AMSR-ARRI National Conference

Ecological Risk Assessment of Land Destruction in Large Surface Coal Mine

– – Exemplified for AnTaiBao Surface Coal Mine, China

QI SUN

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Introduction

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Background

Mining

Retrogressive succession of region ecosystem

Unsustainable development

Mining Area

Environment destruction

Ecological sensitive area

Soil and water loss

Soil pollution

Vegetation degradation

Land desertification

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In China, the area of land destruction, because of mining, is over 86,000 Km^2.

Land destruction in large surface coal mine

Coal mine subsidence in high underground water mining area




Coal mine subsidence in low underground water mining area

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Study area

Shanxi province

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The Loess Plateau

- ⊙ Area is less than 1/20 of the whole country, but the proved reserves are 580 billion tons, which is around 2/3 of China.
- ⊙ 10 large coal mines whose the proved reserves are over 10 billion tons, and 4 super large coal mines whose the proved reserves are over 50 billion tons.

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Study area

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Eco-risk of Excavating Destruction

Damage to native ecosystems

Instability stripping slope

The dust pollution

Instability mining slope

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Eco-risk of Coverage Area

Gangue spontaneous combustion

Unequal settlement

Soil erosion

Soil Compaction

Instability mining slope

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Gangue spontaneous combustion

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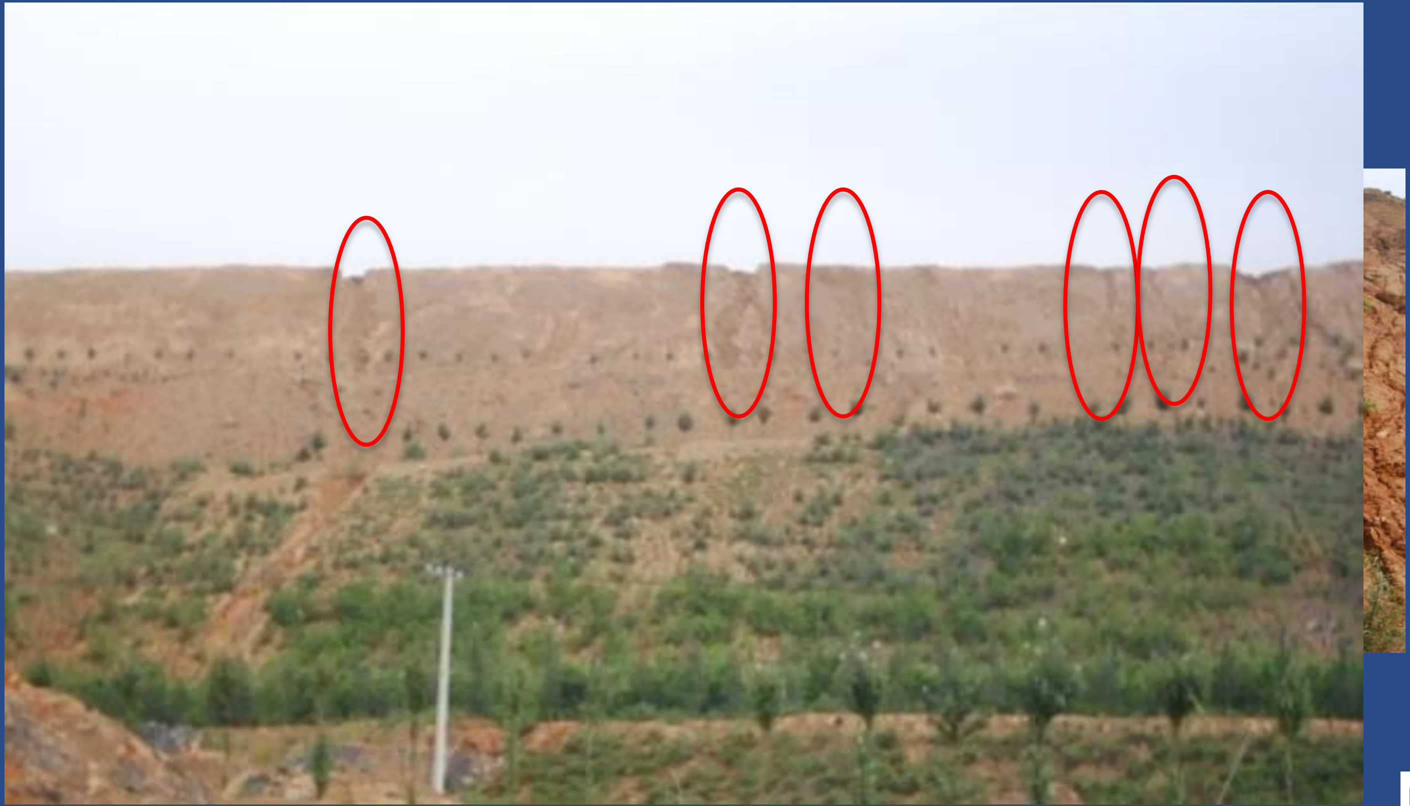
Soil degradation



