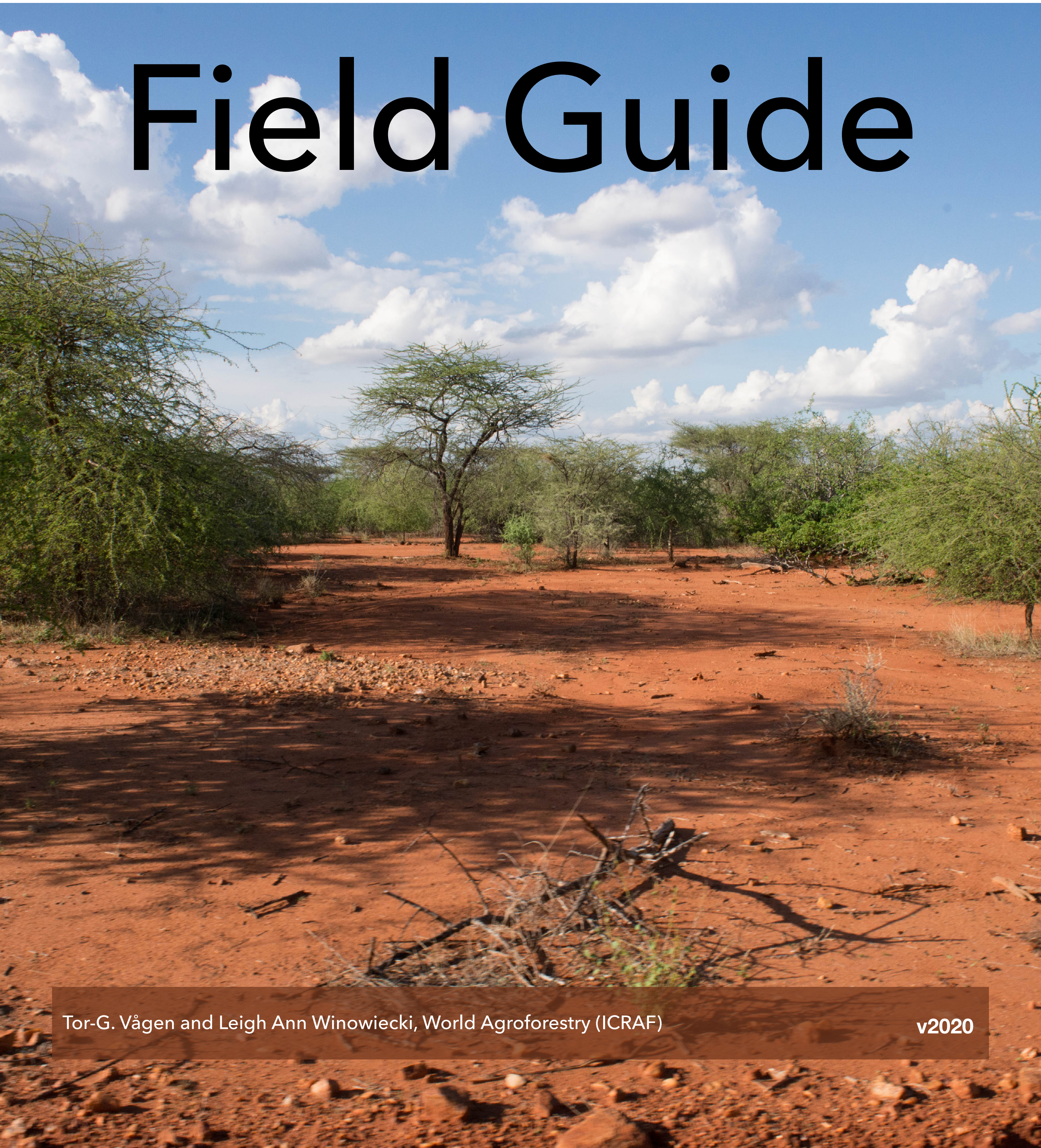
the Land Degradation Surveillance Framework

LDSF

World Agroforestry

Field Guide



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Why systematic baselines?

Very little is known about the state of ecosystems across Africa, including land cover and vegetation trends. This is particularly important in understanding land degradation processes, predicting changes in climate and improving land management.

Systematic baselines of soil and ecosystem properties allows for a proper assessment of landscape performance and/or prediction of change over time.

Introduction

the Land Degradation Surveillance Framework

The LDSF was developed by the authors and colleagues over several years of land degradation research in Kenya's Lake Victoria basin, Madagascar, Mali and southern Africa.

The LDSF is designed to provide a biophysical baseline at landscape level, and a monitoring and evaluation framework for assessing processes of land degradation and the effectiveness of rehabilitation measures (recovery) over time.

The framework is built around a hierarchical field survey and sampling protocol using sites that are 100 km^2 (10 x 10 km).

LDSF sites may be selected at random across a region or watershed, or they may represent areas of planned activities (interventions) or special interest. Within each site, 16 tiles (2.5 x 2.5 km in size) are created and random centroid locations for clusters within each tile are generated. Each cluster consists of 10 plots, with randomized centre-point locations falling within a 564 m radius from each cluster centroid. Thus, the LDSF has two (or in some cases three) levels of randomization, which minimize local biases that may arise from convenience sampling. Each plot is 0.1 ha (1000 m^2) and consists of 4 subplots, 0.01 ha in size.

