Co-development, implementation, and capacity building on NbS and FLR monitoring and reporting frameworks: Case Study in Lumo Conservancy and Taita Taveta Wildlife Sanctuary in Taita Taveta County, Kenya

Leigh Ann Winowiecki, Christine Magaju and Tor-Gunnar Vågen
World Agroforestry (ICRAF)

30 March 2024

Table of Content

1 Introduction

The World Agroforestry (ICRAF), Africa Wildlife Foundation (AWF) and FAO-Kenya are pleased to co-host a two-day reflection workshop for the project, "**Delivering Nature-based Solution Outcomes by Addressing Policy, Institutional and Monitoring Gaps in Forest and Landscape Restoration**". The project is completing the first year of implementation in March 2024 focusing on Makueni Taita Taveta Counties. This reflection workshop is an opportunities to share progress to date and co-develop the roadmap of joint implementation going forward.

Background

This project aims to: 1) Increase capacity on forest and landscape implementation and monitoring for relevant organizations; 2) Aid in the implementation of evidence-based recommendations for reduced emissions at local, county and national levels; and 3) Implement gender-transformative, equitable and socially inclusive activities and outputs. This will be delivered through six work packages (WP) in collaboration with project partners:

WP1: Co-development, implementation, and capacity building on NbS and FLR monitoring and reporting frameworks. WP 2: Domestication of the Forest and Landscape Restoration Implementation Plan (FOLAREP) 2023-2027 into county-level governance. WP 3: Strengthening coordination of community forest associations (CFAs) and their contribution to county forest conservation and management policies. WP 4: Capacity development and engagement of key national-level stakeholders to strengthen implementation of cross-sectoral frameworks and policies on climate change, forestry and restoration. WP5: GESI: Building institutional capacity for equitable and inclusive FLR. WP 6: Project Management and Monitoring Evaluation and Learning.

OBJECTIVE OF THE ASSIGNMENT

The main objective of the assignment is to undertake soil health, land degradation and vegetation assessments using Land Degradation Surveillance Framework (LDSF) across diverse landscapes in Taita Taveta and Makueni counties.

The specific objectives are to:

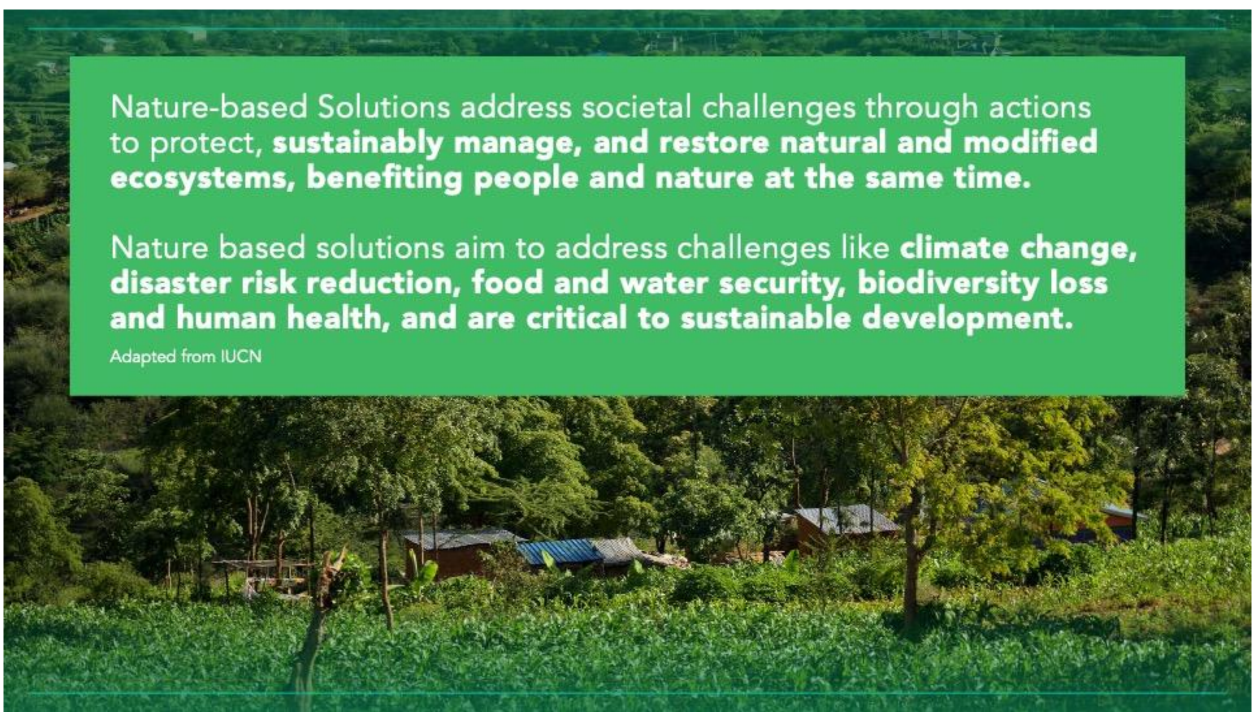
a) Provide a baseline of soil and ecosystem health indicators across the landscape;
b) Build a database of NbS and FLR indicators; and
c) Build capacity of local, county and national stakeholders on NbS and FLR monitoring.

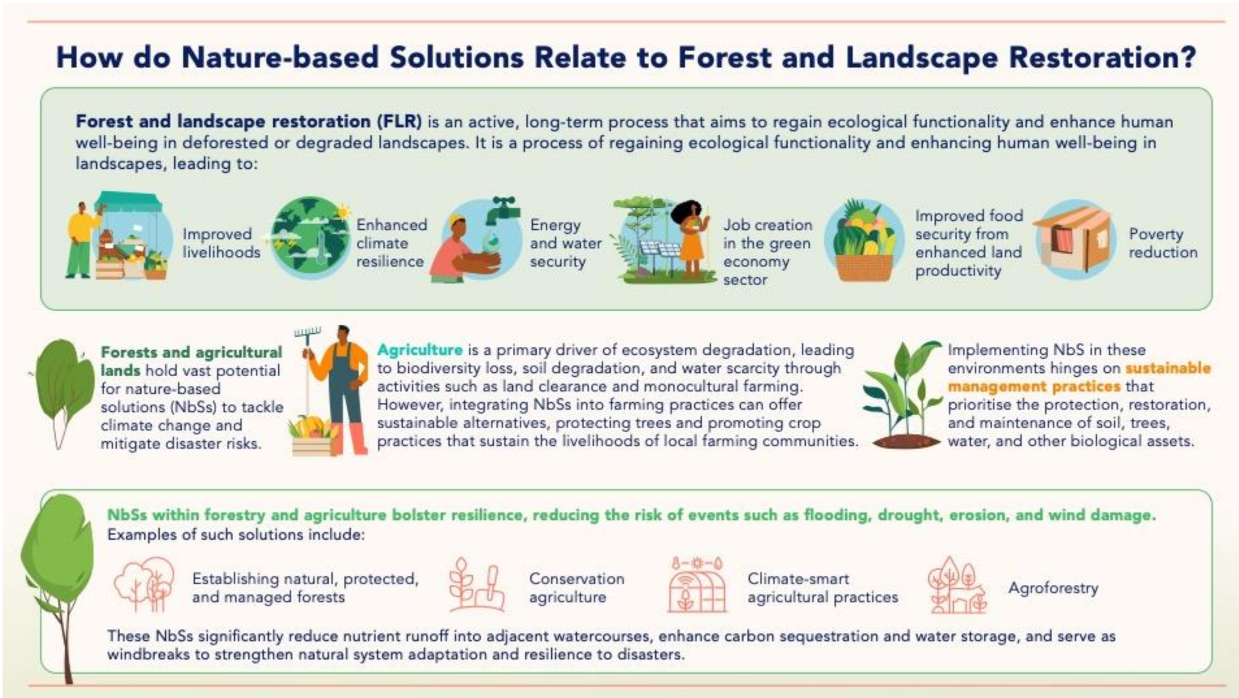
2 Nature-based Solutions

Nature-based solutions (NbS), including forest and landscape restoration (FLR), have the potential to increase biodiversity and ecosystem services, secure jobs and improve livelihoods, while accelerating action on climate change at local, national and international levels. This requires commitment from government officials and land managers to implement evidence-based policies that will deliver nature-based solution outcomes. In Kenya there is an urgent need to strengthen policy implementation at the community, county and national levels. This includes the development and implementation of gender transformative solutions for reduced emissions, as well as cross-sectoral coordination and co-learning around monitoring of FLR at the farm, county and national scale.

