remote sensing

MDPI

Appendix. Supplementary Material

Ecological risk assessment and impact factor analysis of alpine wetland ecosystem based on LUCC and boosted regression tree on the Zoige Plateau, China

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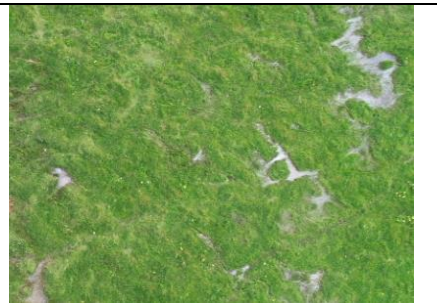
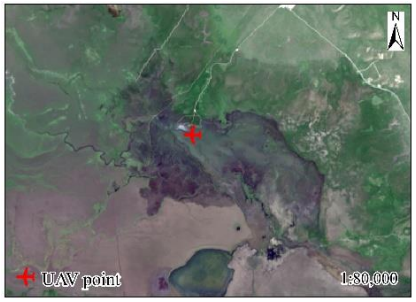
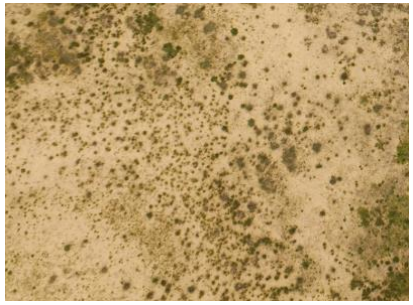
Table S1. Unmanned Aerial Vehicle (UAV) images and their interpretation signs in study area.

LULC type	Characteristics of Landsat images	Interpreted Landsat images (RGB=red, green, blue)	Unmanned aerial vehicle (UAV) images (RGB=red, green, blue)
Alpine grassland	Alpine grassland has different shapes, a patchy distribution and distinct boundaries. The medium- and high-coverage images are green, while the low-coverage images are brownish green. The image has a fine texture, clear texture and uniform color.		
Marsh wetlands	Meadow wetlands are patchy or massive with irregular shapes and unclear boundaries. The image is dark green, lighter than swampy meadow but darker than alpine grassland, and the image structure is uniform.		
	Shallow marshes are striped or massive with irregular shapes and clear boundaries. The image is gray brown and has a delicate texture and uneven structure.		

	The geometrical characteristics of deep marshes are not obvious, are irregular in shape, and have a large-scale distribution and clear boundaries. The image is purple-brown and purple-black with a fine texture and uniform structure.		
River and lake	River wetlands are mainly distributed on plateau tablelands and in mountain valleys. They have clear boundaries, regular geometric shapes, and elongated ribbons of brown and purple, with a fine texture and uniform structure.		
	Lake wetlands are mainly distributed in flat regions, and the water body is relatively stable year round. The boundaries of lake wetlands are clear, the geometric shapes are regular, and the image color is purple and brown-green, with a fine texture and uniform structure.		
Aeolian sediments	Aeolian sediments are patchy and feature a piecemeal distribution with irregular shapes and clear boundaries. The images are mainly white and off-white with a fine texture and uniform structure.		

Method S1

First, based on the field GPS information and UAV images, the main types of indicators were established through comparison with the Landsat images (Table S1). Then, the visual interpretation method was adopted to extract information about the marsh wetlands and construction land. This step is necessary because confusion can occur when distinguishing among marsh wetlands, water bodies and grasslands, as well as among aeolian sediments, gravel land and construction land, as it is difficult to define effective classification indices to discriminate among them. The decision tree algorithm was used to automatically classify the remaining land types in ENVI5.3 software. NDWI is used to distinguish marsh wetlands, including meadow wetlands, shallow marshes and deep marshes, because the water content of wetlands varies markedly, and NDWI is an important indicator of vegetation and soil water content. For the division of alpine grassland, gravel land, river/lake and aeolian lands, NDVI was first used to separate grasslands based on the strong response to green vegetation. Second, considering that gravel lands are mostly distributed in high areas, the regions with elevations higher than 3800m are classified as gravel lands. Finally, BI was used to distinguish rivers/lakes and aeolian lands. The threshold values were determined according to the distribution histograms of various characteristic classification variables. The flow chart and method for classifying the LULC types in the study area are shown in Figure S1.

