA and QRL

The location of rural land is closely related to the QRL. For example, in the study of spatial differentiation of rural quality of life based on natural control factors in Gansu Province, China, Fang Fang found that QRL in Gansu Province is characterised by spatial heterogeneity and agglomeration, altitude, slope, precipitation, and distance to the provincial capital are the natural controlling factors of spatial differentiation of QRL in Gansu Province (Zou et al. 2020). Therefore, the QRL of rural residential areas in mountain areass is affected by natural, social, economic and environmental factors. Generally, in places with flat terrain, close to water sources, good economic conditions, convenient transportation and relatively concentrated population, the QRL of villages is usually high; However, in areas with frequent geological disasters, backward economy, weak living service facilities, inconvenient transportation, scattered and small villages, the QRL of villages is low. In order to determine the spatial location indicators that affect QRL, this paper analyzes the correlation between 9 common indicators of QRL and 8 common indicators of CLSA.

As can be seen from Table 5, as an indicator of CLSA, except that altitude has no correlation with indicators of QRL, there are relevant research results show that the slope has a direct impact on the infrastructure conditions, slope direction has a direct impact on satisfaction with living in the village and harmless treatment rate of pollutants, distance from water source has a direct impact on infrastructure conditions and satisfaction with living in the village, width of routes has a direct impact on cultural activities and public service, distance from city has a direct impact on employment and income, distance from cultivated land has a direct impact on infrastructure conditions and income, aggregation degree of rural residential areas has a direct impact on cultural activities and income. in general except elevation, the remaining 7 indicators (slope, slope direction, distance from water source, width of routes, distance from city, distance from cultivated land and aggregation degree of rural residential areas) are relevant with the 8 common indicators of QRL.

4. DISCUSSION

Mountain areass have highly recognisable geographical and geomorphic features and a natural ecological environment. Compared with plain cities and towns with good land-use conditions, the geological conditions, geomorphic conditions, meteorological and climatic conditions and hydrological conditions of mountain areass are complex, the ecological environment is fragile, and the land-use conditions are poor (Sapkota., 2018). This particularity has excellent resistance to the selection of development land in the mountain construction process, It determines that mountain construction needs more financial resources and higher technical supportr (Fuquan et al., 2009). Theoretically, the main factor affecting the suitability difference of construction land between mountainous and plain areas is the difference in physical and geographical conditions (Al-Masaeid., 1997).

In evaluating construction land in mountain areass, the importance of physical and geographical conditions is often higher than other influencing factors, and the impact on the evaluation results is dominant. In the construction of mountain areass, unique and diversified natural conditions are often the leading factors affecting the land-use evaluation results, such as slope, geological disasters, active faults, karst collapse, mine occupied land, ecological protection red line, permanent bare farmland, current land type, geography and traffic location are often essential factors determining the suitability of urban and rural construction land in karst mountain areass Karst collapse, ecological protection red line and permanent basic farmland are the key factors restricting urban and rural construction and development.

Compared with cities and towns, the particularity of village construction land conditions is mainly reflected in that the suitability assessment indicators are often more micro and detailed, and the impact of social economy on suitability is relatively more significant (Changming et al. 2001). Different villages should also have different representative indicators. For example, compared with cities

Table 5: Correlation matrix for indicators of QRL and CLSA

	Indicators of CLSA							
Indicators of QRL	**Elevation**	**Slope**	**Slope direction**	**Distance from water source**	**Width of routes**	**Distance from city**	**Distance from cultivated land**	**Aggregation degree of rural residential areas**
Satisfaction with living in the village			Correlation(Fordham 2018)	Correlation(Arku 2010)	Correlation(NAKAMAKI 2002)			
Cultural activities					Correlation(Steyn, Nokes et al. 2015)			Correlation(MOIDFAR and AKBARI 2007)
Public service					Correlation(Van de Walle 2002)	Correlation(Hlalele 2012)		Correlation(Birch 2014)
Employment						Correlation(Lagakos 2020)		
Income					Correlation(Van de Walle 2002)	Correlation(d'Acci 2019)	Correlation(Tian, Yang et al. 2007)	Correlation(Liu, Zhang et al. 2020)
Infrastructure conditions		Correlation(She, Shen et al. 2018)		Correlation(Orabone 2008)	Correlation(Shrestha and Routray 2001)	Correlation(Sovová and Krylová 2019)	Correlation(Birch 2014)	Correlation(Gao, Chen et al. 2007)
Harmless treatment rate of pollutants			Correlation(Sapkota 2018)	Correlation(Fuquan, Guodong et al. 2009)				Correlation(Al-Masaeid 1997)
Life expectancy				Correlation(Changming, Jingjie et al. 2001)				

