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Reconstructing daily and seasonal surface water dynamics in Lake Chad with Global WaterPack Time Series

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The Lake Chad is an endorheic lake in Sahelian Africa, with an extension to hyper arid areas. The lake basin is not exempt from global environmental changes which significantly affect fresh water resources across the globe. Despite a plethora of research on lake Chad, the daily and seasonal surface water dynamics is not clearly understood. This study probes to reconstruct the daily and seasonal surface water dynamics, change points and trends in lake Chad with a novel global daily surface water time series dataset (2003 – 2022). The key methods involved time series decomposition and filtering, trends analysis with Mann Kendall Tau and Sen's Slope, and change point detection of abrupt shifts in daily and seasonal surface water time series. The results showed that lake Chad water depicts marked seasonal patterns. The maximum water area in all the pools is registered between the months of December – January and the inter-seasonal surface water area varies between ~1500 km^2 to ~3800 - 4000 km^2. On daily time scale, the southern pool shows high water area above 2400 km^2 at the start and end of each year with the exception of drought years (2006 – 2017). For wet years (2004, 2018, 2019, 2020, 2021), surface water area between day 1 to around day 66, and 301 to 365/6 ranges between 2200km^2 to about 2400km^2. With the exception of extreme dry years, the water area between the rest of 67 – 300 days of the year is between 1600km^2 – 2000km^2. In contrast, the northern pool's maximum water area ranges between 1600km^2 to ~1700km^2. With the exception of 2004, 2012, 2013, 2015, 2020 and 2021, the northern pool only fluctuates between ≤ 200km^2 to ~800km^2, which only stays for few days of the year. While surface water area coverage is quasi-stable across all seasons in the southern pool, the northern pool only has minimal water coverage from April to October yearly. Mean annual water coverage in lake Chad varied from 2953km^2 to 3114km^2 between 2004 and 2021 respectively. Meanwhile between 2005 – 2012 and 2016 – 2019, surface water area is below 2500km^2. While the southern pool remains somewhat stable, the northern pool shows recovery and dwindling phases. Within the monitoring period, two abrupt changes were identified on the cycle of lake Chad, a decreasing trend between 2003 – 2012 (2275km^2) and an increasing trend from 2013 to 2022 (2745km^2), $p = 0.000$. In conclusion, the study found that lake Chad is slowly recovering as revealed by statistical trend analysis (*Tau = 0.157*, *Sen's slope = 0.0782* and $p = 0.012$), with an annual average increase of 28.543km^2.