A global meta-analysis on the impact of human activities on soil microbial diversity and carbon cycling

Jose Mathew[1], Shamik Roy[1, 2, 3] and Sumanta Bagchi[1]

EGU26 GENERAL ASSEMBLY

SSS 4.4

BACKGROUND

- Soil microbes metabolise aboveground inputs, storing some of it in soil and releasing the rest into the atmosphere.
- Changes to the structure or functioning of the microbial community can impact nutrient cycling, plant growth and carbon sequestration.
- Human activities were found to alter microbial diversity and activity across various study sites, but different ecosystems could respond differently to the same disturbance. So we use a meta-analysis of the published literature to identify globally conserved patterns.
- Microbes have high functional redundancy, so we focus on functional – in particular – *catabolic* diversity rather than the number of species.

METHODOLOGY

Find papers from Web of Science that cite any of the 5 papers by Degens describing the catabolic diversity protocol.

Short-list studies that report soil respiration or catabolic response in both presence and absence of human activity.

Record site climate and soil information, as well as the nature and impact of the human activity on soil respiration and the Shannon / Simpson index of catabolic diversity.

In each data-point, the effect size (log response ratio) is $LRR = log(\frac{\bar{X}_t}{\bar{X}_c})$ and within-study variance $V_i = \frac{\sigma_t^2}{n_t \bar{X}_t^2} + \frac{\sigma_c^2}{n_c \bar{X}_c^2}$

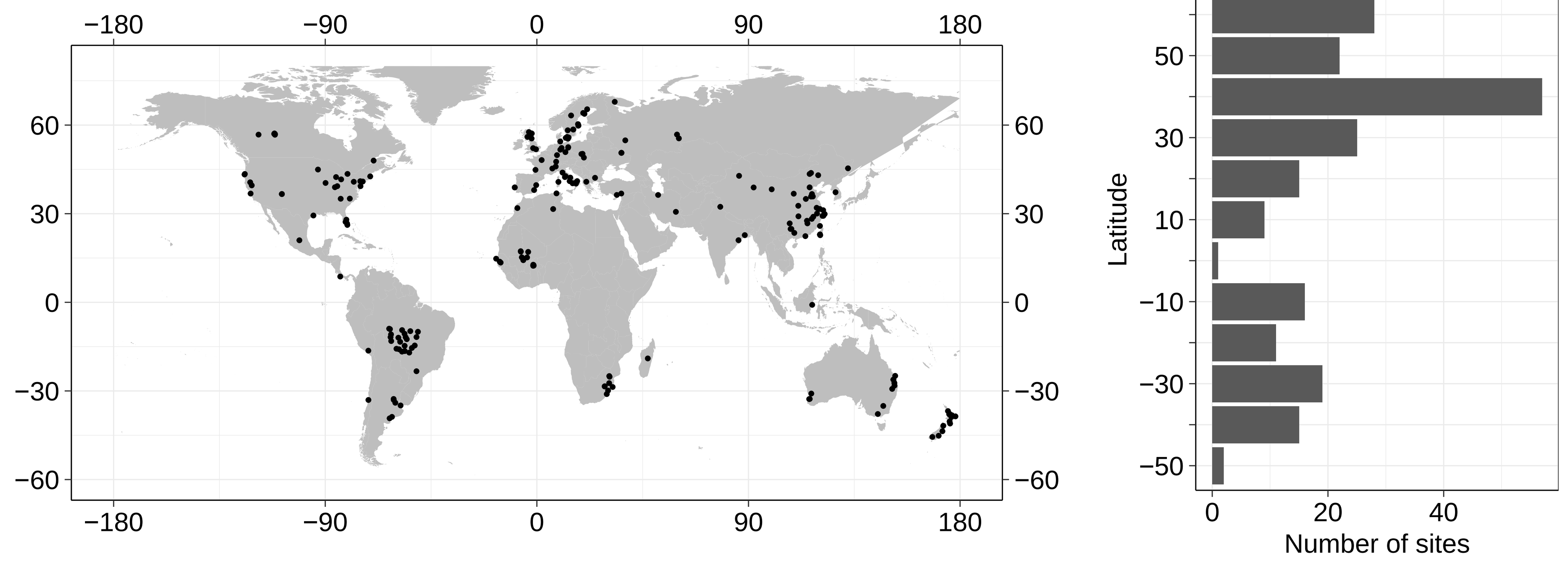
Effect of each human activity on each response variable (respiration / diversity index) is calculated from these *LRR* and V_i values using a robust variance estimation algorithm.

