

Understanding spatial variability of soil physical and hydraulic properties in agricultural land in Zambia and Malawi

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CONCLUSIONS

- Soils in small-holder farmers' fields have weaker structure and low organic matter content compared to commercial farms in the region.
- Saturated hydraulic conductivity is higher in commercial fields, despite their higher clay content.

INTRODUCTION

The success of rainfed soybean and maize cultivation depends significantly on soil physical properties, influencing water availability, nutrient retention and overall soil health. Remote sensing, coupled with ground-based measurements, offer valuable insights into spatial distribution of soil properties different scales, and their impact on cultivation, enabling precision agriculture and targeted management strategies.



Figure 2: Loose soil sampling for texture and chemical properties. Infiltration measurements using a single ring infiltrometer for field-saturated hydraulic conductivity and undisturbed soil core sampling for bulk density and water retention characteristics.

RESEARCH OBJECTIVES

Objective 1: Observing variability of the soil's texture and agrophysical parameters in Zambia and how they affect soybean and maize cultivation for small-scale and commercial farmers.

Objective 2: Investigating hydraulic properties and their implications for water management strategies.

SITE SELECTION & DATA COLLECTION

Figure 1 includes the sites selected: Lusaka, Kalomo, and Katete; each representing a different farming type (commercial or small-scale) and agroclimatic conditions. Soil sampling was conducted during February and March 2024 (Figure 2):

- Physical, chemical, and hydraulic top- and subsoil properties according to the Land Degradation Surveillance Framework.
- Single ring infiltrometer measurements on selected fields.

