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Satellite derived estimates of forest leaf area index in South-west Western Australia are not tightly coupled to inter-annual variations in rainfall: implications for groundwater decline in a drying climate.

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There is increasing concern that widespread forest decline could occur in regions of the world where droughts are predicted to increase in frequency and severity as a result of climate change. Ecological optimality proposes that the long term average canopy size of undisturbed perennial vegetation is tightly coupled to climate. The average annual leaf area index (LAI) is an indicator of canopy cover and the difference between the annual maximum and minimum LAI is an indicator of annual leaf turnover. In this study we analysed satellite-derived estimates of monthly LAI across forested coastal catchments of South-west Western Australia over a 12 year period (2000-2011) that included the driest year on record for the last 60 years. We observed that over the 12 year study period, the spatial pattern of average annual satellite-derived LAI values was linearly related to mean annual rainfall. However, inter-annual changes to LAI in response to changes in annual rainfall were far less than expected from the long-term LAI-rainfall trend. This buffered response was investigated using a physiological growth model and attributed to availability of deep soil moisture and/or groundwater storage. The maintenance of high LAIs may be linked to a long term decline in areal average underground water storage storage and diminished summer flows, with a trend towards more ephemeral flow regimes.