nature research

Corresponding author(s): Marcell Peters

Reporting Summary

Nature Research 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 Research policies, see Authors & Referees and the Editorial Policy Checklist.

Statistical parameters

When statistical analyses are reported, confirm that the following items are present in the relevant location (e.g. 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
☒	☐	An indication of 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 statistics 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
☐	☒	Clearly defined error bars *State explicitly what error bars represent (e.g. SD, SE, CI)*

Our web collection on statistics for biologists may be useful.

Software and code

Policy information about availability of computer code

Data collection	Original data was downloaded as csv files with permission of data owners via the KiLi data base or send by personal emails. All data was originally stored as csv files (handled with Microsoft Excel 2013) and imported into R version 3.3.0 using the R Studio (version 1.0.44) programme.
Data analysis	All data analyses was conducted in R 3.3.0 via R studio (version 1.0.44) and the following R packages: mgcv (1.8-23), vegan (2.5-1), reshape2 (1.4), MuMIn (1.40.4), gdata (2.18.0), phyloseq (1.19.1), HMR (0.4.2), randomForest (4.6-14); To analyze LAI data the programme FV-2200 (LI-COR Bioscience USA, 2011) was used.

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/reviewers upon request. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research 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 list of figures that have associated raw data
- A description of any restrictions on data availability

The data that support the findings of this study are documented and archived in the central project database of the DFG-Research Unit 1246 (https://www.kilimanjaro.biozentrum.uni-wuerzburg.de) and are available from data owners upon reasonable request. Data will be published in September 2020 via GFBio (https://www.gfbio.org/), following the Rules of Procedure of the German Research Foundation (DFG) and the DFG-Research Unit 1246.

Field-specific reporting

Please select 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/authors/policies/ReportingSummary-flat.pdf

Ecological, evolutionary & environmental sciences study design

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

Study description	In the study we tested the effects of climate (mean annual temperature and precipitation, quantitative variable) and land use (measured by the quantitative LUI index) on species richness (vascular plants, animals, microbes; all quantitative), species composition (plants, animals, microbes) and 30 ecosystem functions (all quantitative) along a 3.6 km elevation gradient on Mt. Kilimanjaro. For most response variables the sample size was 60; for few response variables the sample size was lower as data was missing for some study sites. The sample size is indicated for each response variable in the method section. As all study sites were geographically seperated by a distance of at least 300 m and 97% of all study site pairs were seperated by >2 km we considered study sites as independent replicates and used simple ordinary linear models (e.g. linear regression) for nearly all of the analyses.
Research sample	All data (species richness, species composition, ecosystem functions; climate data, land use data) was collected on 60 study sites distributed on the south-south-eastern slopes of Mt. Kilimanjaro. The sample size for most analyses was N = 60. For each response variable the sample size is given in the method section.
Sampling strategy	The number of study sites represents a balance between good statistical power and feasability. It was not chosen with a single specific variable in mind (as we targeted in total 36 response variables) but based on our large experience in the analyses of ecological data sets.
Data collection	Data was collected between 2011 and 2016 by the author and a majority of coauthors (M.K.P., A.H., T.A., J.B., C.B., A.C., F.D., A.E., S.B.F., S.W.F., F.G., F.G., A.G., M.H.-B., C.H., W.J.K., A.K., A.M., E.M., C.N., H.N., I.O., H.P., M.R., J.R., G.R., D.S.C., N.S.-C., M.G.R.V.) on the 60 research study plots established by the KiLi project using specific methods for plants, different groups of animals, microbes and proxies of 30 ecosystem functions. Details of the sampling protocols are described in the method section of the paper.
Timing and spatial scale	All data were collected from January 2011 through December 2016 on the southern and south-eastern slopes of Mt. Kilimanjaro (Tanzania, East Africa; 2°45'-3°25'S, 37°00'-37°43'E). Depending on the variable, data on study sites was collected few (e.g. most species richness data sets) to hundreds of times (e.g. climate data). Detailed collection protocols are described in the method section.
Data exclusions	No data was excluded.
Reproducibility	As this was not a true experiment but an analyses of a real-world ecosystem, the experiment could not be truly repeated. Most variables were taken multiple times per study site in order to achieve a high precision.
Randomization	We think that this point applies more to a true experiment, while we describe and analyse patterns in a real mountain ecosystem where covariates are necessarily partly correlated. We dealt with this by using different statistical techniques (jackknifing data sets, using multi-model inference, using only subsets of the data) which all produced the same results.
Blinding	See above. This was a study in a real-world mountain ecosystem but not a true experiment. The data was sampled by the coauthors without the specific hypotheses of the current study in mind which, in our view, generates a comparative "blinding effect"

