GLACIER AREA AND SNOW COVER CHANGES IN THE RANGE SYSTEM SURROUNDING TARIM FROM 2000 TO 2020 USING GOOGLE EARTH ENGINE

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1. Introduction

Glacier and snow are sensitive indicators of regional climate variability. In the early 21st century, glaciers in the West Kunlun and Pamir regions showed stable or even slightly positive mass budgets, and this is anomalous in a worldwide context of glacier recession. The analysis was focused on the high mountain ranges surrounding the Tarim Basin, where the spatial distribution of snow cover is quite variable. The study was based on multi-temporal remote sensing data to monitor glacier and snow cover area in the Tarim Basin high mountain area. MODIS data was used to calculate the Normalized Difference Snow Index (NDSI) and a threshold was applied to extract the Tarim Basin glacier area and seasonal snow cover. Between 2000 and 2020, the total area of the Tarim Basin Glacier declined at a rate of 0.94% per year. Because of differences in atmospheric circulation and environmental conditions, changes in the glacier area of the Tarim Basin show differences across five sub-regions. The rate of glacier area loss was fastest (2.98% per year) in the East Tian Shan, while Pamir Mountains and East Kunlun had the slowest rates, i.e. 0.50% per year and 0.81% per year, respectively.

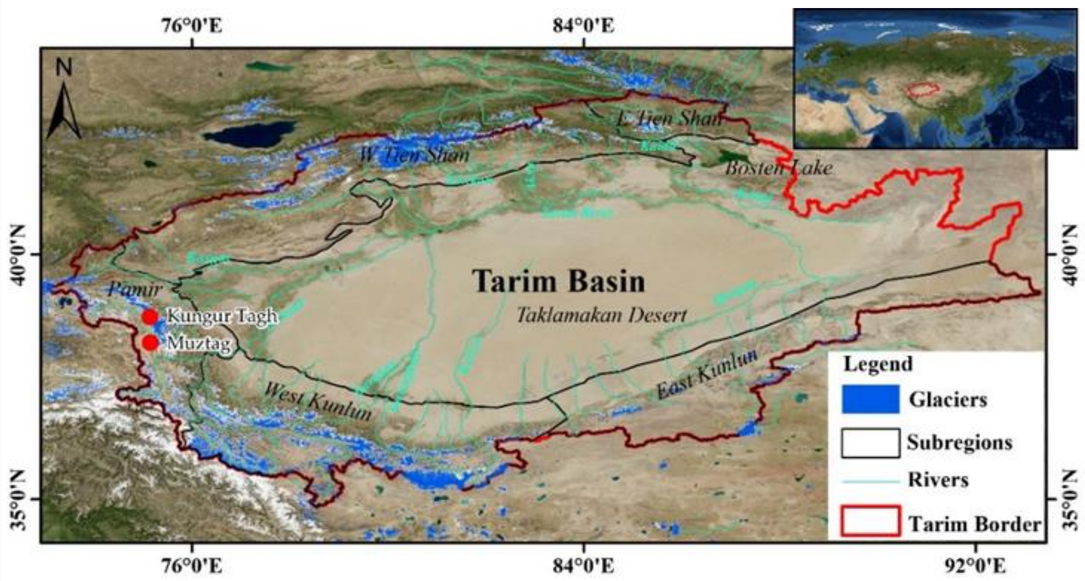


Figure 1. Map of the Tarim Basin. Glacierized areas and the boundary of the Tarim Basin are indicated.