Nature-based solutions demand complementary capacities in science, implementation, monitoring, policy, community engagement and conservation. Therefore, this project has formed a strong consortium with ICRAF, African Wildlife Foundation (AWF), FAO, and Practical Action (PA), building on decades of experience, expertise and complementary capacities in evidence-based knowledge sharing, policy engagement at national, county and community levels, transdisciplinary research and policy change in climate change, forestry, environment and livelihood issues.

The project will enhance production and access to evidence on the status of land degradation, as well as other key indicators on forest and landscape restoration to support the targeting and monitoring of restoration efforts in Kenya. This generation of evidence on the effectiveness of a suite of land restoration practices with the aim of triggering behavior change and action among state and society will be critical for replication. Combined with a strong stakeholder engagement process to translate evidence into information that can be readily interpreted by farmers, community members, policy makers and other decision makers will aid in the development of strategic communication to stakeholders beyond those directly engaged in the project and will be key for scaling.





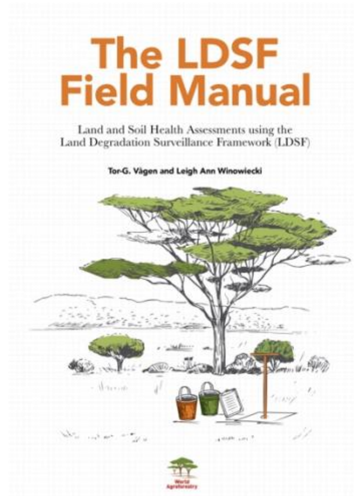
3 Background on LDSF

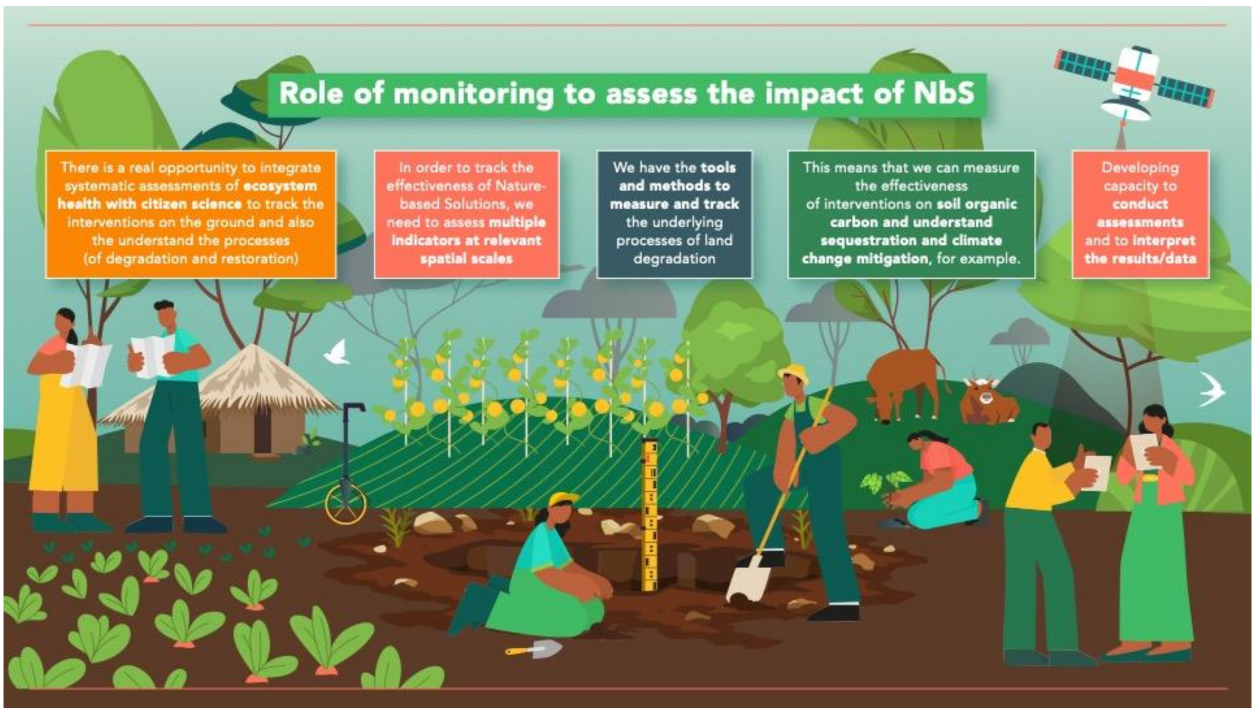
3.1 Background on the Land Degradation Surveillance Framework (LDSF)

The project will identify and measure key indicators of land and soil health in order to understand drivers of degradation, and monitor changes over time using the Land Degradation Surveillance Framework (LDSF) methodology: Updated 2023 LDSF field manual: https://www.cifor-icraf.org/knowledge/publication/25533

The LDSF provides a field protocol for measuring indicators of the "health" of an ecosystem.

The LDSF was developed by the World Agroforestry (ICRAF) in response to the need for consistent field methods and indicator frameworks to assess land health in landscapes. The framework has been applied in projects across the global tropics, and is currently one of the largest land health databases globally with more than 30,000 observations, shared at http://landscapeportal.org. This project will benefit from existing data in the LDSF database, while at the same time contributing to these critically important global datasets through on-going data collection. Earth Observation (EO) data will be combined with the LDSF framework to develop the outputs for the project, including land degradation and soil health. The framework is built around a hierarchical field survey and sampling protocol using sites that are 100 km2, each containing 160-1000m2 sampling plots (Figure 1).





Materials and resources on the LDSF:

- LDSF field manual: https://www.cifor-icraf.org/knowledge/publication/25533
- LDSF insight brief: https://regreeningafrica.org/wp-content/uploads/2023/02/Insights-series_LDSF.pdf
- LDSF Flyer: https://worldagroforestry.org/output/land-degradation-surveillance-framework

