

2024-05-01

Novel use of portable gamma sensors to rapidly assess soil status and recovery in degraded East African agro-pastoral land

Blake, Will

Copernicus Publications

<https://dspace.nm-aist.ac.tz/handle/20.500.12479/2636>

Provided with love from The Nelson Mandela African Institution of Science and Technology

2024-04-16

Novel use of portable gamma sensors to rapidly assess soil status and recovery in degraded East African agro-pastoral land

Blake, W

<https://pearl.plymouth.ac.uk/handle/10026.1/22392>

10.5194/egusphere-egu24-13351

Copernicus Publications

All content in PEARL is protected by copyright law. Author manuscripts are made available in accordance with publisher policies. Please cite only the published version using the details provided on the item record or document. In the absence of an open licence (e.g. Creative Commons), permissions for further reuse of content should be sought from the publisher or author.

Novel use of portable gamma sensors to rapidly assess soil status and recovery in degraded East African agro-pastoral land

Will Blake¹, **Aloyce Amasi**², **Claire Kelly**¹, **Shaun Lewin**¹, **Francis Mkilema**², **Furaha Msale**², **Kelvin Mtei**², **Linus Munishi**², **Mona Nasser**³, **Patrick Ndakidemi**², and **Alex Taylor**¹

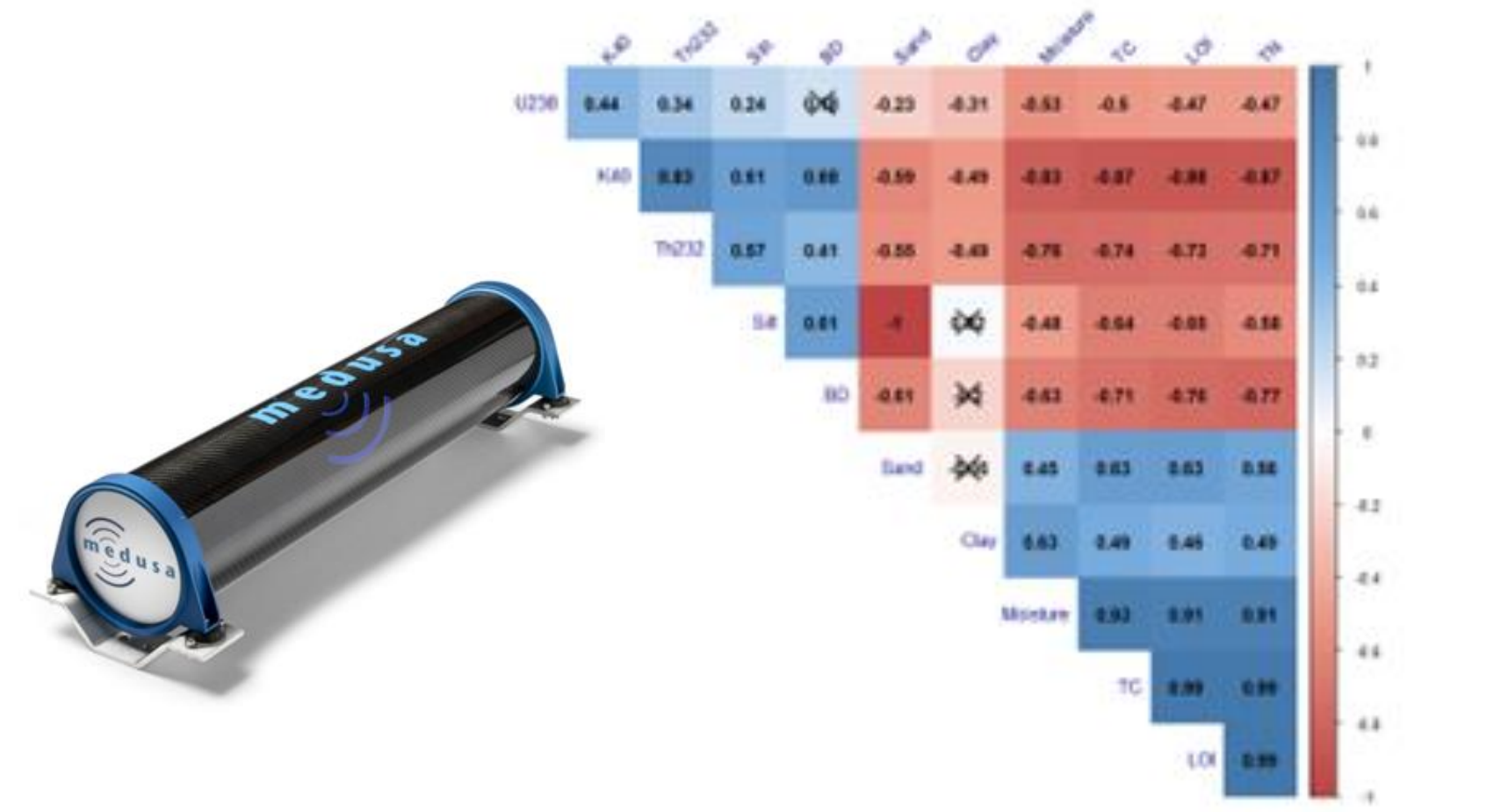
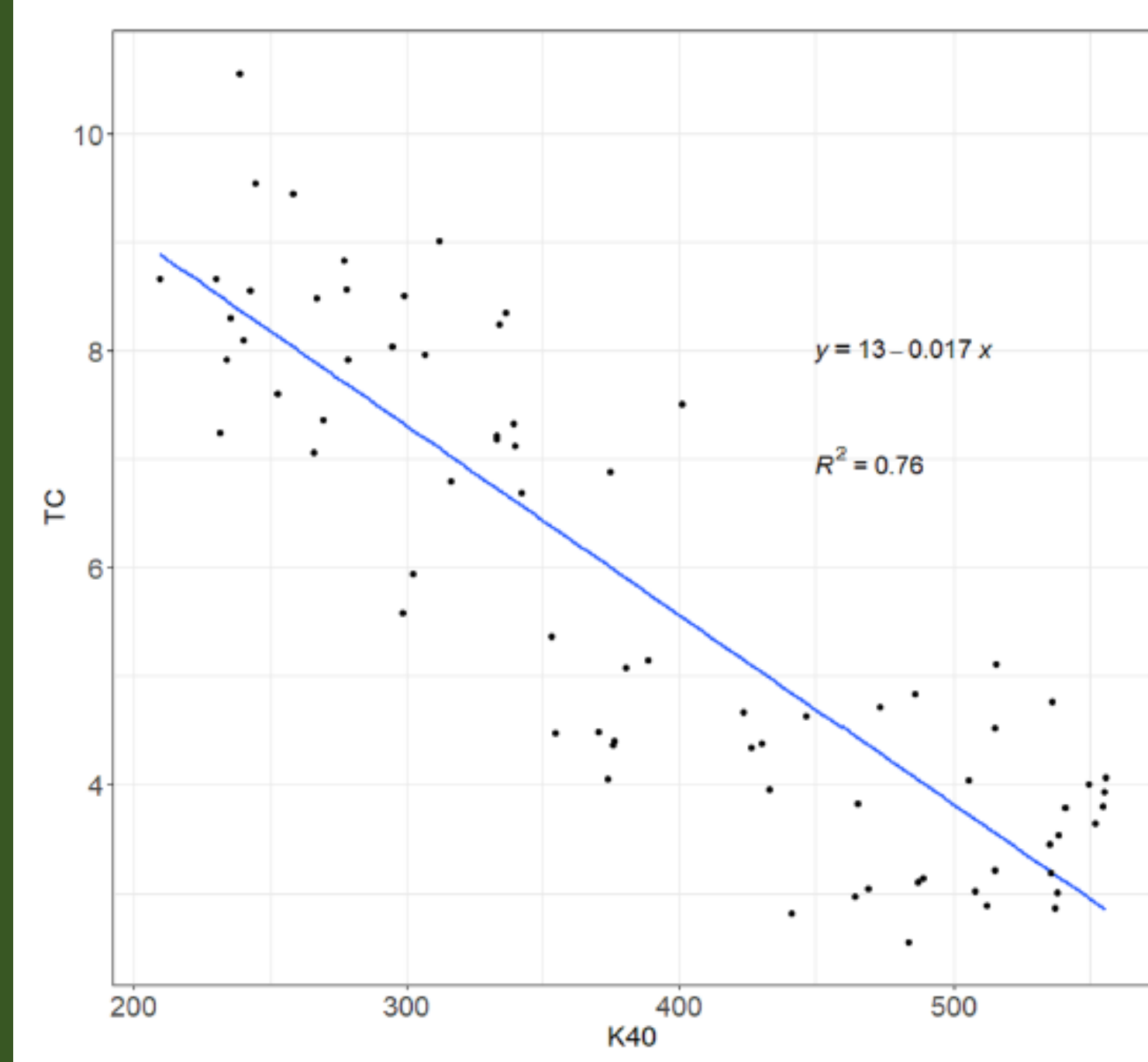
¹School of Geography, Earth and Environmental Sciences, University of Plymouth, UK (william.blake@plymouth.ac.uk); ²Nelson Mandela African Institution of Science and Technology, Arusha, Tanzania; ³Schumacher College, Faculty of Ecological Design Thinking, Devon, UK

