

Supplementary Material

On the fractal dimension of ecotones among African vascular plants

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Fig. S1 An illustration of the box-counting fractal dimension method, where A to G sequentially exhibit a corresponding number of boxes at different arbitrary sizes tracing a fractal line segment to its initial form. This procedure necessitates the application of a fractal dimension to spatially characterise fractal structures.

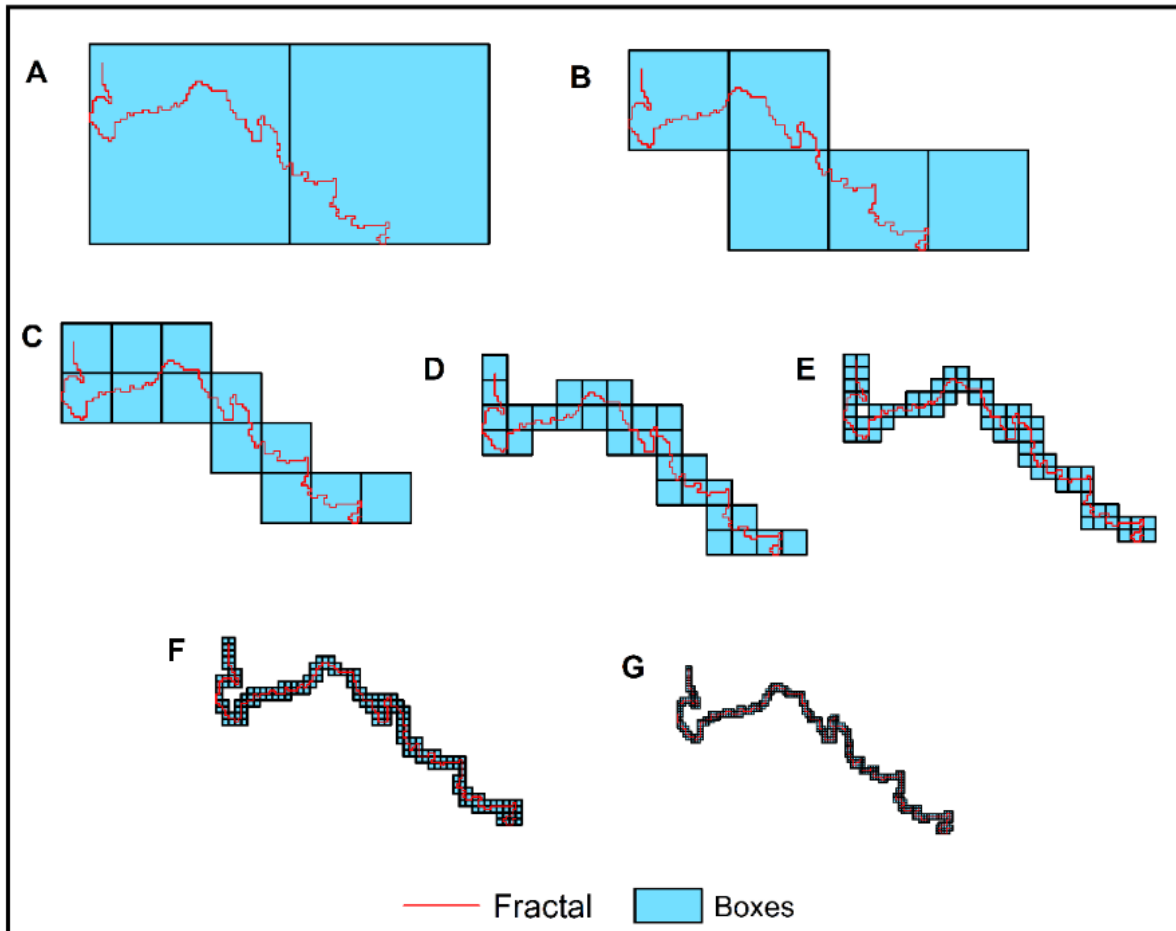


Table S1 Detailed description of predictors used in this study.

