Temperature and Rainfall Patterns Constrain the Multidimensional Rewilding of Global Forests

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Temperature and rainfall patterns constrain the multidimensional rewilding of global forests

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**Figure S7** Partial correlation analyses reveals that climate is significantly correlated with the restoration of multiple ecosystem attributes (lnRR) even when controlling for changes across different age ranges (lnRR stand age).

**Text S1.** The reference lists of selected literature.
**Table S1** Attributes used to derive the seven ecosystem functions and biodiversity.

| Ecosystem functions & biodiversity | Attribute |
|-----------------------------------|-----------|
| **Plant biomass**                 | Basal area, coverage, DBH, stand volume, community height, aboveground biomass, belowground biomass, total biomass, litter biomass, forest floor biomass and dead woody biomass |
| **Plant biodiversity**            | Richness, evenness, Simpson and Shannon index |
| **Soil carbon**                   | Soil total carbon stock, soil organic carbon content, soil organic carbon content stocks, soil organic matter content |
| **Soil fertility**                | Total nitrogen content, total nitrogen stocks, ammonium nitrogen concentration, nitrate nitrogen concentration, mineral N concentration, total phosphorus concentrations, available phosphorus concentrations, and total potassium concentrations |
| **SOM decomposition**             | N mineralization, urease, cellulolytic enzymes, invertase, phosphatase, catalase, polyphenol oxidase, peroxidase, β-d-cellubiosidase, xyllosidase and cellulase dehydrogenase, β-Glucosidase, N-Acetyl-β-D-glucosaminidase, α-glucosidase, β-D-xylanase, Leucine-α-aminopeptidase |
| **Microbial habitat**             | Total PLFAs, bacterial biomass, fungi biomass, Gram-positive bacteria, Gram-negative bacteria, Arbuscular mycorrhizal fungi biomass, Actinomycetes biomass, microbial biomass carbon, microbial biomass nitrogen, microbial biomass phosphorus |
| **Microbial biodiversity**        | Bacterial richness, bacterial evenness, bacterial Simpson, bacterial Shannon, bacterial Chao 1, bacterial OTU, fungal richness, fungal evenness, fungal Simpson, fungal Shannon, fungal Chao 1, fungal OTU, microbial richness, microbial evenness, microbial Simpson, and microbial Shannon |
**Table S2** The Reporting Standards for Systematic Evidence Syntheses in Environmental Research (ROSES) report for our meta-analysis.

| Section / sub-section | Topic          | Description                                                                                                                                                                                                 | Further explanation                                                                                     | Checklist/Meta-data | Author response                                                                 |
|-----------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|---------------------|----------------------------------------------------------------------------------|
| **Title**             | Title          | The title must indicate that it is a systematic review protocol, and must indicate if it is an update/amendment: e.g. "A systematic review update protocol...".                                                   | The title should normally be the same or very similar to the review question.                            | Meta-data           | Climate constrains the multidimensional rewilding of global forests               |
| **Type of review**    | Type of review | Select one of the following types of review: systematic review, systematic review update, systematic review amendment, systematic review from a systematic map.                                        | See CEE Guidance on amendments and updates.                                                            | Meta-data           | systematic review                                                                 |
| **Authors contacts**  | Authors contacts| The full names, institutional addresses, and email addresses for all authors must be provided.                                                                                                              |                                                                                                          | Checklist           | Yes                                                                              |
| **Abstract**          | Structured summary | Abstract must not exceed 350 words and must include two sections 1) Background, the context and purpose of the review, including the review question; 2) Methods, how the review will be conducted and the outputs that are expected (specifically mention search strategy, inclusion criteria, critical appraisal, data extraction and synthesis). |                                                                                                          | Checklist           | Yes                                                                              |
| **Background**        | Background     | Describe the rationale for the review in the context of what is already known. Protocol must indicate why this study was necessary and what it aims to contribute to the field.                          | A theory of change and/or conceptual model can be presented that links the intervention or exposure to the outcome. | Checklist           | Yes                                                                              |
| Stakeholder engagement | Stakeholder engagement | Description | Checklist | Yes |
|------------------------|------------------------|-------------|-----------|-----|
| The planned/actual role of stakeholders throughout the review process (e.g. in the formulation of the question) must be described and explained (using a broad definition of ‘stakeholder’, including e.g. researchers, funders and other decision-makers). | | | | |

