Model-Based Assessment of Grazing Impact on Soil Carbon Stocks and Dynamics of a Kenyan Rangeland

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BACKGROUND

The extensive coverage of rangelands worldwide and their widespread degradation make them potential carbon sinks that can contribute to climate change mitigation. Through the carbon cycle, rangeland grasses capture and store atmospheric CO_2 in the soil as Soil Organic Carbon (SOC) and provide additional benefits (Fig 1). Studies have shown that SOC is influenced by management with practices either increasing or decreasing stocks over time. About 80 million hectares of land in East Africa is rangeland but despite the huge potential as carbon sinks, there have been few studies to deepen our knowledge of SOC dynamics in response to management in the region.

AIM

- To quantify C sequestration potentials in rangeland systems in East Africa under contrasting management.

OBJECTIVES

- To simulate the long term impacts of different grazing intensities on SOC dynamics under clayey and sandy soil types at a plot scale.
- To simulate the effect of climate change on SOC dynamics.

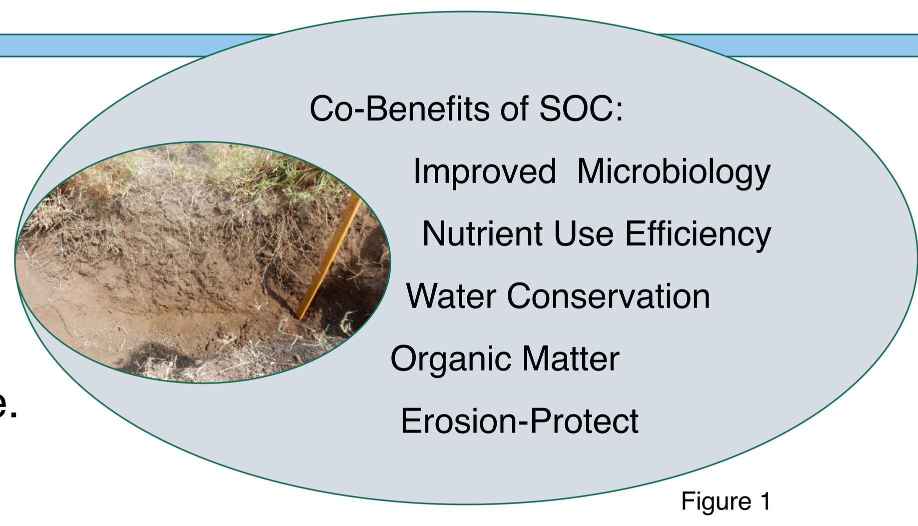


Figure 1

METHODOLOGY

Site: Kapiti Livestock Ranch (Southern Kenya)

- Location: -1.6 S, 37.1 E
- 13,000 ha, semi arid rangeland with C4 grasses
- Livestock and wildlife grazing have resulted in some areas being over grazed
- Chemical and physical analysis of soil samples differenciated two soil types- clay and sand (2017 sampling)
- Current SOC stocks measured by Walkley-Black test
- Measured SOC and plant production data as validation dataset for model output

We modelled long-term impacts of three grazing regimes

1. Moderate; **GM** (20% monthly removal of aboveground live matter (aglm))
2. Heavy; **GH** (45% removal of aglm)
3. Rotational; **GR** (two years of GH followed by a year of GM)

