nature portfolio

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Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☒	☐	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☒	☐	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☒	☐	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☒	☐	A description of all covariates tested
☒	☐	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Based on Google Earth engine platform, Landsat5/7/8/9 surface reflectivity data, terrclimate meteorological data acquisition and Hansen forest dynamic data were obtained. The above data have been pre-processed and directly provided to users.
Data analysis	This study employed two custom Python algorithms to analyze forest distribution and fragmentation patterns. The Four-Directional Forest Boundary Detection Algorithm was implemented using Python 3.9 to process binary forest distribution images and compute the distance of each forest pixel to the nearest border in four cardinal directions: east, south, west, and north. By efficiently identifying edge-to-internal gradient distances, this algorithm reduces computational redundancy and facilitates ecological studies related to forest edge effects.The Distributed Fragment Connectivity Identification (DFCI) Algorithm was also developed in Python 3.9 to analyze large-scale, highly fragmented forest datasets. By utilizing a distributed computing approach, the algorithm systematically identifies and links forest patches, overcoming memory limitations in processing extensive binary forest maps. This enables scalable and efficient assessment of forest fragmentation patterns and ecological connectivity. We used a geographic detector algorithm deployed in R environment to explore the driving factors of forest productivity at different levels of fragmentation (see Wang JF, Li XH, Christakos G, Liao YL, Zhang T, Gu X & Zheng XY. 2010.Geographical detectors-based health risk assessment and its application in the neural tube defects study of the Heshun region, China. International Journal of Geographical Information Science 24(1): 107-127.); Meanwhile, the subsequent data analysis was all based on local software, including 1) fishing net generation software (ArcGIS10.8);2) Forest landscape pattern index calculation software (Fragstats4.2); 3) The entropy weight method was used to assign three indices to build FFGI(office2019);

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

The Hansen Global Forest Data of 2000 and 2023 is available at https://code.earthengine.google.com/?scriptPath=Examples:Datasets/UMD_hansen_global_forest_change_2023_v1_11;The Landsat 5 TM/ 7ETM+/ 8 OLI/ 9 OLI-2 can be found at https://developers.google.com/earth-engine/datasets/catalog/landsat?hl=zh-cn;The Climate dataset can be found at https://developers.google.com/earth-engine/datasets/catalog/IDAHO_EPSCOR_TERRACLIMATE;The kNDVI datasets is available at https://code.earthengine.google.com/2732a2f441cf7effa91d47355d3784b5;The fishnet dataset can be found at https://github.com/rodericklr/kNDVI_Analysis.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	This information has not been collected.
Reporting on race, ethnicity, or other socially relevant groupings	This information has not been collected.
Population characteristics	This information has not been collected.
Recruitment	This information has not been collected.
Ethics oversight	This information has not been collected.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	From the perspective of a two-dimensional framework of forest-interior gradient distances and landscape patterns, a comprehensive and understandable FFGI index was constructed to quantitatively assess the fragmentation of African tropical forests and its impact on productivity and stability in 2000 and 2023 on a 5km×5km grid scale. At the same time, the driving factors of forest productivity change (temperature, precipitation, radiation and wind speed) under different fragmentation degrees were explored.
Research sample	The samples used in this study cover the forest pixels (30m×30m) of African tropical forests in 2000 and 2023, which are 4314.18×10000 and 5312.58×10000, respectively, and about 404,234 5km×5km grids. Forest data are sourced from the Hansen dataset, which currently provides year-by-year forest change data from 2000-2023.
Sampling strategy	In order to make the research results global and representative, this study used any forest pixel with a forest coverage rate greater than 25% in the study area to study the impact of forest fragmentation on productivity and response to climate change.
Data collection	In this study, original data such as forest layer data and meteorological data are all derived from Google earth engine cloud platform, while kNDVI is calculated based on GEE and Landsat remote sensing data. The above data are collected and processed by the author.
Timing and spatial scale	Africa is more fragmented in these years, and Hansen data records the forest loss in any region of the world until 2023, so the time scale is 2000 and 2023; In addition, in a huge study area in Africa, the spatial scale is too small to consume computing power and cannot take into account the fragmentation of large forest patches, while the spatial scale is too large to ignore the spatial details, so the spatial scale is set at 5km×5km.
Data exclusions	Pixels that are forest in 2000 but not forest in 2023 are excluded, because this study focuses on the impact of forest fragmentation

Data exclusions	on forest productivity and the response to climate. If the kNDVI of the corresponding pixel is no longer the forest when the forest land type changes, the result will be biased.
Reproducibility	This study has strong reproducibility, because the author tried to compare the impact of the degree of forest fragmentation on productivity in 2013, and found that compared with 2023, when the degree of fragmentation is maintained to a certain degree, the productivity is maintained to a higher degree, and when the productivity exceeds a certain threshold, the productivity decreases with the increase of the degree of fragmentation.
Randomization	The FFGI constructed in this study is based on the normalization and objective weighting of the three landscape indices based on the entropy weight method (EWM), and then the FFGI is divided into 5 fragmentation degree levels based on equal spacing, and the samples are divided according to this algorithm, which has been proved to be completely objective and scientific
Blinding	The ecological field of this study is based on the real reflection of remote sensing data, and the analysis method used is a completely objective EMF algorithm, so blinding is not applied.

Did the study involve field work? ☐ Yes ☒ No

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☐	☒ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Dual use research of concern

Policy information about dual use research of concern

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes
☒	☐ Public health
☒	☐ National security
☒	☐ Crops and/or livestock
☒	☐ Ecosystems
☒	☐ Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes	
☒	☐	Demonstrate how to render a vaccine ineffective
☒	☐	Confer resistance to therapeutically useful antibiotics or antiviral agents
☒	☐	Enhance the virulence of a pathogen or render a nonpathogen virulent
☒	☐	Increase transmissibility of a pathogen
☒	☐	Alter the host range of a pathogen
☒	☐	Enable evasion of diagnostic/detection modalities
☒	☐	Enable the weaponization of a biological agent or toxin
☒	☐	Any other potentially harmful combination of experiments and agents

Plants

Seed stocks	This information has not been collected.
Novel plant genotypes	This information has not been collected.
Authentication	This information has not been collected.