Sensor tech for soil health

Combining sensor technology with citizen science to support soil and food security, combat the climate crisis, promote biodiversity, and drive economic prosperity

- Soil resources in East African agro-pastoral lands are being rapidly depleted by erosion, threatening food, water and livelihood security (Blake et al., 2018; Wynants et al., 2020).
- Here we explore the utility of innovation in portable gamma sensors to rapidly assess soil health.
- Spatial variability in naturally occurring radioactivity (NORM) is used as a proxy measurement of soil organic matter (SOM) .
- This provides (i) visual information that enables local communities (as citizen scientists, Kelly et al., 2022) to take local sustainable land management action to mitigate land degradation and (ii) quantitative evidence to inform policy makers for longer-term planning and regeneration of soil health

Portable gamma spectrometry (Medusa Radiometrics MS700) as a proxy measure of soil organic carbon



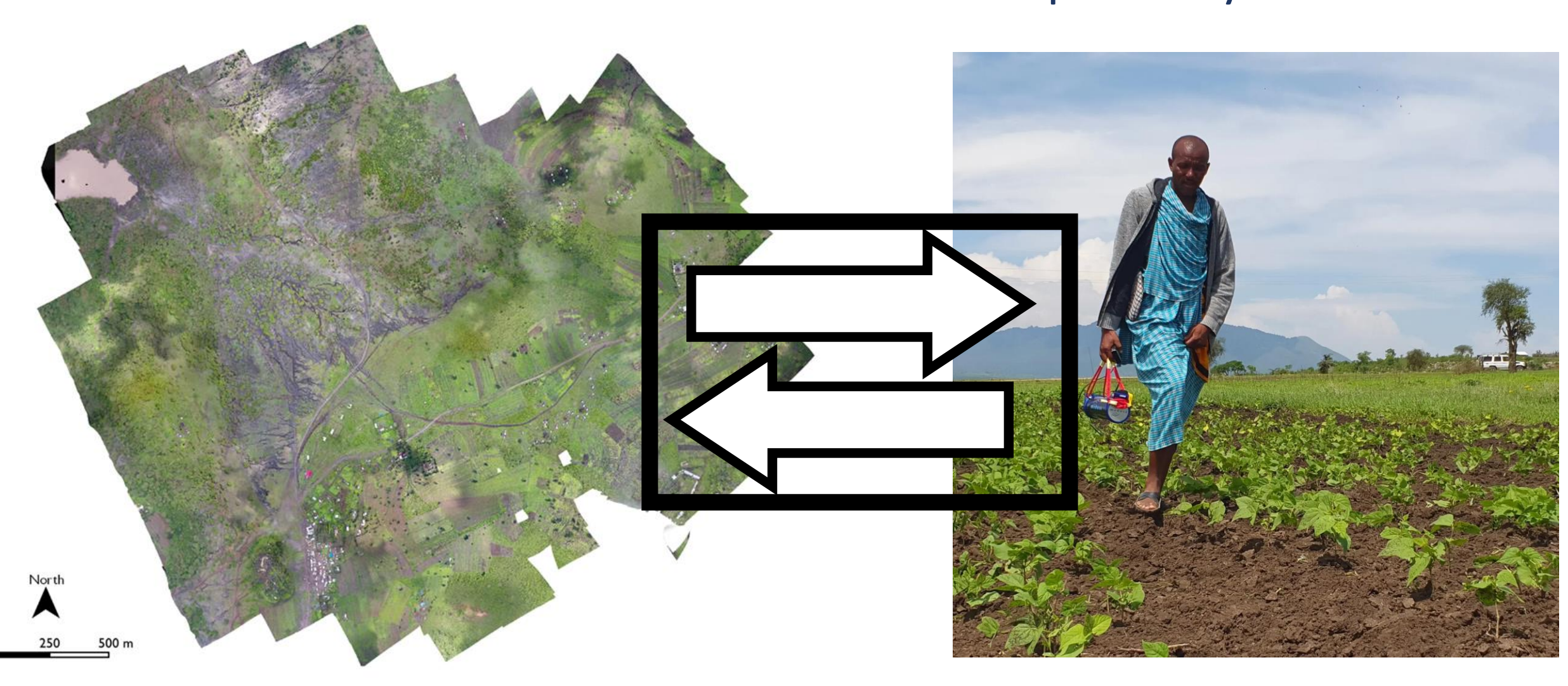
Taylor et al (2023) demonstrate relationship between NORM measured using Medusa Radiometrics MS700 and soil organic carbon in agricultural soil

