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Strengthening of carbon and water cycle connection in response to rising aridity in India

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Abstract

Climate change, anthropogenic activities and frequent extreme events have caused significant changes in vegetation cover, photosynthetic activity, and productivity around the world in recent decades. At the same time, in the global warming scenario around 40% of land is experiencing moisture stress. India, is the second largest contributor to global greening, has an agrarian economy and lies in tropical region with higher carbon uptake potential. Henceforth, it is it is critical to investigate recent changes in carbon-water cycle interactions in India. However, the scarcity of data, the extensive computational requirements, and the complex biosphere-atmosphere-hydrosphere interactions make accurate monitoring difficult, particularly in India. We use remote sensing data, a suite of advanced statistical techniques, including machine learning algorithms like random forest and causal analysis, to determine recent changes in carbon-water cycle in India. Soil moisture (SM) has direct causal links with carbon use efficiency (CUE) and its drivers. SM also has the strongest control on the changes in photosynthetic activity, CUE and water use efficiency (WUE) in India during recent decades. However, there is rising aridity in terms of SM, Climatic Water Deficit (CWD) and Vapour Pressure Deficit (VPD) in India. There is a decline in photosynthetic activity (browning), decline in CUE and increase in WUE in response to rising aridity in regions of higher CUE (> 0.6) and WUE (> 1.2), like northeast, lower Indo-Gangetic Plain and South India. The efficient carbon sinks in India are weakening due to rising aridity, deforestation and extreme events in recent decades. Our study reveals that the carbon-water cycle connection in India is strengthened in recent decades as a response to climate change and anthropogenic intrusions.

Keywords

Vegetation Dynamics; Carbon Use Efficiency (CUE); Water Use Efficiency (WUE); Aridity; Remote Sensing Big Data; Machine Learning