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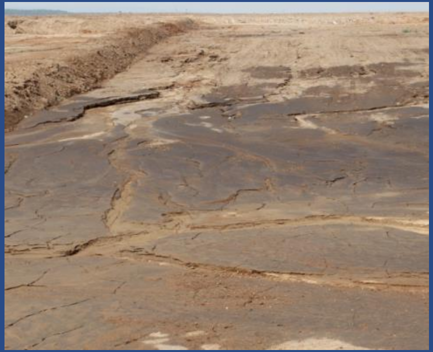
Unequal settlement



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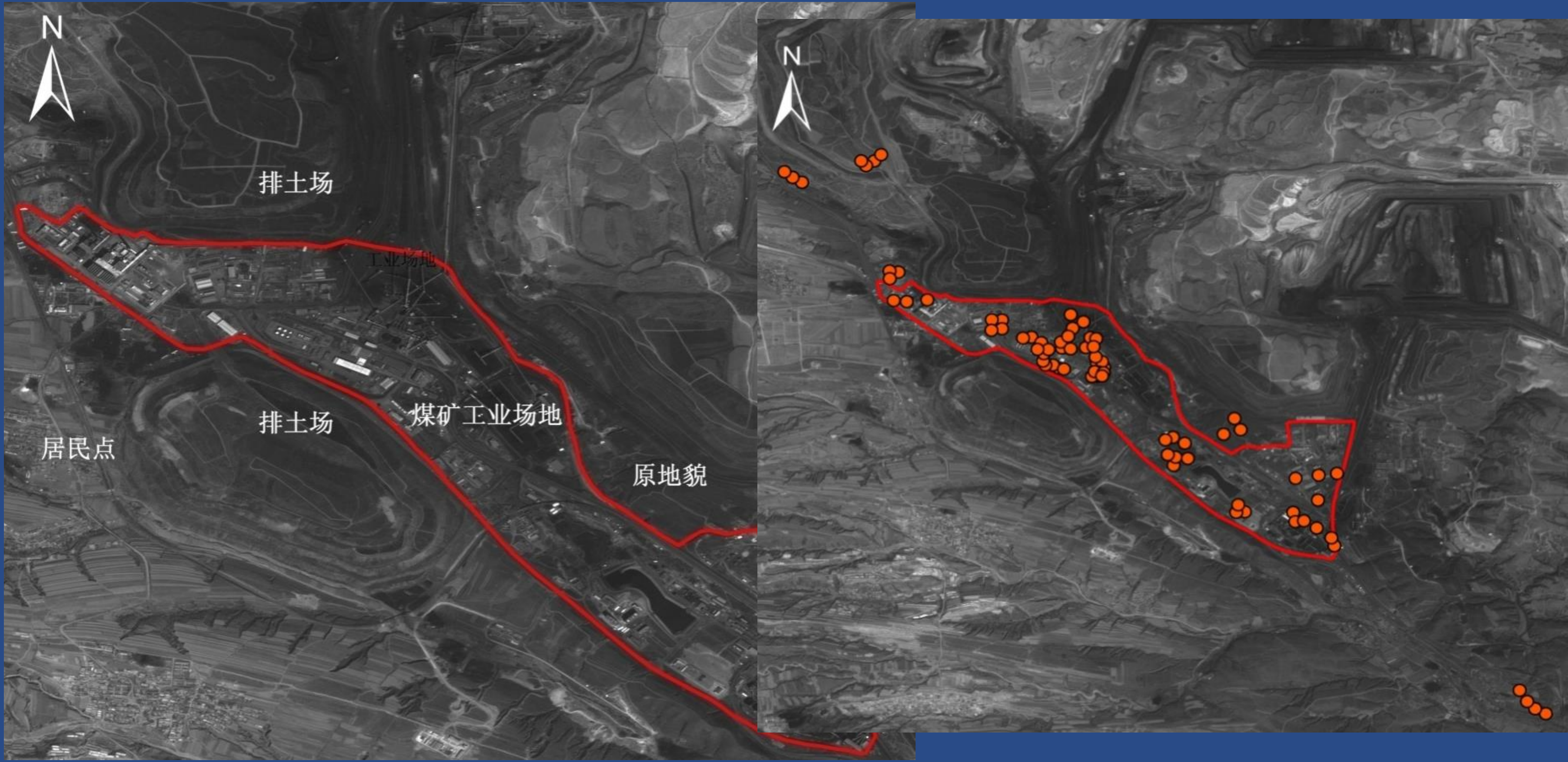
Eco-risk of Occupation Area