**Objective of the review**

| Objective | Objective | Describe the primary question and secondary questions (when applicable). | Checklist | Yes |
|-----------|-----------|------------------------------------------------------------------|-----------|-----|
| | | The primary question is the main question of the review. Secondary questions are usually linked to sources of heterogeneity (effect modifiers). | | |

**Definitions of the question components**

| Definitions of the question components | Break down and summarise question key elements e.g. population, intervention(s)/exposure(s), comparator(s), and outcome(s). | Meta-data | Yes |
|--------------------------------------|------------------------------------------------------------------------------------------------|-----------|-----|

**Methods**

| Searches | Search strategy | Detail the planned search strategy to be used, including: database names accessed, institutional subscriptions (or date ranges subscribed for each database), search options (e.g. ‘topic words’ or ‘full text’ search facility), efforts to source grey literature, other sources of evidence (e.g. hand searching, calls for evidence/submission of evidence by stakeholders). | Checklist | Yes |
|-----------|-----------------|------------------------------------------------------------------------------------------------|-----------|-----|
| | | Details regarding search strategy testing should be provided. | | |
| **Search string** | Provide Boolean-style full search string and state the platform for which the string is formatted (e.g. Web of Science format) | **Meta-data** | [Web of science, Google Scholar, CNKI] (“forest restoration” OR “secondary succession” OR “forest succession” OR “natural regeneration” OR “tree plantations”, AND “soil carbon” OR “soil nitrogen” OR “soil phosphorus” OR “plant biomass” or “microbial communities” OR “microbial biomass” OR “diversity” OR “richness” OR “Shannon” OR “OTU”)

| **Languages – bibliographic databases** | List languages to be used in bibliographic database searches. | **Meta-data** | English

| **Languages – grey literature** | List languages to be used in organizational websites searches and web-based search engines. | **Meta-data** | English and Chinese

| **Bibliographic databases** | Provide the number of bibliographic databases to be searched. | **Meta-data** | n/a

| **Web – based search engines** | Provide the number of web – based search engines to be searched. | **Meta-data** | Google Scholar

| **Organisational websites** | Provide the number of organisational websites to be searched. | **Meta-data** | n/a

| **Estimating the comprehensiveness of the search** | Describe the process by which the comprehensiveness of the search strategy was assessed (i.e. list of benchmark articles). | **Checklist** | Yes

| **Search update** | Describe any plans to update the searches during the conduct of the review. | **Checklist** | Yes

| Optional. A search update is good practice if original searches were performed more than two years prior |
| Article screening and study inclusion criteria | Screening strategy | Describe the methodology for screening articles/studies for relevance/eligibility. | Checklist | Yes |
|---------------------------------------------|--------------------|----------------------------------------------------------------------------------|-----------|-----|
|                                             | Consistency checking | Describe clearly the process for checking consistency of decisions including the levels at which consistency checking will be undertaken and estimated proportion of articles/studies that will be screened and checked for consistency by two or more reviewers (e.g. Titles (10%), abstracts (10%), full text (10%)). | Checklist | Yes |
|                                             | Inclusion criteria | Describe the inclusion criteria used to assess relevance of identified articles/studies. These must be broken down into the question key elements (e.g. relevant subject(s), intervention(s)/exposure(s), comparator(s), outcomes, study design(s)) and any other restrictions (e.g. date ranges or languages). | Checklist | Yes |
|                                             | Reasons for exclusion | State that you will provide a list of articles excluded at full text with reasons for exclusion. | Checklist | Yes |
|                                             | Critical appraisal strategy | Describe here the method you propose for critical appraisal of study validity (including assessment of individual studies and the evidence base as a whole). | Checklist | Yes |
| Topic                                      | Description                                                                                                          | Checklist | Yes |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------------|-----------|-----|
| Critical appraisal used in synthesis      | Describe how the information from critical appraisal will be used in synthesis.                                       |           |     |
| Consistency checking                      | Describe how repeatability of critical appraisal of study validity will be tested.                                     |           |     |
| Data extraction                           | Description of the method for meta-data extraction and coding for studies (potentially providing forms/data sheets ideally piloted, list if variables to be extracted as meta-data and those that will be coded). |           |     |
| Data extraction strategy                  | Describe the method for extraction of qualitative and/or quantitative study findings (potentially providing forms/data sheets ideally piloted)). |           |     |
| Approaches to missing data                | Describe any processes for obtaining and confirming missing or unclear information or data from authors.              |           |     |
| Consistency checking                      | Describe how repeatability of the meta-data/data extraction process will be tested.                                  |           |     |
| Potential effect modifiers/reasons for heterogeneity | Provide a list of and justification for the effect modifiers/reasons for heterogeneity that will be considered in the review. Also provide details of how the list was compiled (including consultation of external experts). |           |     |
| Data synthesis and presentation           | State type of synthesis conducted as part of the systematic review (narrative only, narrative and quantitative, narrative and qualitative, narrative, narrative and mixed-methods). | Meta-data |     |
qualitative and quantitative, narrative and mixed-methods