and towns, village development needs to rely more on the surrounding growth pole, and the growth pole affecting village development can be refined to cities, towns, central villages, and other levels.

The impact of traffic on village development can also be refined to different levels such as Township Road, county road, provincial road and National Road (Gao et al. 2007). Since different villages are in different environments, the indicators under specific environments must be carefully considered according to local conditions. As this paper only compares and evaluates the suitability of land which is available for construction, it does not consider policy factors and some factors that can directly overturn the feasibility of construction land, such as the distance from high-voltage power grid, farmland protection, vegetation protection, water area protection, geological disasters, ecological protection red line and so on.

It can be seen from the previous analysis: except elevation, other indicators such as slope, topography, water supply accessibility, traffic accessibility, public service accessibility, distance from work place and population density significantly impact land use, and it should be adjusted according to the characteristics of mountain areas.

4.1. Natural factors

(1) Elevation: Elevation refers to the vertical distance between a point and the absolute base—the greater the elevation value, the greater the development difficulty. From the table 4, it can be seen that elevation is not related to QRL, so it should be excluded from the factors for CLSA.

(2) Slope: The slope is the ratio of the vertical height of the slope to the horizontal distance, indicating the surface's degree of land slowness. The greater the slope, the greater the difficulty of development, and the weaker the stability and safety of the foundation. Same. The digital elevation model generated by GIS software can be used to extract the slope and make statistics on the slope data.

(3) Topography: the orientation of the mountain and slop derection of land have an effect on the sunshine hours and solar radiation intensity. For example, in the northern hemisphere, the radiation income is the most on the south slope, followed by the southeast slope and the southwest slope, and the least on the north slope. In cold plateaus and mountain areass, residential buildings have specific requirements for sunshine time, so this research take the slope direction to replace the topography in land selection of residential areas.

4.2. Man-made factors

(1) Distance from work place: In rural, it is refers to the distance from the residential area to the agricultural operation area. According to the existing investigation and research, it is found that the demand for cultivation radius varies in different regions, but the most suitable cultivation radius is 1 meter, and the cultivation radius will not exceed 1 kilometre. Although the mechanised farming mode continues to develop, the research area is mainly dominated by traditional farming methods, and the transportation is mainly on foot. So this research take the proportion of cultivated land with a slope of fewer than 25 degrees within 1 kilometre radius around the plot as the measured value.

(2) Public services accessibility: In rural areas, public service accessibility mainly depends on the distance from the market, hospital and primary school. due to the most of public service locate in town, the town will have varying degrees of impact on the scale and scope of the surrounding land layout and then play a role in the development of the surrounding areas. The closer they are to the town, the lower the construction cost and the higher the development and living standards. therefore, for rural residential land, the degree of impact of towns is closely related to the distance from the town.

(3) Water supply accessibility: it is determined by the distance between the plot and the water source. Most domestic water in rural areas originates from rivers and groundwater. Due to limited data access, this study uses reservoirs or rivers as the data source for water supply accessibility analysis. For rural residential land, the accessibility of water supply is closely related to the distance from the river.

(4) Traffic accessibility: it mainly refers to the distance from the main traffic arteries. The closer the area is to the traffic arteries, the more convenient the production and life are and the lower the costs are. Combined with the situation in rural areas, the distance from township roads should be taken as the evaluation factor.