Soil samples in industrial field

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Methods

In the process of mining exploitation, due to geographical immutability, the mining area ecological system is easy to be disturbed, which is more complicated than general regions. To build the ecological risk assessment model of land destruction Ecological Risk Value (ERV) mainly includes two aspects: the effect of ATB opencast coal mining exploitation and ecological sensitivity of mining area. The bigger environment influence of mining area by mining exploitation, the higher risk the ecological system will take. From another perspective, if the ecological system is more sensitive and fragile, the resistance corresponding and the ability to recover is lower. This paper divided study area into 30m by 30m grid unit, through to the evaluation of each unit, realize the mapping and classification of eco-risk in mining area.

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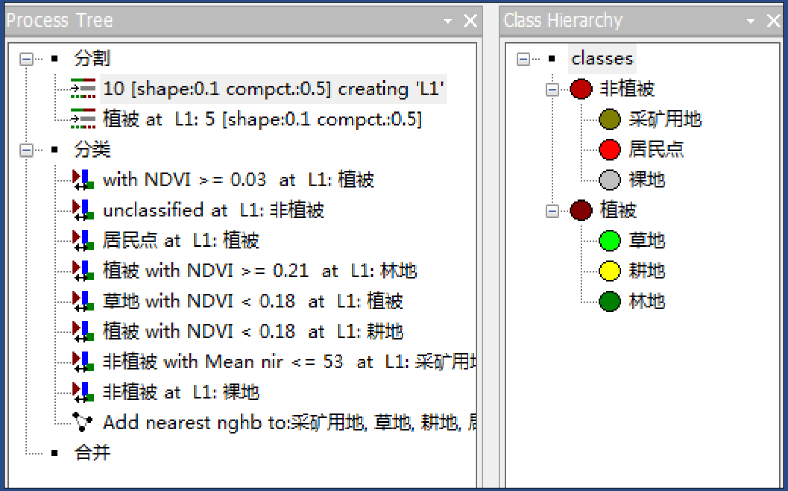
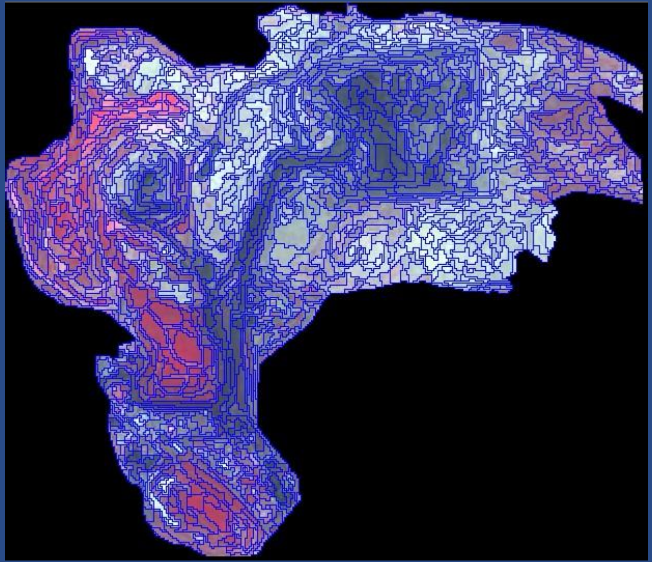
Data resources and processing