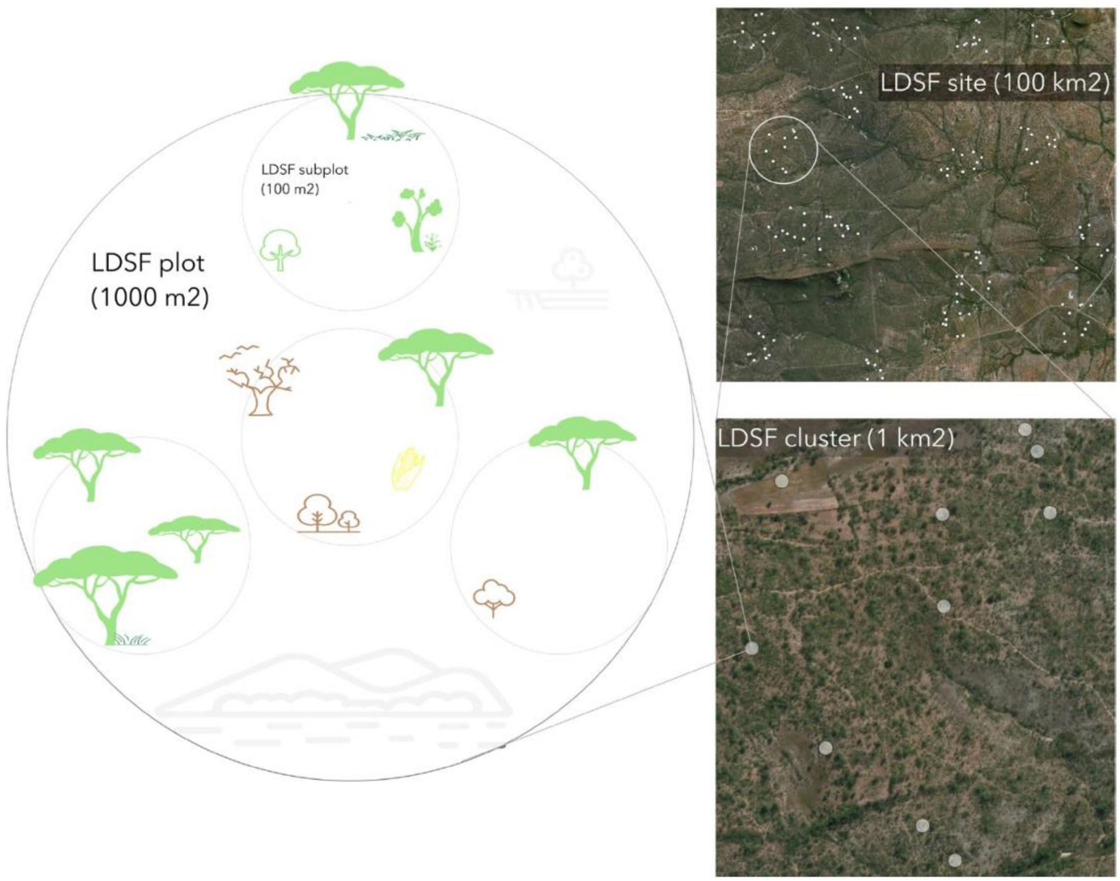


Fig. 2. The Land Degradation Surveillance Framework (LDSF) is a systematic, hierarchical sampling approach designed to sample key indicators of ecosystem health across multiple spatial scales. Each LDSF site is 100 km² and contains 16 1-km² clusters. Each cluster contains 10 circular sampling plots that have an area of 1000 m² each. Finally, each plot contains four 100-m² subplots. The graphics highlighting the LDSF site are overlaid on satellite imagery of the Agincourt LDSF site. Field observations were made at the plot and subplot scales.

Figure 1: Hierarchical design of the LDSF- SIte (100km2); Cluster (1km2); Plot (1000m2).

There is a real need for robust and consistent methodologies to assess soil and land health across ecosystems, including across grasslands, rangelands and savannahs. These becomes especially important for setting baselines, tracking changes overtime, prioritizing interventions as well as when engaging in carbon markets. Since landscapes are highly variable, the sampling design must capture this variability at multiple scales. Furthermore, the indicators for assessment and monitoring of land degradation should be: 1. Science based; 2. Readily measurable (quantifiable); 3. Rapid; 4. Based on field assessment across multiple scales (plot, field, landscape, region); and 5. Representative of the complex processes of land degradation in the landscape. The LDSF assesses multiple indicators at each geo-referenced location. The below figure highlights the key indicators measured, including soil erosion prevalence, land management, tree, shrub, grass, and forb diversity as well soil health indicators including soil organic carbon, sand content, pH.

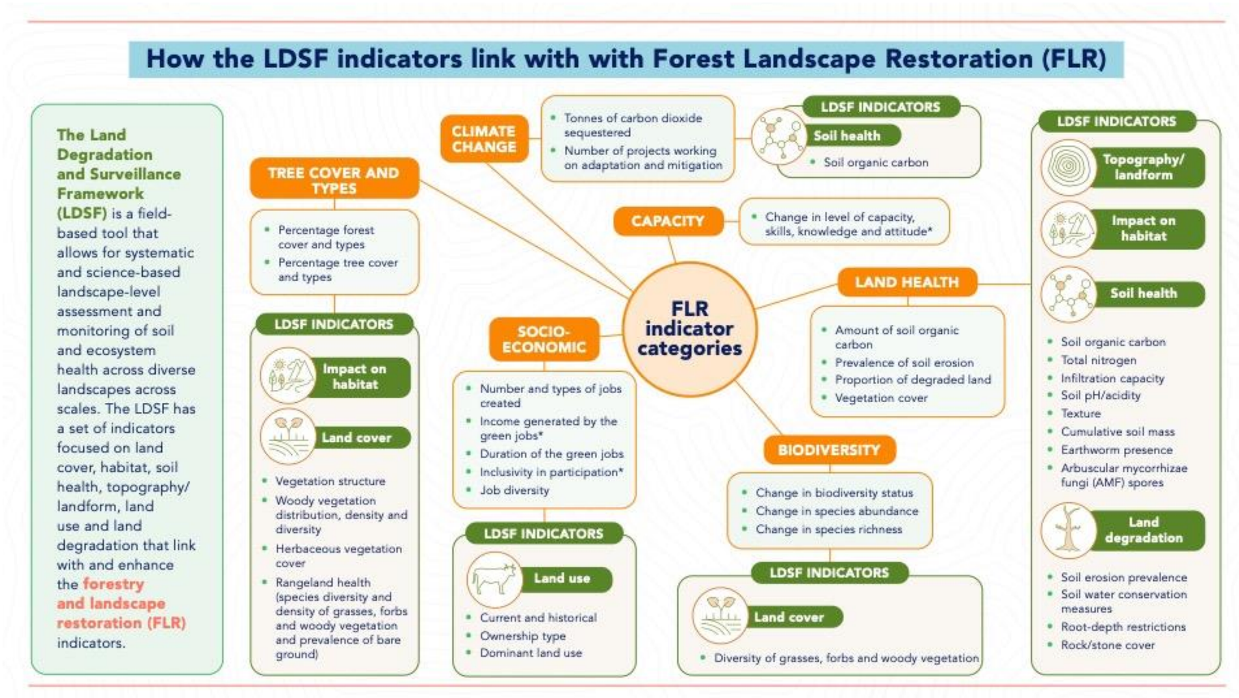


Figure 2: LDSF indicator framework.

Recent advances in soil and land health monitoring enable more efficient and consistent baseline assessments and monitoring of impacts towards avoided or reversed land degradation, monitoring of both biomass carbon and soil organic carbon, and biodiversity. These advances include a combination of systematic field-based methodologies coupled with remote sensing analyses to provide real-time as well as past assessments of key indicators of land degradation, vegetation cover and biomass, and soil organic carbon.

These advances present opportunities to revolutionize the way in which spatial resources are monitored, analyzed and predicted, including opportunities to engage women and youth in the monitoring process. In addition to biophysical variables, there are opportunities to integrate gender dis-aggregated perceptions of land degradation and restoration activities into the data collection modules. Engagement of land managers, including women and youth, in the monitoring process has shown to increase agency, raise awareness of the drivers of degradation, while simultaneously contributing to the scaling of restoration activities. There are real opportunities for combining systematic field observations, remote sensing and citizen science data collection to monitor rangeland health while also increasing community engagement in restoration. This includes applying these tools across a network of sites to encourage co-learning across the rangeland community. This in turn greatly enhances the potential for providing evidence-based and timely decision support at multiple spatial scales, and with immediate relevance for communities, and represents a real opportunity to enable science-based monitoring approaches that can be applied in agricultural and environmental management. The LDSF has been applied in over 40 countries across the tropics, see figure below.

Figure 3: Insight Brief linking monitoring and stakeholder engagement: https://regreeningafrica.org/wp-content/uploads/2023/02/Insights-series_LDSF.pdf

Figure 4: Location of the LDSF sites. Each site is 100 km2.

Specifically, the rangeland health module will be applied as this LDSF is across Lumo Conservancy and Taita Taveta Wildlife Sanctuary.

Rangeland health

The LDSF rangeland module aims to assess the health of a rangeland and can be applied in each LDSF plot (1000 m^2) in both the dry and wet seasons.

The rangeland health assessments are conducted using the transect method. A stick/pin is placed every 2 m along two 28 m transects (one N-S and E-W). At each point the nearest annual grass, perennial grass, forb and woody vegetation is identified.

Key rangeland indicators that are measured include:

Rangelands are important ecosystems and can harbour a high biodiversity of grass species and high soil organic carbon (SOC) content. There is a real need to collect systematic data on rangeland health to assess degradation status, productivity and biodiversity measures.

Figure 5: Rangeland health indicators measured in the LDSF.

