A new vegetation mapping of Qinghai-Tibet Plateau based on terrain-climate-remote sensing

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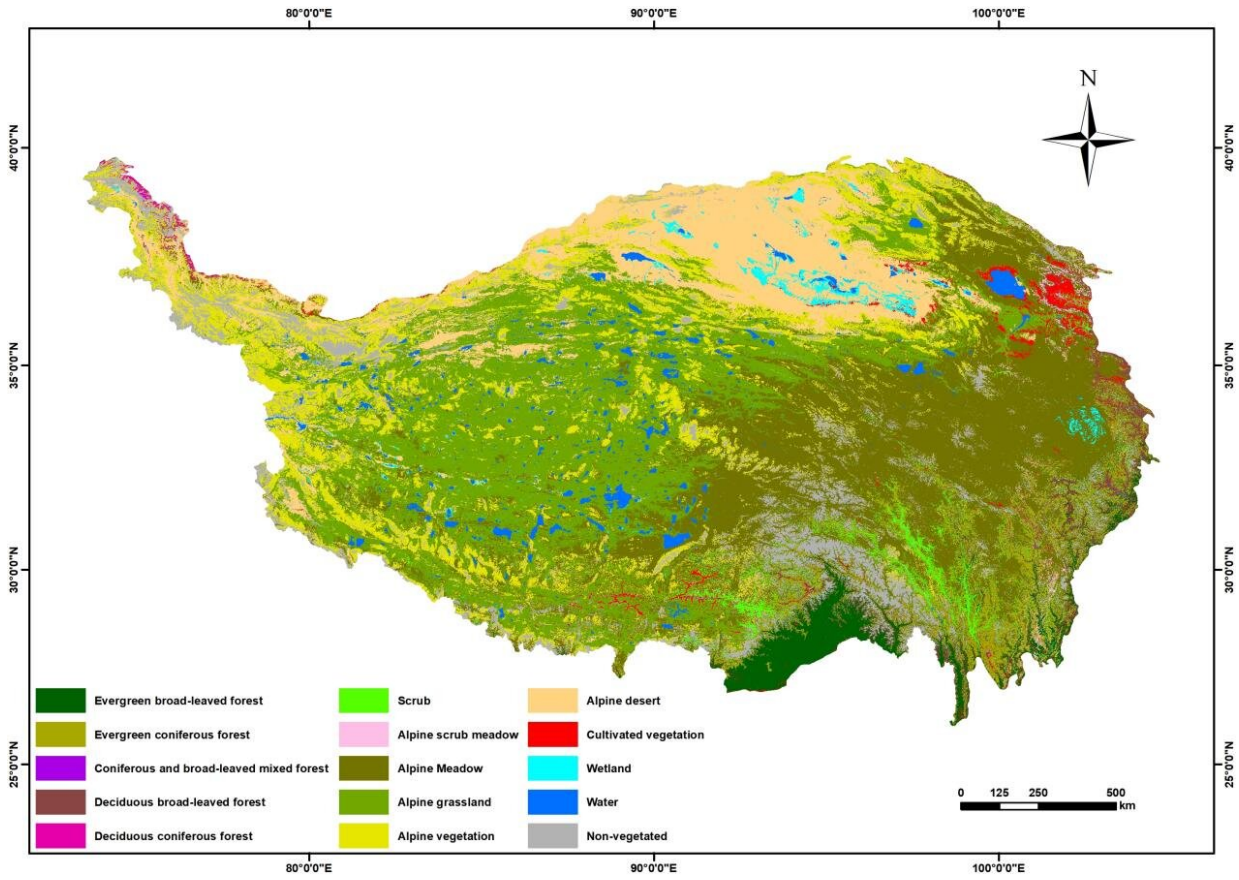

Vegetation types and their spatial distribution at 10 m spatial resolution on the Qinghai-Tibet Plateau in 2020. Credit: Science China Press

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The Qinghai-Tibet Plateau is the roof of the world and the water tower of Asia. It is known as the third pole of the Earth. It is an important ecological security barrier, a strategic resource reserve base, and an important area for preservation of Chinese culture. Obtaining high-precision vegetation types and distribution data is a key to revealing the impact of climate change on the vegetation on the Qinghai-Tibet Plateau.

At present, data on vegetation types and their distribution in the Qinghai-Tibet Plateau are limited. Firstly, the vegetation map of the People's Republic of China (1:1000000) mainly reflects the vegetation types and their distribution from the 1980s to the mid-1990s. Secondly, the grassland area of Qinghai-Tibet Plateau is approximately 1.5 million km^2, including alpine meadow, alpine grassland, alpine scrub meadow, and alpine desert, accounting for approximately 57% of the total area of Qinghai-Tibet Plateau.

Existing land cover products are only classified as grassland type, which cannot reflect the vegetation type of the Qinghai-Tibet Plateau and its response to climate change. Thirdly, alpine vegetation is a unique vegetation type in the Qinghai-Tibet Plateau and is very sensitive to climate change, covering an area of approximately 0.3 million km^2.

Alpine vegetation type was not considered in the existing surface cover products. Finally, the scale of the vegetation map of the People's Republic of China is 1:1000000, whereas the spatial resolution of the existing surface coating products is mostly 30 m or larger, which needs to be improved.

Remote sensing has been widely used to obtain information on land use and land cover types. With the rapid development of satellite remote sensing technology with high spatial and temporal resolution and high spectral resolution, vegetation mapping methods based on automatic classification of satellite remote sensing images have been widely recognized and applied.

In satellite remote sensing mapping, the parameters involved in automatic classification mainly focus on remote sensing band reflectance and its combination with vegetation indices. The high altitude of the Qinghai-Tibet Plateau and the drastic change of its altitude difference make dramatic changes in the weather and climate conditions, resulting in a unique vegetation type and distribution.

Thus, in addition to remote sensing information, climate and terrain information also have important impacts on vegetation mapping on the Qinghai-Tibet Plateau. Thus, this study developed a regional vegetation mapping method based on terrain-climate-remote sensing information using the new generation of earth science data and analysis application platform GEE (Google Earth Engine), random forest classification algorithm, and optimal vegetation mapping characteristics.

This method can provide technical support for obtaining long-term accurate data on regional vegetation types and their distribution and for studying the impact of climate change on vegetation. In order to verify the applicability of the proposed method, the fine-mapping of vegetation over Qinghai-Tibet Plateau with 10 m spatial resolution in 2020 was conducted, in terms of Sentinel-2A/B remotely sensed images, climate, and terrain.

In terms of the out-of-bag accuracy analysis, considering that too few features may lead to low accuracy of vegetation classification and too many features may lead to excess complexity, prolonged running time,

and over-fitting of vegetation type classification, the 11 features of importance were selected as the input features of the random forest classification model of vegetation on the Qinghai-Tibet Plateau: elevation, annual mean temperature, annual precipitation, slope, aspect, LSWI_B8aB11 15% percentile, LSWI_B8aB12 15% percentile, EVI 45% percentile, EVI 90% percentile, CIre 90% percentile, and MNDWI 15% percentile.

The random forest model was established by invoking the random forest classifier of the GEE platform to obtain 10 m spatial resolution vegetation mapping of the Qinghai-Tibet Plateau in 2020.

The overall accuracy of this method for vegetation mapping with spatial resolution of 10 m over the Qinghai-Tibet Plateau in 2020 was 89.5%, and the Kappa coefficient was 0.87 based on vegetation validation samples (790). The mapping accuracy results showed that the mapping accuracy of deciduous broad-leaved forests, alpine scrub meadows, and wetlands was low (