The Land Degradation Surveillance Framework was developed as a response to a lack of methods for systematic landscape-level assessment of soil and ecosystem health. Many projects use the LDSF sampling framework for such assessments. The framework provides field protocols for measuring indicators of the "health" of an ecosystem, including vegetation cover, structure and floristic composition, historic land use, visible signs of soil degradation, and soil physical characteristics. A sampling framework for collection of soil samples is also provided, as described in more detail later.

This field guide describes the LDSF field survey methods and is designed to be used in both training and as a reference in field, during survey campaigns.

Why use a hierarchical sampling design?

Due to the complex nature of ecosystems, multiple perspectives are needed to understand ecosystem processes, and variability of ecological variables at different spatial scales. A nested hierarchical sampling design is useful for developing predictive models with global coverage, while maintaining local relevance.

Preparing

to go to the field

Proper preparation before going to the field is critical to ensure a successful field sampling campaign, and for the safety and well-being of the field team. Prior to any field campaign, it is important to have a good understanding of the area to be surveyed, including its topography, climate and vegetation characteristics, accessibility, and its security situation.

When conducting field campaigns in new countries it is generally recommended that a reconnaissance survey is conducted where local contacts are established and agreements are made.

Obtain permission from the land owner(s) to sample a given area, and make sure that he/she understands what you are doing. Informing local government officers and community leaders about your activities is also a good idea.

Example of pre-existing information about the area to be surveyed include: maps (topographical, geological, soils and/or vegetation), satellite images and/or historical aerial photographs, long-term weather station data, government statistics, census data etc.

Load coordinates of sampling locations into the GPS units before going to the field. If possible, load local maps into the unit to aid in navigation in the field.

Do a thorough equipment check (see Appendix) before leaving for the field. This includes making sure you have enough water to complete the infiltration tests.

Ideally, a 4- to 5-person field team can complete 10 sampling plots per day, this includes completing 3 infiltration tests per cluster.

Safety Tips:

Avoid any areas where you might be placing the field team at any risk of harm or injury. Always carry an emergency first aid kit.

When in remote areas, be sure someone knows where the team will be operating. Carry a satellite phone, where necessary.

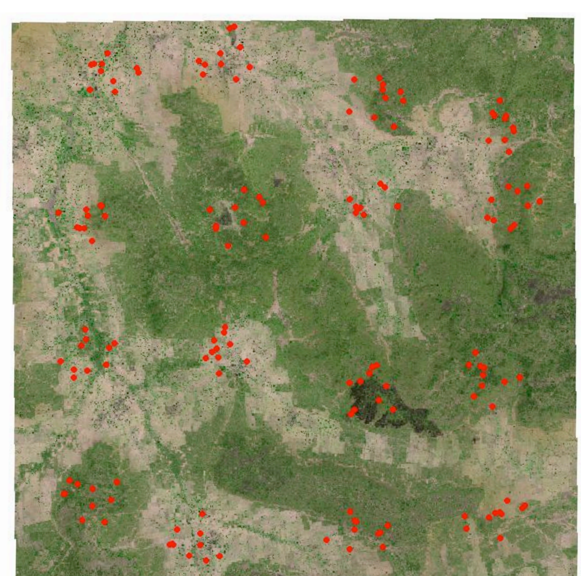
At least one field crew member should be properly trained in first aid. Identify emergency evacuation routes and nearest hospitals in case of emergency.

the LDSF sampling design

LDSF (sentinel) "Sites" are 10 x 10 km in size. The basic sampling unit is called a "Cluster", and consists of 10 "Plots" (described later).

The centre-point of each cluster in the LDSF is randomly placed within a "tile" in each Sentinel Site . The sampling plots are then randomized around each cluster centre-point, resulting in a spatially stratified, randomized sampling design (see example on the right).

Randomizing the plots in the cluster is extremely important as you will want to minimize any local biases that may arise from convenience sampling. The randomization procedures are normally done using customized programs or scripts, but can be also be conducted in any spreadsheet program.

