Application of land ecological environment risk assessment based on SAR image

Wenguang Ji1 · Juanmin Cui1

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Abstract

The ecological environment of land is an important part of the ecosystem. Extracting land ecological environment information is very important to realize environmental change monitoring and sustainable development. In the past, people used surface measurement and optical remote sensing technology to extract land ecological environment information. According to the data measured by the surface survey method, the accuracy is relatively low, and it is difficult to meet the application needs of people. However, because of its own characteristics, optical remote sensing is easy to be disturbed by the weather and cannot extract the land ecological environment information timely and accurately. The development of SAR technology provides a new way to extract land ecological environment information. This technology cannot be affected by cloud, rain, and fog and can be used for all day monitoring of land ecological environment risk assessment. In addition, the full polarimetric SAR image directly opens up a new method of land ecological information extraction. According to Wishart H/α, the classification algorithm extracts the land ecological environment cover information from the full polarimetric SAR image. The classification algorithm is applied to all the polarization data in a certain area, and the coverage information is extracted according to the scattering mechanism of the terrestrial ecological environment. After comparing the extraction accuracy with the optical image, it is found that the land ecological environment coverage information is extracted by different methods under different visual values of multi-view processing. Using error analysis to improve the classification algorithm, improve the accuracy of land eco-environmental cover information extraction, the past accuracy of 54.0% to 81.7%, and the accuracy of 73.1% to 88.0%. Based on the impact of the application of SAR image in land ecological environment risk assessment, a new concept assessment model is established. Through this method, the past evaluation model can be improved.

Keywords SAR image · Land · Ecological environment · Risk evaluation

Introduction

In recent years, with the support of NSFC, 863 project, and other projects, polarimetric SAR data analysis has made great progress in China. However, compared with developed countries, the level of sensor development is low, and polarimetric SAR data sources are insufficient. Therefore, China is still in the early stage of development in land ecological cover information extraction and biomass inversion based on polarimetric SAR and has not achieved epoch-making research results. Based on the understanding of the basic theory of polarimetric SAR, a land ecological cover information extraction algorithm based on fully polarimetric SAR image is established (Kuleli et al. 2011). Then, the algorithm is used to classify the full polarimetric SAR images of the survey area, and the land ecological environment coverage information is extracted according to the scattering characteristics of the land eco-environment. Then, optical data is used to verify the accuracy of the classification algorithm, error analysis and improvement are carried out, and the accuracy of land eco-environmental coverage information extraction is achieved (Kourosh Niya et al. 2013). Then, the inversion algorithm of biomass was established to select the suitable microwave scattering model for the sample training, and the relationship between...
backscattering coefficient and biomass was established according to the inversion algorithm (Kosarev et al. 2012). The inversion of land eco-environmental biomass based on polarimetric SAR data is realized. Finally, the extraction of land ecological environment information based on complex terrain is explored. Complex terrain has serious geometric distortion and radiation distortion, so it is necessary to further study the preprocessing method. Using the above classification algorithm and inversion algorithm, the land ecological environment information of complex terrain can be extracted (Thieler et al. 2009). Ecological risk assessment starts with environmental impact assessment (EIA). EIA refers to the prediction and evaluation of environmental problems in various future periods before human activities. Until the late 1980s, ecological risk assessment methods and techniques gradually appeared, moving towards standardization. However, in the early stage of the study, the harmful effects of pollutants on the ecosystem were mainly predicted based on the theories of chemistry, ecology, and toxicology (Lahijani et al. 2009). With the development of science, the research field of ecological risk is also expanding. In 1992, the United States Environmental Protection Agency first proposed the definition of ecological risk assessment. Evaluate the possible or possible negative ecological impact process after exposure to one or more stress factors (Svitoch and Yanya 2006). At present, in addition to the American model, there are also the Australian model and the European model for ecological risk assessment. Ecological risk assessment in Australia mainly focuses on soil pollution, and the research on ecological risk assessment of soil environmental pollution is relatively mature (Rasuly et al. 2010). The main characteristics of the European model are that it emphasizes the consideration of social opinions and needs, gives priority to prevention, and establishes risk assessment indicators with numerical values to represent allowable risks (Leroy et al. 2009). Ecological risk assessment has a wide range of applications, including many fields, and the corresponding evaluation methods and steps are different.