DAYCENT MODEL

Figure 2. Model Inputs

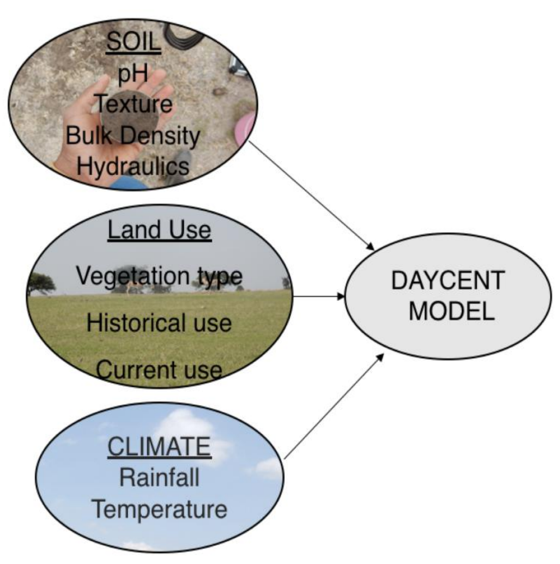
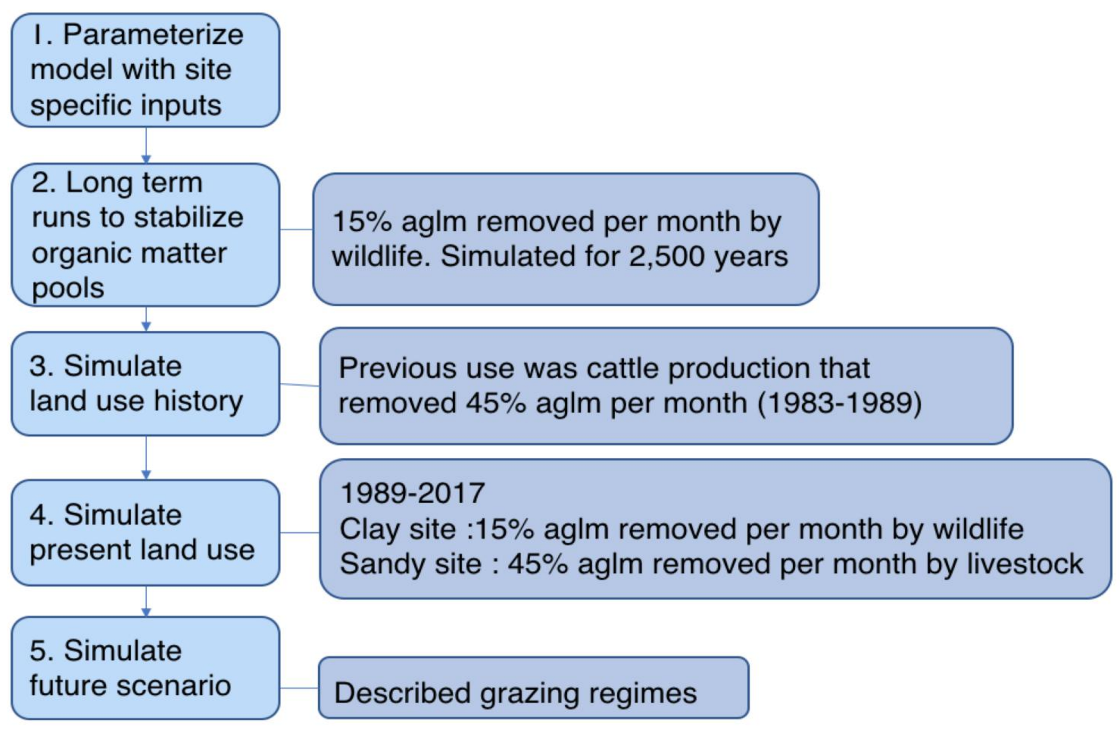
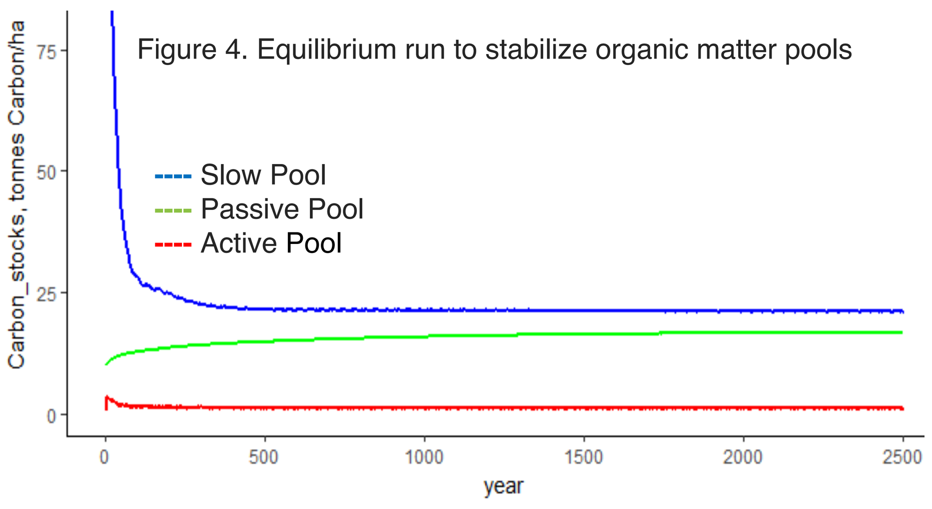