Check for publication bias, changes in effect size over time.

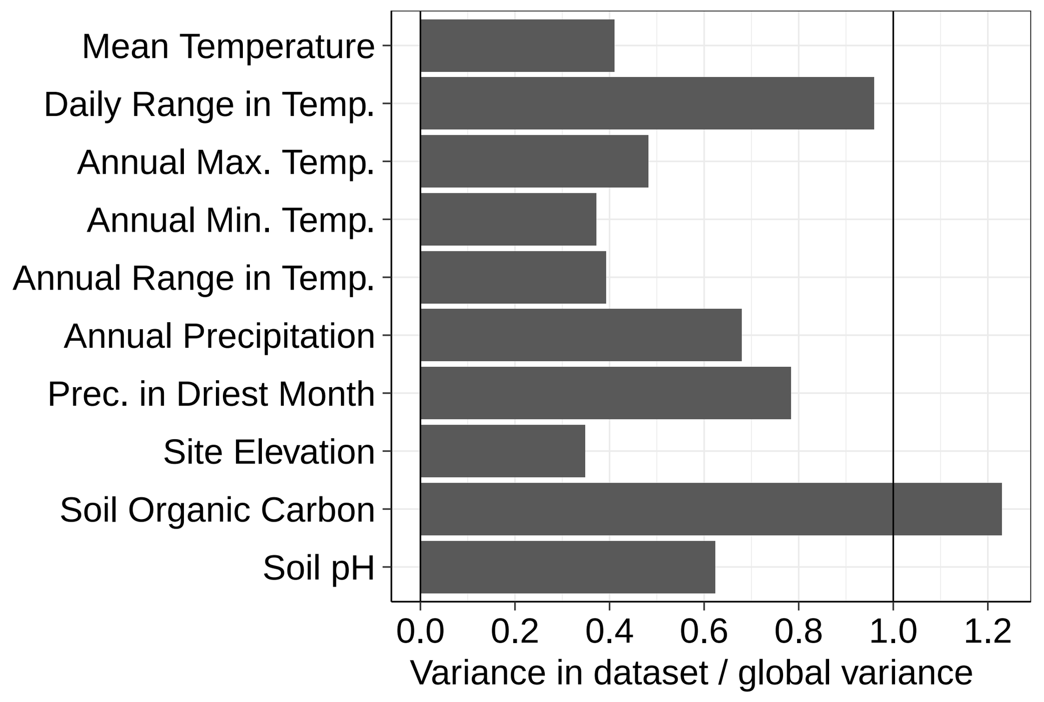
The R code, dummy data and other details are available at `https://codeberg.org/JoseMathew/egu26-3355` or by scanning this QR code:-