**Materials and methods**

**Overview of the study area**

The study scope of this article is city a, and 17 shale gas exploration areas and area a of main exploration areas have been selected for shale gas development. The potential ecological risks and potential ecological risks of city a have been analyzed. Meanwhile, the focus of risk planning stage and the variation characteristics of ecological environmental risks of developed and undeveloped areas have been screened.

A city has complex geological structure and high-quality shale (Vinayaraj et al. 2011). A is located in the high steep structural belt to the east of a province and the medium-low stable structural belt to the south. After several periods of structural evolution, high organic matter content, high maturity, good formation conditions of storage layer, and high quality lower Paleozoic shale with certain thickness were accumulated. This is the main shale gas development area in China.

All the strata in a city are exposed in the Quaternary system from the Sinian system except the late Silurian system, Late Devonian system, late coal period, and tertiary system. The Cenozoic strata are distributed in the city, while the Mesozoic strata are mainly distributed in the northwest of the Wansheng line and Wulong line, and generally in the northeast. The karst water resources in this area are rich, about 11.835 billion m³/ A, accounting for 73.65% of the water resources.

The terrain of a city is high in the south, southeast, and northeast and low in the west. The terrain of the territory is obviously controlled by the geological structure, and the direction of the mountain is basically consistent with the tectonic line. Daba Mountain is located in the northeast, Wushan mountain is located in the East, and Wuling Mountain is located in the south, with an altitude of 1000-2500m. In the center and middle of the valley, there are parallel ridges and low hills in the valley. Most of the west is hilly terrain with an altitude of 500-900 meters. The topography of city a includes mountains, hills, and flat terrain (Zuzek et al. 2003). The reservoir covers an area of about 0.2 thousand square kilometers, accounting for 2.4% of the total area.

**Research methods**

**SAR image**

Synthetic aperture radar (SAR) imaging system is a lateral radar system which can realize two-dimensional (range and azimuth) high-resolution image, and it is also an active remote sensing system operating in the microwave band. SAR system usually lies on its side along the flight direction and runs on a mobile platform (aircraft or satellite). At the same time, it receives the microwave signal scattered by ground objects and continuously transmits the microwave pulse to the surface. In short, the SAR imaging system consists of microwave pulse transmitting equipment, transmitting and receiving antenna, and receiving equipment. $R_0$ represents the angle formed by the incidence angle of the radar, the height $h$ of the radar, and the oblique distance $R_0$. 

**Ecological environment risk assessment model**

In Southwest China, there are many rainfall, karst growth, surface karst exposure, decreasing soil quantity, serious local soil erosion, and soil erosion and rock desertification are very sensitive. In addition, landslides and debris flows are easy to
occur in the area. A is the ecological barrier area in the upper reaches of the Yangtze River, which lives in a wide range of species, rare species, and endangered species, and has important ecological functions such as water, soil, and nutrients in the protection area and its surrounding areas.

The ecological risk value ERV (ecological risk value) is a quantitative indicator of regional ecological risk. This is the result of comprehensive action to the damage and disturbance of various land in the ecosystem. The impact index (CEI), ecological importance (ECV), and ecological vulnerability index were used to determine the disaster situation of land. The calculation method is as follows:

\[
ERV_i = CEI_i \times (EVI_i + EIV_i)
\]

(1)

The cumulative impact coefficient of land damage (CEI) is used to characterize the impact of various types of land damage on the ecosystem in the process of shale gas development. Disturbance intensity of land damage (\(\beta\)) and the cost factor (SCC) of the curl phenomenon is quantified. The greater the value, the greater the cumulative loss of land destruction. The calculation method is as follows:

\[
CEI_i = \beta_i \times (1 - SCC_i)
\]

(2)

Considering the characteristics of shale gas development and referring to the relevant methods of ecological red line boundary, the degree of soil erosion, rock desertification sensitivity, and geological disaster sensitivity are selected to represent the ecological vulnerability of Southwest China. The calculation is as follows:

\[
EVI = \max (A, S, DE)
\]

