Conducting a soil and land health baseline using remote sensing and the Land Degradation Surveillance Framework (LDSF) within KCEP-CRAL

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World Agroforestry (ICRAF)

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Objective of the ICRAF Component

This project will identify and measure key indicators of land and soil health in order to establish a baseline and to monitor changes over time within the KCEP-CRAL project area.

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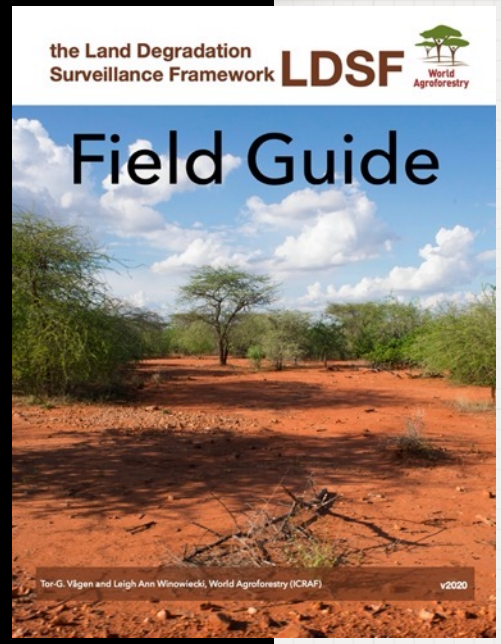
Specific Activities for the ICRAF Component

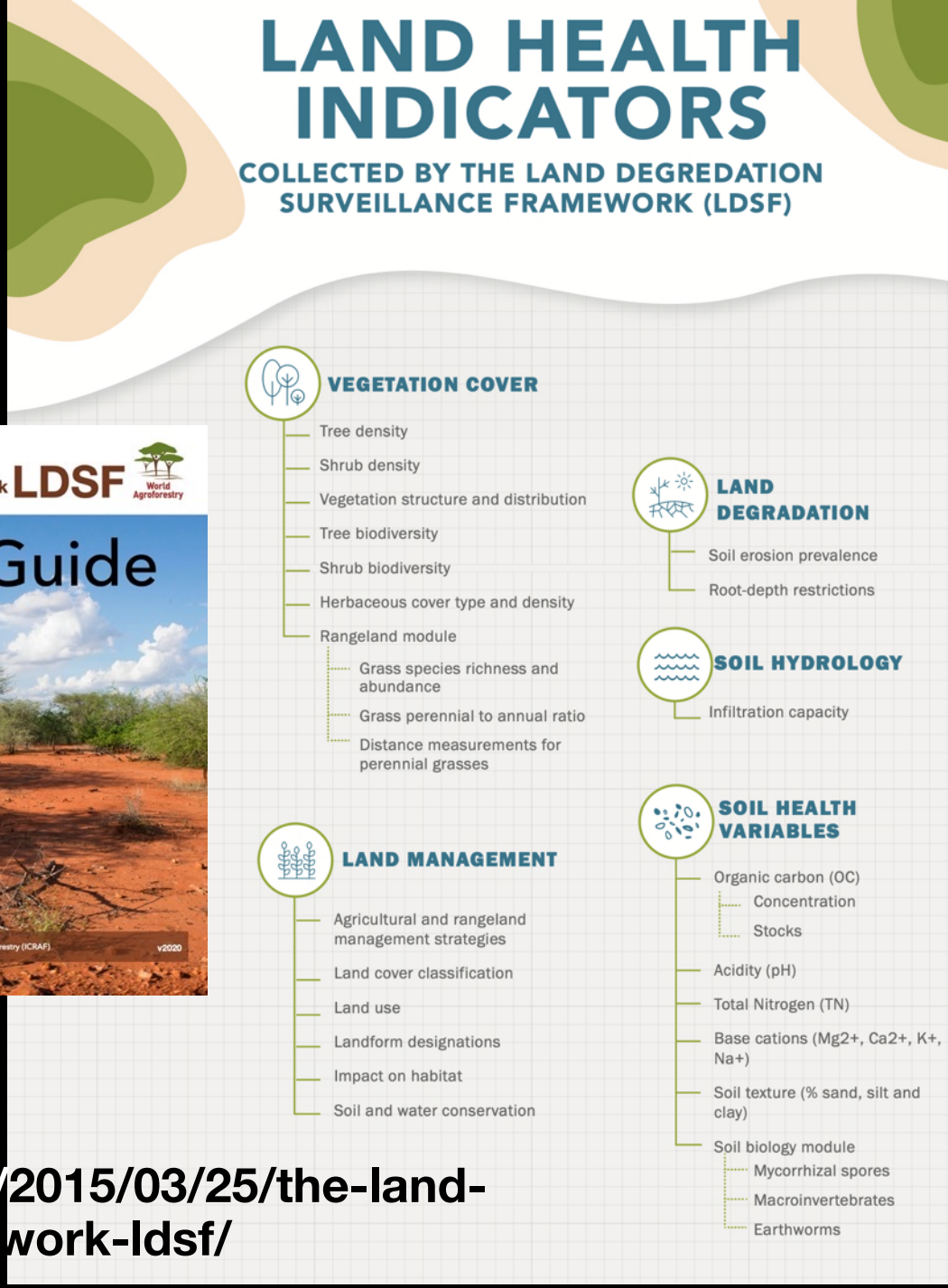
I. Develop survey methodology detailing study design, methodology, tools, work plan and timelines documented
II. Procure of assorted LDSF Field Survey equipment
III. Conduct five LDSF surveys across the KCEP-CRAL action areas
IV. Process, analyse and document the soil samples
V. Conduct Earth Observation-based assessment of biophysical indicators over time
VI. Conduct capacity development opportunities with members of the PCU M&E staff and Government counterparts on LDSF field methodology
VII. Share outputs and data from the LDSF

