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# Mapping 35 years of change in Leaf Mass per Area across the globe from multispectral satellite data

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With thousands of plant functional trait observations across the world, there is still a lack of spatially and temporally explicit estimates of traits that help inform how biodiversity, ecological and biogeochemical processes are changing across the globe. The Leaf Mass per Area (LMA) is a key trait that influences plant ecological strategies, and it is strongly correlated with leaf photosynthesis, plant growth, vegetation primary production and decomposition rates. Based on biophysical principles of the radiative transfer in canopies, we designed a new multispectral remote sensing index that is highly sensitive to the community weighted mean of LMA. We called this index iLMA, as an acronym for “index for LMA''. We tested and calibrated this index with ground data of a wide range of forest types and herbaceous communities collected at 510 plots from 77 sites located in the American continent ($R^2$ = 0.64). Using Landsat imagery, iLMA and the resulting calibrating equation, we made a 30m resolution global map of LMA. The LMA spatial pattern is consistent with our current understanding of LMA variation across major terrestrial biomes but at an unprecedented high-resolution. Then, we used Landsat imagery from 1985 to 2019 to produce yearly global estimates of LMA and map its rate of change. This map of change in LMA indicates that there has been a widespread decrease in LMA across the globe over the last 35 years, with the fastest and strongest declines happening in evergreen conifer forests in boreal and mountainous regions of the world, and tropical evergreen broadleaf forests in Africa and Asia. We discuss potential causes of such widespread decrease in LMA, including climate change and widespread changes in vegetation composition and structure, and its potential consequences for biogeochemical processes.