Qualitative link between NORM and degree of land degradation

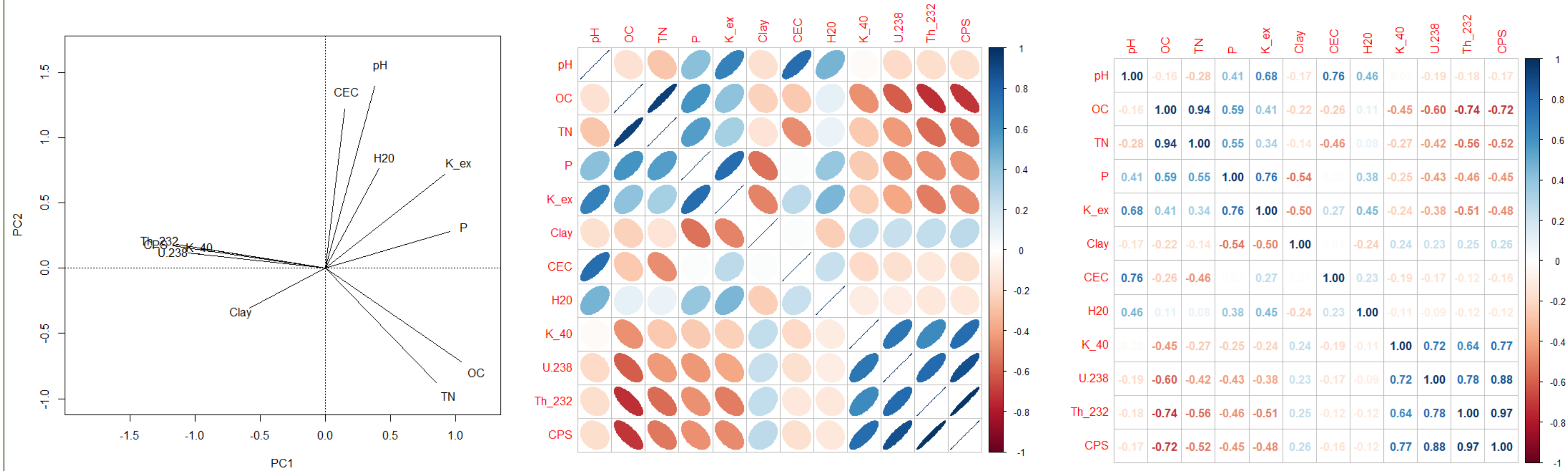


- Good correlation between NORM measurements and qualitative evaluation of land degradation status was observed
- Severely gullied soil/subsoil, heavily grazed surface soil, recovered grazed soil (ca 3 years exclusion of livestock) and conservation agriculture plots showed a clear gradient in raw total gamma count rate (bright colours = higher counts per second (cps), dark = lower cps).
- CPS at 1200 ± 100 , 980 ± 70 , 814 ± 60 and 720 ± 60 counts per second across the above four areas respectively.