Population density: it is the quantitative distribution of rural population in a particular area on its unit land area. It can reflect the density of the rural population in a certain region and show the population distribution between different regions. The higher the degree of aggregation, the more suitable for the utilisation and layout of rural residential land. To facilitate statistics and calculation, this research use the population density within 1 kilometre radius around the plot as the measurement value

5. CONCLUSION

The transformation of rural residential areas should pay attention to meeting the daily needs of farmers, which has been ignored in the current research. Farmers have different preferences in choosing living places and carrying out daily activities. This preference reflects the relationship between farmers and their living environment, which affects their willingness to relocate to rural settlements. Therefore, bringing the QRL into the suitability assessment index system of rural construction land is significant to improve the strategies or guidelines for policymakers, and mitigate the issues of the low quality of inhabited rural environments caused by a lack of rational land layout guidance. Therefore, the indicators of CLSA for QRL in mountain areas are: slope, slope direction, proportion of cultivated land with a slope of fewer than 25 degrees within 1 kilometre radius around the plot, distance from the town, distance from the river, distance from township roads, population density within 1 kilometre radius around the plot(as shown in the Table 6).

Table 6 The indicators of CLSA for QRL in mountain areas

Factor layer	Indicators layer
Natural factors	slope
	Slope direction
Man-made factors	proportion of cultivated land with a slope of fewer than 25 degrees within 1 kilometre radius around the plot
	distance from the town
	distance from the river
	distance from township roads
	population density within 1 kilometre radius around the plot

6. REFERENCES

Al-Masaeid, H. R. J. C. J. o. C. E. (1997). Impact of pavement condition on rural road accidents. 24(4), 523-531.

Arku, F. S. J. P. i. D. s. (2010). Time savings from easy access to clean water: Implications for rural men's and women's well-being. 10(3), 233-246.

Bamrungkhul, S., & Tanaka, T. (2022). The assessment of land suitability for urban development in the anticipated rapid urbanization area from the Belt and Road Initiative: A case study of Nong Khai City, Thailand. Sustainable Cities and Society, 83, 103988.

Bathrellos, G. D., Skilodimou, H. D., Chousianitis, K., Youssef, A. M., & Pradhan, B. (2017). Suitability estimation for urban development using multi-hazard assessment map. Science of The Total Environment, 575, 119-134.

Bérenger, V., & Verdier-Chouchane, A. J. W. D. (2007). Multidimensional measures of well-being: Standard of living and quality of life across countries. 35(7), 1259-1276.

Bhatti, S. S., Tripathi, N. K., Nagai, M., & Nitivattananon, V. J. S. i. r. (2017). Spatial interrelationships of quality of life with land use/land cover, demography and urbanization. 132(3), 1193-1216.

Biagi, B., Ladu, M. G., & Meleddu, M. J. E. E. (2018). Urban quality of life and capabilities: An experimental study. 150, 137-152. Bi, A.P., 2014. Research progresses of rural regional-system degradation. Chin. Agric. Sci.Bull. 30, 112–116.

Birch, J. (2014). Between villages and cities: settlement aggregation in cross-cultural perspective. In From Prehistoric Villages to Cities (pp. 15-36): Routledge.

Boncinelli, F., Pagnotta, G., Riccioli, F., Casini, L. J. R. o. U., & Studies, R. D. (2015). The determinants of quality of life in rural areas from a geographic perspective: The case of Tuscany. 27(2), 104-117.

Changming, L., Jingjie, Y., & Kendy, E. J. W. i. (2001). Groundwater exploitation and its impact on the environment in the North China Plain. 26(2), 265-272.

Chen-jing, F. A. N., Shi-guang, S., Si-hui, W., Guang-hui, S. H. E., & Xin-yi, W. (2011). Research on Urban Land Ecological Suitability Evaluation Based on Gravity-Resistance Model: A Case of Deyang City in China. Procedia Engineering, 21, 676-685.

Chen, S., Cerin, E., Stimson, R., & Lai, P. C. (2016). An Objective Measure to Assessing Urban Quality of Life based on Land Use Characteristics. Procedia Environmental Sciences, 36, 50-53

d'Acci, L. J. C. (2019). Quality of urban area, distance from city centre, and housing value. Case study on real estate values in Turin. 91, 71-92.

