

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 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
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| ☐ | ☒ 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
<i>Give P values as exact values whenever suitable.</i> |
| ☒ | ☐ 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 EndNote X9 was used for reference management. Microsoft Excel was used for data extraction.

Data analysis The spatial mapping of global water retention was processed using ArcGIS v10.3. For code access to polynomial fitting please contact the author.

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 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 Köppen–Geiger climate classification map is available at www.gloh2o.org/koppen. The precipitation dataset is available at <https://crudata.uea.ac.uk/cru/data/hrg/>. The DEM data used in this study is available at <http://www.gdem.aster.ersdac.or.jp>. The soil data is available at <https://data.isric.org/geonetwork/srv/eng/catalog.search#/home>. MODIS land cover data (MCD12Q1) is available at <https://e4ftl01.cr.usgs.gov/MOTA/MCD12Q1.006/2018.01.01/>. The intact-forest-cover data is available at <http://www.intactforests.org48>.

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](https://www.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	We quantified the water retention of canopy, litter, and soil layers in global forest ecosystems to investigate how they were shaped by natural factors, such as location, terrain, climate, forest structure, litter characteristics, and soil physical properties. We found that different factors had obvious variations in the influence on water retention in three forest layers, through the correlation analysis and polynomial curve fitting between the water retention capacity and single factor. We further incorporated the strong-correlated factors into the structural equation model to construct the relationship between multiple factors and water retention in different layers. In general, we comprehensively considered the influence of 21 natural factors on water retention capacity.
Research sample	The research sample according to the comprehensive storage capacity method, represents water retention at forest observational sites. Since the observational sites were distributed globally, the number of sites was constrained by available resources in terms of time and available funds. Nevertheless, these sites cover 99.15% of forest types and 92.79% of climate zones in the global.
Sampling strategy	We obtained 982 observations from 254 peer-reviewed literature through a meta-analysis of literature synthesis.
Data collection	We conducted the synthetical review of peer-reviewed literature published in English using Web of Science, incorporated the literature into the EndNote software, and recorded the observation data in the literature in the form of tables.
Timing and spatial scale	Data covered global forest ecosystems from 1964 to 2018. We resampled all the data to a spatial resolution of 0.083°.
Data exclusions	In order to unify the of literature data, we excluded the data measured by the non-comprehensive storage capacity method and remote sensing monitoring data, and only recorded the site-observed data.
Reproducibility	Not relevant as we did not conduct experiments.
Randomization	Site-data were allocated to seven forest-cover types and 10 climate zones.
Blinding	Our study does not deal with experiments than require blinding.
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
☒	☐ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

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