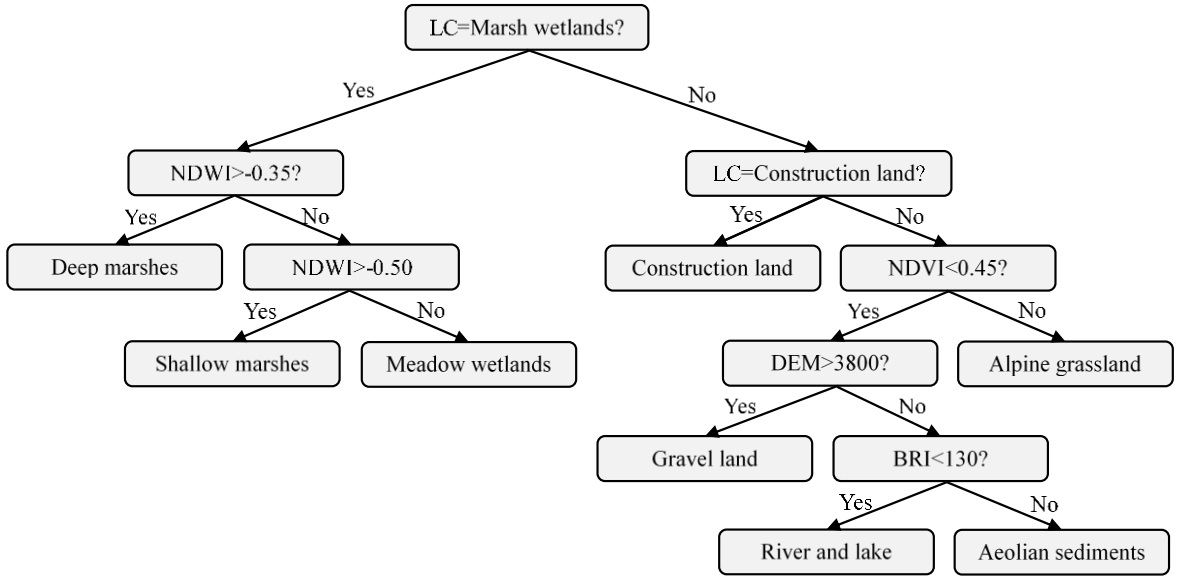


Figure S1. Classification rules for various land use/cover types. LC and BI represent land cover types and brightness components of the tassel transform, respectively.

Method S2

EI_i can measure the degree of disturbance by nature and human factors. It is used to determine the resistance of the landscape pattern to the external disturbance. It is usually characterized quantitatively by the exponentially weighted sum of the landscape indexes, such as landscape fragmentation (C_i), landscape segmentation (S_i) and landscape dominance (DO_i). The formulas are as follow [1-5]:

$$C_i = n_i/A_i \quad (1)$$

where n_i is the patch number of landscape type i, and A_i is the area of landscape i.

$$S_i = D_i/P_i \quad (2)$$

where D_i is the distance index of landscape i; P_i is the area index of landscape i.

$$DO_i = 2ln(P_i/4)/lnA_i \quad (3)$$

where P_i is the perimeter of landscape i in the study area.

$$EI_i = aC_i + bS_i + cDO_i \quad (4)$$

where a, b, and c are the weights of fragmentation, segmentation, and fractal dimension, respectively, of the landscape, and $a + b + c = 1$. According to the relevant research results, $a = 0.5$, $b = 0.3$, and $c = 0.2$.

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