2. Data and Method

2.1 Data

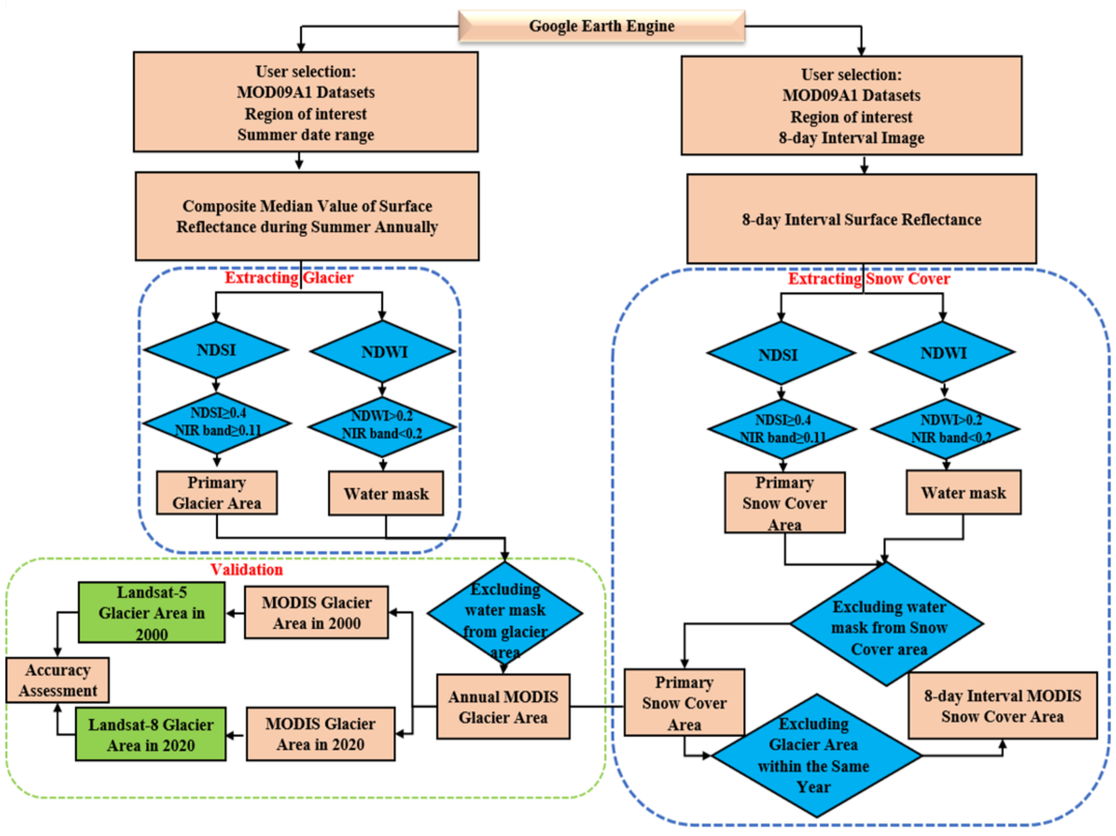
We evaluated snow cover based on the MODIS 8-day composite images between 18 February 2000 and 25 January 2021.

2.2 Extracting Glacier Area

NDSI can be applied to discriminate glacier/snow from many other land cover features and decreases the influence of atmospheric effects and viewing angles. This is achieved by normalizing the spectral difference between Green and SWIR to their sum:

$$NDSI = \frac{Green - SWIR}{Green + SWIR} \quad (1)$$

2.3 Method



3. Results and Analysis

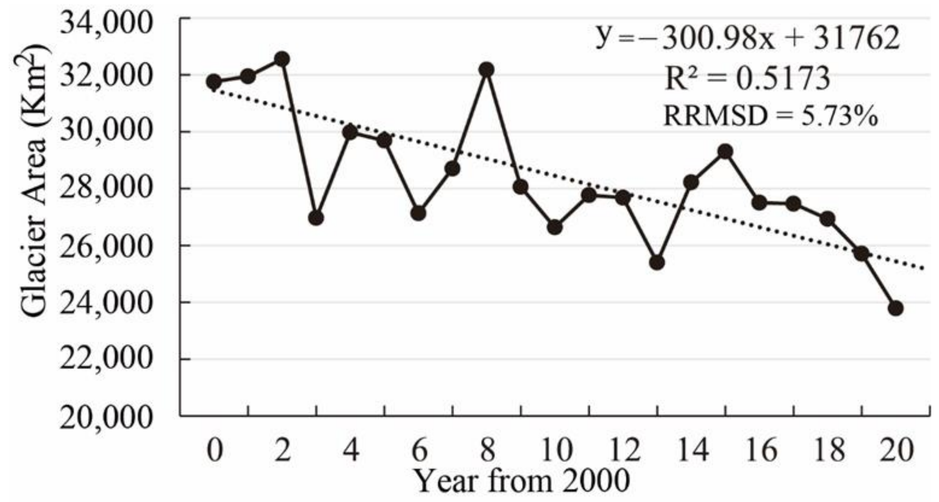


Figure 2. Annual glacier area in the Tarim Basin from 2000 to 2020 based on MODIS 500 m summertime composite images.