Δ Predictor	Unit	Code	Description	Environmental data origins and source
Δ Mean annual precipitation	mm	MAP	Difference in mean annual precipitation calculated as the absolute difference in the mean values of the mean annual precipitation between two adjacent clusters of an ecotone	Data was based on the annual total precipitation estimating the total water inputs, based on the mean of the years 1970-2000 at 5 minutes spatial resolution (~10km) http://www.worldclim.org/
Δ Mean annual temperature	°C	MAT	Difference in mean annual temperature calculated as the absolute difference in the mean values of the mean annual temperature between two adjacent clusters of an ecotone	Data was based on the annual mean temperature estimating the total energy inputs, based on the mean of the years 1970-2000 at 5 minutes spatial resolution (~10km) http://www.worldclim.org/

Table S1 Detailed description of predictors used in this study [Cont.].

Δ Predictor	Unit	Code	Description	Data Source
Δ Soil clay content	g/100g (%)	SCC	Difference in soil clay content calculated as the absolute difference in the mean values of the soil clay content between two adjacent clusters of an ecotone	Data was based on the proportion of clay particles (< 0.002 mm) in the fine earth fraction for topsoil interval (0-5cm) at 250m spatial resolution https://soilgrids.org/
Δ Soil sand content	g/100g (%)	SSC	Difference in soil sand content calculated as the absolute difference in the mean values of the soil sand content between two adjacent clusters of an ecotone	Data was based on the proportion of sand particles (> 0.05 mm) in the fine earth fraction for topsoil interval (0-5cm) at 250m spatial resolution https://soilgrids.org/

Table S1 Detailed description of predictors used in this study [Cont.].

Δ Predictor	Unit	Code	Description	Data source
Δ Bulk density	kg/dm ³	BD	Difference in bulk density calculated as the absolute difference in the mean values of the bulk density between two adjacent clusters of an ecotone	Data was based on the bulk density of the fine earth fraction for topsoil interval (0-5cm) at 250m spatial resolution https://soilgrids.org/
Δ Soil pH	pH	PH	Difference in soil pH calculated as the absolute difference in the mean values of the soil pH between two adjacent clusters of an ecotone	Data was based on the pH of soil for topsoil interval (0-5cm) at 250m spatial resolution https://soilgrids.org/

Table S1 Detailed description of predictors used in this study [Cont.].

Δ Predictor	Unit	Code	Description	Data source
Δ Soil organic carbon	g/kg	SOC	Difference in soil organic carbon calculated as the absolute difference in the mean values of the soil organic carbon between two adjacent clusters of an ecotone	Data was based on the soil organic carbon content in the fine earth fraction for topsoil interval (0-5cm) at 250m spatial resolution https://soilgrids.org/
Δ Topographic roughness	m	TR	Difference in topographic roughness calculated as the absolute difference in the mean values of the topographic roughness between two adjacent clusters of an ecotone	Data was based on the standard deviation of elevation, obtained as the 2000 shuttle radar topography mission (SRTM) digital elevation model (DEM) at spatial resolution of 90m http://srtm.csi.cgiar.org/

Table S1 Detailed description of predictors used in this study [Cont.].

Δ Predictor	Unit	Code	Description	Data source
Δ Human footprint	Cumulative human pressure	HFP	Difference in human footprint calculated as the absolute difference in the mean values of the human footprint between two adjacent clusters of an ecotone	Data was based on a layer of cumulative measure based on eight pressures (built environments, crop lands, pasture lands, population density, nightlights, railways, roads and navigable waterways) humans place on nature for 2009 at 1 km spatial resolution https://sedac.ciesin.columbia.edu/
Δ Fire frequency	no. of times a pixel burnt	FF	Difference in fire frequency calculated as the absolute difference in the mean values of the fire frequency between two adjacent clusters of an ecotone	Data was based on a derived fire frequency representing the number of times a pixel burnt for the period 2003-2016 based on the global fire atlas at 500m spatial resolution https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1642

Table S1 Detailed description of predictors used in this study [Cont.].