RESULTS

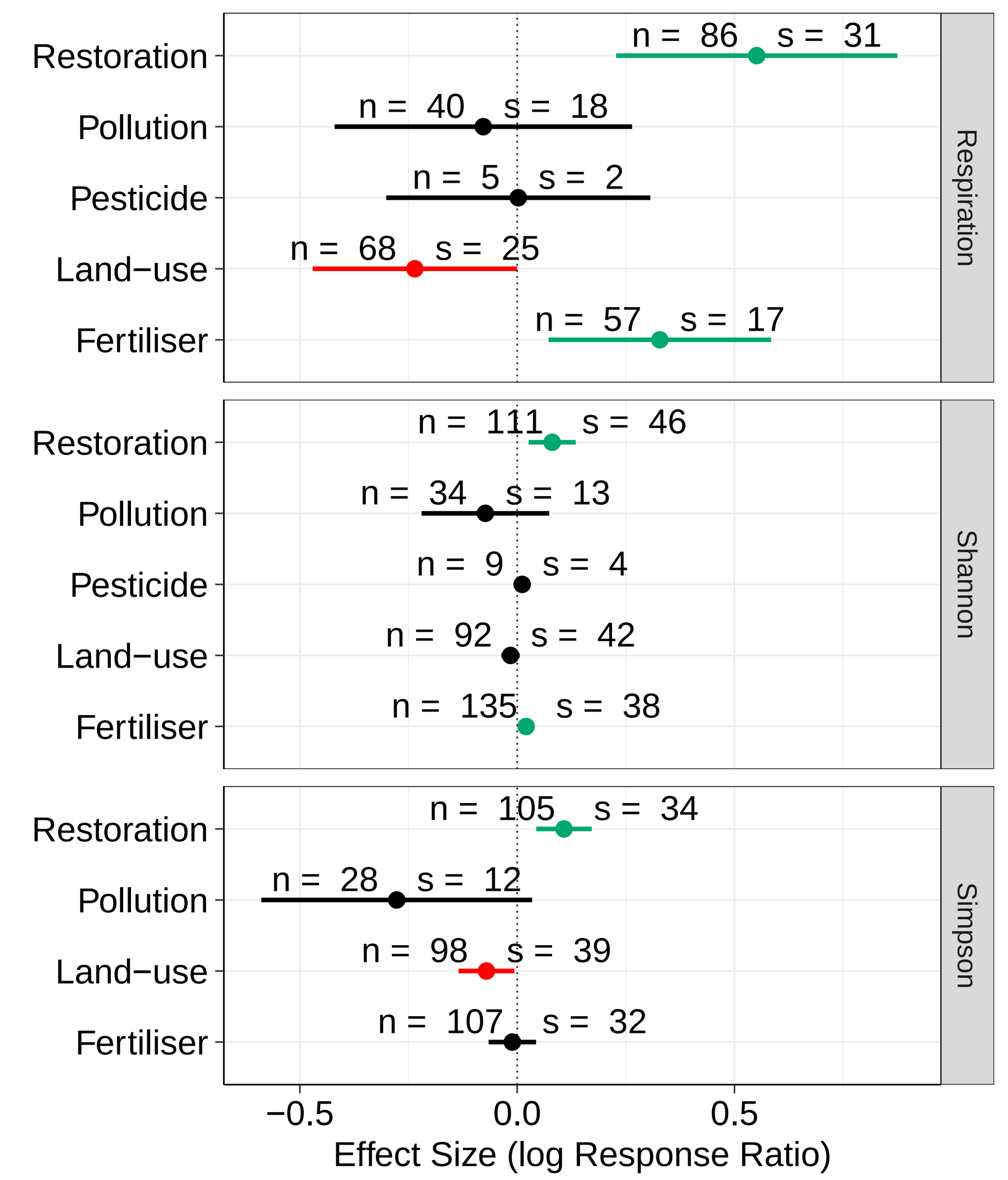
1. Locations of Included Study Sites



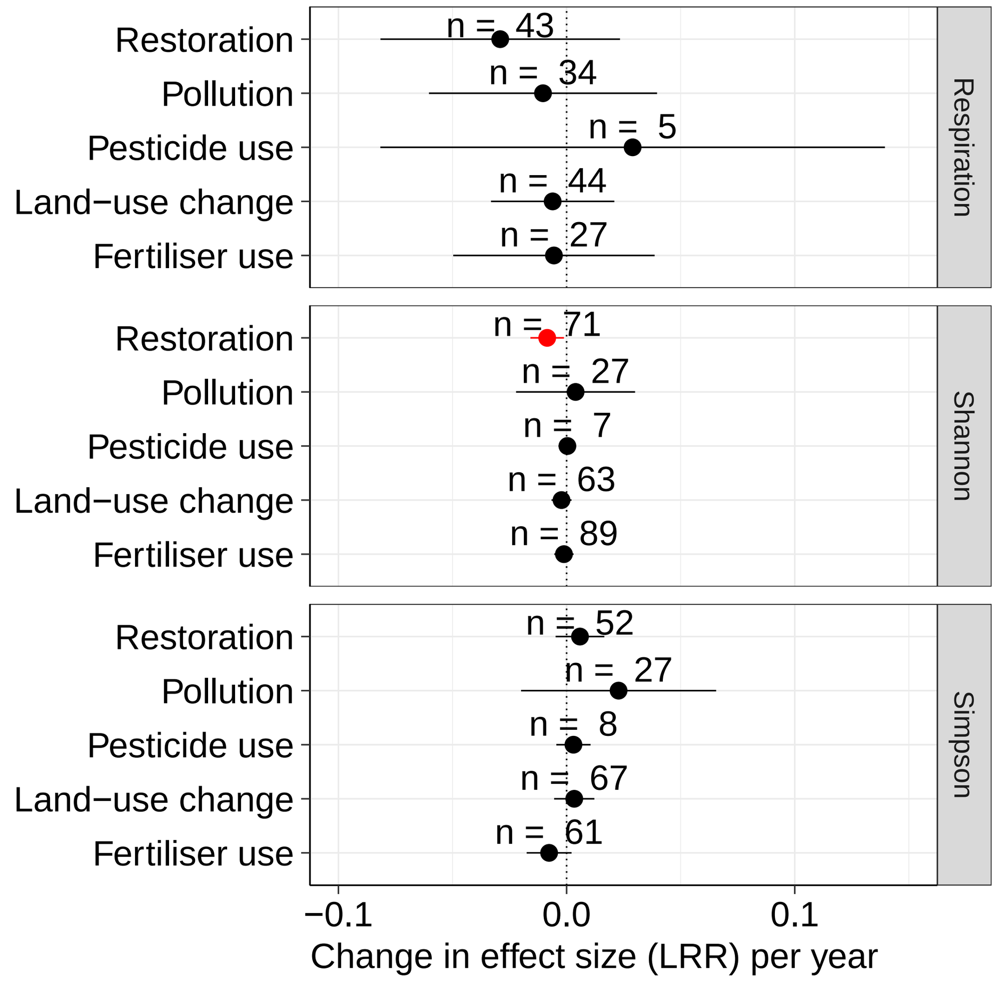
2. Environmental Variance Captured in Dataset Compared to Variance among Randomly Chosen Points on the Earth