De Feudis, Mauro Falsone, Gloria Gherardi, Massimo Speranza, Maria Vianello, Gilmo Vittori, & Livia, A. (2021). GIS-based soil maps as tools to evaluate land capability and suitability in a coastal reclaimed area (Ravenna, northern Italy). International Soil and Water Conservation Research, 9(2), 167-179.

Dong, G., Ge, Y., Jia, H., Sun, C., & Pan, S. J. L. (2021). Land use multi-suitability, land resource scarcity and diversity of human needs: A new framework for land use conflict identification. 10(10), 1003.

Dong, X. (2021). Village planning based on GIS land suitability--A case study of Longfenggou Village in Hebei Province. Paper presented at the IOP Conference Series: Earth and Environmental Science.

Fang, F., Ma, L., Fan, H., Che, X., & Chen, M. J. J. o. e. m. (2020). The spatial differentiation of quality of rural life based on natural controlling factors: A case study of Gansu Province, China. 264, 110439.

Fordham, C. (2018). Solar design For Wellbeing and Expression: Louis Kahn's Psychiatric Hospital Addition. Paper presented at the ARCC Conference Repository.

Fuquan, N., Guodong, L., Huazhun, R., Shangchuan, Y., Jian, Y., Xiuyuan, L., . . . Protection. (2009). Health risk assessment on rural drinking water safety—A case study in Rain City District of Ya'an City of Sichuan Province. 2009.

Gad, A.-A. (2015). Land capability classification of some western desert Oases, Egypt, using remote sensing and GIS. The Egyptian Journal of Remote Sensing and Space Science, 18(1, Supplement 1), S9-S18.

Gao, Y., Chen, G., & Shen, M. J. W. U. J. o. N. S. (2007). Scattered rural settlements and development of mountainous regions in western sichuan, china. 12(4), 737-742.

Habibie, M. I., Noguchi, R., Matsushita, S., & Ahamed, T. (2020). Development of micro-level classifiers from land suitability analysis for drought-prone areas in Indonesia. Remote Sensing Applications: Society and Environment, 20, 100421.

Hlalele, D. J. P. i. E. (2012). Social justice and rural education in South Africa. 30(1), 111-118.

Javadian, M., Shamskooshki, H., & Momeni, M. (2011). Application of Sustainable Urban Development in Environmental Suitability Analysis of Educational Land Use by Using Ahp and Gis in Tehran. Procedia Engineering, 21, 72-80.

Knight, J., Gunatilaka, R., 2010. The rural-Urban divide in China: income but not happiness? J. Dev. Stud. 46 (3), 506-534

Lagakos, D. J. J. o. E. p. (2020). Urban-rural gaps in the developing world: Does internal migration offer opportunities? , 34(3), 174-192.

Leonardo Casini., (2021). Evaluating rural viability and well-being: Evidence from marginal areas in Tuscany, Journal of Rural Studies, 82, 64-75.

Liu, M., Zhang, Q., Gao, S., & Huang, J. J. J. o. R. S. (2020). The spatial aggregation of rural e-commerce in China: An empirical investigation into Taobao Villages. 80, 403-417.

Ma, L., Liu, S., Fang, F., Che, X., Chen, M. J. S. C., & Society. (2020). Evaluation of urban-rural difference and integration based on quality of life. 54, 101877.

Mary Silpa, T. J., & Nowshaja, P. T. (2016). Land Capability Classification of Ollukara Block Panchayat Using GIS. Procedia Technology, 24, 303-308.

Mccrea, R., Marans, R.W., Stimson, R., Western, J., 2011. Subjective measurement of quality of life using primary data collection and the analysis of survey data. Soc. Indicat. Res. 44, 55–75

Messerli, B., D. Viviroli and R. Weingartner (2004). "Mountains of the World: Vulnerable Water Towers for the 21st Century." Ambio: 29-34

MOIDFAR, S., & AKBARI, S. (2007). CITY–RURAL RELATIONS AND ITS DEVELOPMENTAL EFFECTS, THE CASE STUDY OF SAVUJBULGH.