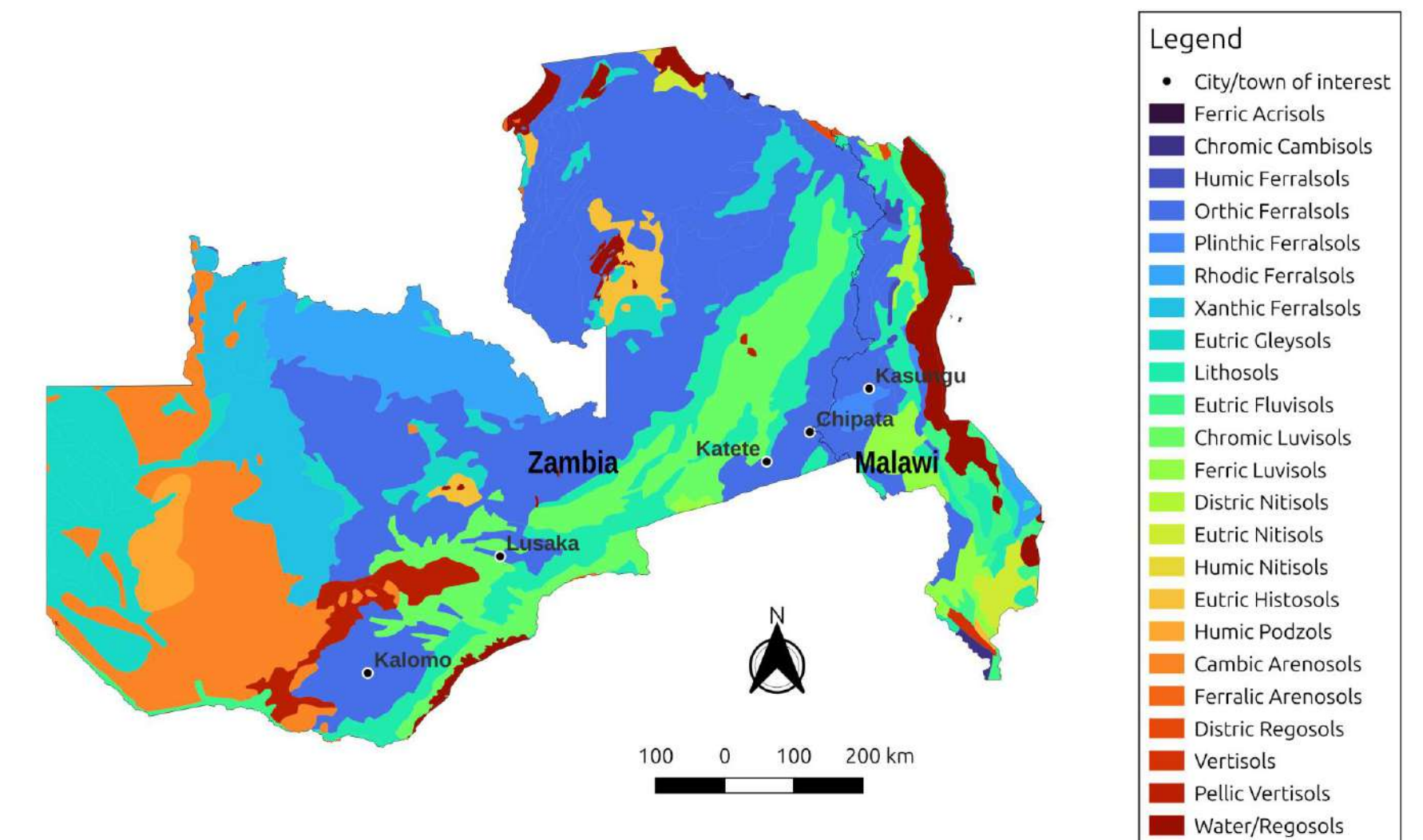


Figure 1: FAO soil map of Zambia and Malawi (produced in 1980), and important sites, including the sites of interest in our study.

RESULTS & DISCUSSION

Commercial fields in Lusaka higher clay content in the top and subsoil (40 and 45% mean clay content respectively) compared to fields in Kalomo (18 and 26% for top and subsoil respectively)(Figure 4). Commercial fields also have the highest organic carbon content (OC) in topsoil with 0.9% mean OC closely followed by Katete (0.8% mean OC), a region marked by topography induced micro-climates (Figure 3).

Field-saturated hydraulic conductivity (K_{fs}) was moderate but generally higher at commercial fields despite higher clay content (Figures 5). In Lusaka, K_{fs} was 134 mm h^{-1} on average, while it was 46 mm h^{-1} in Katete and 72 mm h^{-1} in Kalomo. A moderate correlation was observed between OC and K_{fs} .

NEXT STEPS

- Measuring soil moisture vs crop and farming properties.
- Monitoring NDVI and yield in the 2023-2027 farming seasons.
- Determine relationship between water retention characteristics and maize and soybean yield in the region

WHAT DOES THIS STUDY ADD?

- The addition of open soil data to the mostly incomplete and patchy sub-Saharan African soil dataset.
- Promoting precise understanding of farmers soil and crop health.
- Enhanced understanding of the spatial variation of soil physical properties and its impact on soybean and maize yield.

