# Herder land-use in southern Kenya: geochemical analysis of soil enrichment

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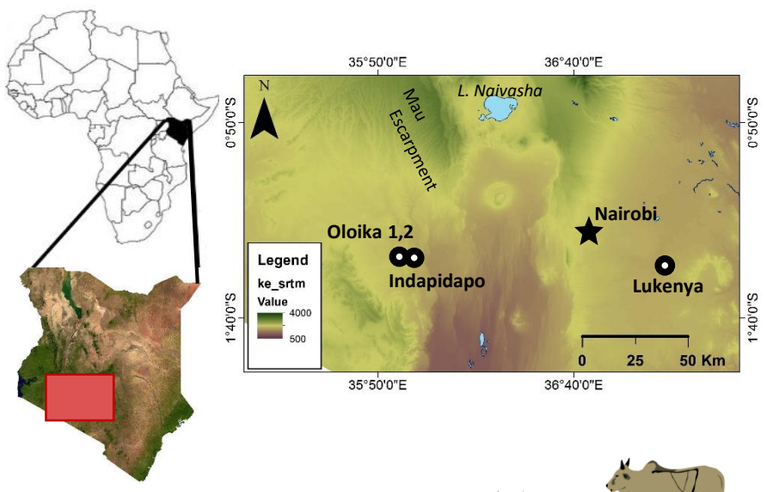



## 1 Objectives

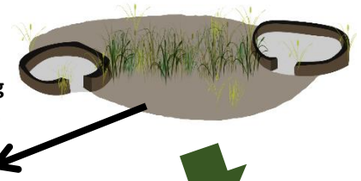
- East African herder land-use & livestock penning practices enriching savanna soils, positively affect bio-diversity (Little 1996; Porensky & Veblen 2015).
- What is the time-depth of this pattern? How long does nutrient enrichment on ancient herder sites persist?
- Broader goal to understand the deep time impacts of herder land-use on East African savannas.

## 2 Methods

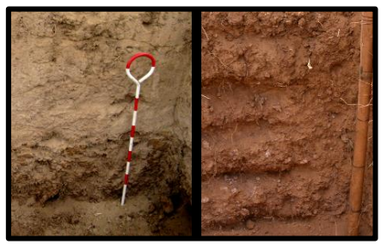
In 2011 we (S.A., F.M., S.G. & A.W.) excavated/sampled sedimentary profiles at 5 ancient herder sites in southern Kenya with ashy-grey horizons associated with degraded animal dung. Off-site profiles were sampled for comparison. These sites were Oloika 1 & 2 and Indapidapo in Narok, and GvJm 44 & 48 at Lukenya. Sites dated to between 3200-2000 BP.

We performed ICP-MS elemental analysis on sediment samples with an Agilent 7750 ICP-MS. 100mg samples were digested in $HNO_3$ in a microwave at 180 °C for 1 hour, diluted to a 10x solution, passed through a 22 µm filter, & diluted again to a 100x solution. Internal reference standards & $HNO_3$ blanks were run every 5 samples for calibration and to minimize drift and memory effects.

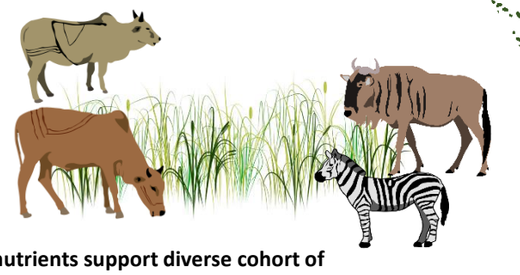
**Animal dung accumulates in livestock enclosures at short-term homesteads**



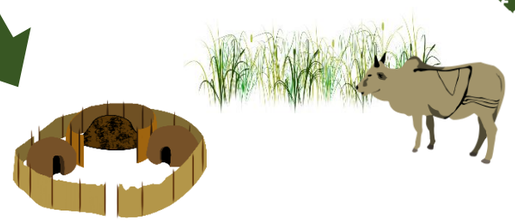
**Homestead is abandoned, dung decays into fine grey sediment. Micro-nutrients in dung become bio-available**



On-site Off-site



**Micro-nutrients support diverse cohort of grasses preferred by wild and domestic animals**

**Herders re-inhabit desirable locations**

**Multiple patches of micronutrient enriched grasslands are established.**

## 3 Results

Several elements (see right) were consistently elevated in archaeological "dung" layers relative to off-site sediments. Enrichment was strongest in lower portions of dung-derived deposits.

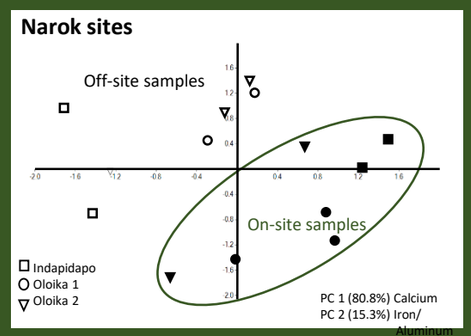
Metals like iron & aluminum were relatively depleted in archaeological layers.

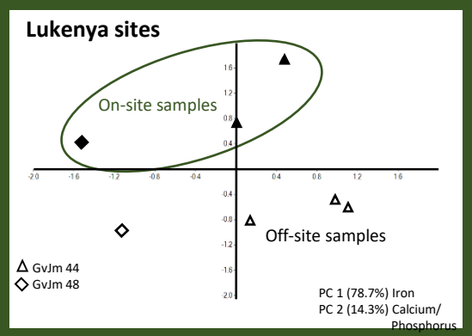
**Elements enriched on-site**

- Calcium (x10)
- Phosphorus (x2)
- Potassium (x1.5)
- Magnesium (x2-4)
- Sodium (x2.7)
- Strontium (x1.5)

Principal components analyses (PCA) shows calcium, magnesium, iron explain >95% of variability for Narok & Lukenya site-groups (see plots below).

Specific enrichments and depletions match expectations for dung accumulations (McBride & Spiers 2001; Nielson et al. 2014). Variation in elemental values between sites are affected by diet/species of dung producing livestock (Shahack-Gross 2011), local geology, ecology, taphonomy.




## 4 Conclusions

- Ancient herder sites have much higher levels of elements important as plant macro-nutrients.
- Anthropogenic nutrient enrichment from **~3,000 years ago** was reinforced & **maintained into the present**.
- Expansion of herding in East Africa had a significant positive role in shaping current savanna ecologies.

## References

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***Questions?***

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