In this study, remote sensing data is the landsat-5 multi-spectral image of 193 d, 2010, precision of 30 m, which the land use type of difference is the most obvious one-year time, and vegetation growth is good, surface information is rich, is conducive to the recognition of the ecological environment factors.

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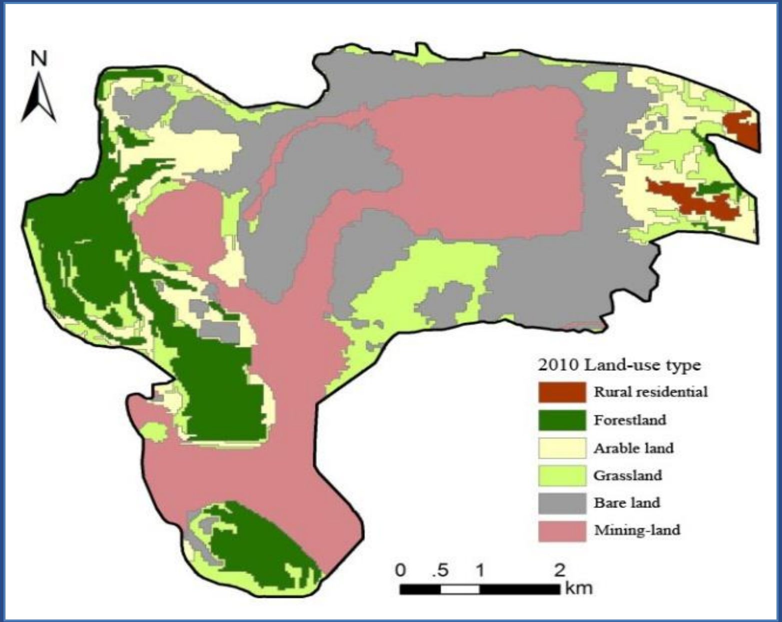