(3)

The sensitivity of soil erosion reflects the sensitivity of soil erosion to human activities. According to the principle of universal soil loss equation (USLE) and Liu Yuechen’s improvement of soil erosion sensitivity assessment method in a certain area, the rainfall erosivity (R), soil erodibility (K), slope length, and soil erosion sensitivity assessment of the investigated area were realized, and the slope coefficient (LS) and surface vegetation coverage coefficient (C) were studied, the specific calculation is as follows:

\[
A = P \times K \times S \times C \times LS
\]

(4)

The excavation and hydraulic fracturing in shale gas development have changed the geological structure of the area to a certain extent, causing microseismic and geological disasters. This paper analyzes the geological sensitivity of the area. Considering the hazards that are vulnerable to geological hazards. The specific calculation is as follows:

\[
DE = P \times T \times (1 - \beta)
\]

(5)

Here, DE is the risk degree of geology, \(P\) is the sensitivity of geological risk, \(T\) is the influence degree of geological risk, and \(\beta\) is the attenuation coefficient.

Naturalness refers to the degree to which an ecosystem remains in its original state. In this study, the proportion of impervious areas was used to represent the nature of the ecosystem, while the impervious surface of the area was obtained from remote sensing images.

Vegetation on impervious surface cannot grow and has high thermal radiation ability. According to the spectral characteristics of remote sensing, the reflectance of near-infrared band is low and the thermal infrared emissivity is high, but it has the same spectral characteristics as water, soil, and sand. The sand with high reflectance in the infrared and visible light bands has two situations: the water in the visible light band is high or low. Therefore, based on the low reflectivity of NIR band on impervious surface, mid-infrared and visible bands can be added. If the water area is in the low visible light band, the water area index band is used to replace the visible light band to form a weak reflection group on the impervious surface which is different from the soil, sand, and water area. The specific calculation is as follows:

\[
NDISI = \frac{MNDWI + NIR + MIR_1}{TIR + (MNDWI + NIR + MIR_1)/3}
\]

(6)

Where, MNDWI is an improved normalized water body index.

\[
MNDWI = \frac{\text{Green} - \text{MIR}_1}{\text{Green} + \text{MIR}_1}
\]

(7)

Among them, NIR, MIR, and TIR are the near-infrared, mid-infrared, and thermal infrared bands of the image, respectively. Green is the band of green. In order to evaluate the value of terrestrial ecosystem services, the specific calculation is as follows:

\[
ESV = \sum_{i=1}^{n} A_i \times VC_i
\]

(8)

Data sources

City A is located in the upper reaches of the Yangtze River, which is the throat of the ecological barrier in the Yangtze River Basin. Affected by the strong movement of new technology, the area will rise intermittently, which is in sharp contrast to the third-order Jianghan Plain where the crust is relatively sinking. Under the influence of external erosion and peeling, the terrain of the region was destroyed. Under the effect of modern terrain process, the development of regional ecosystem is affected by the continuous evolution of inherent vulnerability on the surface. The lithofacies of a city are mainly purple mudstone, calcareous mudstone, and marl soil. The
lithofacies are soft, weak in corrosion resistance, and easy to be eroded and dissolved. Surface erosion can easily occur under heavy rain and exposure. In addition, city A has a subtropical humid monsoon climate with more annual precipitation (900-1500mm on average) and frequent storms (one of the storm centers in China). According to the rainfall statistics from 1971 to 2014, the number of storms with initial rainfall exceeding the intensity in A city is 4-16 times a year, with an average of 6.6 times, as shown in Table 1.

## Results

### Land ecological vulnerability

The data of rainfall erosivity, topographic relief, and vegetation cover were obtained (Fig. 1, Fig. 2 and Fig. 3). The sensitivity index of soil erosion was calculated by the improved general formula of soil and water loss (MULE), and the sensitivity distribution map of soil erosion was made (Fig. 4).

Figure 1 shows the sensitivity of rainfall erosivity in a city. Figure 2 shows the relief sensitivity of A city. The surface coverage sensitivity of A city is shown in Figure 3. The sensitivity of soil erosion in A city is shown in Figure 4.

