

Title: Estimating Carbon Storage Capacity and Community Sensitization on The Roles of Maasai *Alalili* Silvo-Pastoral Conservation Systems in The Era of Climate Change

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Status: Research project in progress

1.0 Community Sensitization and Conservation Education

Five districts, each represented by one sample village, were visited, and community education was provided through a three-day workshop involving 150 participants (30 from each sample village). The five villages were Gelailumbwa in Longido District, Mswakini Juu in Monduli District, Oloirobi in Ngorongoro District, Ruvu remiti in Simanjiro District and Ndedo in Kiteto District. The communities were informed about the changes in the northern Tanzania rangelands, their drivers, and the recommended solutions. Also, the conservation potentials of the *Alalili* systems were explained. This project made a reminder of the roles of the *Alalili* systems as a hub of fodder plants important for the restoration of degrading rangelands, and sustaining the community's livelihood (Fig.1).



Figure 1: Project team conducting community sensitization workshops in the study districts @ Elkana Hezron (2025)

The focus group discussion on the impacts of climate change was conducted, and it was linked to the possible use of *Alalili* systems in combating such effects. Four groups were formed, i.e., a Group of Experts (comprised of representative members of the NGOs, District Rangeland Officers, District Game Officers, Livestock extension officers, Village or Ward Executive Officer), a Group of Village Rangeland Management committee (7 members), a Group of female pastoralists (9 participants) and a Group male pastoralist (9 participants) (Fig. 2).



Figure 2: (a) Discussing with the female group (b) Overall Plenary discussion @ Elkana Hezron (2025)

Three main aspects were recorded during the session;

1.1 Existing evidence depicting *Alalili* systems is beneficial

All focused groups reported the existence of evidences depicting that *Alalili* systems are beneficial in support of their livelihoods. They reported that *Alalili* systems steadily restore degraded rangelands, secure dry-season forage, conserve biodiversity, reduce overgrazing, enhance climate resilience and support cultural sustainability. Analysis of this data is ongoing.

1.2 Community perspective on the Impacts of Climate Change in rangelands

More than 90% of the participants in the plenary discussion from each group (Fig. 3) suggested that there are a number of ways through which climate change is affecting the rangelands of northern Tanzania. They suggested that the impacts of climate change are evident through (1) increased drought, (2) reduced pasture availability, (3) reduced water availability, (4) land degradation, (5) soil erosion, (6) bush encroachment, (7) invasive species, (8) increasing pests and diseases, (9) loss of biodiversity, (10) disturbance of *Alalili* systems (11) conflicts over limited pastures and water resources, and (12)

decreasing livelihood resilience of pastoralists. Analysis of this information is ongoing for compilation.



(a)



(b)

Figure 3: Participants giving their perspectives on the impacts of climate change in rangelands
@ Elkana Hezron (2025)

1.3 Role of *Alalili* systems in combating the effects of climate change

Again, more than 70% of the participants in the plenary discussion from each group (Fig. 4) recommended that *Alalili* systems can play a potential role in combating the effects of climate change at the local level.



(a)



(b)

Figure 4: (a) Discussion with the group of male participants (b) Discussion with village rangeland management committee @ Elkana Hezron (2026)

It was discussed that, *Alalili* systems help in (1) drought buffering (2) rangeland restoration (3) Carbon sequestration, (4) soil and water conservation (5) Biodiversity conservation, (6) giving flexibility of livestock grazing as an adaptation, (7) minimizing the pressure of overgrazing, (8) consolidation

pastoral resilience and livelihoods, as well as (9) conflict reduction over scarce resources of space, pastures and water. The data analysis is ongoing towards the compilation of the final report.

2.0 Estimating Carbon Storage Capacity

The study area was categorized into four land use strata with the adoption of the maps generated during the first project (Characterization of *Alalili* systems). Among the pre-determined *Alalili* systems, two of them were systematically sampled from each surveyed land-use category, making a total of eight studied sample *Alalili* systems. Participatory field visits were conducted in each sample *Alalili* system across the four land-use strata. One line transect of 1Km length was established across each *Alalili* system from East to West, whereby three quadrats of 20x20m were formed at a constant distance of 300m apart for enhanced sampling of plants and soil. Four 1x1m quadrats were established at an interval of 7m apart along the diagonal of each 20x20m quadrat. Two main methods described below were employed to determine the carbon stocking capacity of the *Alalili* systems.

2.1 Non-destructive Method

This technique was used in the 20x20m quadrats established for the determination of shrub and tree carbon stocking capacity. The diameter at breast height (DBH) and the plant height were measured by using a vernier calliper and a Suunto Hypsometer, respectively (Fig. 5).



Figure 5: (a) Measuring the DBH by using a Calliper (b) Measuring the tree height by using a Suunto Hypsometer @ Elkana Hezron (2025)

Woody Biomass was estimated using allometric equations generated from tree and shrub species data comprising physical parameters, i.e., DBH, tree height, and wood density which is obtained from the Global Wood Density Database. Species were identified in situ with the help of a botanist whereas voucher specimens of species that were not readily identified, were taken to Tanzania Plant Health and Pesticides Authority (TPHPA) for identification. The same procedure was conducted in both dry and rain seasons for an enhanced comparison of the carbon stocking capacity of the *Alalili* systems in the two seasons. The analyses of the data are ongoing.