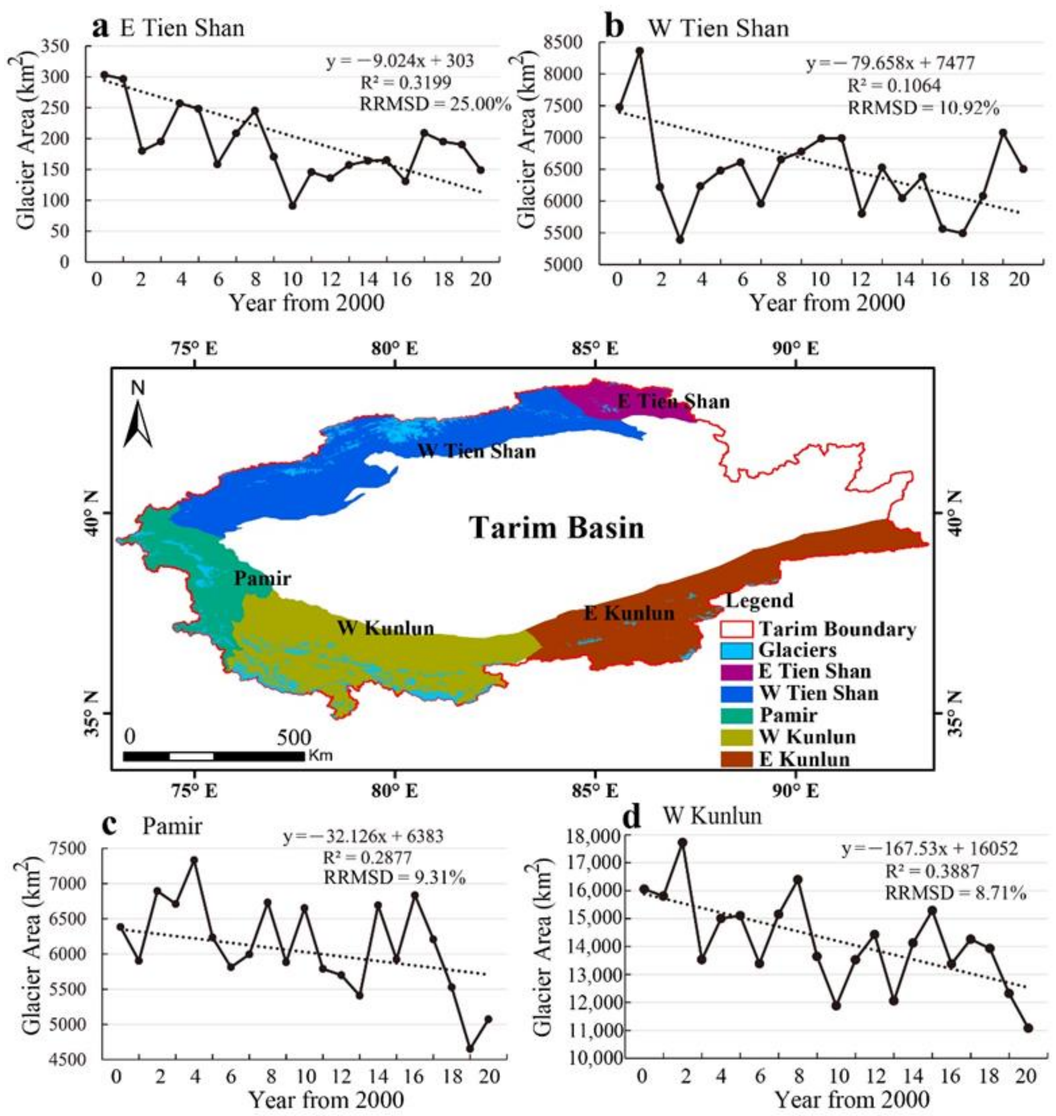


Figure 3. Evolution of annual glacier area in the subregions of the Tarim Basin in 2000–2020: (a) E Tien Shan; (b) W Tien Shan; (c) Pamir; (d) W Kunlun; (e) E Kunlun. The central map shows the study area and the five subregions with the location of glaciers.

4. Conclusion

Glacier area extraction from satellite images is an important aspect of glacier mapping and studies on glacier changes. The major innovation in our method is the use of the median surface reflectance to composite several images pixel by pixel. This does not require that cloud-free observations of all pixels are available on the same day, just that a sufficient number of cloud-free samples is acquired for each pixel. The composite image improves the reliability of estimated change in glacier area, because the median is a robust statistic. Changes in glacier and intermittent snow area between 2000 and 2020 were first evaluated for the entire Tarim Basin. The results show that the glacier area decreased by 7975.71 km^2 (25.11%), with the annual rate of decrease being 0.94%/a.