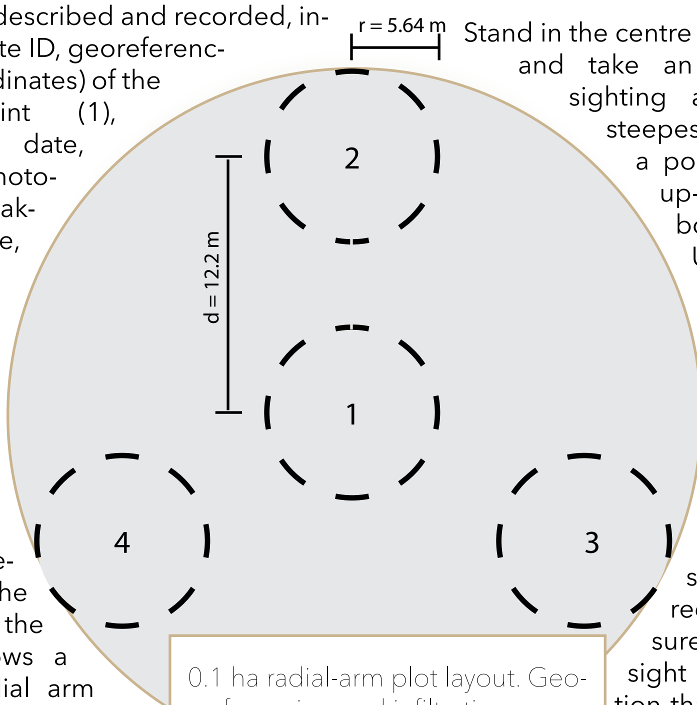


10 x 10 km site with clustered sampling plots.

the LDSF sampling design

Plot-level measurements

At the plot level, basic site characteristics are described and recorded, including site ID, georeferencing (coordinates) of the center-point (1), altitude, date, and a photograph is taken. Slope, landform, presence/absence of soil and water conservation structures are also recorded. The figure on the right shows a LDSF radial arm plot. Each plot is designed to sample a 1,000 m^2 area.



0.1 ha radial-arm plot layout. Georeferencing and infiltration measurements should be completed in the center of the plot (sub-plot 1). The dashed circles represent 0.01 ha sub-plots in which soil surface and vegetation observations are made. r is the subplot radius, d is the distance between sub-plot center-points.

Plot-level vegetation cover types and strata, land use, land ownership and primary current use are based on a modification of the FAO Land Cover Classification System (LCCS).

Initially, record the easting (longitude), northing (latitide), elevation and position error on the field recording sheet.

Slope Measurements

Stand in the centre of the plot and take an up-slope sighting along the steepest part to a point on the up-slope plot boundary. Use a clinometer to measure the slope in degrees. Repeat the process in the down-slope direction. Ensure that you sight to a location that is at the same height as the observer's eye-level.

In steep terrain (slope > 25°), use the following formula to calculate the distance from the center-point to the other sub-plots;

slope distance = horizontal distance/cos(Slope)

Subplot-level measurements

Soil Surface Characterization

In each sub-plot (n= 4 per plot), signs of visible erosion are recorded and classified (rill, gully or sheet).

Pecent rock/stone/gravel cover on the soil surface is also recorded.

Vegetation Measurements

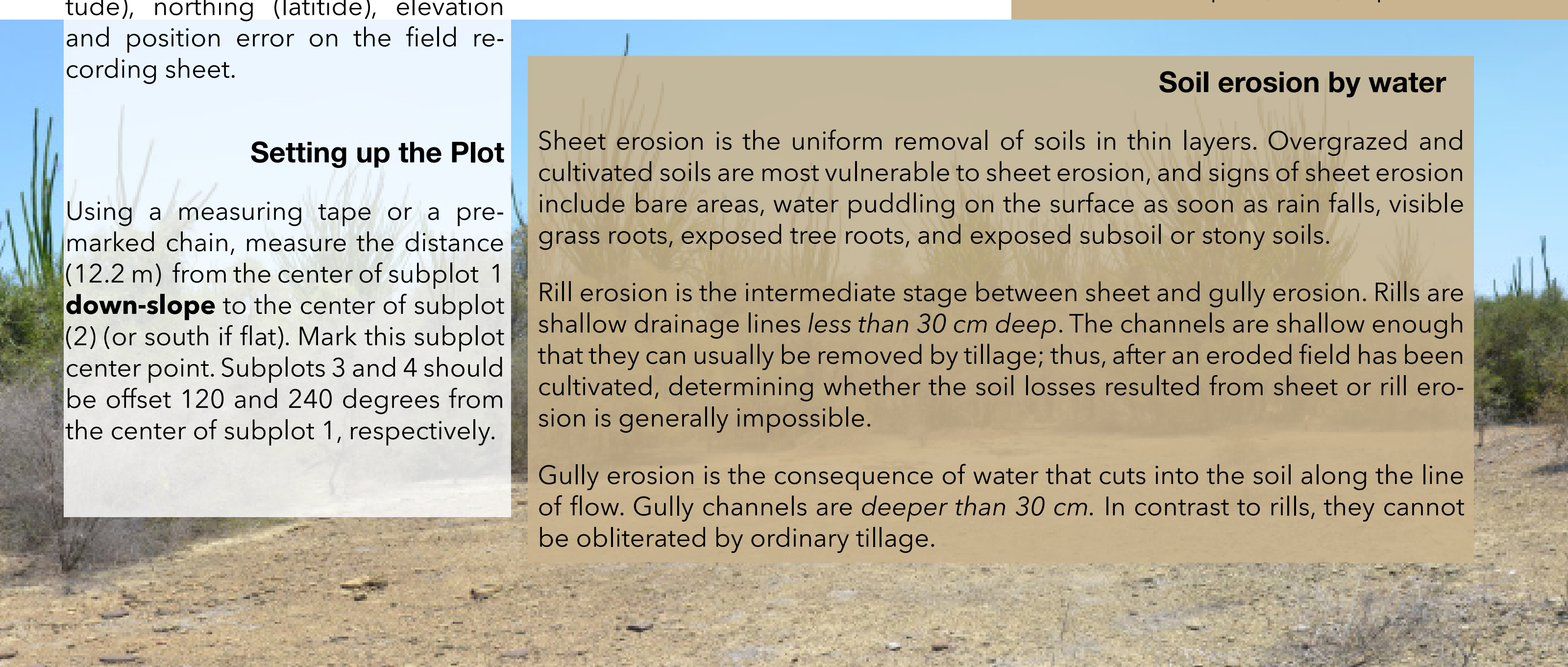
Woody- and herbaceous cover ratings are made using a Braun-Blanquet (Braun-Blanquet, 1928) vegetation rating scale from 0 (bare) to 5 (>65% cover).