### Ecological importance of land

Naturalness is defined as the difference between the current forest vegetation and the original forest vegetation in that area. Impermeable surface expansion is one of the most direct ways for human beings to change nature. The direct change of surface structure is connected with the change of surface structure on the basis of region, which has the chain driving mechanism of human activities → land use / cover change → structural change and the deterioration of landscapes ecosystem function. According to the assessment of the regional ecosystem, human construction activities gradually replace the natural landscape of vegetation with artificial impermeable buildings, destroy the ecological environment, and on the impermeable surface, the more characteristic the natural ecosystem is, the lower the degree of the natural ecosystem, and vice versa.

This paper studies the urban impervious surface extraction method proposed by Xu Hanqiu et al., which is used to extract the 2010 landsat5tm and 2015 landsat8oli impervious surface of a city respectively. Combined with the urban development plan of city a, the impervious surface map was updated in 2015, and the A city impervious surface distribution map in 2020 was obtained. The results are shown in Figure 5.

In 2010, the impervious surface area of city A is 6685.81 square kilometers, and the planned shale gas area is 488.63 square kilometers. With the development of the city, the urban construction land is gradually expanding. In 2015, the impervious area of city a increased to 636.45 square kilometers. It is estimated that the impervious surface of city a will reach 614.28km² by 2020. In 7.90% of the area of city a, the impervious surface area of the shale gas planning area is 422.04km². From 2010 to 2020, Dadu River, Wannan District, Yubei District, Yongchuan District, and other large watershed cities with more growth surface area are concentrated in the main surrounding urban development areas. In addition, the growth of the surface area of the planning and major exploration areas, including the southeast of the Central Park and Qianjiang, is not obvious. As a typical mountain city, the urban expansion is closely related to the terrain. It is understood that urban expansion mainly occurs in the slope area, with the development of ridges, gentle slopes, steep slopes, ground, and valleys. However, due to the limitation of terrain, urban construction land is mainly concentrated in the main urban areas along the Yangtze River and Jialing River, while the development of the surrounding areas in the West and other areas is not obvious. As a result, the spatial distribution of impervious surface area ratio of city a generally decreases from west to East, and the area along the mainstream of the Yangtze River is significantly higher than other areas. In addition, due to the influence of traffic, impermeable water surfaces such as houses, factories, and mining industries are distributed along the roads.

Due to the unique climate conditions, diverse topography, and environmental heterogeneity of area A, the regional ecosystem structure becomes complex and diverse. Diverse

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**Table 1** Data sources of ecological vulnerability assessment in A city

| Data name                                      | Source                                                                 |
|-----------------------------------------------|------------------------------------------------------------------------|
| Monthly average rainfall data at meteorological station A from 1970 to 2014 | Rainfall statistics from meteorological stations of City A Meteorological Bureau |
| Downscaling data of kilometer grid in city A from 2002 to 2014 | National Science and Technology Basic Conditions Platform—National Earth System Science Data Sharing Platform-Southwest Mountain Data Resource Point |
| DEM data of city A (90m)                     | Chinese Academy of Sciences Geospatial Data Cloud                       |
ecological types are very important for the survival and reproduction of rare animals and plants, the maintenance of regional ecological environment, and the guarantee of economic and social development. Area A is rich in species, including rare species, endangered species, and many native species. There are more than 30 kinds of animals and plants under first-class state protection and more than 100 kinds under second-class state protection. The biodiversity of city A is very typical and valuable. The assessment of biodiversity in a city is mainly based on the distribution areas of the main species in the first and second livable countries in China, as well as the spatial distribution of regional nature reserves, forest parks, and four mountain protection areas to determine the importance level of biodiversity. The results are shown in Figure 6.
In terms of quantity, the biodiversity area of a city is very important, accounting for 6.08% (5003.50 square kilometers) of the city, of which the planned area of shale gas is 1912.31 square kilometers, accounting for 4.12% of the planned area. The important area accounts for 4.75% (3915.50 km²) of the city, and the shale gas planning area accounts for 3199 km², accounting for 6.89% of the planning area. Moderately important areas account for 5.36% (4411.25 square kilometers) of the cities, and shale gas planning areas cover 1696.85 square kilometers, accounting for 3.65% of the planning areas. From 2015 to 2020, the important biodiversity area of the shale development zone is 3.39 km², accounting for 2.21% of the total area of key development zones.

