Evaluating the role soil nutrients play in regulating soil greenhouse gas fluxes from the pristine tropical forests: evidence from a nutrient manipulation experiment in Uganda

Other Conference Item

Author(s):

Tamale, Joseph; Hüppi, Roman ; Griepentrog, Marco ; Turyagyenda, Laban Frank; Barthel, Matti; Doetterl, Sebastian ; Fiener, Peter; Van Straaten, Oliver

Publication date:

2021-04

Permanent link:

<https://doi.org/10.3929/ethz-b-000526235>

Rights / license:

[Creative Commons Attribution 4.0 International](#)

Originally published in:

EGUsphere, <https://doi.org/10.5194/egusphere-egu21-1415>

EGU21-1415

<https://doi.org/10.5194/egusphere-egu21-1415>

EGU General Assembly 2021

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.

Evaluating the role soil nutrients play in regulating soil greenhouse gas fluxes from the pristine tropical forests: evidence from a nutrient manipulation experiment in Uganda

Joseph Tamale^{1,5}, Roman Hüppi⁴, Marco Griepentrog³, Laban Frank Turyagyenda⁵, Matti Barthel⁴, Sebastian Doetterl³, Peter Fiener¹, and Oliver van Straaten^{2,6}

¹University of Augsburg, Institute of Geography, Augsburg, Germany (tamjos95@gmail.com)

²Environmental Control Department, Nordwestdeutsche Fortliche Versuchsanstalt, Göttingen, 37079, Germany

³Soil Resources, Department of Environmental Systems Science, ETH, Zurich, 8092, Switzerland

⁴Sustainable Agroecosystems, Department of Environmental Systems Science, ETH, Zurich, 8092, Switzerland

⁵Ngetta Zonal Agricultural Research and Development Institute (NGEZARDI), P.O.Box 52, Lira, Uganda

⁶Soil Science of Tropical and Subtropical Ecosystems, Büsgen-Institute, University of Göttingen, Göttingen, 37077, Germany

The exchange of the climate-relevant greenhouse gases (GHGs) at the soil-atmospheric interface is regulated by both abiotic and biotic controls. However, evidence on nutrient limitations of soil GHG fluxes from African tropical forest ecosystems is still rare. Therefore, an ecosystem-scale nutrient manipulation experiment (NME) consisting of nitrogen (N), phosphorus (P), N + P, and control treatments was set up in a tropical forest in northwestern Uganda. Soil carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) fluxes were measured monthly using static vented chambers for 14 months. A root trenching treatment was also done in all the experimental plots in order to disentangle the contribution of root and microbial respiration to total soil CO₂ effluxes. In parallel to soil GHG flux measurements, soil temperature, soil moisture, and mineral N were determined. Lifting the N limitation on the soil nitrifiers and denitrifiers through N fertilization significantly increased N₂O fluxes in N, and N + P addition plots in the transitory phase (0-28 days after N fertilization, $p < 0.01$). However, sustained N fertilization did not significantly affect background (measured more than 28 days after fertilization) N₂O fluxes. Alleviation of the P limitation on soil methanotrophs through P fertilization marginally and significantly increased CH₄ consumption in the transitory ($p = 0.052$) and background ($p = 0.010$) phases, respectively. Simultaneous addition of N and P (N + P) significantly affected transitory soil CO₂ effluxes ($p = 0.010$), suggesting a possible co-limitation of N and P on soil respiration. Microbial CO₂ effluxes were significantly larger than root CO₂ effluxes ($p < 0.001$) across all treatment plots so was the contribution of microbial respiration to the total soil CO₂ effluxes (about 70 %, $p < 0.001$). Despite the fact that soil respiration was affected through N + P fertilization, neither heterotrophic nor autotrophic respiration significantly differed in either the N + P or the other treatments. Overall, the study findings suggest that the contribution of tropical forests to the global soil GHG budget could be altered by changes in N and P availability in these biomes.

Key words: Soil greenhouse gas fluxes, nutrient manipulation experiment, soil nutrient limitation,

and Ugandan tropical pristine forest.