Woody plants, shrubs (1.5-3 m height) and trees (>3 m height), are counted in each subplot for density calculations. Tree and shrub distance-based measurements are carried out using the T-square method (Krebs, 1989) to determine vegetation distribution.

Soil Sampling

Top- and subsoil samples are collected from the center of each subplot at 0-20 cm and 20-50 cm depth increments, respectively. Top soil subplot samples are pooled (composited) into one sample for each plot, the same is done with subsoil samples.

Auger depth restrictions are recorded at each sub-plot (in cm), if present.



Setting up the Plot

Using a measuring tape or a pre-marked chain, measure the distance (12.2 m) from the center of subplot 1 **down-slope** to the center of subplot (2) (or south if flat). Mark this subplot center point. Subplots 3 and 4 should be offset 120 and 240 degrees from the center of subplot 1, respectively.

Soil erosion by water

Sheet erosion is the uniform removal of soils in thin layers. Overgrazed and cultivated soils are most vulnerable to sheet erosion, and signs of sheet erosion include bare areas, water puddling on the surface as soon as rain falls, visible grass roots, exposed tree roots, and exposed subsoil or stony soils.

Rill erosion is the intermediate stage between sheet and gully erosion. Rills are shallow drainage lines *less than 30 cm deep*. The channels are shallow enough that they can usually be removed by tillage; thus, after an eroded field has been cultivated, determining whether the soil losses resulted from sheet or rill erosion is generally impossible.

Gully erosion is the consequence of water that cuts into the soil along the line of flow. Gully channels are *deeper than 30 cm*. In contrast to rills, they cannot be obliterated by ordinary tillage.

Field Measurements

Soil infiltration capacity

Soil infiltration measurements are the most time consuming aspect of the field measurements, so these should be set as soon as you reach the plot.

A minimum of three infiltration measurements should be conducted per cluster. Allocate these randomly to the different plots in the cluster. We usually recommend to use Plot 1 as the reference plot and to conduct infiltration there.

1. To complete the infiltration measurement you will need an infiltration ring (17 cm outer diameter, 20 cm in height), a ruler, a hammer, a block of wood,~25L jerry can of water, a small cup for scooping water, a timer, and an infiltration form.
2. The infiltration ring should be placed at the center of subplot 1.
3. Using the hammer, drive the ring at least 2 cm into the soil taking care not to disturb the soil surface. Make sure the ring is level. Make sure the beveled end of the ring is inserted into the ground.
4. Place and stabilize the ruler inside the infiltration ring.
5. Fill the infiltration ring with water (pour slowly to not disturb the soil surface). Continue pre-wetting for 15 minutes. Ensure that the ring does not leak! If it leaks, remove the ring and place it elsewhere. If there is floating litter inside the ring, you can remove it to allow for accurate readings on the ruler.
6. To start the test, fill the ring to the the start level (the start level should be easy to read on the ruler and at the top of the ring (i.e., 16 or 17 cm)). When pouring the water, be sure not to disturb the soil surface.
7. Start the timer and record the exact start level (in cm) on form.
8. Record the end level of the water on the ruler at the end of each time interval, refilling the ring back to the start level to proceed with the test. Do not stop the timer, let the time run continuously.
9. Never allow the ring to empty completely, always be sure you can clearly read the end level on the ruler. This may mean you need to reduce the time interval if infiltration is fast (e.g., take a measurement every 2 min). Record these changes on the form.
10. Infiltration measurements take up to 2.5 hours (150 minutes).

These data will be used to plot infiltration rates of water into soil and to calculate the saturated hydraulic conductivity. By repeating measurements across the landscape, we will be able assess the effects of land management and vegetation types on soil hydrological properties.

Why are we using single-ring infiltration testing?

The LDSF emphasizes landscape-level measurements, or in other words measurements are repeated many times across large areas (landscapes).

The approach is to collect a statistical sample of the landscapes being surveyed and develop models based on these data.

The single-ring infiltration test is a robust method for calculating infiltration rates. While double-ring may also be used, they are often too time consuming and require very large quantities of water, not allowing for repeated measurements across a landscape.

Landform and land cover classification

Land cover is recorded in all plots using a simplified version of the FAO Land Cover Classification System (LCCS), which was developed in the context of the FAO-AFRICOVER project (http://www.africover.org). In addition, vegetation is classified according to White, 1983. Also, scores are made of "impact on habitat", adapted from Royal Botanic Gardens, Kew (http://www.kew.org).