From the perspective of spatial distribution, the important areas for biodiversity conservation include nature reserve, forest park, Wuling Mountain Nature Reserve in the south of a
city, and Chengkou area in the north. This area is located in Zhongshan area, with high altitude and high forest coverage. There are a variety of biological species, and the number of species accounts for 95% of all species in the city. For example, in the national evergreen broad-leaved forest nature reserve, 298 species of animals and plants are listed as the main national protected species. In the center of Yubei, the main cities such as the south bank, Jiulongpo, Dadukou, Beique, and shaping are located in Yunshan, Mingyueshan, and Zhongliangshan management areas, which are very important areas to protect biodiversity; in the core area of the Three Gorges in the central part of the parallel Valley, the protection of biodiversity belongs to a relatively important level.

Soil is an important foundation for human survival. The soil types, soil types, and their distribution needed for this study are from the soil of city A. the parameters related to soil fertility, such as soil nutrients and trace elements, are from China soil science database. Various geological structures form complex topography and various soil types. The dominant soils were yellow soil, purple soil, and paddy soil. Among them, paddy soil is the third largest soil type in a city, accounting for 13.36% of the total area, which comes from long-term human cultivation. The distribution area of this soil type is the main guarantee area of food production in a city. In addition to the above three soil types, the other soil types in a city include lime soil, yellow brown soil, newly deposited soil, and mountain grass soil, which are 9.33%, 5.81%, 0.36%, and 0.26% of the total area of a city, respectively. The newly deposited soil is mainly distributed in the first and second terraces of the river system, and the soil of the pasture land in the mountain area is mainly distributed in the high mountains, with a height of more than 1500 meters (Table 2).

In this study, the indexes of soil pH, organic matter, nitrogen, phosphorus, potassium, and other soil nutrients were selected, and the fuzzy mathematics method was used to realize the comprehensive evaluation of soil fertility in A city. As shown in Table 3, the data of soil nutrient content in city A are mainly from the data and survey results of area A in the second population census.

Fuzzy mathematics method was used to calculate the membership degree of each evaluation element according to membership function, and the weight of each element was determined by correlation coefficient, so as to comprehensively evaluate various types of soil fertility in A city (Table 4, Table 5, Figure 7).
The results showed that the comprehensive indexes of soil fertility in A city were as follows: lime soil > yellow soil > paddy soil > purple soil > aquatic soil. The yellow soil is 1717.011 km². The soil nutrients of paddy soil and purple soil in A were 14.62% and 31.27% in the middle and lower layers, respectively.

However, due to the influence of topography and resources, the main cultivated land in A city is paddy field, accounting for 47.67% of the total cultivated land area, mainly concentrated in the valley parallel to the west. The central part of the region and other flat terrain is rich in water resources. The second is purple soil, which accounts for one-third of the arable land. The karst mountainous areas in the northeast and southeast of the region account for 11.37% and 9.98%, respectively. The development of loess, calcareous soil, and karst in these areas leads to serious loss of water and soil, which is not conducive to large-scale agricultural development.

### Land ecological risk

The above seven assessment elements are standardized, including ecological vulnerability and ecological importance. According to the expert’s scoring ring, combined with the reality of the region, AHP is used to set the judgment matrix to obtain the weight of each index. The consistency test of less...
than 0.1 decision matrix $Cr = 0.025$ shows rationality, as shown in Figure 8.