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	The study was conducted along the south/south-eastern slopes of Mt. Kilimanjaro Tanzania; along an elevation gradient from the lowlands (ca. 800 m asl) to the highest point with vegetation (4555 m asl). Along the elevation gradient mean annual

	temperature starts with 25°C at the foothills and decreases ca. 5.6°C per 1000 m elevation. Mean annual precipitation is unimodally distributed with a peak (2700 mm) at 2200 m asl and lowest values in the lowlands (ca. 500 mm).
Location	All data were collected from January 2011 through December 2016 on the southern and south-eastern slopes of Mt. Kilimanjaro (Tanzania, East Africa; 2°45'-3°25'S, 37°00'-37°43'E). We worked on sixty 50 × 50 m study sites, which spanned an elevational gradient of 866 to 4550 m asl.
Access and import/export	We studied biodiversity and ecosystem functions in all major habitats of the study region. Research was conducted together with our counterparts (of which many are coauthors) in full compliance with local, national and international laws. Permits for field work and export of samples were issued to all data collectors by the Tanzania Commission for Science and Technology (COSTECH) and the Tanzania Wildlife Research Institute (TAWIRI) under the following permit numbers: COSTECH, TAWIRI: 2010-241-NA-96-44, 2010-239-ER-96-44, 2010-356-NA-96-44 to 2010-368-NA-96-44, 2011-311-ER-96-44, 2011-310-ER-96-44, 2011-337-NA-96-44-to 2011-350-ER-96-44, 2012-417-ER-96-44, 2012-416-ER-96-44 2012-468-ER-96-44 to 2012-469-ER-96-44, 2013-310-ER-96-44 to 2013-323-ER-96-44, 2014-329-NA-96-44, 2014-331-NA-96-44, 2014-295-NA-96-44 to 2014-300-NA-96-44, 2014-303-ER-96-44 to 2014-313-NA-96-44, 2015-178-NA-96-44, 2015-178-NA-96-44, 2015-174-NA-96-44 to 2015-178-NA-96-44, 2016-100-ER-96-44, 2016-102-ER-96-44, TNP/HQ/C.10/13.
Disturbance	As we aimed at collecting data on the real ecosystems, we did not experimentally modify any vegetation. Vertebrates were sampled by acoustic and visual detection, which did not cause any disturbance. To assess biodiversity of arthropods we had to collect, kill and preserve them. However, we are confident that this did not have a major impact on the species populations.

Reporting for specific materials, systems and methods

Materials & experimental systems

n/a	Involved in the study
☒	☐ Unique biological materials
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology
☐	☒ Animals and other organisms
☒	☐ Human research participants

Methods

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

Animals and other organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research

Laboratory animals	No laboratory animals were used.
Wild animals	During the study we recorded 53 mammals, 202 birds and 1909 arthropods. Mammals and birds were identified by visual and acoustic detection; they were not captured nor killed. Snails and arthropods were collected using ethanol or ethylenglycol for killing and preservation of specimens. Snails and arthropods were mounted and labelled to be stored in public museum collections in Germany and Tanzania.
Field-collected samples	Field samples taken on Mt. Kilimanjaro were stored in ethanol (nearly all arthropod samples), Xpedition sample processor (microbes; Zymo Research Corporation, Irvine, CA, USA), pressed and dried (plants) before further processing in the laboratory.