Δ Predictor	Unit	Code	Description	Data source
Δ Geographic extent	no. of grid cells	EXT	Difference in cluster size calculated as the absolute difference in the mean values of the cluster extent between two adjacent clusters of an ecotone	Data was based on cluster membership, Extracted from cluster attribute information
Δ Latitude	m	LAT	Difference in latitude calculated as the absolute difference in the mean values of the latitude between two adjacent clusters of an ecotone. North and South latitudes were treated equally. Area-weighted mean was not considered, due to maintaining a degree of consistency with all other predictors	Data was based on latitude spatial attribute embedded in the predictors data

Fig. S2 Maps showing bioregion delineations adapted from (Olson & Dinerstein 2002) on the top panel and on the bottom (Dinerstein et al. 2017).

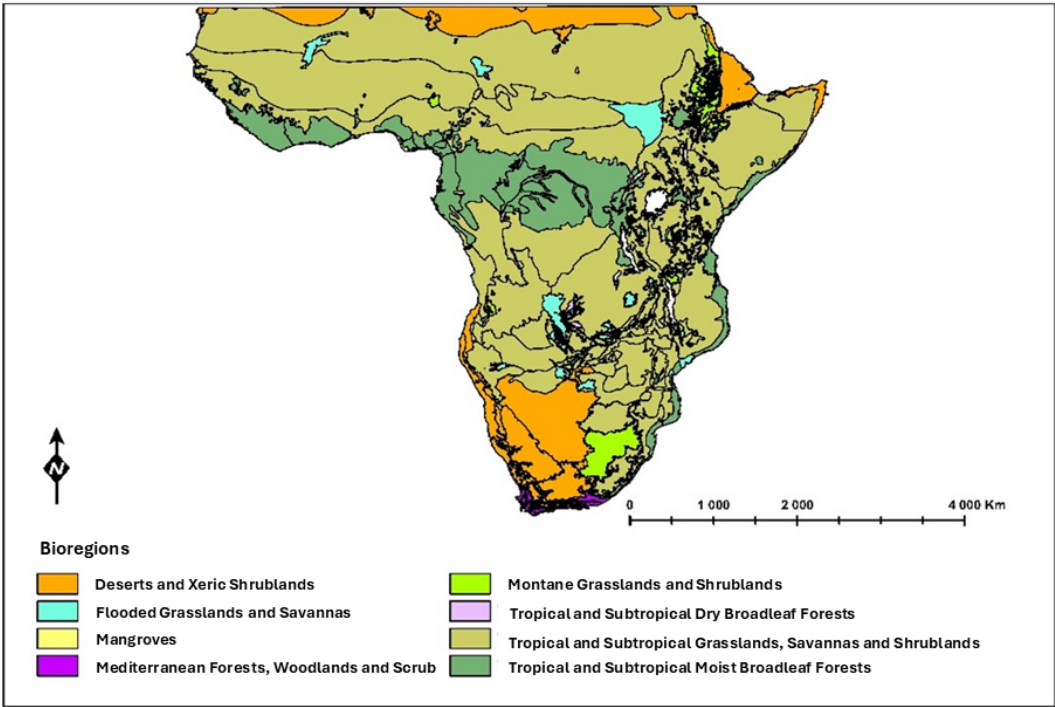
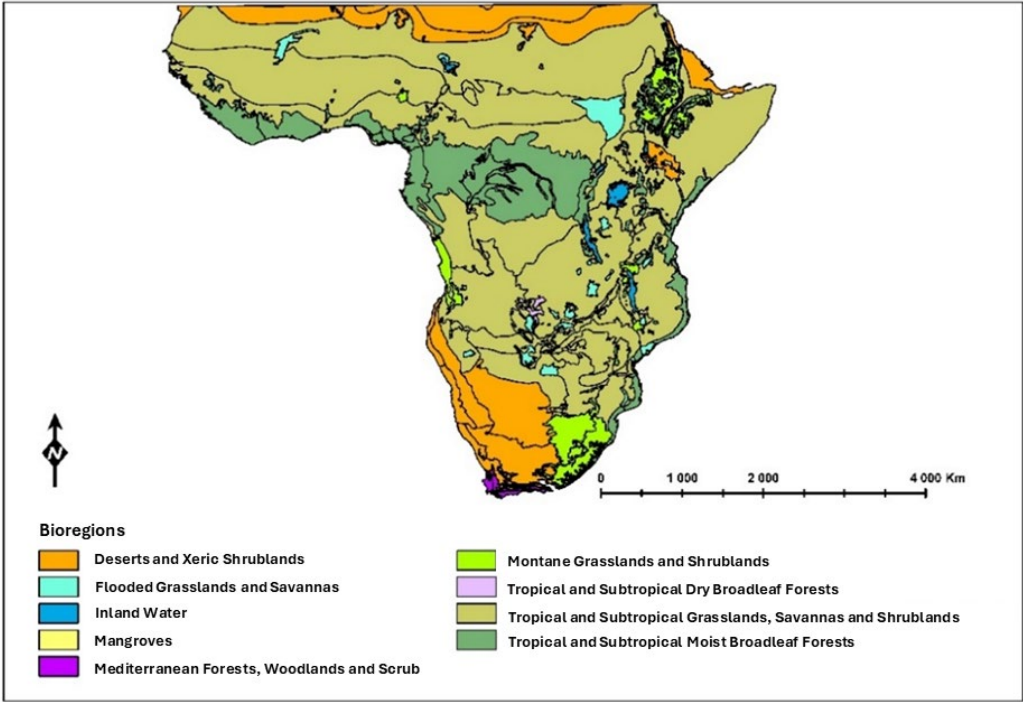