3.2 LDSF Data collection

The LDSF field surveys took place in September and October 2023. One hundred and sixty plots were sampled. Ten plots were sampled in all clusters. Figure 3 shows the spatial spread of the sampled clusters. The team consisted of including the lead technician, botanist, and driver from ICRAF-Kenya. The team proceeded to meet with the Africa Wildlife Foundation (AWF) and Lumo Conservancy management team to discuss the sampling plan and logistics.

Figure 6: Photo of the field team.

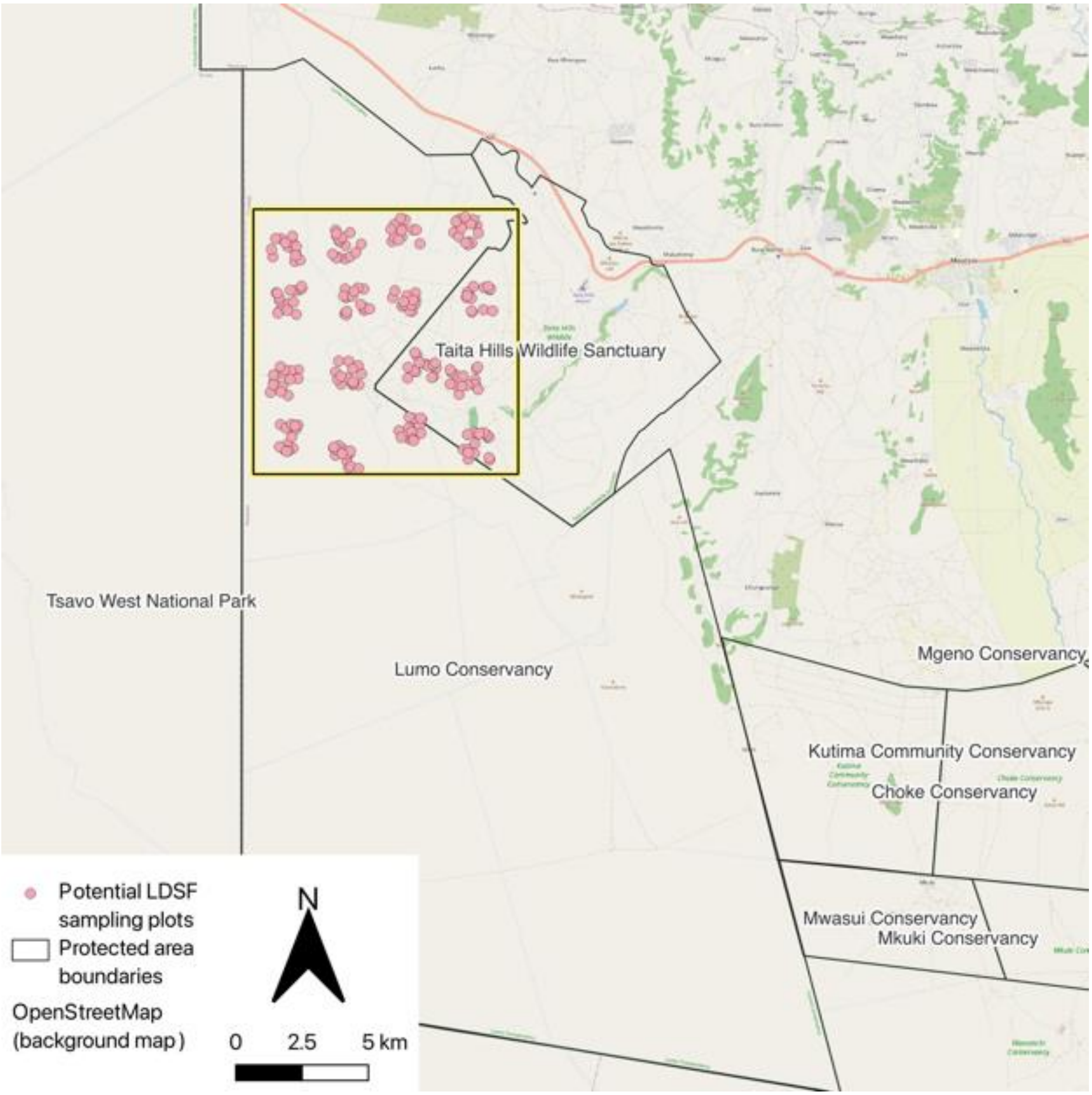


Figure 7: Location of the LDSF site.

4 Results and Discussion of the LDSF Data

4.1 Land Ownership

The site spans across Lumo Conservancy and Taita Taveta Wildlife Sanctuary (see map below).

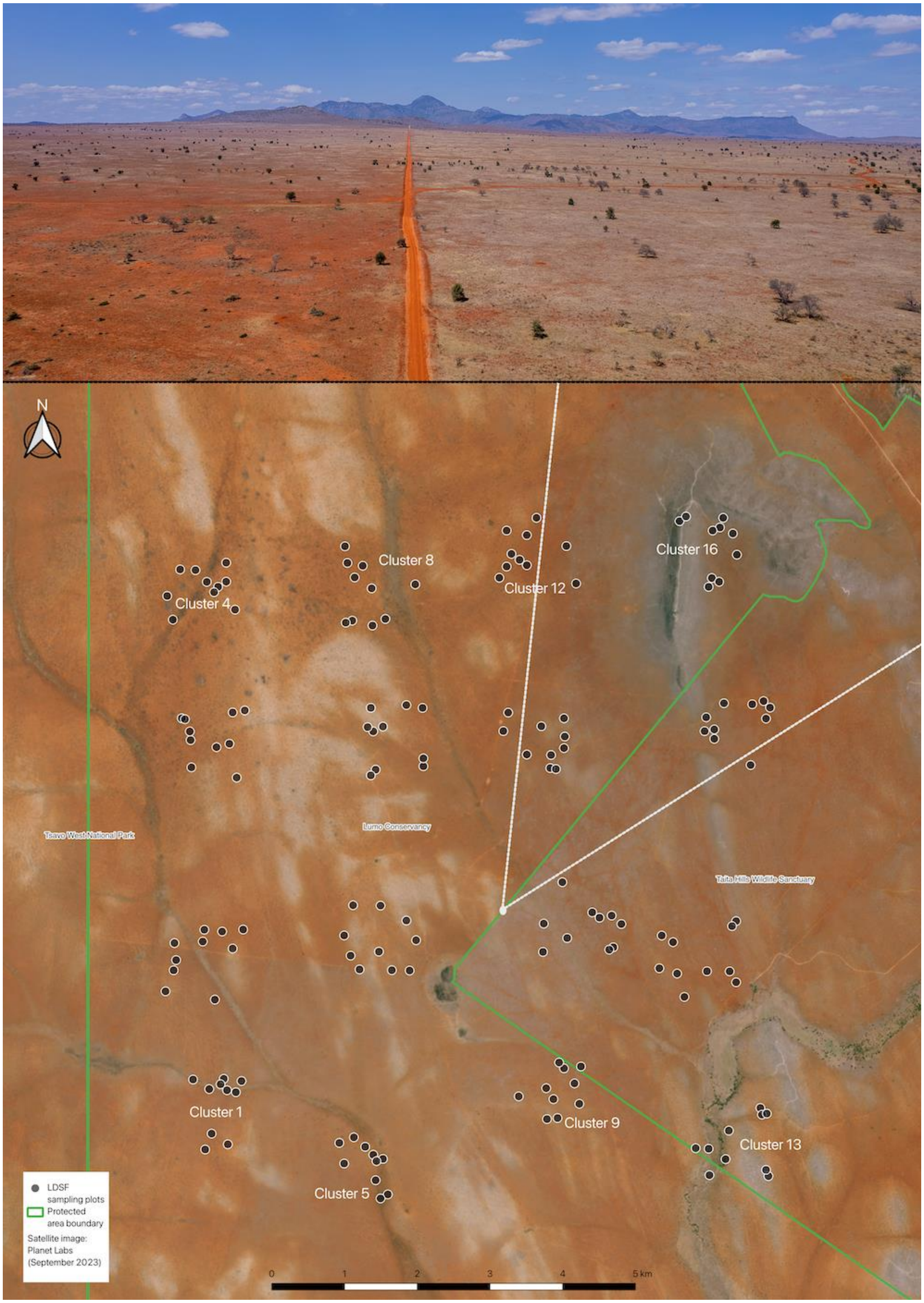


Figure 8: Most clusters were in Lumo Conservancy. Clusters 10, 13,14,15 were in Taita Taveta Wildlife Sanctuary.