The "binary phase" of LCCS recognizes 8 primary land cover types, 5 of which are sampled in the LDSF. These are (i) cultivated and managed terrestrial areas, (ii) natural and semi-natural vegetation, (iii) cultivated aquatic or regularly flooded areas, (iv) natural or semi-natural aquatic or regularly flooded vegetation, and (v) bare areas.

Artificial surfaces, natural and artificial water bodies, and surfaces covered by snow, or ice are not formally surveyed in the LDSF, but if a plot falls within such features this is noted and the plot is georeferenced.

The LCCS further differentiates primary land cover systems on the basis of dominant vegetation life form (tree, shrub, herbaceous), vegetation cover, leaf phenology and morphology, and spatial and floristic aspects. All the associated features are assessed visually and are generally coded on either categorical or ordinal rating scales. The questions in the field recording sheet are designed to guide you through the classification process.

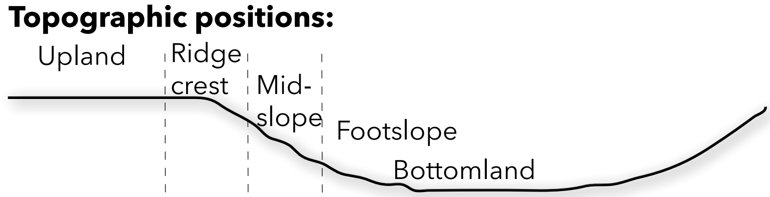
Landform and Topographic Position

To complete the section describing landform and topographic position, visually inspect the plot and the surrounding area to select the appropriate categories provided on the field form. See diagram to the right to best describe where the plot sits along the topographic position.

No	Type	Description
1	Forest	A continuous stand of trees, their crowns interlocking.
2	Woodland	An open stand of trees with a canopy cover of 40 % or more. The field layer is usually dominated by grasses.
3a	Bushland	A mix of trees and shrubs with a canopy cover of 40% or more
3b	Thicket	A closed stand of bushes and climbers usually between 2 and 7 m tall
4	Shrubland	An open or closed stand of shrubs up to 3 m tall
5	Grassland	Land covered with grasses and other herbs, either without woody vegetation or the woody cover is less than 10 %
6	Wooded grassland	Land covered with grasses and other herbs, with woody vegetation covering between 10 and 40 % of the ground
7	Cropland	Cultivated land (or being prepared for cultivation (if sampling in the dry season)) with annual or perrenial crops
8	Mangrove	Open or closed stands of trees or bushes occurring on shores between high and low water mark.
9	Freshwater aquatic	Herbaceous freshwater swamp and aquatic vegetation/ Wetland
10	Halophytic	Saline and brackish swamp vegetation
11	Distinct / restricted	Formation of distinct physiognomy (vegetative formations) but restricted distribution, e.g. bamboo, inselbergs etc.
12	Other	Describe...

Source: White (1983)

Topographic positions:



Soil sampling

You will need a soil auger marked at 20, 50, 80 and 110cm, sturdy plastic bags, a mixing trowel, a permanent marker, labels and buckets. You will need buckets with different colors for topsoil and subsoil samples.

1. Collect topsoil (0-20 cm) from the center of each subplot using an auger and put the sample in the labeled bucket.
2. Collect subsoil (20-50 cm) samples from the center of each subplot using an auger and put the sample in the labeled bucket. ***Caution: When augering the subsoil, make sure no soil from the surface (topsoil) falls into the auger hole.***
3. Pool (composite) all of the topsoil samples from each subplot into one bucket, and mix the soil thoroughly.
4. Pool (composite) all the subsoil samples from each subplot into one bucket,and mix the soil thoroughly.
5. Take a representative ~500g sub-sample of the topsoil and place it in a labeled bag.
6. Take a representative ~500g sub-sample of the subsoil and place it in a labeled bag.

   Note that there should be one bag of topsoil and one bag of subsoil for each plot.

Auger depth restrictions are recorded (in cm) for each subplot, if they occur during sampling.

After getting back from the field the samples should be air-dried for at least 3 days as described in the laboratory Standard Operating Procedures (SOP).

Cumulative mass soil sampling

Cumulative mass sampling is done to calculate nutrient and/or carbon stocks on a soil mass basis rather than using bulk density. The idea is to auger in 20 cm increments to 110cm, collecting ALL of the soil from each depth increment.

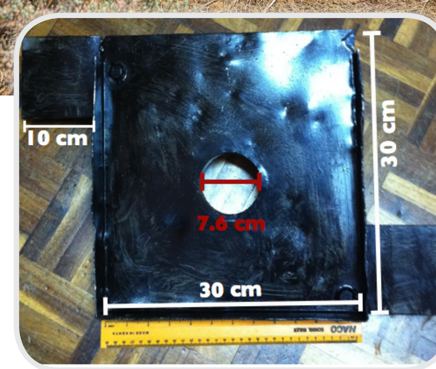
The cumulative mass sample is collected from the center of the plot.