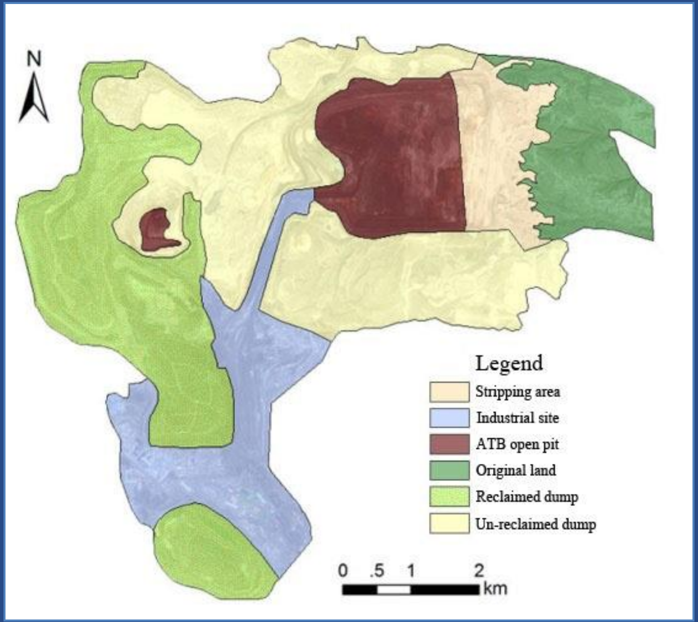

Two kinds classification systems were designed as follow according to land-use situation in the study area and the standard of land-use status classification in China (GB/T 21010-2007): the classification systems of land-use and disturbed land. The land-use classification system concludes arable land, grassland, forestland, bare land, rural residential, mining-land. The disturbed land classification system concludes ATB open pit, stripping area, un-reclaimed dump, reclaimed dump, industrial site and original land.

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Methods

Ecological risk value is used to describe the quantitative characterization of the ecological risk mining area, which is resulted by mining land destruction comprehensive activities. It is defined by Eq. (1) :

$$ERV_i = \beta_i \cdot ESI_i \cdots\cdots\cdots\cdots 1)$$

Where is ecological risk value, is influence value of land destruction (Table 1), is ecological sensitivity index, i is the unit of 30 m×30 m grid.

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Methods

$$ESI_i = EIV_i + EVI_i$$

$$EIV = \sum W_{Ii} \times I'_i$$

$$EVI = \sum W_{Vi} \times V'_i$$

Where ESI is ecological sensitivity index, EIV is ecological important value, EVI is ecological vulnerability index, W_{Ii} and W_{Vj} are weights, and $\sum W_{Ii} + W_{Vj} = 1$, Ii and Vi are the corresponding parameter values, I'_i is the standard value of Ii, V'_j is the standard value of Vi, i is the unit of 30 m×30 m grid.