4.2 Tree Species Diversity

The LDSF site had low tree density (4 tree ha-1) and six tree species (woody plants above 3m tall) observed. This was expected as this is a grassland ecosystem.

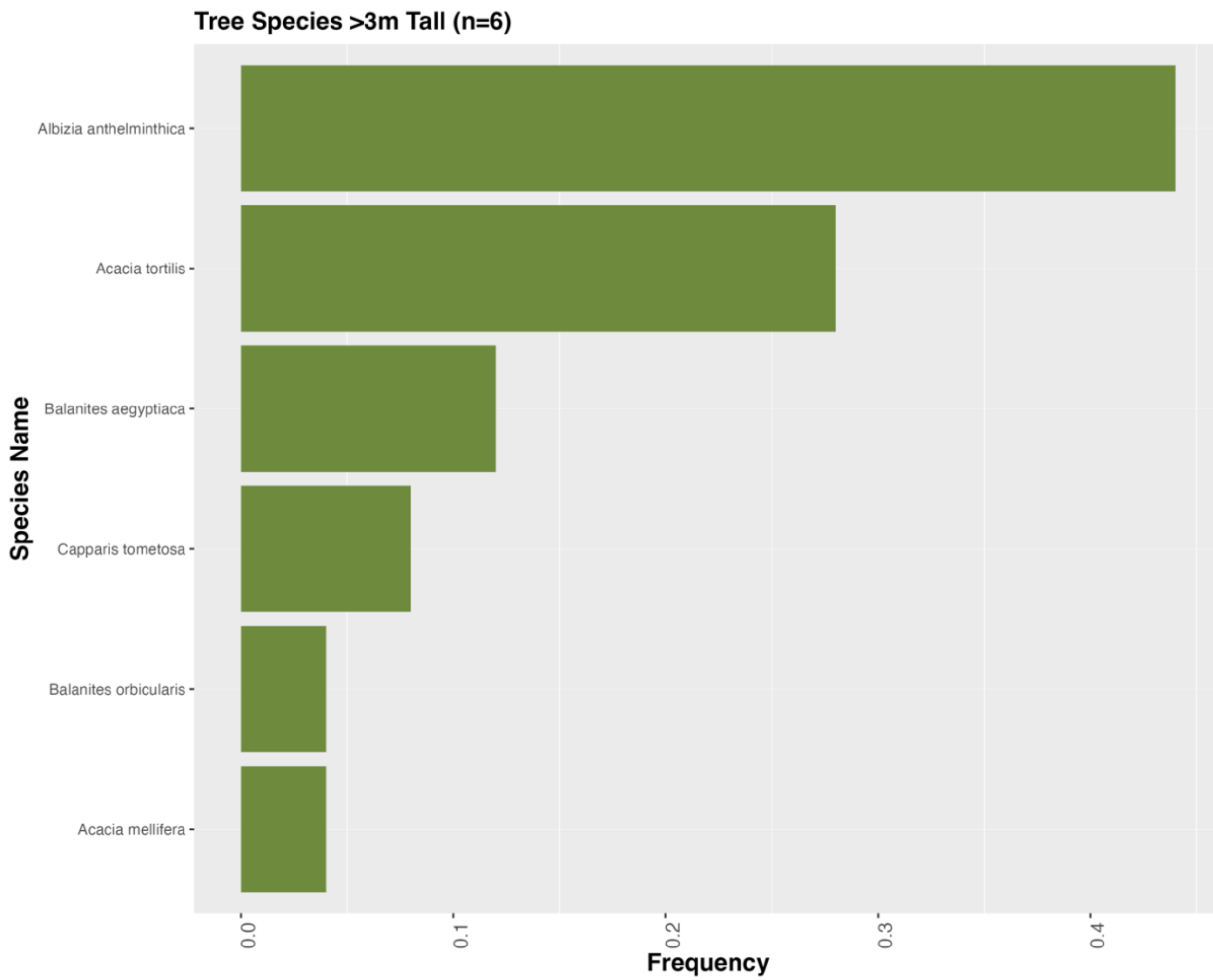


Figure 9: Albizia anthelminthica was the most common tree species. Photo: Tony Wild.

Shrubs are considered woody vegetation that is between 1.5 and 3 m tall. There were 18 unique shrub species recorded, with *Commiphora africana* as the most common.

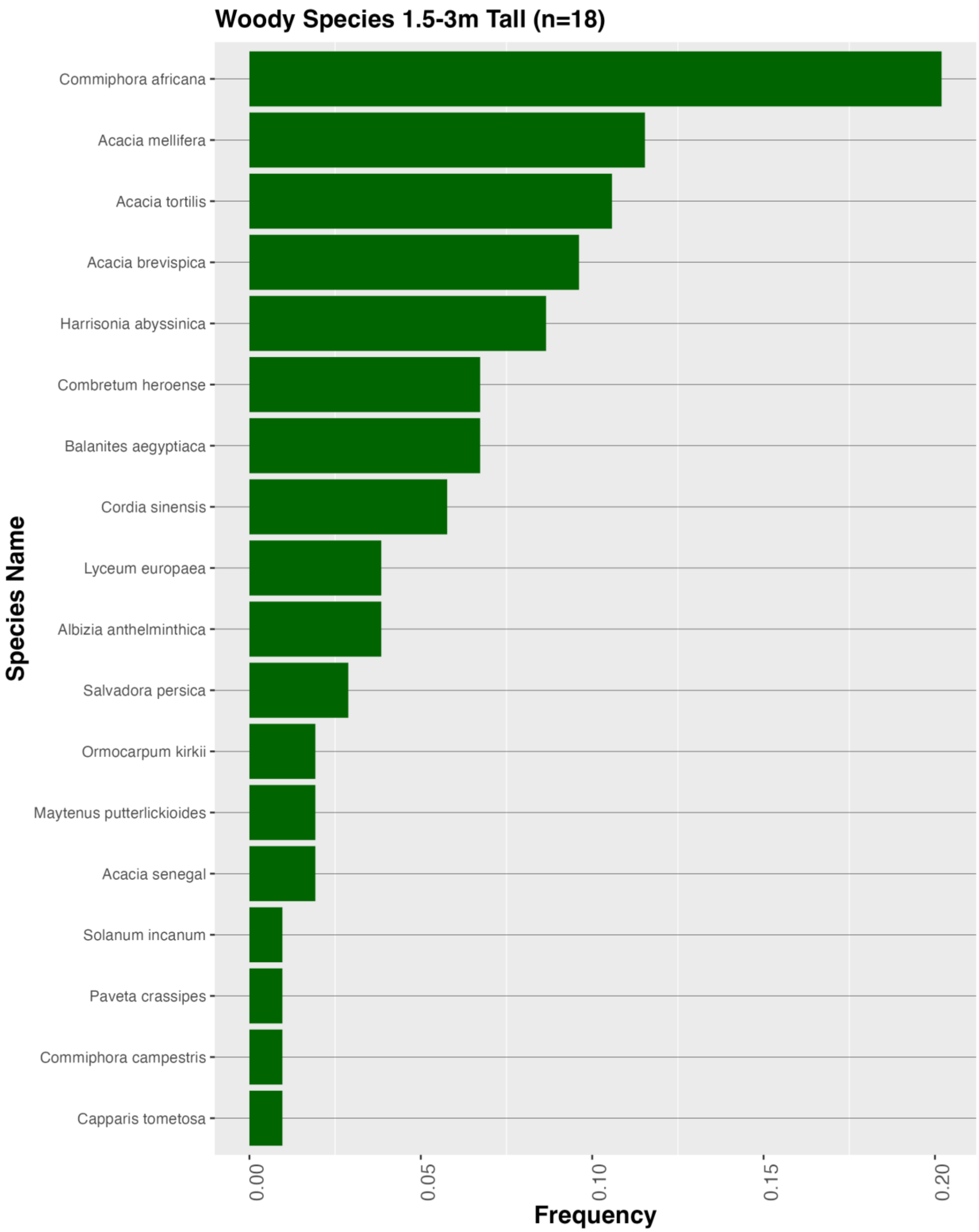


Figure 10: Shrub species diversity.