2.2 Destructive Method

This method was employed in 1x1m quadrats to collect herbaceous species and soil samples to determine herbaceous stocking and soil organic carbon (SOC), respectively as described below.

2.2.1 Herbaceous Carbon Stocking

The herbaceous species contained in the quadrat were clipped off at 1.5 cm above the ground using hand sickles to enhance estimation of the above-ground carbon. The roots of the herbaceous species were also collected after clipping or separation from leaves and stems to enhance estimation of the below-ground carbon stock (Fig. 6).



Figure 6: (a) Sampling the herbaceous species during dry season (b) Sampling the herbaceous species during rainy season @ Elkana Hezron (2026)

The samples of clipped leaves and stems of herbaceous species and their roots were immediately transferred to pre-weighed labelled paper bags and instantly weighted for fresh weight using an electronic weighing balance (Model: CG 2002L ± 0.001 g accuracy) (Fig. 7).



(a)



(b)

Figure 7: (a) Measuring fresh weight of collected samples during the dry season (b) Measuring fresh weight during the rainy season @ Elkana Hezron (2026)

The samples were taken into the laboratory for a forced-air oven at 60°C for 48 h to constant weight to obtain dry matter (DM) (Fig. 8). The same procedure was conducted in both dry and rain seasons for an enhanced comparison of the carbon stocking capacity of the *Alalili* systems in the two seasons. The analyses are still ongoing.



(a)



(b)

Figure 8: (a) Preparing samples for oven drying step (b) Samples placed in the oven for a forced-air drying step @ Elkana Hezron (2026)

2.2.2 Soil Carbon Stocking

The soil samples were collected in each 1x1m quadrats to enhance estimation of soil carbon stocking inventory. The sampling of the soil was done at three land surface depth categories, i.e., D1 (0 – 10cm), D2 (10 – 20cm) and D3 (20 – 30 cm). The soil samples were composited for each depth class per plot and the fresh weight of each soil composite was recorded in situ, packed in the

paper bags and transported to the laboratory for analysis based on standard laboratory procedures (Fig. 9). The same procedure was conducted in both dry and rain seasons. The analyses are in final stages for report writing.

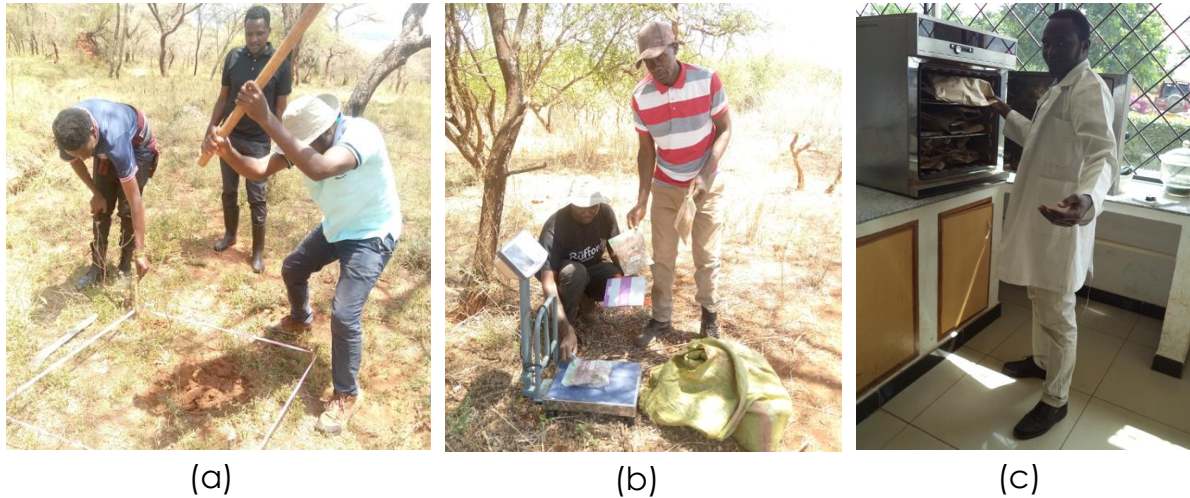


Figure 9: (a) Digging a hole for soil sampling (b) Measuring the fresh weight of soil composites (c) Oven-drying the soil samples @ Elkana Hezron (2026)

3.0 Data Analysis and Manuscript Preparation

The data collection process has been completed successfully and the ongoing activity is the data analysis and compilation of information for final report writing and manuscript production.

4.0 Remarks

Generally, the research project is progressing well, the activities are being taken on finely and their implementation has attained 90%, with only two activities remaining to accomplish it. However, this study was extended beyond the time frame because the project activities were ceased since November 2024 to July 2025 following my travel to India, where I went to accomplish my requirements to finalise my PhD thesis and graduation. Due to this, the research team couldn't manage to finalise the data collection, which was done by 15% only in my absence. Following the fulfilment of the thesis requirements and fully graduated, and back at my workplace, the fieldwork was resumed in August 2025 and it is at its final stages. The analyses are progressively undertaken for final report generation.

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