**Discussion**

**Analysis of risk factors of land ecological environment**

In terms of quantity, the median and high-value areas of ecological risk in city a were 25777.16 km² and 7278.02 km², respectively, in 2010, accounting for 31.28% and 8.83% of the total urban area, among which, the planned area of ecological risk in median area and high-value area was 14183.73 km² and 3571.67 km², respectively. The ecological risk value of a city is similar to that of low-value area, accounting for about 1/3 of the city areas with 24165.13 km² and 25179.68 km², respectively. From 2015 to 2020, the potential ecological risk of shale gas development in city a has increased significantly, with the area of low-value areas and low-value areas reduced by nearly 10%, and that of medium value areas and high-value areas increased by 10%. Among them, the planned shale gas area has increased by 4% in the median and high-value areas. From 2010 to 2020, with the urbanization process, construction land expansion, and shale gas development land destruction, the ecological risk of city areas increases, and the ecological risk in the northeast and southeast of the region increases greatly.

From the perspective of spatial distribution, the high-value areas of ecological risk in city A are mainly distributed in Xiushan, southern Nanchuan, Qianjiang, and Jiangjin. The vegetation coverage of these areas is mainly coniferous forest, broad-leaved forest, coniferous forest, and broad-leaved forest mixed together. The ecosystem is of various species, complex structure, rich reproductive species, many rare and endangered natural animals and plants, and rich genetic diversity (Aedla et al. 2015). The ecological service value of this area is high, and the focus of ecological protection is an important area of ecological sensitive city A biodiversity. Moreover, this area is a sensitive area for soil erosion and rock desertification, and its ecosystem is fragile. Therefore, the land occupied by shale gas development projects will bring great potential risks to the area. Moreover, in the west and central regions, ecological risks are relatively low, and the big urban circle and urban development zone are located in the western region. Besides, the high urbanization, industrialization, and population density, Jinyun Mountain, Yueshan, Liangshan vegetation belt, and its surrounding areas are rich in biodiversity, and the ecological natures of other areas are low (Boak and Turner 2005). The central parallel ridge canyon area has a relatively concentrated population and low ecological sensitivity and is dominated by agricultural afforestation and water resources protection. Therefore, the potential ecological risk of shale gas development is relatively small (Alizadeh Ketek Lahijani et al. 2008).

**Analysis of land ecological environment risk assessment**

City A is located in Southwest China, with complex geological structure and high-quality shale. As one of the main shale gas-producing areas in China, it has specific typical characteristics. In addition, a is located in the hinterland of the Three Gorges and the ecological barrier area of the upper reaches of the Yangtze River. A is sensitive to water environment and fragile in ecology. In shale gas development of a, the utilization of water resources, the discharge of pollutants, and the occupation of space may cause ecological and environmental

### Table 3 Statistical table of soil nutrient content in area A

| Soil       | Organic matter | Total nitrogen | Alkaline hydrolysis of nitrogen | Total phosphorus | Available phosphorus | Total potassium | Quick-acting potassium |
|------------|----------------|----------------|---------------------------------|------------------|----------------------|-----------------|------------------------|
| Yellow soil| Mean 16.8      | 1.46           | 129.9                           | 0.67             | 20.3                 | 15.7            | 93.6                   |
| Paddy soil | Mean 19.1      | 1.45           | 126                             | 0.55             | 9.7                  | 17.6            | 81.1                   |
| Purple soil| Mean 13.1      | 0.99           | 85.6                            | 0.75             | 17.8                 | 18.4            | 93.1                   |
| Chao soil  | Mean 12.7      | 1.07           | 95.1                            | 0.65             | 16.8                 | 16.4            | 63.8                   |
| Lime soil  | Mean 25.9      | 1.46           | 129.9                           | 0.65             | 17.1                 | 15.7            | 93.6                   |

### Table 4 Comprehensive index of soil fertility in A city

| Soil       | Paddy soil | Purple soil | Chao soil | Lime soil | Yellow soil |
|------------|------------|-------------|-----------|-----------|-------------|
| Mean       | 0.605      | 0.548       | 0.546     | 0.78      | 0.680       |
| Coefficient of variation % | 25.7 | 31.5 | 26.9 | 30.3 | 34.8 |
risks such as insufficient water resources, water environmental pollution, and ecological damage in the area (Chaichitehrani et al. 2019).