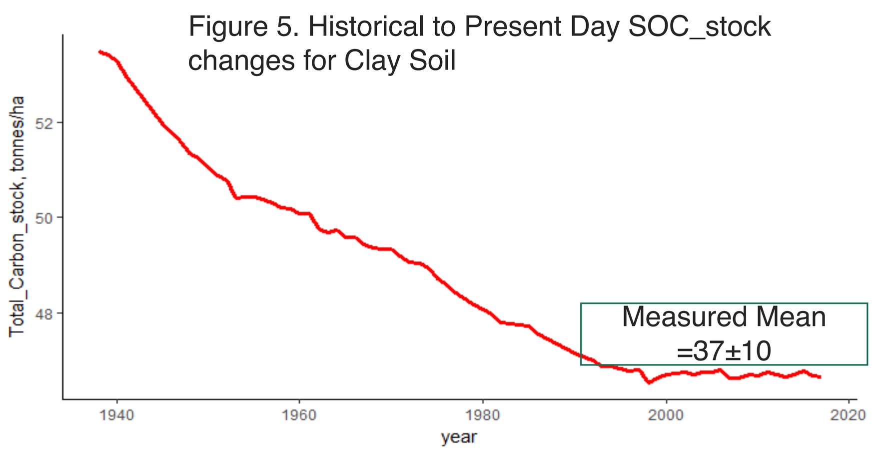
Figure 3. DayCent Modelling Steps



PRELIMINARY RESULTS

Model Validation (Testing modelled output against measured data)