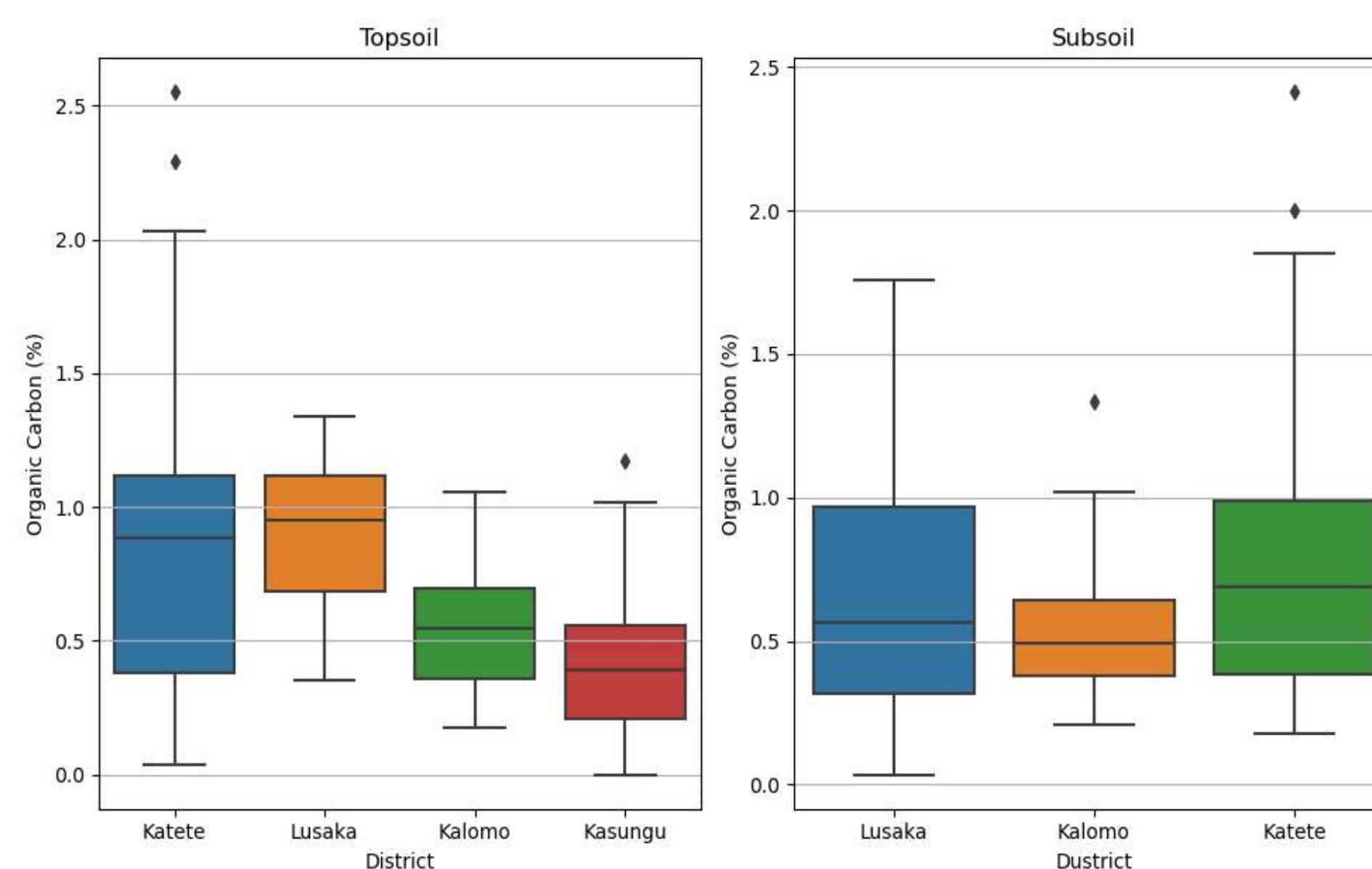


Figure 3: Organic carbon content of topsoil (0-10cm) and subsoil (30-40cm) in Lusaka, Kalomo, Katete, and Kasungu.

