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EAST CHINA UNIVERSITY OF TECHNOLOGY



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Restoration monitoring of rare earth element (REE) mines in southern Jiangxi, China

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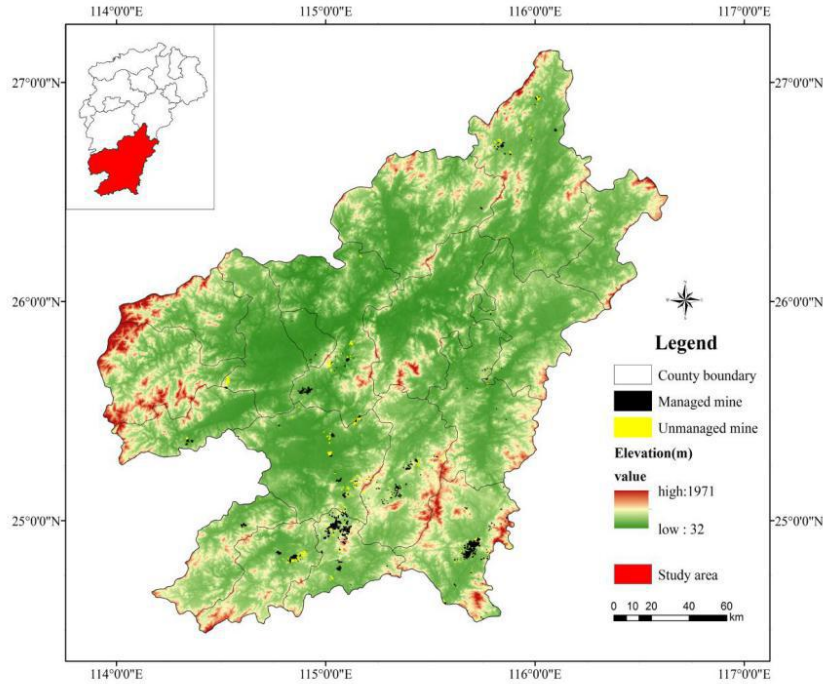
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Disordered mining and limitation of mining technology, rare earth resources are seriously wasted, and the mining soil loses nutrients, resulting in almost no grass growth, landscape fragmentation, and groundwater pollution in the mining area. Therefore, monitoring the basic characteristics and status of the recovery process of REE mines can scientifically assess whether the recovery methods adopted by managers are practical and effective.