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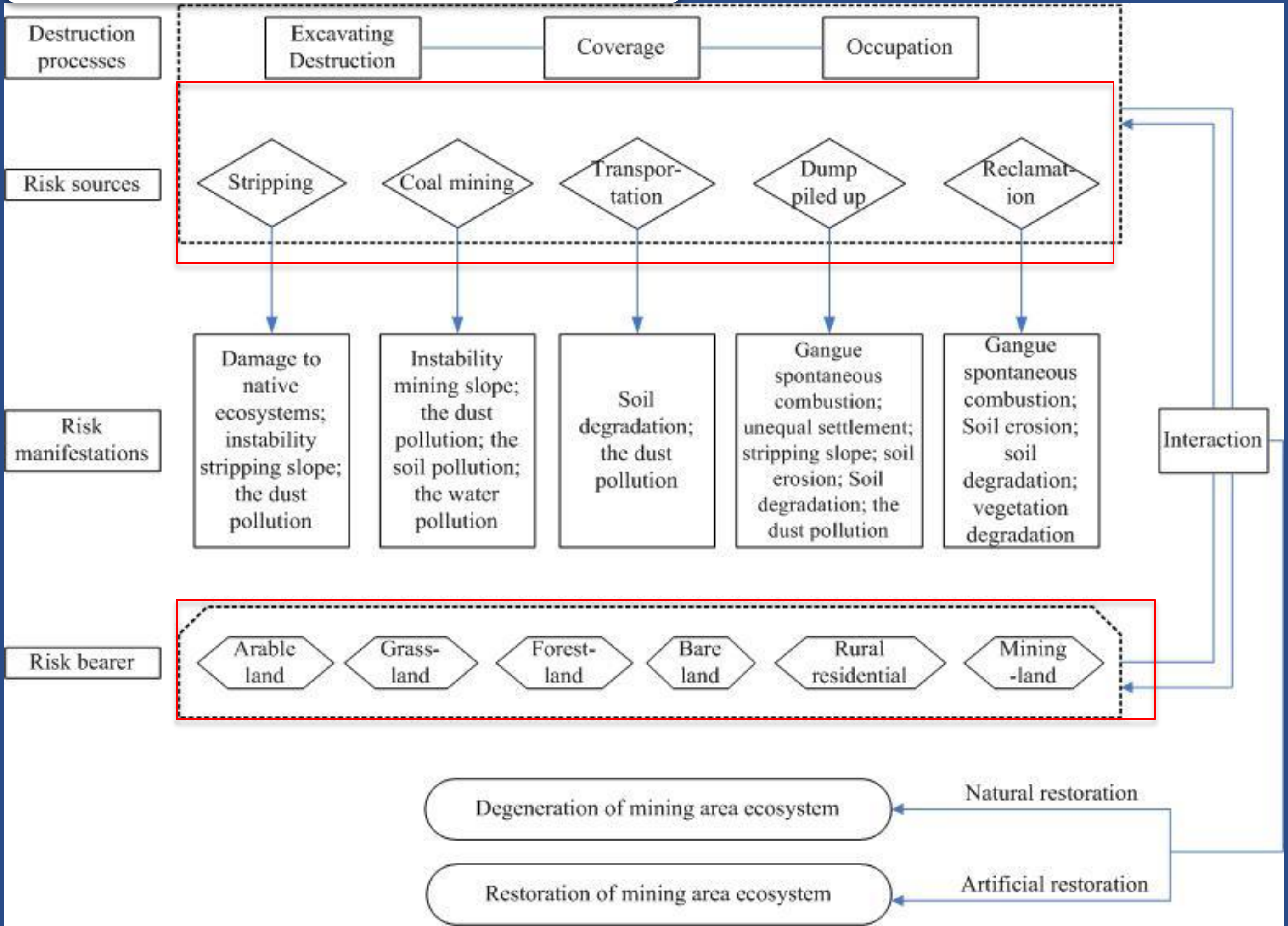
Causal chain in mining area



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The weight of land-destruction risk influence in ATB open-pit mine

Destruction type	Destruction process	Risk manifestations	Weight	Influence value of land destruction（β）
Excavating Destruction	stripping	Damage to native ecosystems	0.0504	0.1391
		Instability stripping slope	0.1043	
		The dust pollution	0.0719	
	coal mining	Instability mining slope	0.1043	0.0971
		The coal-dust pollution	0.0540	
Coverage	dump piled up	Gangue spontaneous combustion	0.1151	0.3664
		Unequal settlement	0.1259	
		Instability mining slope	0.1043	
		Soil degradation	0.0971	
		Soil Compaction	0.0827	
		The dust pollution	0.0719	
	Reclamation management	Gangue spontaneous combustion	0.1151	0.2119
		Vegetation degradation	0.0504	
		Soil degradation	0.0827	
		Soil degradation	0.0971	
Occupation	Coal preparation	The dust pollution	0.0540	0.1854
		The heavy metal pollution	0.0755	
		The organic pollution	0.0899	
		The water pollution	0.0827	

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The weight of ESI in ATB open-pit mine

Rules	Factors	Weights	Effect	Methods
Ecological Important Value (EIV)	Ecosystem service value	0.18	-	Area × its ecosystem service value equivalent
	Soil quality	0.14	-	Sampling date of mining area plots
	Vegetation coverage	0.16	-	NDVI
Ecological Vulnerability Index (EVI)	Soil erosion	0.20	+	Analysis of slope, vegetation type, annual precipitation and extent of reclamation
	Humidity index	0.13	-	Calculation of different bands(Xu H Q, 2008)
	Bare soil index	0.19	+	Calculation of different bands(SI and IBI)

Note: (+) means a positive effect of factors in an evaluation rule and (-) means a negative effect of factors in an evaluation rule.