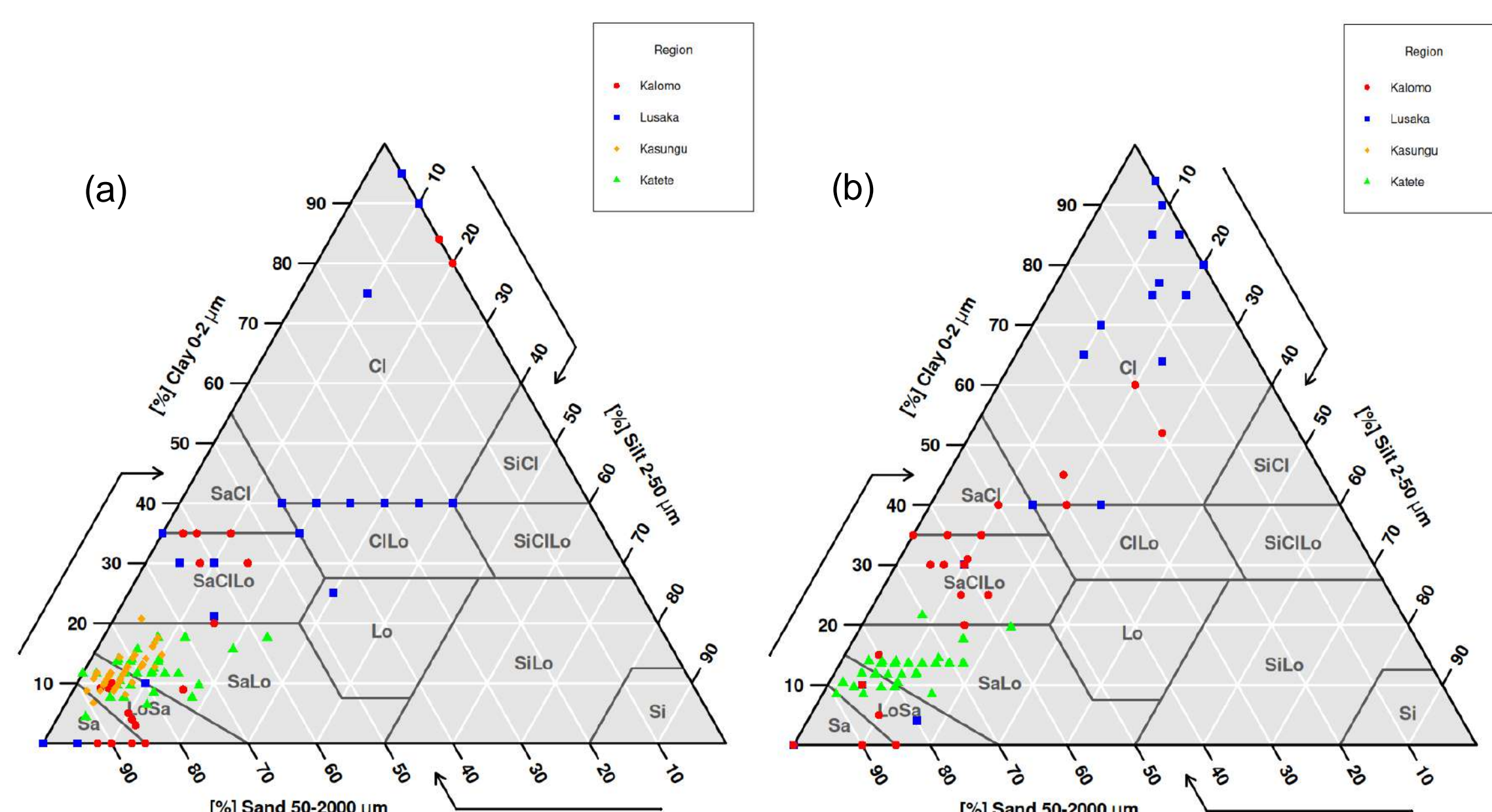


Figure 4: Texture Triangles of (a) topsoil (0-10cm) and (b) subsoil (30-40cm) in Lusaka, Kalomo, Katete, and Kasungu.

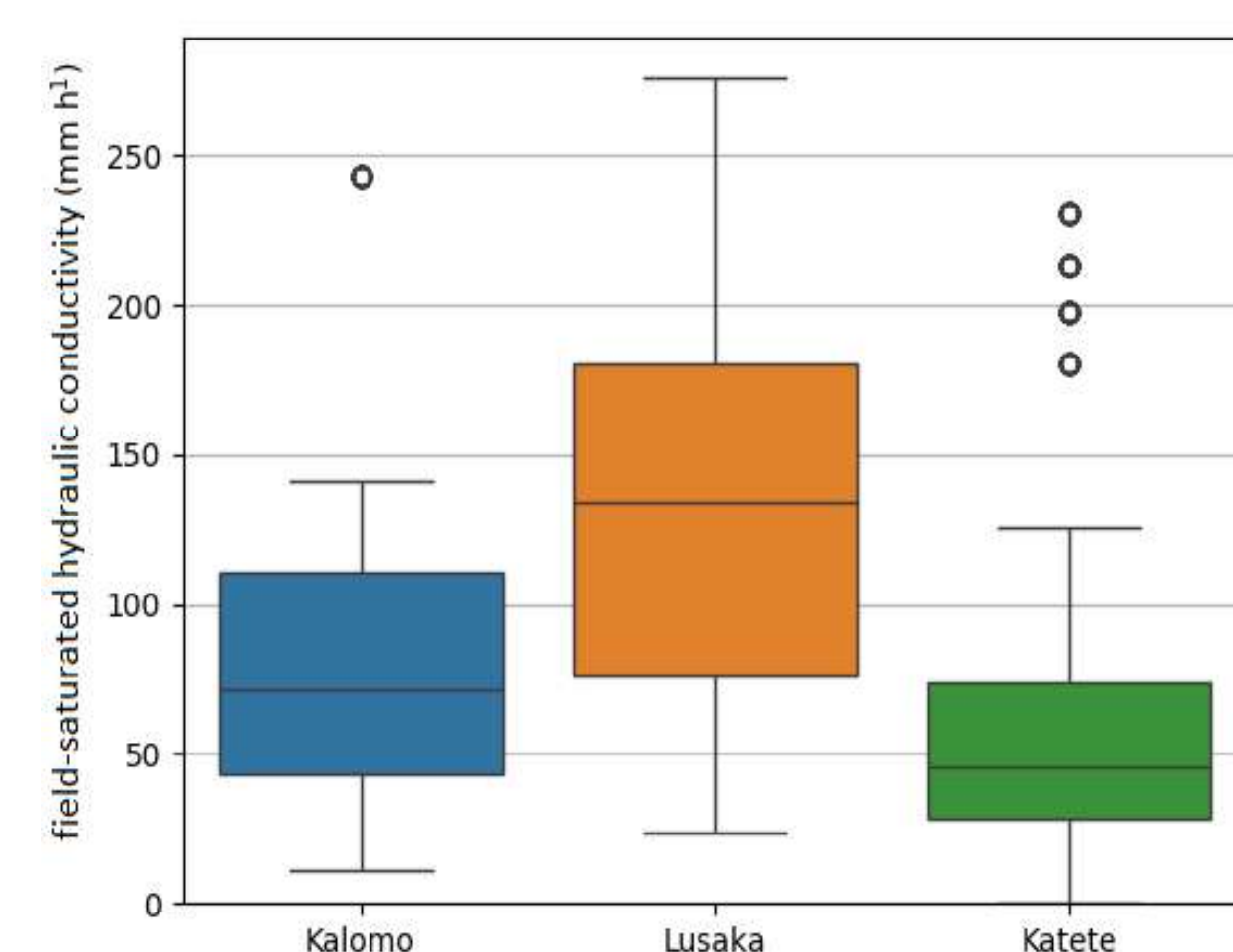


Figure 5: Field-saturated hydraulic conductivity for the different fields determined using single ring infiltration measurements.



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