| Methodology          | Description                                                                 | Checklist | Mandatory |
|---------------------|-----------------------------------------------------------------------------|-----------|-----------|
| Narrative synthesis | Describe methods to be used for narratively synthesising the evidence base in the form of descriptive statistics, tables (including any map databases) and figures. |            | Yes       |
|                    | Vote-counting (tallying of studies based on the direction or significance of their findings) must be avoided. Must include a summary of the outputs of critical appraisal of the evidence base as a whole. |            |           |
| Quantitative synthesis | If data are appropriate for quantitative synthesis, describe planned methods for calculating effect sizes, methods for handling complex data, statistical methods for combining data from individual studies, and any planned exploration of heterogeneity (e.g. sensitivity analysis, subgroup analysis and meta-regression). If all studies may not be selected for synthesis explain criteria for selection (e.g. incomplete or missing information). | Compulsory if appropriate for data | Yes       |
| Qualitative synthesis | Describe methods to be used for synthesising qualitative data and justify your methodological choice. Describe if and how you plan to analyse subgroups/subsets of data. If all studies may not be selected for synthesis explain criteria for selection (e.g. incomplete or missing information). | Compulsory if appropriate for data | Yes       |
| Other synthesis strategies | Describe any other approaches to be used for synthesising data or combining qualitative and quantitative synthesis (e.g. mixed-methods) and justify your methodological choice. | Compulsory if appropriate for data | Checklist | n/a |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-----------|-----|
| Assessment of risk of publication bias | Describe planned methods for examining the possible influence of publication bias on the synthesis. | For quantitative syntheses this may be done using diagnostic plots or statistical tests | Checklist | Yes |
| Knowledge gap identification strategy | Describe the methods to be used to identify and/or prioritise key knowledge gaps (unrepresented or underrepresented subtopics that warrant further primary research). | Optional | Checklist | Yes |
| Demonstrating procedural independence | Describe the role of systematic reviewers (who have also authored articles to be considered within the review) in decisions regarding inclusion or critical appraisal of their own work. | Reviewers who have authored articles to be considered within the review should be prevented from unduly influencing inclusion decisions, for example by delegating tasks appropriately. | Checklist | Yes |
| Declarations | Competing interests | Describe of any financial or non-financial competing interests that the review authors may have. | Checklist | Yes |
| References                  | Plant biodiversity | Microbial biodiversity | Plant biomass | Microbial habitat | Soil carbon | Soil fertility | SOM decomposition |
|-----------------------------|--------------------|------------------------|---------------|-------------------|-------------|----------------|-------------------|
| Zethof et al., 2018         |                   |                        |               |                   |             |                |                   |
| Yankelevich et al., 2007    |                   |                        | yes           |                   |             | yes            |                   |
| Winbourne et al., 2018      |                   |                        | yes           |                   |             | yes            |                   |
| Shi et al., 2012            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Zhao et al., 2020           |                   |                        | yes           | yes               | yes         | yes            | yes               |
| Shi et al., 2017            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Lin et al., 2015            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Liu et al., 2013            | yes                |                        |               |                   |             |                |                   |
| Wu et al., 2016             | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Duo et al., 2012            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Xiong et al., 2021          | yes                |                        |               |                   |             |                |                   |
| Liu et al., 2012            |                   |                        | yes           |                   |             | yes            | yes               |
| Lu et al., 2017             | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Ren et al., 2018            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Chen et al., 2013           | yes                |                        |               |                   |             |                |                   |
| Tongkoom et al., 2018       | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Yuan et al., 2019           | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Wang et al., 2016           | yes                |                        |               |                   |             |                |                   |
| Zaitsev et al., 2012        | yes                |                        |               |                   |             |                |                   |
| Yan et al., 2008            | yes                |                        |               |                   |             |                |                   |
| Shao et al., 2017           | yes                |                        |               |                   |             |                |                   |
| Liu et al., 2019            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Jones et al., 2019          |                   |                        | yes           | yes               | yes         | yes            | yes               |
| Turpeinen et al., 2020      | yes                |                        |               |                   |             |                |                   |
| Deng et al., 2013           |                   |                        | yes           | yes               | yes         | yes            | yes               |
| Zhang et al., 2018          | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Zhao et al., 2018           | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Zhang et al., 2018          | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Lu et al., 2019             | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Zhao et al., 2015           | yes                |                        |               |                   |             |                |                   |
| Mo et al., 2013             |                   |                        | yes           | yes               | yes         | yes            | yes               |