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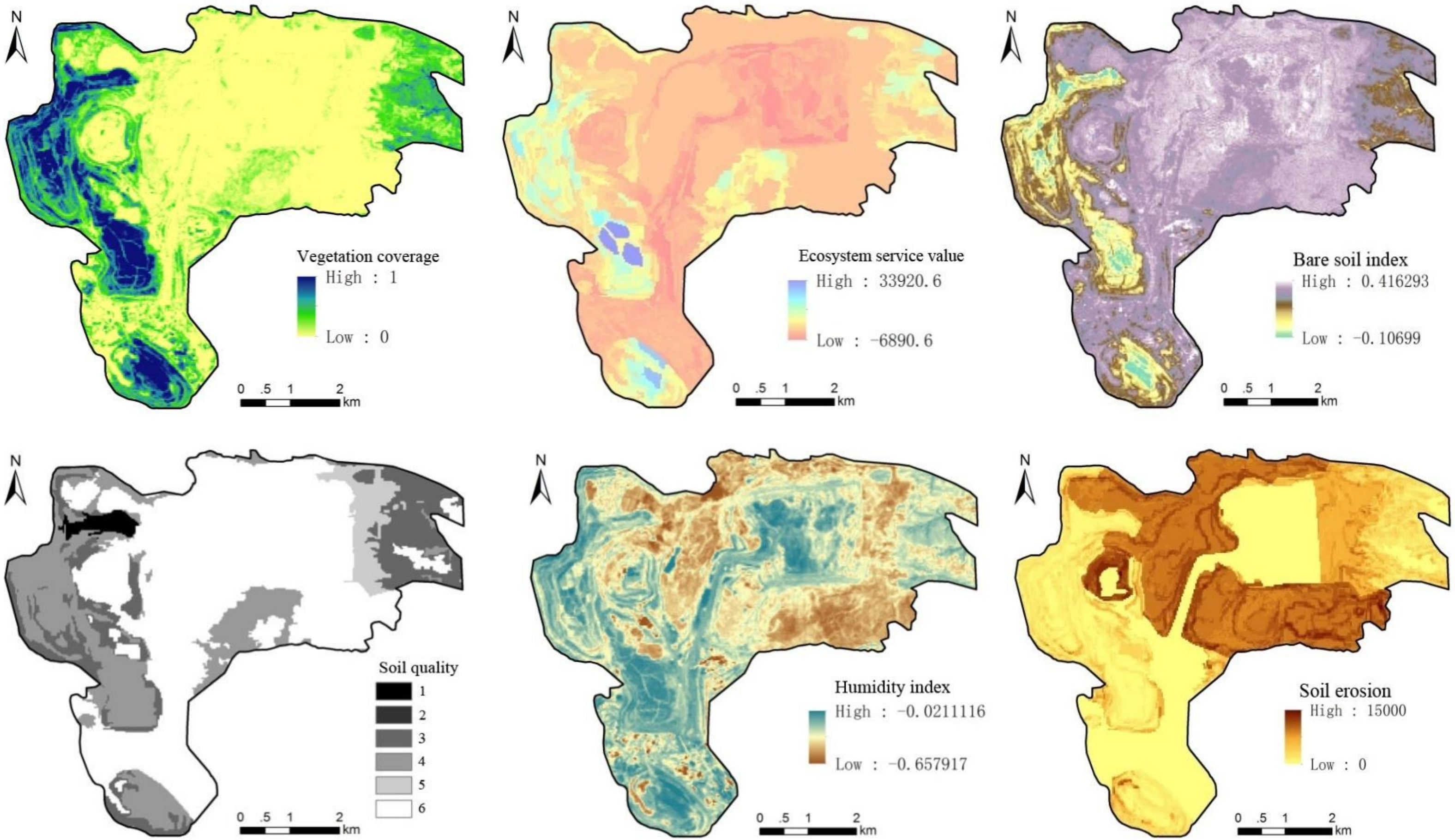