A sampling plate is used to easily capture any soil that falls out of the auger before transferring it to the bucket and to prevent collapse of the auger hole (see inset photo below).

1. Press the sampling plate firmly onto the soil, so the plate is flush with the soil surface.
2. Place the auger in the centre of the hole in the plate and begin to auger straight down.
3. Becareful not to overfill the auger as this will distort the volume of the hole. To avoid this empty the soil from the auger after every ~3 full turns.
4. Auger down to 20 cm, collecting ALL of the soil from the auger into the bucket. Then transfer all of the soil to a clearly labeled plastic bag.
5. The next samples to be collected are from 20-50, 50-80 and 80-110 cm.

Depending on soil texture, a clay, combination or sand auger can be used, but use the same auger for the entire depth (profile). Changing augers may change the volume of the auger hole. Record auger diameter!

If the soil is very dry, it may be difficult to auger. Pre-wetting the soil before augering each increment may help.



Labeling is critical!

Site, cluster, plot and depth code and date should be legibly recorded with a permanent marker on the outside of the soil sample bag. A paper label containing the same information (written with a permanent marker or pencil) should be placed inside the bag. **Samples should be double-bagged.**

Example from Merar site, cluster one, plot one (topsoil (TOP) and cumulative mass (CM) sample, respectively):

- Merar.1.1 TOP date || Merar.1.1 SUB date
- Merar.1.1 CM 0-20 date|| Merar.1.1 CM 20-50 date || Merar.1.1 CM 50-80 date || Merar.1.1 CM 80-110 date

measuring

Woody Cover

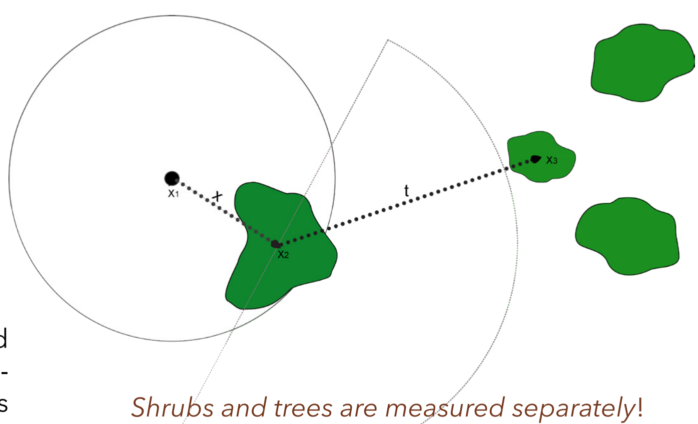
Impact on habitat (0 = none; 3 =severe)

1. Impact of tree cutting
2. Impact of agriculture
3. Impact of grazing
4. Impact of fire
5. Urban activities
6. Industrial activities
7. Impacts of erosion
8. Impact of alien vegetation]
9. Impact of firewood collection

Shrub and Tree Densities

Count all trees and shrubs in each subplot and enter the results into the field form.

T-square method



Shrubs and trees are measured separately!

The "T-square" method is one of the most robust distance methods for sampling woody plant communities, particularly in forests, but also in rangelands. It can be used to estimate stand parameters such as density, basal area, biovolume, and depending on the availability of suitable allometric equations, also biomass.

The advantage of this method, over other commonly used distance methods such as the point-centered quarter method, is that it is less prone to bias where plants are not randomly distributed.

Standing at the center of each subplot record the distance x from the subplot center point (x_1) to the nearest tree or shrub (x_2). Measure this either to the center of the tree trunk, or to the central portion of the shrub. Next, measure the distance t to its nearest neighboring plant (x_3).

Note, however that the angle of the measurement must be constrained to lie in the hemisphere of a line that lies perpendicular to x. This is the T-square distance.

Biomass measurements

For both trees and shrubs, measure the height of each individual plant using either the height pole or a clinometer.

For trees, record the circumference at breast height (1.35m above ground level) of each of the trees in each subplot. In instances where a tree branches below this level, measure the main trunk or the circumference of all of the branches and average these. For trees that are tilted determine the 1.35m level from the down-slope direction and measure the circumference there.

For shrubs, measure the width and length of each shrub in each subplot.

Biodiversity measurements

Biodiversity of aboveground woody vegetation will be assessed.

Record the species of each tree and shrub in each subplot. If you do not know the scientific names of the shrubs or trees, record the common or local names.

Rangeland Health
assessments

LDSF Rangeland Module

Rangelands are important ecosystems and often harbour high biodiversity of grass species and high sol organic carbon (SOC) content. However, degraded rangelands have low productivity both interms of livestock and grass biomass. The LDSF rangeland module aims to assess the health of the rangeland and can be applied in each LDSF plot (1000 m2) and can be conducted in the dry and wet seasons.

Key rangeland indicators measured include: perrenial species diversity; ratio of annual to perrenials; percent bare soil; distance to nearest perrenial; and percent perrenial cover. The grass measurements are conducted in each cardinal directions at 2-m intervals using the rangeland form at the end of the guide. Because the rangeland module is conducted alongside the LDSF, other key indicators of rangeland health are also included: shrub density and diversity (as a measure of encroachment or presence of invasive woody species), as well as infiltration capacity and soil properties.