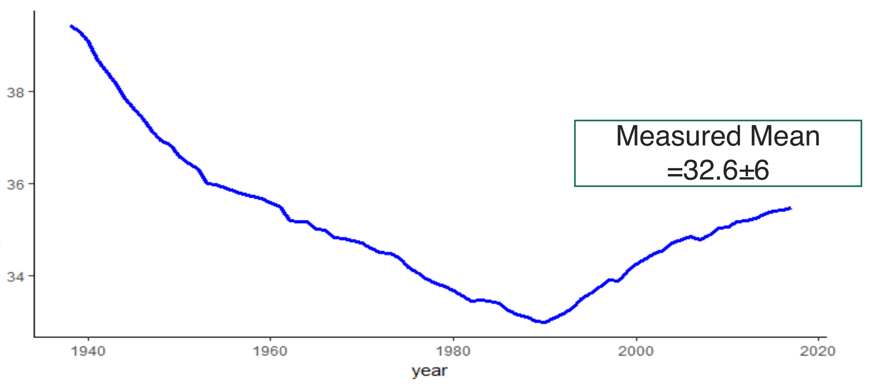


Figure 6. Historical to Present Day SOC_stock changes for Sandy Soil

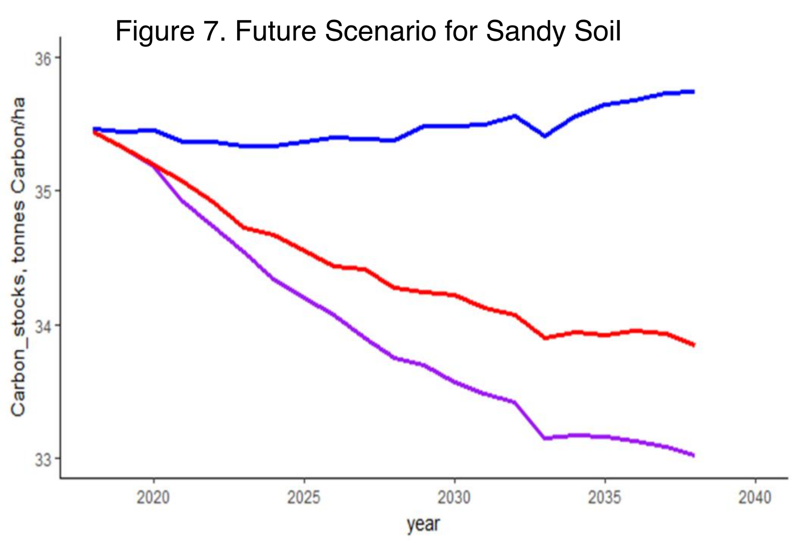
Site	Aboveground Biomass (g C/ m²)		Net Primary Productivity (g C/ m²)	
	Measured Mean ± SD	Simulated	Measured	Simulated
Sandy	44 ± 9.5	51.2	460	385
Clay	44 ± 12.6	31.7	460	336

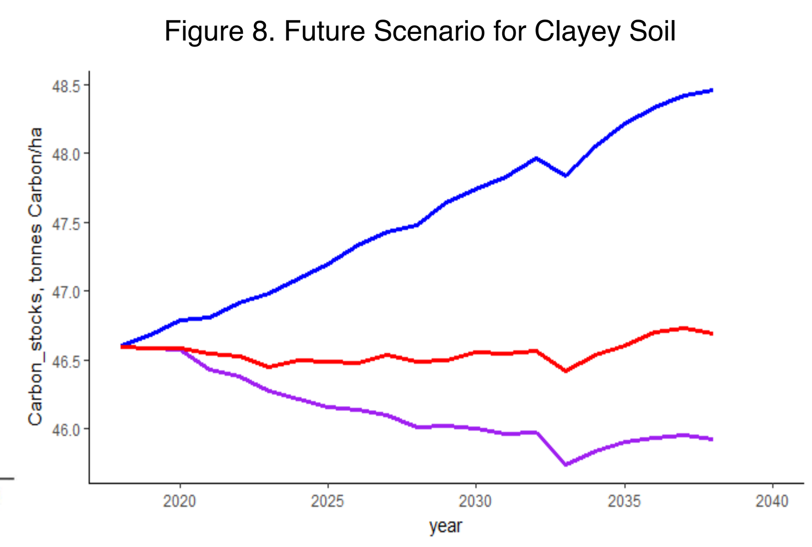
Table 1. Plant productivity data, measured versus modelled

Future SOC_Stock Trend

SOC_dynamics in the next 20 years as affected by the different grazing intensities.

GM GR GH





DISCUSSION AND CONCLUSION

SANDY SOIL: At the end of the 20-year run, GH and GR both resulted in carbon losses of 7% and 4.6% respectively while GM gained 250kg C/ ha.

CLAYEY SOIL: GH lost 1.4% the current SOC stocks. GR gained 0.2% carbon. GM resulted in a total gain of 1.9 tonnes C/ ha at an annual rate of 154 kg C/ ha.

- The result, so far, indicates reduced grazing intensity and improved management as potential ways to sequester soil carbon . Clay soils may have higher carbon potentials in comparison to sandy soils when subjected to the same grazing regimes.

FURTHER WORK

- Explore effects of other grazing intensities regimes.
- Use of future climate data (RCP scenarios) to model the effect of climate change.

CHALLENGES

- Heterogeneity and complex nature of soil processes.
- Availability of required model inputs.

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