Subpixel mapping of Water Cover with MODIS on Tibetan Plateau

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1.Introduction

The Tibetan Plateau is a high-altitude arid steppe interspersed with mountain ranges and large brackish lakes. The assessment of water resources, both in terms of quantity and quality can provide valuable data on study of climatic change on the Tibetan Plateau. Moderate Resolution Imaging Spectroradiometer(MODIS) data is suitable for water mapping, easy to get and having high temporal and wide spatial coverage. In this paper, we propose a comprehensive methodology to map water cover in Tibetan Plateau with MODIS Surface Reflectance products (MOD09) at 463.51 m resolution. And the method is well-suited to mountainous environment.

2. Material and Methods

The study area (29° 50′ N～40 ° 3′ N, 80° 35′ E～104° 27 ′ E) is located in the Tibet Autonomous Region of China, and the MOD09 products are acquired on September 31 in 2003. Multi-index end-member selecting algorithm was applied to identify end-members including water, forest, grasslands, barren and cloud. Based on the character of land cover spatial distribution, a typical-and-near end-member selecting method and a fully constrained linear unmixing method were adopted to unmix the mixed pixels. A trial-and-error strategy was employed to find the best set of end-members that would enable robust estimation of water cover. We used five typical end-members and five near end-members to produce a best fit solution with a minimum residue. A visual inspection clearly showed that shadow induces errors of the mapping result, due to low reflectance of both shadow and water in all the 7 bands of MOD09. So a final filtering of the water maps was processed using DEM and temperature products acquired from Shuttle Radar Topography Mission

(SRTM) and MODIS (MOD11) respectively. Shadow masks which account for slopes facing away from the solar rays were identified using shadow algorithm with DEM data. The difference between daytime Land Surface Temperatures (LST) and nighttime LST derived from the MOD11 was used to remove spurious pixels unlikely to contain any water by empirical threshold segmentation.

3. Results

ETM+ images at 30 m spatial resolution and ASTER images at 15 m spatial resolution were selected to assess the accuracy of subpixel water fraction maps. Both water maps, from which shaded areas were removed, were produced using the Normalized Difference Water Index (NDWI), and then were aggregated to the resolution of the MODIS water maps using a mean operator. We compared the MODIS water maps with the ETM+ water maps and ASTER water maps respectively using total water cover area, pixel based metrics and visual inspection. The comparisons indicate that the details of the river can be well revealed using the new methodology; at the same time the impact of shadow can be removed, and the final water maps with MODIS have a high accuracy.