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Lake Chad vegetation cover and surface water variations in response to rainfall fluctuations under recent climate conditions (2000−2020)

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Abstract

Monitoring the evolution of the Sahelian environment is a major challenge since the great Sahelian droughts marked by significant environmental consequences and social impacts. We combined remote sensing images with a water level database from the Hydroweb project to determine the response of Lake Chad vegetation cover and surface water variations to rainfall fluctuations in the Lake Chad watershed under recent climate conditions. The variance in lake surface water levels was determined by computing the monthly anomaly time series of surface water height and area. The spatiotemporal variability of watershed rainfall and vegetation cover of Lake Chad was highlighted through multivariate statistical analysis. The results show an increase in watershed rainfall, vegetation cover, and surface water area and height, as their slopes were all positive i.e., 5.1 10 −4 (mm/day); 4.26 10 −6 (ndvi unit/day); 1.2 10 −3 (km 2 /day) and 6 10 −5 (m/day), respectively. The rainfall variations in the watershed drive those of Lake Chad vegetation cover and surface water, as the rainfall trend was strongly and positively correlated with those of vegetation cover (0.79), surface water height (0.57), and area (0.53). The time lag between the watershed rainfall fluctuations and lake surface water variations corresponded to approximately ∼112 days. Between rainfall variations and vegetation cover changes, the time lag was <16 days in the western shores of the lake and on both sides of the great barrier, about 16 days in the bare soils of the northern basin and the eastern part of the south basin, and >64 days in the marshlands of the southern basin. This research provides a robust method that computes the variances of the lakes trends and seasonality and correlates them with the variances of climate changes. The correlations obtained have strong potential for predicting future changes in lake surface water worldwide.

Keywords

Sahel, Lake Chad, Rainfall, Spatiotemporal changes