Electronic field data entry

In the LDSF, databases and data entry screens have been developed for various mobile devices and smartphones for direct data entry in the field. The data entered is uploaded to the central database in Nairobi, Kenya, after the completion of a survey. These systems increase efficiency and reduce potential errors in the data capture process.

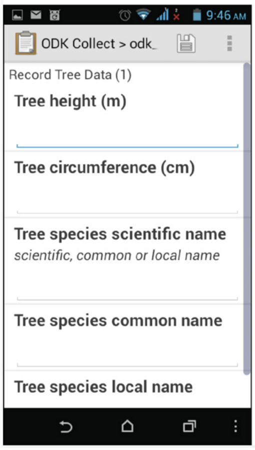
Open Data Kit

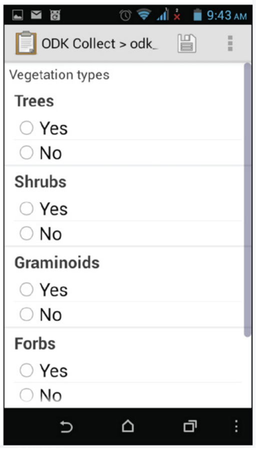
The Open Data Kit (http://www.opendatakit.org) software is a free and efficient method for gps field data collection. The form can be uploaded on smartphones or GPS units compatible with Androids.

Open Data Kit is primarily a data capture tool, but also has some basic GIS functionality. We developed an Open Data Kit application for LDSF field data entry.

Teams should upload their completed LDSF electronic forms to the server based in Nairobi, Kenya daily.

See examples of the tree and vegetation measurments in the LDSF electronic data entry form on the left.





PLOT (1,000 m²) **LDSF Field Form v2020**

Site:	Date (ddmmyy):	Latitude (DD):	
Cluster:		Longitude (DD):	Country:
Plot:	Elevation (m):	Pos error (m):	Name:

Slope Up °: ____ **Slope Down °:** ____

Major landform: ☐ Level ☐ Sloping ☐ Steep ☐ Composite

Position on topographic sequence:

☐ Upland ☐ Ridge/Crest ☐ Midslope ☐ Footslope ☐ Bottomland

Landform designation:

☐ Medium gradient mountain	☐ Dissected plain	☐ Major depression
☐ Medium gradient hill	☐ High gradient mountain	☐ Narrow plateau
☐ Medium gradient escarpment	☐ High gradient hill	☐ Plain
☐ Ridges	☐ High gradient escarpment	☐ Low gradient mountain
☐ Mountainous highland	☐ Valley	☐ Low gradient hill

Plot bare > 10 months? ☐ Yes ☐ No
Plot regularly flooded? ☐ Yes ☐ No
Plot cultivated*? ☐ Yes ☐ No

Dominant Land Use: ☐ annual_crop ☐ perennial _crop ☐ annual_agroforestry ☐ perennial_agroforestry ☐ fallow ☐ woodlot ☐ protected area ☐ pasture_rangeland

*Note that cultivated plots can include plots with annual or perennial crops and even planted woodlots

Vegetation types:			**Woody leaf types:**			**Vegetation structure**:**
Trees	☐ Yes	☐ No	Broadleaf	☐ Yes	☐ No	
Shrubs	☐ Yes	☐ No	Needle leaf	☐ Yes	☐ No	
Graminolds	☐ Yes	☐ No				
Forbs	☐ Yes	☐ No	Evergreen	☐ Yes	☐ No	**Other description:**
Other	☐ Yes	☐ No	Deciduous	☐ Yes	☐ No	

***** Forest, Woodland, Bushland, Thicket, Shrubland, Grassland, Wooded grassland, Cropland, Mangrove, Freshwater aquatic, Halophytic, Other***

Herbaceous height (m): ☐ 0.8-3.0 (m) ☐ 0.3-3.0 (m) ☐ 0.3-0.8 (m) ☐ 0.03-0.3 (m) **Herbaceous annual:** ☐ Yes ☐ No

Same landuse since 1990: ☐ Yes ☐ No **Land ownership:** ☐ Private ☐ Communal ☐ Government ☐ Don't Know

Primary current use:			**Soil/water conservation measures:**	
Food/Beverage	☐ Yes	☐ No	Number of	☐ None
Timber/fuelwood	☐ Yes	☐ No	measures in	☐ Vegetative
Forage:	☐ Yes	☐ No	plot :______	☐ Structural
Other:	☐ Yes	☐ No		Other: _____

0	1	2	3	**Impact on habitat:**
☐	☐	☐	☐	Impact of tree cutting
☐	☐	☐	☐	Impact of agriculture
☐	☐	☐	☐	Impact of grazing/browsing
☐	☐	☐	☐	Impact of fire
☐	☐	☐	☐	Impact of urban activities
☐	☐	☐	☐	Impact of industry
☐	☐	☐	☐	Impact of erosion
☐	☐	☐	☐	Impact of alien vegetation
☐	☐	☐	☐	Impact of firewood collection
☐	☐	☐	☐	Other:

Vegetation strata description:

Describe land cover/ use history:

SUB-PLOT (100 m²)	1	2	3	4
Rock/stone, Gravel cover (%)	☐ <5 ☐ 5-40 ☐ >40	☐ <5 ☐ 5-40 ☐ >40	☐ <5 ☐ 5-40 ☐ >40	☐ <5 ☐ 5-40 ☐ >40
Visible erosion	☐ None ☐ Sheet ☐ Rill ☐ Gully	☐ None ☐ Sheet ☐ Rill ☐ Gully	☐ None ☐ Sheet ☐ Rill ☐ Gully	☐ None ☐ Sheet ☐ Rill ☐ Gully
Woody Cover rating (%)	☐ Absent ☐ 15-40 ☐ < 4 ☐ 40-65 ☐ 4-15 ☐ > 65	☐ Absent ☐ 15-40 ☐ < 4 ☐ 40-65 ☐ 4-15 ☐ > 65	☐ Absent ☐ 15-40 ☐ < 4 ☐ 40-65 ☐ 4-15 ☐ > 65	☐ Absent ☐ 15-40 ☐ < 4 ☐ 40-65 ☐ 4-15 ☐ > 65
Herbaceous Cover rating (%)	☐ Absent ☐ 15-40 ☐ < 4 ☐ 40-65 ☐ 4-15 ☐ > 65	☐ Absent ☐ 15-40 ☐ < 4 ☐ 40-65 ☐ 4-15 ☐ > 65	☐ Absent ☐ 15-40 ☐ < 4 ☐ 40-65 ☐ 4-15 ☐ > 65	☐ Absent ☐ 15-40 ☐ < 4 ☐ 40-65 ☐ 4-15 ☐ > 65
Auger depth restriction (cm) (If no restriction, write 50 cm)				

Notes (indicate if a Cumulative Soil Mass sample was taken (CM= depth) or if infiltration was conducted:

TREE and SHRUB MEASUREMENTS - SUB-PLOT (100 m^2) **LDSF Field Form v2020**

Site: **Date:**
Cluster: **Plot:**

Density and Distance Measurements of Trees and Shrubs

Subplot	1		2		3		4	
Description	**Shrubs** Subpot 1	**Trees** Subplot 1	**Shrubs** Subplot 2	**Trees** Subplot 2	**Shrubs** Subplot 3	**Trees** Subplot 3	**Shrubs** Subplot 4	**Trees** Subplot 4
Plant density								
Point-plant distance	m	m	m	m	m	m	m	m
plant-plant dist	m	m	m	m	m	m	m	m

Tree and Shrub Measurements in each Subplot

Subplot		1		2		3		4	
Description		**Shrubs** Subpot 1	**Trees** Subplot 1	**Shrubs** Subplot 2	**Trees** Subplot 2	**Shrubs** Subplot 3	**Trees** Subplot 3	**Shrubs** Subplot 4	**Trees** Subplot 4
1	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
2	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
3	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
4	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
5	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
6	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
7	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
8	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
9	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
10	Height	m	m	m	m	m	m	m	m
	Length	m	cm	m	cm	m	cm	m	cm
	Width	m	Circumference↑	m	Circumference↑	m	Circumference↑	m	Circumference↑
	Species								
11									
12									
13									
14									

LDSF Infiltration Form			
Site:		**Plot:**	
Cluster:		**Date:**	
Start time	**End time**	**Start level (cm)**	**End level (cm)**
00:00:00	00:05:00		
00:05:00	00:10:00		
00:10:00	00:15:00		
00:15:00	00:20:00		
00:20:00	00:25:00		
00:25:00	00:30:00		
00:30:00	00:40:00		
00:40:00	00:50:00		
00:50:00	01:00:00		
01:00:00	01:10:00		
01:10:00	01:20:00		
01:20:00	01:30:00		
01:30:00	01:50:00		
01:50:00	02:10:00		
02:10:00	02:30:00		

Let the stopwatch run continuously! Record the end level then refill to the start level at the indicated time intervals.

Distance to nearest tree from infiltration ring (meters): __________

Distance to nearest shrub from infiltration ring (meters): _________

Record observations about the vegetation around the infiltration ring:

LDSF Rangeland Module 2017 v2							
Site:				**Plot:**			
Cluster:				**Date:**			
Distance (m)	**Point**	**Under canopy (Y/N)**	**Grass tuft (Y/N)**	**Leaf litter (Y/N)**	**Nearest grass or herb (annual (A) or perrenial (P))?**	**Nearest perennial grass spp**	**Distance to nearest perennial (cm)**
South to North Transect							
0 m	1						
2 m	2						
4 m	3						
6 m	4						
8 m	5						
10 m	6						
12 m	7						
14 m	8						
16 m	9						
18 m	10						
20 m	11						
22 m	12						
24 m	13						
26 m	14						
28 m	15						
East to West Transect							
0 m	16						
2 m	17						
4 m	18						
6 m	19						
8 m	20						
10 m	21						
12 m	22						
14 m	23						
16 m	24						
18 m	25						
20 m	26						
22 m	27						
24 m	28						
26 m	29						
28 m	30						

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