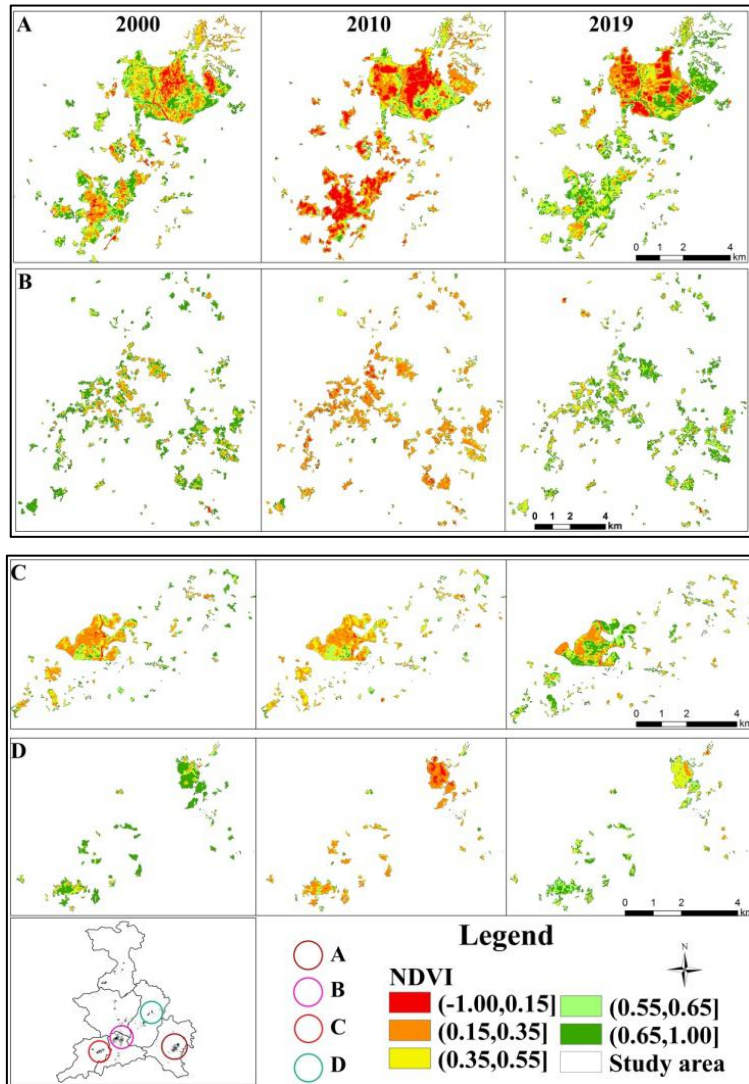
The study area



Location of study area and distribution of the REE mines

The study area is located the Ganzhou city, Jiangxi ($113^{\circ}54'$ - $116^{\circ}38'E$, $24^{\circ}29'\sim 27^{\circ}09'N$) and is adjacent to the Fujian, Guangdong and Hunan provinces in China. The Gannan region has abundant ionic REE mines and is known as the "Rare Earth Kingdom". long-term disorder of mining in this area, the native vegetation has been severely damaged and the original geomorphologic profile has changed greatly since 1950s.

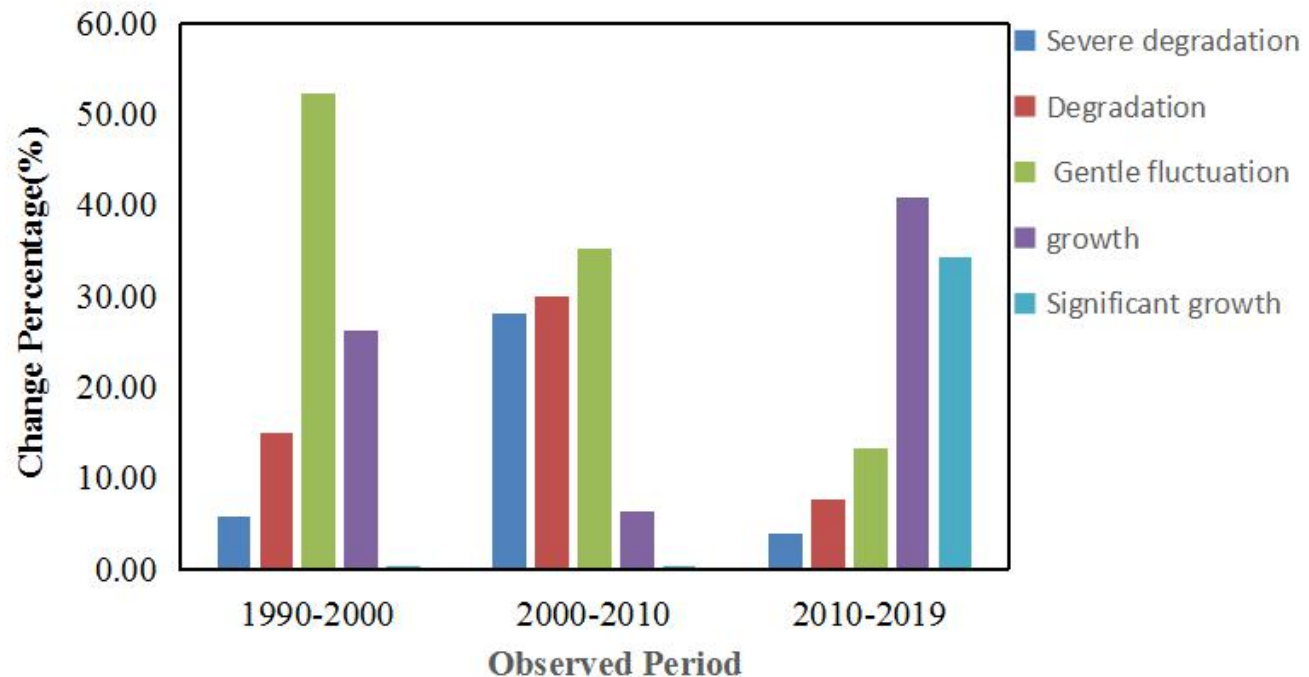
Spatiotemporal characteristics of vegetation coverage