| Dou et al., 2013            |                   |                        | yes           | yes               | yes         | yes            | yes               |
| Hum et al., 2016            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Powers et al., 2009         |                   |                        | yes           | yes               | yes         | yes            | yes               |
| Jia et al., 2005            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Toniato et al., 2004        |                   |                        | yes           | yes               | yes         | yes            | yes               |
| Cai et al., 2018            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Guggenberger et al., 1999   |                   |                        | yes           | yes               | yes         | yes            | yes               |
| Zhu et al., 2010            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Liu et al., 2011            | yes                |                        | yes           | yes               | yes         | yes            | yes               |
| Amazonas et al., 2011       |                   |                        |               |                   |             |                |                   |
| Authors            | Year   | Yes 1 | Yes 2 | Yes 3 | Yes 4 | Yes 5 |
|--------------------|--------|-------|-------|-------|-------|-------|
| Martelletti et al., 2019 |        |       |       |       |       |       |
| Wu et al., 2020     |        | yes   |       |       |       |       |
| Wu et al., 2018     |        | yes   |       |       |       |       |
| Jin et al., 2019    |        | yes   |       |       |       |       |
| Yan et al., 2006    |        |       | yes   |       |       |       |
| Yan et al., 2009    |        | yes   |       |       | yes   |       |
| Yang et al., 2020   |        |       |       |       |       | yes   |
| Zhang et al., 2016  |        | yes   |       |       |       | yes   |
| Zeng et al., 2015   |        | yes   |       |       |       | yes   |
| Zeng et al., 2013   |        | yes   |       |       |       | yes   |
| Yao et al., 2020    |        | yes   |       |       |       | yes   |
| Saynes et al., 2005 |        | yes   |       |       |       | yes   |
| Wang et al., 2020   |        | yes   |       |       |       | yes   |
| He et al., 2016     |        | yes   |       |       |       | yes   |
| Xu et al., 2018     |        |       | yes   |       |       | yes   |
| Chen et al., 2014   |        | yes   |       |       |       | yes   |
| Feudis et al., 2020 |        | yes   |       |       |       | yes   |
| Wang et al., 2018   |        | yes   |       |       |       | yes   |
| Huang et al., 2015  |        | yes   |       |       |       | yes   |
| Aravena et al., 2002|        | yes   |       |       |       | yes   |
| Lucas-Borja et al., 2019 |   | yes |       |       |       | yes   |
| Brearley et al., 2011|      | yes   |       |       |       | yes   |
| Zhang et al., 2010  |        | yes   |       |       |       | yes   |
| Castellanos-Castro et al., 2015 |   | yes |       |       |       | yes   |
| Lu et al., 2016     |        | yes   |       |       |       | yes   |
| McClellan et al., 2018 |   | yes |       |       |       | yes   |
| Cao et al., 2020    |        | yes   |       |       |       | yes   |
| Alberti et al., 2008|        | yes   |       |       |       | yes   |
| Lu et al., 2018     |        | yes   |       |       |       | yes   |
| Badalamenti et al., 2019 |   | yes |       |       |       | yes   |
| Emmer et al., 1998  |        | yes   |       |       |       | yes   |
| Bai et al., 2019    |        | yes   |       |       |       | yes   |
| Fang et al., 2010   |        | yes   |       |       |       | yes   |
| Kaneda et al., 2020 |        | yes   |       |       |       | yes   |
| Smith et al., 2015  |        | yes   |       |       |       | yes   |
| Han et al., 2020    |        | yes   |       |       |       | yes   |
| Li et al., 2015     |        | yes   |       |       |       | yes   |
| Han et al., 2015    |        | yes   |       |       |       | yes   |
| Bush et al., 2008   |        | yes   |       |       |       | yes   |
| Tang et al., 2010   |        | yes   |       |       |       | yes   |
| Cindy et al., 2014  |        | yes   |       |       |       | yes   |
| Valdespino et al., 2009 |   | yes |       |       |       | yes   |
| Hasegawak et al., 2010 |   | yes |       |       |       | yes   |
| Reference                  | year 1 | year 2 | year 3 | year 4 |
|----------------------------|--------|--------|--------|--------|
| Reyes et al., 2019         | yes    |        |        |        |
| Huang et al., 2013         | yes    |        | yes    |        |
| Yuan et al., 2012          |        | yes    | yes    | yes    |
| Aidar et al., 2003         |        | yes    | yes    |        |
| Liu et al., 2002           |        | yes    | yes    |        |
| Li et al., 2013            | yes    | yes    | yes    | yes    |
| Dang et al., 2017          | yes    | yes    | yes    |        |
| Chen et al., 2012          | yes    | yes    | yes    | yes    |
| Woodbury et al., 2020      | yes    | yes    |        |        |
| Liu et al., 2019           | yes    |        | yes    |        |
| Liu et al., 2020           |        | yes    |        |        |
| LiuG et al., 2019          | yes    |        | yes    |        |
| LiuY et al., 2020          | yes    | yes    | yes    | yes    |
| Luan et al., 2011          |        | yes    |        |        |
| Bauters et al., 2019       | yes    |        | yes    |        |
| Ostertag et al., 2008      | yes    | yes    | yes    |        |
| Negrete-Yankelevich et al., 2008 | yes | yes | yes |        |
| Pérez et al., 2020         | yes    |        |        |        |
| Pérez et al., 2004         |        | yes    |        |        |
| Perakis et al., 2015       |        | yes    | yes    |        |
| Ma et al., 2020            |        | yes    | yes    |        |
| Shao et al., 2019          | yes    |        | yes    |        |
| Schwendenmann et al., 2000 |        | yes    | yes    |        |
| Feng et al., 2020          |        | yes    |        |        |
| Yassir et al., 2015        |        | yes    | yes    |        |
| Song et al., 2015          | yes    |        | yes    |        |
| Huang et al., 2018         |        | yes    | yes    |        |
| Sokolowska et al., 2020    | yes    | yes    | yes    | yes    |
| Mylliemngap et al., 2016   | yes    | yes    | yes    | yes    |
| TangG et al., 2010         |        | yes    |        |        |
| Wang et al., 2017          |        | yes    | yes    |        |
| Mo et al., 2006            |        | yes    | yes    |        |
| Yan et al., 2020           | yes    | yes    | yes    | yes    |
| WangJ et al., 2020         | yes    | yes    | yes    | yes    |
| WangH et al., 2020         |        | yes    | yes    |        |
| YanW et al., 2020          | yes    | yes    | yes    | yes    |
Table S4 Contributions of multiple ecosystem attributes to PCA 1 of the principal component analysis.