Considering the uneven distribution of time and space of water resources on the mountain, seasonal and engineering water shortage, drought index risk, and rainfall variation coefficient, the potential vulnerability characteristics are evaluated based on the balance of water resources supply and demand, according to natural conditions such as mountain area, slope, and geology, and combined with the outflow of water resources. The risk assessment of shale gas development water resource shortage is realized in the cities of basin scale, and the results show that the water resources of region a are relatively rich (Genz et al. 2007). However, the water shortage risk of shale gas development is very high in the west area based on resources, seasonal, and engineering water shortage areas in the southeast and northeast.

![Spatial distribution of soil types and comprehensive fertility in A city](image)

### Table 5 Statistical table of comprehensive index of soil fertility in A city

| Area                        | Soil type | Lime soil High | Yellow soil Higher | Paddy soil Medium | Purple soil Lower | Chao soil Low | Waters - | Total       |
|-----------------------------|-----------|----------------|-------------------|-------------------|------------------|--------------|----------|-------------|
| A                           | Area      | 9150.01        | 32474.32          | 12046.01          | 25768.24         | 100.85       | 2860.61  | 82400.00    |
|                             | Proportion| 11.11          | 39.40             | 14.61             | 31.26            | 0.11         | 3.47     | 100.00      |
| Shale gas planning area     | Area      | 4068.25        | 12130.08          | 7037.79           | 14667.06         | 51.68        | 2051.54  | 50123.00    |
|                             | Proportion| 3.75           | 9.22              | 36.97             | 17.50            | 32.5         | 0.09     | 100.00      |
| Key mining area             | Area      | 30.35          | 75.17             | 20.78             | 24.44            | 0            | 2.54     | 133.28      |
|                             | Proportion| 1.97           | 49.06             | 13.57             | 15.94            | 0.00         | 1.64     | 100.00      |
Considering the pollution load in shale gas development, the risk characteristics are evaluated based on the living background of city A production and watershed pollution load. According to the natural conditions of mountain area, slope, and geology, we propose a water dye space to express the difficulty of water pollution. According to the idea of “source path – acceptor” of the water vulnerability, the risk assessment of surface water environmental pollution in shale gas development in a city of watershed scale is realized (Gharibreza et al. 2018). From 2010 to 2020, the contribution rate of pollution load in shale gas development reaches 11.5%. The overall spatial distribution of surface water pollution risk is as follows: major urban areas > new development areas around major urban areas > northeast > southeast.

Land ecological environment risk control strategy

The development space of shale gas has changed the original land use type and destroyed the ecological structure. Aiming at the special ecological service area and fragile ecological environment area, this paper puts forward the following suggestions from the perspective of regional selection, development technology, and ecological restoration (Ibrayev et al. 2010).

All kinds of nature reserves, scenic spots, forest parks, and so on are prohibited. Strictly manage the main ecological functional areas and ecologically sensitive areas in the southeast and northeast of a city, carry out development, and construction activities, and ensure that the ecological functions, regions, and characteristics remain unchanged.

For ecologically sensitive areas such as rock desertification, soil erosion, and geological hazards, such as Wuling Mountain in the southeast and Daba Mountain in the northeast, it is necessary to reasonably plan the construction scope, reduce the disaster areas, and avoid damaging the vegetation beyond the construction scope. Reasonable layout of construction time series shorten the construction time and reduce the impact on the surrounding environment (Isaie Moghaddam et al. 2018). In the process of exploitation or stoppage, shale gas development project should timely restore its surrounding environment, including soil erosion control, soil erosion control and waste utilization, ecological restoration, living environment, and other fields, and carry out ecological restoration.
Land ecological resource management path

Shale gas development projects are characterized by a large amount of water extracted, which has a great impact on water resources. From the point of view of water resources management, water extraction permission must be obtained before water extraction (Kermani et al. 2016). If the distribution of water resources in area A is uneven, the development of shale gas may lead to regional water supply pressure.

As for the development of shale gas, in the early stage of shale gas development, the operators should plan the development process of shale gas in the whole life cycle management and put forward written opinions to the people’s government at or above the county level or to the river basin administrative organs, and the construction project experts who organize the review of water management plan, as the technical basis for the verification of water resources in environmental impacts assessment (Kakroodi et al. 2012).