In 2010, vegetation coverage in the four regions decreased dramatically with NDVI concentrated the range from 0 to 0.15, show the degradation area has been continuously expanded. In 2019, Xunwu, Dingnan, Longnan, and Anyuan NDVI were concentrated 0.35-0.65, 0.55-1.00, 0.15-0.65, 0.35-0.65, respectively, showing that the overall NDVI values increases gradually

Spatiotemporal changes of NDVI

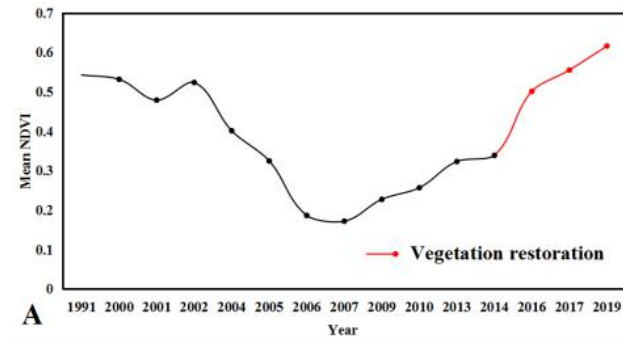
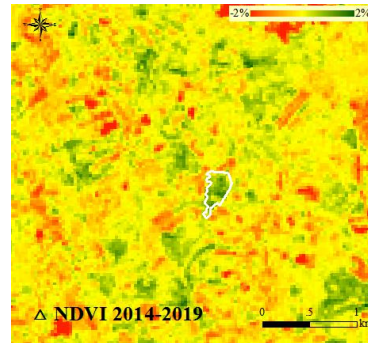
Monitoring and analysis of vegetation growth status



vegetation change percentage in the observed period

As a whole, after 2010, the growth of vegetation has improved, indicated that the management of rare earth minerals has achieved certain effectiveness.

Assessment restoration in typical mine



Comparison high resolution images of mining stage and vegetation restoration stage, and NDVI trajectories in typical REE mines

This typical mine is a “Heap leaching” technique type mine , located in Anyuan County. From 1991to 2005 , the average value of NDVI decreased from 0.55 to 0.18, showing the mining area is constantly expanding year by year. The ecosystem was severely disturbed by mining and was seriously degraded in 2006-2014. After 2014, the NDVI trajectory shows an increase after land leveling, and the vegetation has recovered for 4-5years, mainly by the growth of herbaceous plants. Δ NDVI is about 0.278 , indicated that vegetation cover has been significantly improved, and the treatment effect is obvious. The ecology has basically recovered to the same level as the surrounding environment.

REE mine management project in Ganlin Village



(a)



(b)



(c)



(d)

Note: (a) is the image of unmanaged period, (b) is the eroded residual mountain, (c) and (d) are slope protection and greening project.

Through the field observation in Ganlin Village, we learned that the greening in this mining area was mainly planted with Bermudagrass, and the effect is visually obvious. However, the planted *Pinus massoniana* grows poorly and has a low survival rate. This indicates that the subsoil remains unrestored and probably, the groundwater pollution unprocessed. Thence, future assessment shall consider soil and groundwater pollution.

Conclusion



- ◆ REE mines are managed late, mainly after 2010
- ◆ Artificially controlling the mining area has positive effect on restoring the ecological environment of the mining area
- ◆ The damaged vegetation cover caused by open mining and pollution has low capacity to recover without human intervention, where continue serious water loss and soil erosion
- ◆ A holistic management should be implemented in both surface, subsoil and groundwater, and monitoring be conducted by remote sensing in combination with soil sampling in future study



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Thanks for your attention !