4.3 Rangeland vegetation surveys

Key indicators of rangeland health were assessed at the plot level. Specifically, annual, and perennial grass species were identified. The three most common perennial grass species identified included *Tetrapogon roxyburghiana, Sporobolus fimbriatus, and Digitaria macroblephara.*

The three most common annual grasses identified included E*ragrostis cilianensis*, *Aristida kenyensis*, and *Digitaria velutina*.
Other indicators measured were diversity and density of forbs and woody vegetation.

Figure 11: Lead botanist Musembi Kimeu (right) recording the plant species in the LDSF rangeland health form as Clemence Mnyika, community facilitator for Taita Taveta follows along.

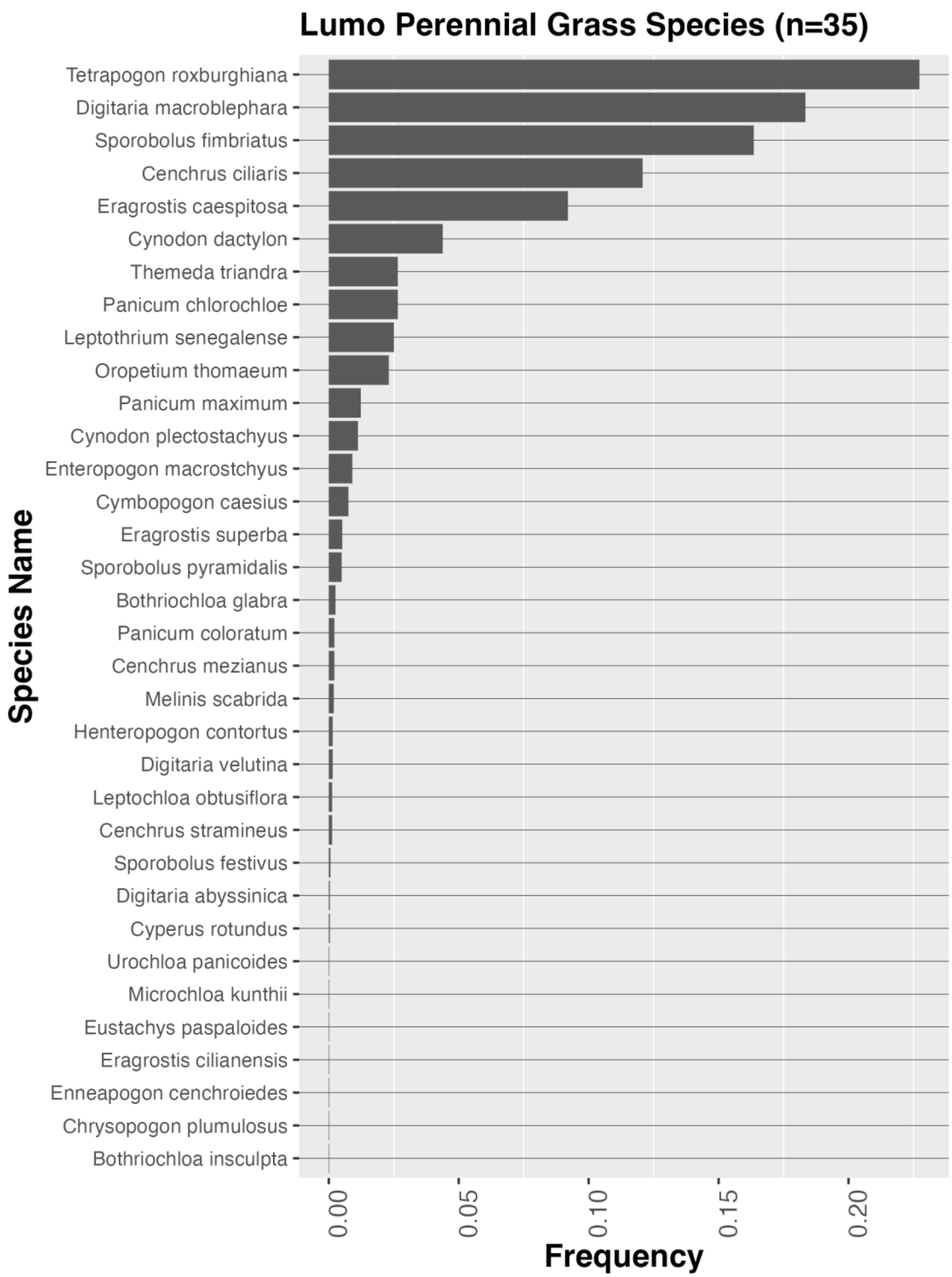


Figure 12: Perennial grass species.

4.4 Erosion Prevalence

Erosion is the most widespread form of land degradation. Erosion was scored and classified in each subplot (n=4) per plot. The below graphic shows the percent of plots classified as having severe erosion. Overall, erosion was common across all cluster, with the exception of clusters 9, 10, and 16..

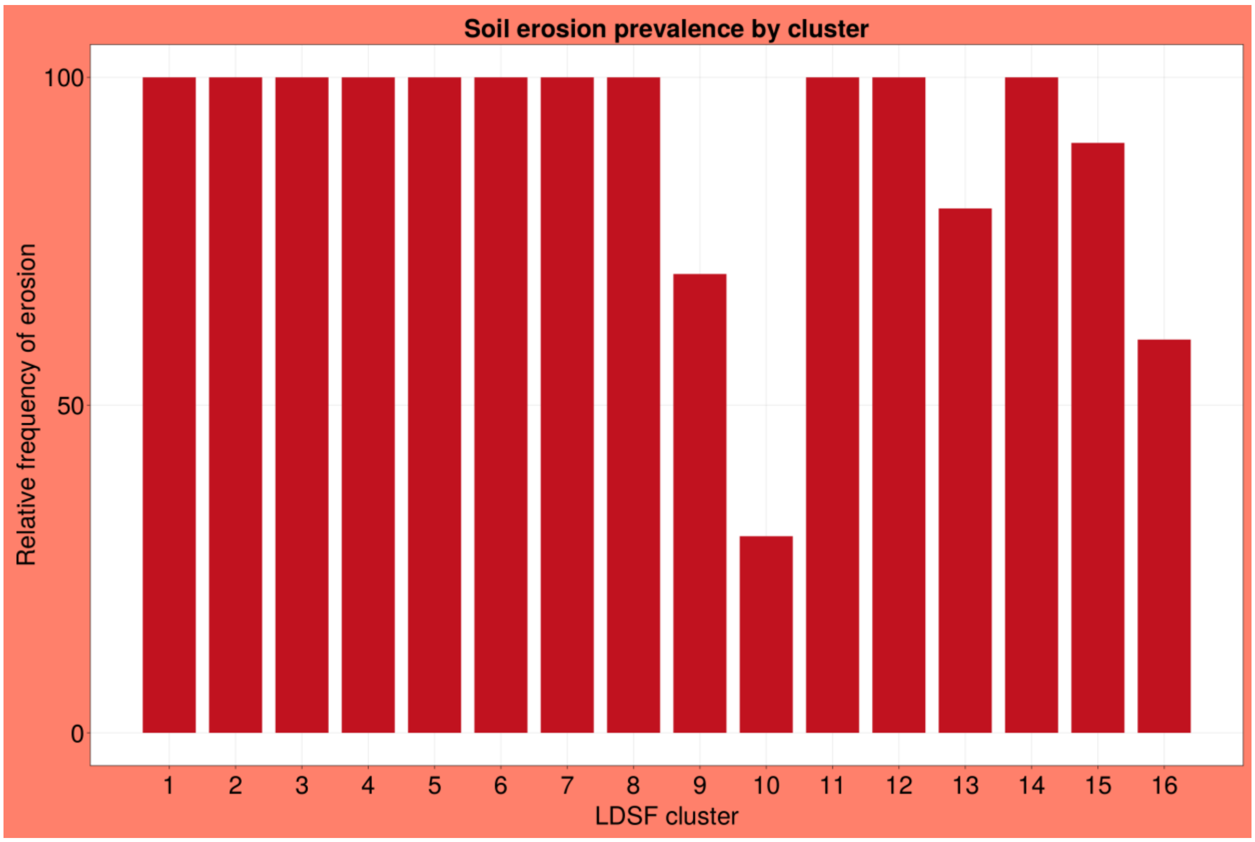


Figure 13: Erosion prevalence across the Lumo LDSF sites.