Shale gas development projects should minimize the basic occupation of land for oil and gas engineering projects. According to the requirements of relevant land management measures, the permanent and temporary land cover of shale gas development projects should be reported to the land management department for gradual approval. When the development of shale gas occupies the forest zone, the examination and recognition procedures of forest zone occupation shall be handled according to the forest zone occupation and the required examination and approval measures. For the temporarily occupied forest, the trees in the forest shall be compensated temporarily, and the forest shall be restored after the construction.

Conclusion

In this paper, we propose a neural network algorithm based on mimic model simulation to obtain biomass from full polarimetric SAR images and establish a scattering model to simulate the relationship between backscattering coefficient and growth parameters. In this paper, the mimic model is simplified initially. Compared with the optical image, by analyzing the biomass extraction results of the two temporal images, it is concluded that the fluctuation tendency of biomass is consistent with the growth tendency, and the information extraction of the complex terrain area is successful. The conceptual model of eco-environmental risk assessment in the survey area is established by using the ecological risk assessment procedure in the idea of ecological risk assessment. It is considered that the risk acceptors are natural environment system, landscape pattern, ecosystem function, and social economy. Then, from the impact of natural environment, social and economic environment, landscape model analysis, ecological service value profit, and loss analysis, the final risk index system is selected and established, and the importance index is screened according to the countermeasure principle and representative principle of regional situation. Then, by using the comprehensive index evaluation model to calculate the integrated ecological environmental risk index, the ecological environmental risk assessment is implemented. Finally, the proposed coverage information extraction algorithm and biomass inversion algorithm based on Polarimetric SAR data are applied to the complex terrain area, and these information are extracted.

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Declarations

Conflict of interest The authors declare no competing interests.

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Alizadeh Ketek Lahijani H, Tavakoli V, Amini AAH (2008) South Kermani et al. (2016). If the distribution of water resources in area A is uneven, the development of shale gas may lead to regional water supply pressure.

As for the development of shale gas, in the early stage of shale gas development, the operators should plan the development process of shale gas in the whole life cycle management and put forward written opinions to the people’s government at or above the county level or to the river basin administrative organs, and the construction project experts who organize the review of water management plan, as the technical basis for the verification of water resources in environmental impacts assessment (Kakroodi et al. 2012).

Shale gas development projects should minimize the basic occupation of land for oil and gas engineering projects. According to the requirements of relevant land management measures, the permanent and temporary land cover of shale gas development projects should be reported to the land management department for gradual approval. When the development of shale gas occupies the forest zone, the examination and recognition procedures of forest zone occupation shall be handled according to the forest zone occupation and the required examination and approval measures. For the temporarily occupied forest, the trees in the forest shall be compensated temporarily, and the forest shall be restored after the construction.

Conclusion

In this paper, we propose a neural network algorithm based on mimic model simulation to obtain biomass from full polarimetric SAR images and establish a scattering model to simulate the relationship between backscattering coefficient and growth parameters. In this paper, the mimic model is simplified initially. Compared with the optical image, by analyzing the biomass extraction results of the two temporal images, it is concluded that the fluctuation tendency of biomass is consistent with the growth tendency, and the information extraction of the complex terrain area is successful. The conceptual model of eco-environmental risk assessment in the survey area is established by using the ecological risk assessment procedure in the idea of ecological risk assessment. It is considered that the risk acceptors are natural environment system, landscape pattern, ecosystem function, and social economy. Then, from the impact of natural environment, social and economic environment, landscape model analysis, ecological service value profit, and loss analysis, the final risk index system is selected and established, and the importance index is screened according to the countermeasure principle and representative principle of regional situation. Then, by using the comprehensive index evaluation model to calculate the integrated ecological environmental risk index, the ecological environmental risk assessment is implemented. Finally, the proposed coverage information extraction algorithm and biomass inversion algorithm based on Polarimetric SAR data are applied to the complex terrain area, and these information are extracted.

Acknowledgements Project 2019 of Hebei social science foundation project: research on land ecological security risk assessment in Hebei province from DPSIR perspective, project no.: HB19JL001, project leader: Juanmin Cui.

Declarations

Conflict of interest The authors declare no competing interests.

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