|                  | Eigen vectors | Contribution (%) | cos2 |
|------------------|---------------|------------------|------|
| Plant biodiversity| 0.35          | 11.97            | 0.44 |
| Microbial biodiversity | -0.31      | 9.60             | 0.35 |
| Plant biomass    | -0.45         | 20.45            | 0.75 |
| Microbial habitat| 0.42          | 17.94            | 0.66 |
| Soil carbon      | 0.38          | 14.17            | 0.52 |
| Soil fertility   | 0.48          | 23.36            | 0.86 |
| SOM decomposition| 0.16          | 2.51             | 0.09 |
Figure S1 Article selection process using Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines.
Figure S2 Global distribution of the selected stand forest. The blue and red circles indicate which experiment provided selected angiosperm and conifers stands, respectively. Based green map represents the distribution of global evergreen, deciduous and mixed forests. The observations of Angiosperm and conifers forests were 141 and 65, respectively.
Figure S3 Probability density of the forest restoration effect on plant biodiversity, microbial biodiversity, plant biomass, microbial habitat, soil carbon, SOM decomposition and soil fertility. Results are based on 180 observations for plant biodiversity, 251 observations for microbial biodiversity, 594 observations for plant biomass, 309 observations for microbial habitat, 549 observations for soil carbon, 268 observations for SOM decomposition and 922 observations for soil fertility.
Figure S4 Estimates (±95% CI) of the log response ratio for plant biodiversity, microbial biodiversity, plant biomass, microbial habitat, soil carbon, SOM decomposition, and soil fertility of different climate type (A, dryland and mesic) and tree functional type (B, evergreen, deciduous and mixed forest). The vertical line was drawn at LnRR=0. Number values for each bar indicate the sample size. The error bars indicated the 95% confidence interval (CI). If the CI did not overlap with zero, a response was considered to be significant.
Figure S5 Relationships between stand age with the response ratios (LnRR) of plant biodiversity (A), microbial biodiversity (B), plant biomass (C), microbial habitat (D), soil carbon (E), soil fertility (F) and SOM decomposition (G) for dryland and mesic forests.
Figure S6 Relationships between stand age with the response ratios (LnRR) of plant biodiversity (A), microbial biodiversity (B), plant biomass (C), microbial habitat (D), soil carbon (E), soil fertility (F) and SOM decomposition (G) for arid, cold, and tropical/temperate forests.

