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Global patterns of soil microbial carbon, nitrogen and phosphorus stoichiometry in terrestrial ecosystems

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Incorporating site-specific microbial processes may improve models of carbon (C) and nutrient cycling across terrestrial ecosystems. To better understand the concentrations and stoichiometry of C, nitrogen (N) and phosphorus (P) in soil microbial biomass, we compiled and analyzed the existing published data on microbial C, N and P in soils spanning the global range of land-use types (forest, grassland, paddy, upland and orchard) and soil types based on Harmonized World Soil Database (FAO/IIASA/ISRIC/ISSCAS/JRC, 2012). It was found that the microbial stoichiometry had some flexibility under various environmental conditions. Flooded paddy soil had the highest C:N ratio of soil microbes among the global land-use types while C:P and N:P ratios highlighted the differences between forest and grassland, following upland field, and paddy or orchard fields. Agricultural soils (except paddy) had significantly lower C, N and P concentrations in soil microbial biomass than natural land-use, indicating large anthropogenic effects (e.g., land management). The spatial patterns of microbial-C and nutrient ratios differed considerably among soil types. For global microbial C:N ratio, the geometric mean varied from maximum 12.7 for Phaeozems to minimum 5.8 for Podzols. The microbial N:P ratio for Andosols was significantly higher than other soils. The consistency of this pattern in plant-soil-microbe ecosystems supports that P is often the major limiting element for Andosols. Meanwhile, higher concentrations of microbial-N and P may relate to high soil water contents, i.e., low permeability soils of Gleysols and Fluvisols. In this study, we provide more reliable parameters to determine soil microbial properties especially in agricultural land-use, i.e., Andosols mainly used for upland fields and Fluvisols used for paddy fields, as there are no existing data available.

Keywords: Andosols, Harmonized World Soil Database, Land-use, Global scale analysis, Terrestrial ecosystem, Paddy fields