NAKAMAKI, T. J. G. R. o. J. (2002). A Geographic Study of the Modernization of Transportation and Changes in Mountainous Villages: A Case of Takayama Area, Fujioka-shi, Gunma Prefecture. 75(7), 492-507.

Oraboune, S. (2008). Infrastructure (rural road) development and poverty alleviation in Lao PDR.

Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; (2021). The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. Syst. Rev. 2021, 10, 89.

Sapkota, J. B. J. D. i. P. (2018). Access to infrastructure and human well-being: Evidence from rural Nepal. 28(2), 182-194.

Sapkota, J.B.J.D.i.P., (2018). Access to infrastructure and human well-being: Evidence from rural Nepal.28(2): p. 182-194.

She, Y., Shen, L., Jiao, L., Zuo, J., Tam, V. W., & Yan, H. J. H. I. (2018). Constraints to achieve infrastructure sustainability for mountainous townships in China. 73, 65-78.

Shi, T., Zhu, W., & Fu, S. J. C. E. R. (2021). Quality of life in Chinese cities. 69, 101682.

Shrestha, C., & Routray, J. (2001). Application of settlement interaction based rural road network model in Nawalparasi district of Nepal. Paper presented at the First Road Transportation Technology Transfer Conference in AfricaTanzania Ministry of Works.

Sovová, L., & Krylová, R. J. M. G. R. (2019). The countryside in the city? Rural-urban dynamics in allotment gardens in Brno, Czech Republic. 27(2), 108-121.

Steyn, W. v., Nokes, B., Du Plessis, L., Agacer, R., Burmas, N., & Popescu, L. J. T. r. r. (2015). Evaluation of the effect of rural road condition on agricultural produce transportation. 2473(1), 33-41.

Tarmidi, Z., Maimun, N. H. A., Hassan, N., Nasir, A. N. M., Sidek, A., & Che'Ya, N. N. (2022). Assessing the Suitability of Affordable Housing Based on Demand Criteria. Paper presented at the IOP Conference Series: Earth and Environmental Science.

Tian, G., Yang, Z., & Zhang, Y. J. E. M. (2007). The spatio-temporal dynamic pattern of rural residential land in China in the 1990s using Landsat TM images and GIS. 40(5), 803-813.

Tian, Y., Kong, X., & Liu, Y. (2018). Combining weighted daily life circles and land suitability for rural settlement reconstruction. Habitat International, 76, 1-9.

Ustaoglu, E., & Aydınoglu, A. C. (2020). Suitability evaluation of urban construction land in Pendik district of Istanbul, Turkey. Land Use Policy, 99, 104783.

Van de Walle, D. J. W. d. (2002). Choosing rural road investments to help reduce poverty. 30(4), 575-589.

Velumani, P., Priyadharshini, B., Mukilan, K., & Shanmugapriya. (2022). A mass appraisal assessment study of land values using spatial analysis and multiple regression analysis model (MRA). Materials Today: Proceedings.

Viccaro, M., Romano, S., Prete, C., & Cozzi, M. J. L. U. P. (2021). Rural planning? An integrated dynamic model for assessing quality of life at a local scale. 111, 105742.

Wu, J., Luo, J., Zhang, H., Qin, S., & Yu, M. (2022). Projections of land use change and habitat quality assessment by coupling climate change and development patterns. Science of The Total Environment, 847, 157491.

Xiong, Y., & Zhang, J. (2016). Effects of land use and transport on young adults' quality of life. Travel Behaviour and Society, 5, 37-47. doi:https://doi.org/10.1016/j.tbs.2015.10.002

Yang, Y., Y. Li, and H.J.J.o.G.S. (2018). Report on the first IGU-AGLE commission conference on global rural development and land capacity building.28(1): p. 124-129.

Zou, L., Y. Liu, J. Yang, S. Yang, Y. Wang and X. J. H. I. Hu (2020). "Quantitative identification and spatial analysis of land use ecological-production-living functions in rural areas on China's southeast coast." 100: 102182.