Figure S7 Partial correlation analyses reveals that climate is significantly correlated with the restoration of multiple ecosystem attributes (lnRR) even when controlling for changes across different age ranges (lnRR stand age).
**Text S1** The reference lists of selected literature.

Zethof, J.H.T., Cammeraat, E.L.H., Nadal-Romero, M.E. The enhancing effect of afforestation over secondary succession on soil quality under semiarid climate conditions. *Science of the Total Environment*, **652**, 1090-1101 (2018).

Jones, I. L., DeWalt, S. J., Lopez, O. R., Bunnefeld, L., Pattison, Z., Dent, D. H. Above- and belowground carbon stocks are decoupled in secondary tropical forests and are positively related to forest age and soil nutrients respectively. *Science of the Total Environment*, **697**, 133987 (2019).

Wang, X., Guo, Z., Guo, X., Wang, X. The Relative Importance of Succession, Stand Age and Stand Factors on Carbon Allocation of Korean Pine Forests in the Northern Mt. Xiaoxing’anling, China. *Forests*, **11**, 512 (2020).

Winbourne, J. B., Feng, A., Reynolds, L., Piotto, D., Hastings, M. G., Porder, S. Nitrogen cycling during secondary succession in Atlantic Forest of Bahia, Brazil. *Scientific Reports*, **8**, 1377 (2018).

Zhang-Turpeinen, H., Kivistämö, M., Aaltonen, H., Berninger, F., Köster, E., Köster, K. et al. Wildfire effects on BVOC emissions from boreal forest floor on permafrost soil in Siberia. *Science of the Total Environment*, **711**, 134851 (2020).

Lin, K. Accumulation of carbon, nitrogen, phosphorus, and fractionation of soil phosphorus in the subtropical human-assisted natural regeneration secondary *Castanopsis carlesii* forests. Ph.d dissertation for Fujian Normal University (2015).

Liu, J., Huang, B., Xu, Y., Lu, P., Lin, Y. Soil microbial functional diversity of typical forest in Jigoshan Mountain Nature Reserve of Henan province. *Forest Resources Management*, **1**, 76-85 (2013).

Wu, R., Kang, F., Han, H., Cheng, X., Zhou, W., Wang, L. et al. Soil microbial properties in *Larix principis-rupprechtii* plantations of different ages in Mt. Taiyue, Shanxi, China. *Chinese Journal of Ecology*, **35**, 3183-3190 (2016).

Duo, W. The research on soil microbial biomass and diversity of 3 forests in subtropics. Master thesis for Central South University of Forestry and Technology (2012).

Xiong, X., Zhou, G., Zhang, D. Soil organic carbon accumulation modes between pioneer and old-growth forest ecosystems. *Journal of Applied Ecology*, **57**, 2419-2428 (2020).

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