Fig. S3 Map showing 11 bioregions of African vascular plants spatially distributed across mainland sub-Saharan Africa, based on the CLARA partitioning algorithm (silhouette coefficient = 0.48) The jagged lines indicate the present-day ecotones.

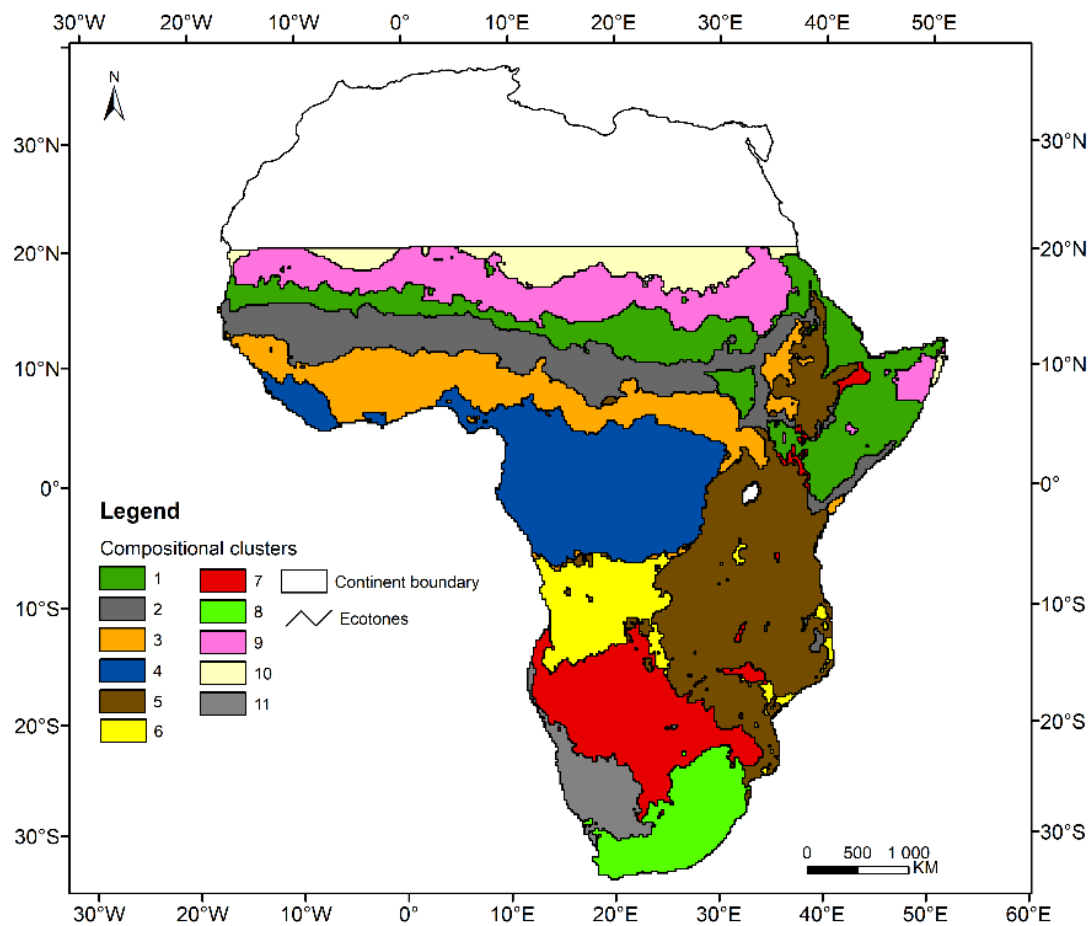


Fig. S4 Log-log plots of the box-counting fractal dimension (FD), demonstrating the relationships between the number of boxes covering an ecotone ($N[r]$) and the linear dimension of the box (r). Each slope indicates the fractal dimension of seven present-day