4.5 Infiltration Capacity

Infiltration was measured using a single ring infiltration method (see photo on right). Infiltration was measured at ~ 48 plots per site. Infiltration measurements were used to calculate saturated hydraulic conductivity (Kfs) for each plot. Plots with high Kfs have higher infiltration rates and possibly lower soil erosion due to water (runoff potential). Plots with low Kfs have low infiltration rates and possibly higher soil erosion due to water (runoff potential).

Figure 14: Infiltration measurement using a single ring infiltrometer.

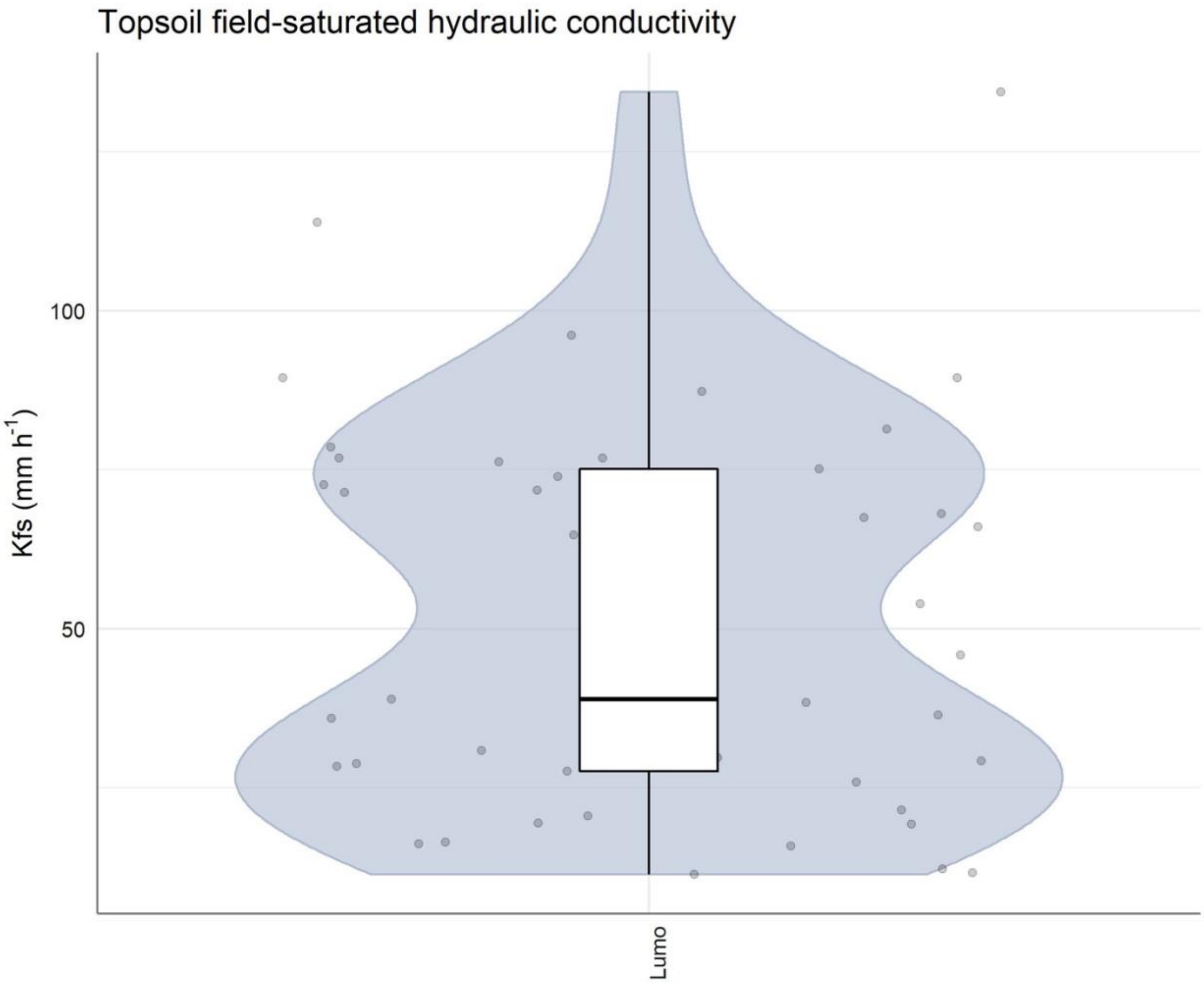


Figure 15: Average field-saturated hydraulic conductivity.

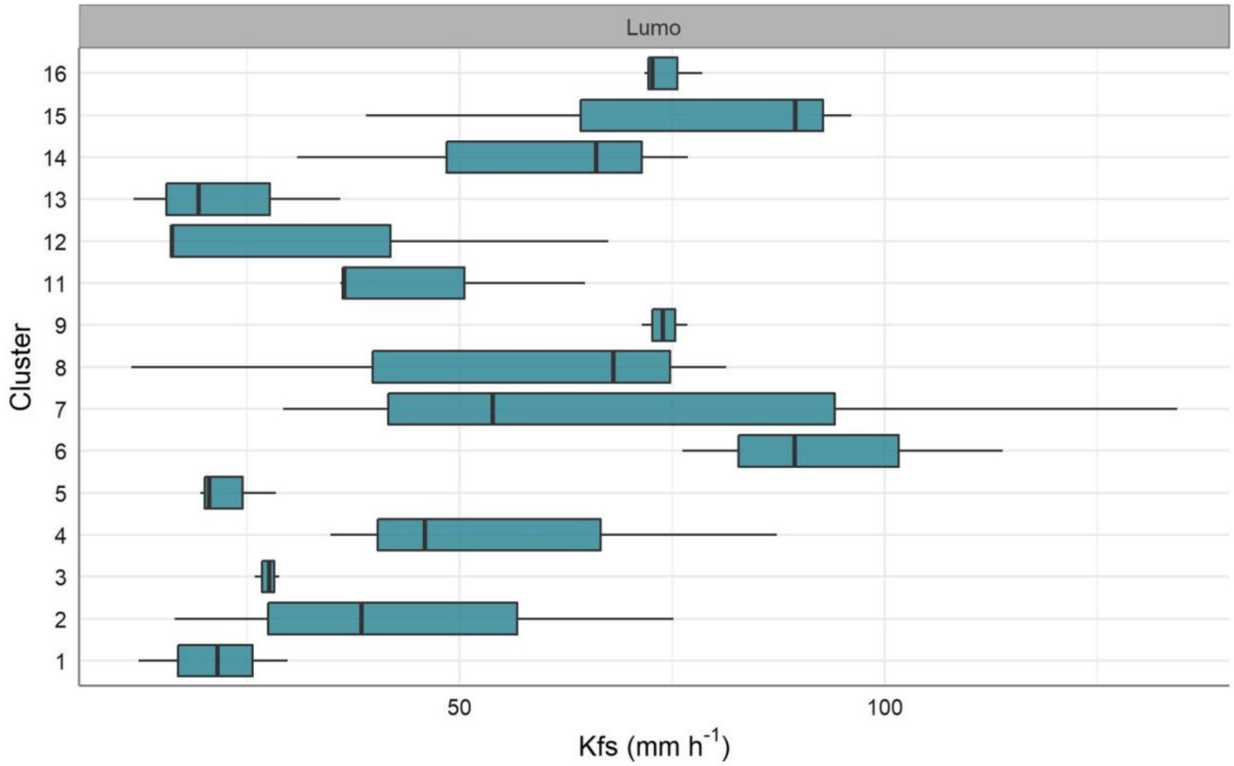


Figure 16: Boxplots of the KfS per cluster.

