

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 <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	The data was extracted directly from graphs via WebPlotDigitizer (https://automeris.io/WebPlotDigitizer), tables, text and/or supplementary materials in peer-reviewed papers.
Data analysis	Data analysis was conducted with the software Microsoft Excel (version 2024), OriginPro (version 2023), and R Studio (version 1.6.0).

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 dataset of anammox and denitrification rates and related physiochemical properties in inland aquatic ecosystems is available from <https://doi.org/10.5281/zenodo.14202839>. Source data are provided with this paper.

Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender	N/A
Population characteristics	N/A
Recruitment	N/A
Ethics oversight	N/A

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	In this study, we aim to (1) quantify the mean rates and variations in anammox and denitrification in aquatic ecosystems, (2) determine the interaction between anammox and denitrification, and (3) explore the responses of anammox and denitrification to the factors driving these processes at a global scale. The anammox and denitrification bacteria tend to co-occur in aquatic ecosystems, suggesting that anammox should be included in nitrogen budgets, according to a global meta-analysis of 136 peer-reviewed articles.
Research sample	The dataset of anammox and denitrification rates were compiled from 136 published literature and contained 2539 observations.
Sampling strategy	Sampling strategy is not relevant to our study. All data were from published literature and open datasets.
Data collection	All data are from published literature and open datasets.
Timing and spatial scale	Data were compiled from the literature published between 1985 and 2023.
Data exclusions	The peer-reviewed papers were screened according to the following criteria: (1) at least one focal variable (e.g., anammox rates and/or the abundance of anammox bacteria) was reported in the peer-reviewed article; (2) the soil anammox rate was measured using ¹⁵ N isotope tracing, and the units for the anammox rate were unambiguous; and (3) the anammox and denitrification rates in the overlying water were excluded from the datasets.
Reproducibility	Results can be reproduced following the data and methods described in the manuscript.
Randomization	Data were randomly split for training and testing of the random forest models.
Blinding	Blinding is not relevant to this study. All data were from published literature and open datasets.

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

Methods

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