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Vegetation coverage
High : 1
Low : 0
0 .5 1 2 km
N
Ecosystem service value
High : 33920.6
Low : -6890.6
0 .5 1 2 km
N
Bare soil index
High : 0.416293
Low : -0.10699
0 .5 1 2 km
N
Soil quality
1
2
3
4
5
6
0 .5 1 2 km
N
Humidity index
High : -0.0211116
Low : -0.657917
0 .5 1 2 km
N
Soil erosion
High : 15000
Low : 0
0 .5 1 2 km

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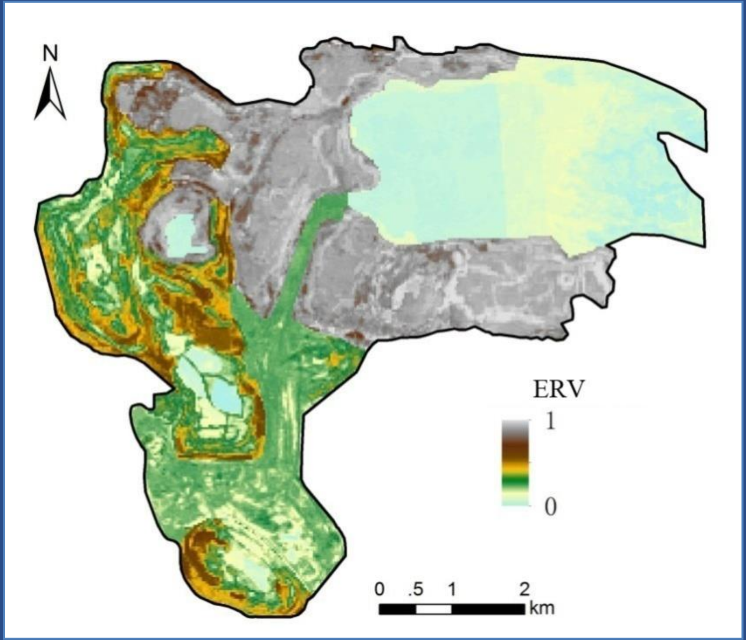

The results show that: un-reclaimed dump is the highest risk area (32.91% of the total area). Due to the reclamation measures and management for many years, reclaimed dump and industrial site are stable (9.66% of the total area). However, the unscientific dump process and weak supervision caused soil and vegetation degradation, therefore, some part of reclaimed dump show a higher risk (26.46% of the total area). The open pit is the lowest risk area (30.97% of the total area).

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Conclusions and Discussions

First, mining area ecological risk sources are identified from two aspects, production process of the mining and land destruction type in mine area; and a typical open-pit mine ecological risk causal chain in Loess Plateau Region has been constructed.

Second, ecological index based on remote sensing and land-use type was developed specially for assessing mining area ecological sensitivity.

Third, the data of the cumulative effect evaluation of land destruction and GIS-based ecological sensitivity evaluation are applied to quantify the comprehensive value of ecological risk.

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Conclusions and Discussions

This paper conducted a case study of mining area eco-risk evaluation of ATB large coal mine in Pinglu District, Shuozhou City, Shanxi Province, China, 2010. Data of mining area were extracted from remote sensing image in 2010 and geographic data. Through spatial analysis tools to measure the risk source by two ways of the land-use types and the mining production processes, and to analyze risk bearer by evaluating the ecosystem sensitivity. Combine the two aspects to achieve the spatialization of mining area ecological risks. Based on this evaluation results and the years of reclamation experience, we can present prevention strategy of mining area ecological risk, and provide some reference for ecological restoration work in similar mining area.

Acknowledgement

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谢谢！

Thanks！