5 Soil Analysis

5.1 Soil Processing and Analysis

All soil samples were air-dried and ground to pass through a 2-mm sieve. Soil samples were air-dried and sieved following the Standard Operating Procedures (SOPs) developed at ICRAF: https://www.worldagroforestry.org/sites/agroforestry/files/SOP%20for%20Sample%20Reception%2C%20Processing%2C%20Log-in%2C%20Shipping%2C%20Archiving%20and%20Disposal.pdf

Landscape-level analysis of the soil samples collected within the LDSF is enabled through the use of mid-infrared spectroscopy (MIRS). MIRS allows for rapid and accurate prediction of soil properties at a fraction of the cost of traditional wet chemistry analysis. Here is a blog on the use of soil spectroscopy: https://wle.cgiar.org/solutions-and-tools/science-driven-solutions/shining-a-light-on-soils-for-land-restoration/

The soil samples were logged into the Laboratory Management System at ICRAF and analyzed on mid-infrared spectrometer with 10% of the samples analyzed using traditional wet chemistry (see below figure).

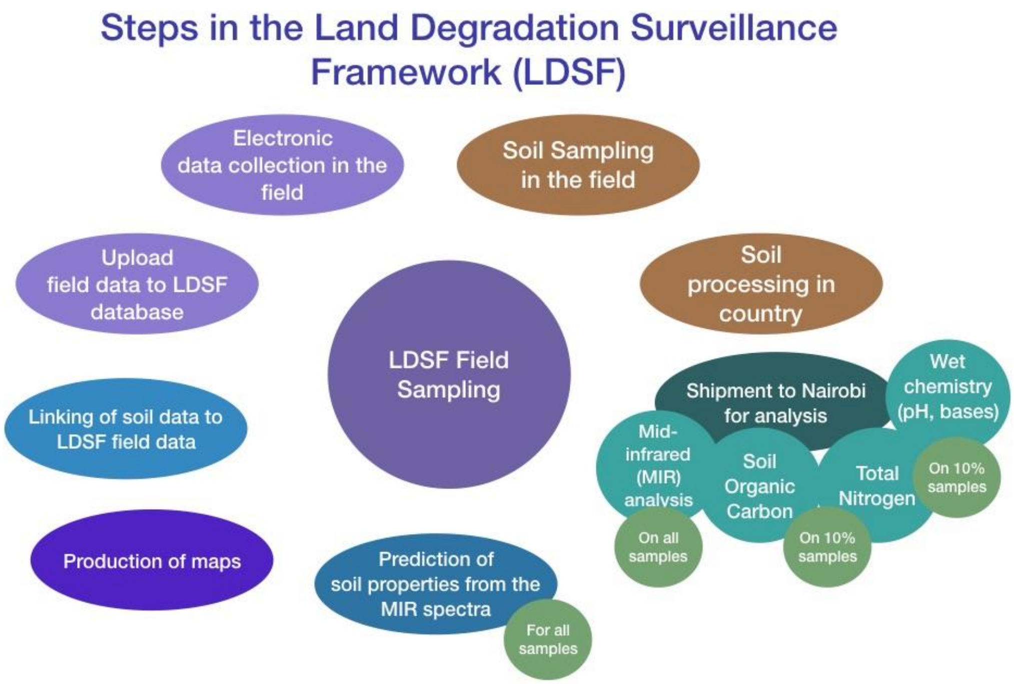


Figure 17: Workflow for LDSF.

Figure 18: Photo of some of the soil samples collected.

5.2 Soil Organic Carbon

Soil organic carbon (SOC) is a key indicator of soil health given its influence on a number of ecosystem properties, including soil fertility, the capacity of the soil to absorb (infiltrate) and hold on to water, the erosivity of the soil and soil biodiversity, to mention a few. Agricultural systems have the potential to store significant amounts of carbon both in biomass (primarily roots) and by increasing SOC. Common approaches for C sequestration recognized by international agreements on climate change such as the United Nations Framework Convention on Climate Change (UNFCCC) include agroforestry, sustainable soil management practices, among others. Management of croplands, grasslands and forests have later been recognized as important for C sequestration. The actual potential for C sequestration in a given system depends on its ecological production potential (e.g. climate and soil characteristics such as texture) as well as management, specific land use types and species composition, for example.

A general threshold of 20 g Carbon per kg ($g\ C\ kg-1$) of soil is often used as a value below which soils are considered low in SOC. Soils with lower SOC than this will be constrained in terms of soil health and productivity. Soils with less than 5 to 10 $g\ C\ kg-1$ will have severe constraints. The below figures shows SOC concentrations for the LDSF site for topsoil (0-20 cm) samples, with a mean of 9.5 g kg-1.

Table 1: Summary statistics of soil properties.

Site	*depth code*	*#*	*mean SOC*	*sd SOC*	*mean pH*	*sd. pH*	*mean Sand*	*sd Sand*	*mean ExBas*	*Sd ExBas*
			g kg-1	g kg-1			%	%	cmol kg-1	cmol kg-1
Lumo	top	160	9.47	3.55	6.42	0.56	37.58	7.65	13.01	22.34
Lumo	sub	157	7.44	1.76	6.47	0.56	35.28	7.73	10.79	13.79

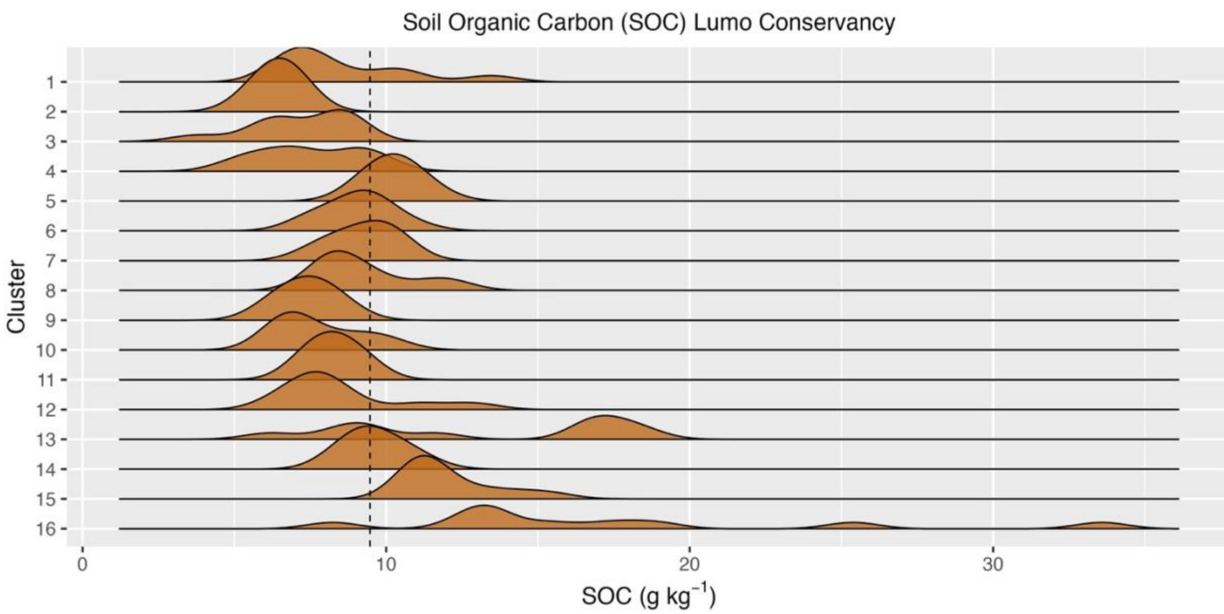


Figure 19: Density plots of topsoil organic carbon per cluster.

6 Capacity Development and Communications

Over twenty people were trained in the LDSF field methodology. These included members of the community, CIFOR-ICRAF community facilitators and AWF staff.

Figure 20: Group photo of the community members trained on the LDSF field methodology.

A high-level photographer, Tony Wild, organized a creative photo story to communicate the findings of the LDSF, including the data collection process:
https://storymaps.arcgis.com/stories/771016f69a8d4c1b8c245b38d7f0fa40