ecotones, coinciding with sharp boundaries that reflect characteristically smoother spatial patterns and sharp changes in plant species composition in mainland sub-Saharan Africa.

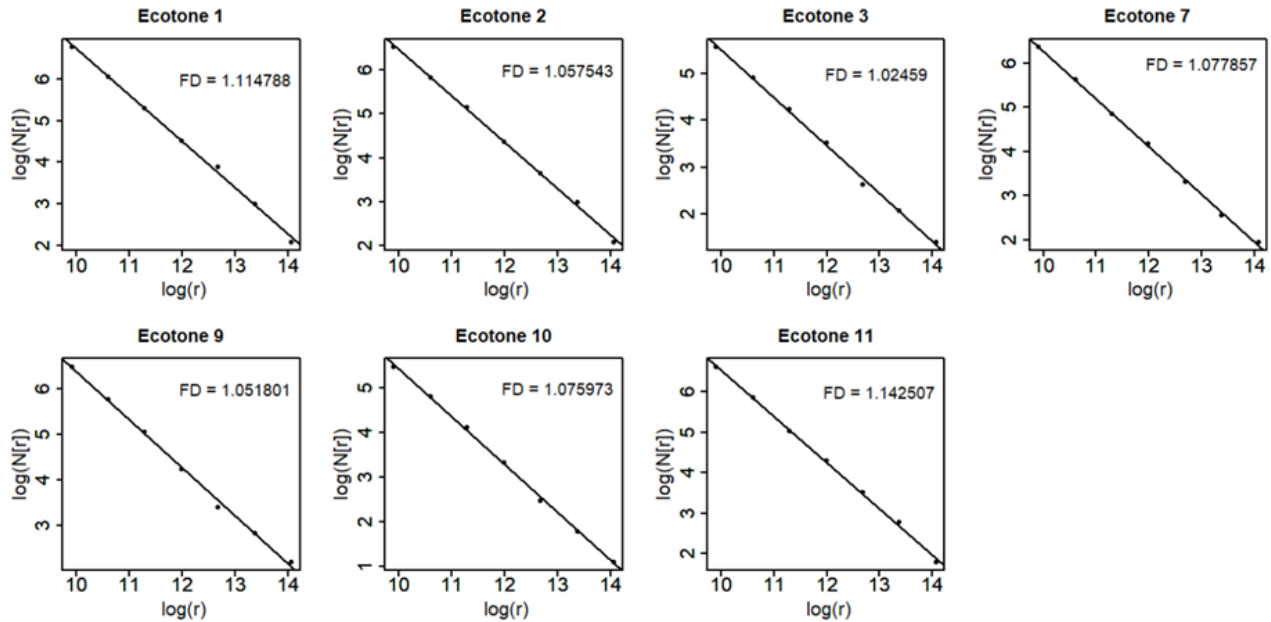


Fig. S5 Bivariate plot from the single-predictor generalised additive model, depicting the response of the fractal dimensions of present-day ecotones to the smoothed absolute difference of soil organic carbon ($P = 0.07$). Ticks above the horizontal axis indicate the data distribution; shaded areas represent the confidence interval.