- Portable gamma sensors offer a powerful visual in situ tool to inform local agricultural communities about relative status of soil health.
- This study suggest evidence can detect soil recover from rotational grazing and vice versa to support livestock management
- Quantification of the relationship between NORM and soil properties is, however, essential to demonstrate the process linkage for full confidence in data



Quantifying relationship between NORM and soil properties



- Principle components analysis (left) of NORM data and basic soil properties, determined by Near Infra Red Spectroscopy (NIRS; Amasi et al., 2021; Kelly et al., 2022), supports modification of NORM signal in this landscape by SOM wherein influence of other factors needs exploring.
- Negative correlation (centre and right) between specific radioisotopes and soil properties suggest that in this context the closest proxy to SOM/SOC is negative correlation with Th-232, which is also closely correlated to cps.
- Further analysis of soil samples to quantify gamma emitting radioisotopes (HPGe Gamma Spectrometry) and major and minor elemental analysis (WD-XRF) will permit deeper multivariate analysis of the relationship between in situ NORM measurements and soil composition.

Conclusion and prospects

- Feedback from community members underpins the value of the sensor as a qualitative assessment tool e.g. using visual colour coding in the live data feed in the field.
- Quantitative comparison of sensor and laboratory data will permit protocols for ground-based and airborne (drone) gamma spectrometry for soil health evaluation at scale
- Portable gamma spectrometry is a promising tool to support evaluation, mitigation and reversal of soil erosion impact in rangeland socioecological systems.

References and acknowledgements

Amasi AIM, Wynants M, Kawala RA, Sawe SF, Blake WH & Mtei KM (2021) 'Evaluating Soil Carbon as a Proxy for Erosion Risk in the Spatio-Temporal Complex Hydropower Catchment in Upper Pangani, Northern Tanzania' Earth 2, (4) 764-780
 Blake WH, Rabinovich A, Wynants M, Kelly C, Nasser M, Ngondya I, Patrick A, Mtei K, Munishi L & Boeckx P (2018) 'Soil erosion in East Africa: an interdisciplinary approach to realising pastoral land management change' Environmental Research Letters 13, (12)
 Kelly C, Wynants M, Patrick A, Taylor A, Mkilema F, Nasser M, Lewin S, Munishi L, Mtei K & Ndakidemi P (2022) 'Soils, Science and Community ActiON (SoilSCAN): A citizen science tool to empower community-led land management change in East Africa' Environmental Research Letters 17,
 Taylor A, Kalins A, Koot M, Jackson R, Tolosa A, Ahmed HS, Goddard R & Blake WH (2023) 'Portable gamma spectrometry for rapid assessment of soil texture, organic carbon and total nitrogen in agricultural soils' Journal of Soils and Sediments 23, (6) 2556-2563
 Wynants M, Kelly C, Mtei K, Munishi L, Patrick A, Rabinovich A, Nasser M, Gilvear D, Roberts CN & Boeckx P (2019) 'Drivers of increased soil erosion in East Africa's agro-pastoral systems: changing interactions between the social, economic and natural domains' Regional Environmental Change
 Part of a research programme funded by UK Natural Environment Research Council grant NE/R009309/1 and Research Council UK Global Challenges Research Fund (GCRF) grant NE/P015603/1; Biotechnology and Biological Sciences Research Council grant BB/T012560/1. The study represents a contribution to the joint UN FAO/IAEA Coordinated Research Projects (CRP) 'D15017: Nuclear Techniques for a Better Understanding of the Impact of Climate Change on Soil Erosion in Upland Agroecosystems' and 'D15018: Multiple Isotope Fingerprints to Identify Sources and Transport of Agro-Contaminants'.