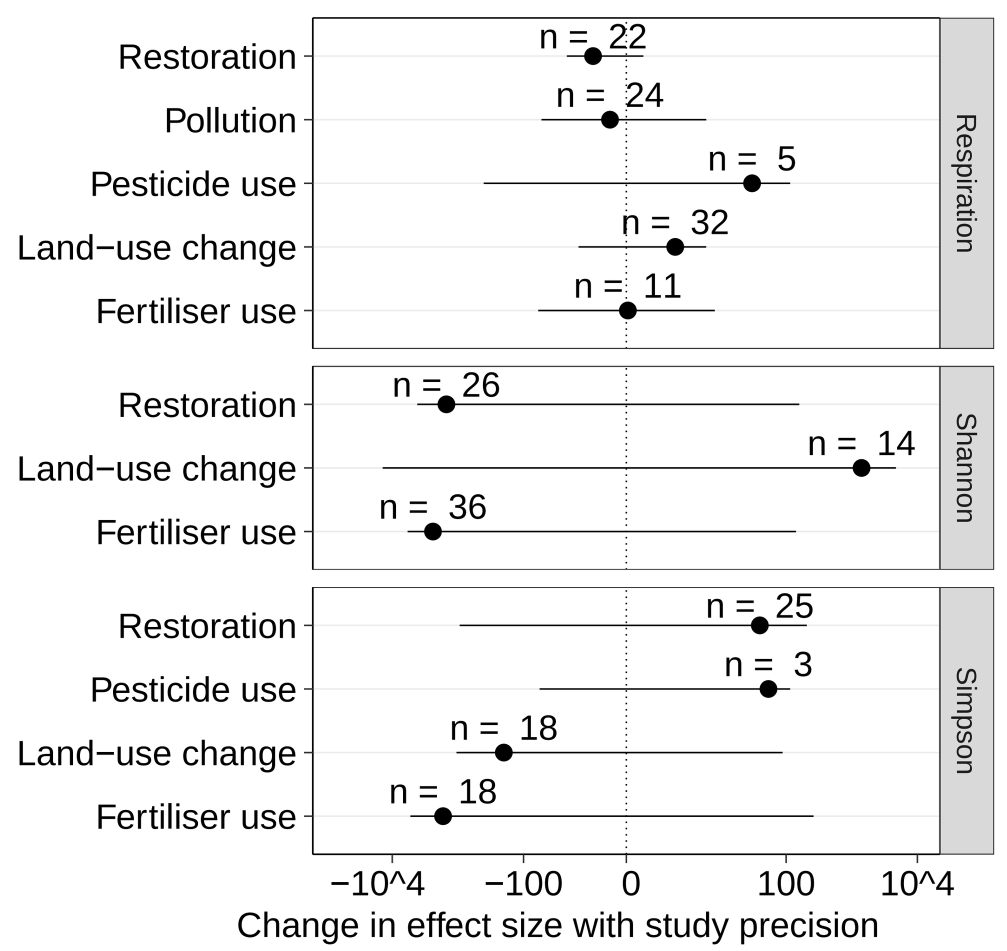
3. Effect of Human Activities



4. Change in Effect Size over Time



5. Publication Bias



Note: In Fig. 3 – 5, green = + ve and red = – ve effect.
n = number of datapoints ; s = number of studies

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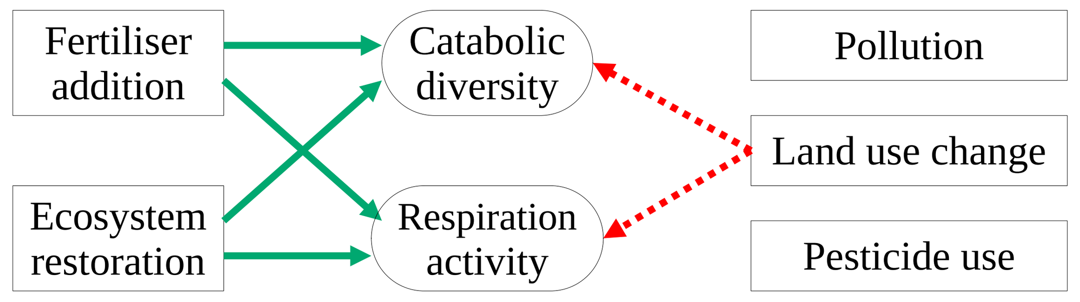
Sharing is encouraged

Abstract link:

DISCUSSION



(Green full arrow = +ve effect, red dotted arrow = -ve efffect)

- No consistent changes in effect size over time.
- Publication bias not statistically significant, but possible.
- Restoration increases respiration about thrice as much as land use change reduces it, even after accounting for the different baselines. Restored ecosystems may be using carbon less efficiently.
- Greater biodiversity is generally expected to improve ecosystem efficiency, so an increase in microbial diversity should reduce carbon loss by respiration. However, human activities always changed diversity and activity in the same direction. Perhaps changes in both diversity and activity are driven by changes in microbial biomass.

CONCLUSION

Land use intensity has a negative effect on soil microbial diversity and carbon cycling, while nutrient addition has a positive impact. Further, restored ecosystems cycle carbon faster than intact ones, perhaps because they use it less efficiently.

CONTACT INFORMATION

- Jose Mathew: Phone: +91 94956 32997 (/), E-mail: josemathew@iisc.ac.in
- Shamik Roy: shamik.roy@uni-ulm.de
- Sumanta Bagchi: sbagchi@iisc.ac.in, Lab website:-

1 JM, SR and SB are from the Centre for Ecological Sciences, Indian Institute of Science, Bengaluru, Karnataka, India.

2 SR is from the Chair of Forest Zoology, Technische Universität Dresden, Tharandt, Sachsen, Germany, and

3 the Ecosystem Resilience Group, Institute of Evolutionary Ecology and Conservation Genomics, Universität Ulm, Baden-Württemberg, Germany.