The LDSF was developed in response to the need for…

Systematic and science-based assessment and monitoring of soil and ecosystem health at scale, using a robust and consistent indicator framework that is…

- **Specific**: The indicator should accurately describe what is intended to be measured, and should not include multiple measurements in one indicator.
- **Measurable**: Regardless of who uses the indicator, consistent results should be obtained and tracked under the same conditions.
- **Attainable**: Collecting data for the indicator should be simple, straightforward, and cost-effective.
- **Relevant**: The indicator should be closely connected with each respective input, output or outcome.
- **Time-bound**: The indicator should include a specific time frame.





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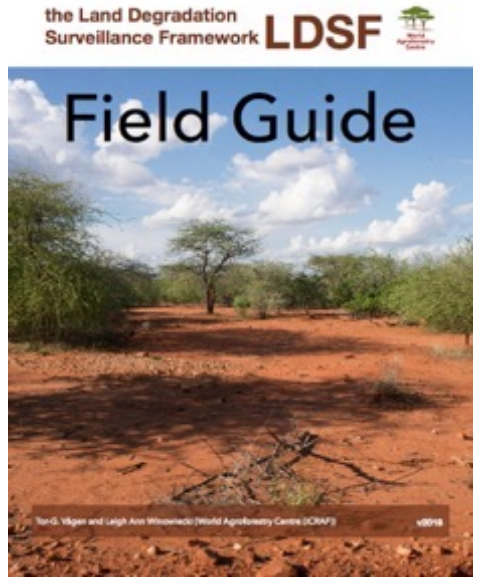
http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/

Land Degradation Surveillance Framework (LDSF)

- A systematic field-based assessment of multiple variables at the same geo-referenced location
- Consistent methods to assess soil health and land degradation status
- Including to monitor changes over time and multiple scales
- Spatial assessments (maps) of indicator sets to effectively target interventions to avoid land degradation or restore degraded areas
- Robust statistical analysis on drivers of degradation and ecological constraints
- Quantitative carbon accounting for climate change mitigation action
- Field guide available online here: http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/



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Robust and rapid monitoring systems across diverse landscapes: The Land Degradation Surveillance Framework (LDSF)

http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/

Data-driven network of LDSF sites (each site is 100 km^2, with 160 sampling plots). One systematic framework across multiple projects, donors.

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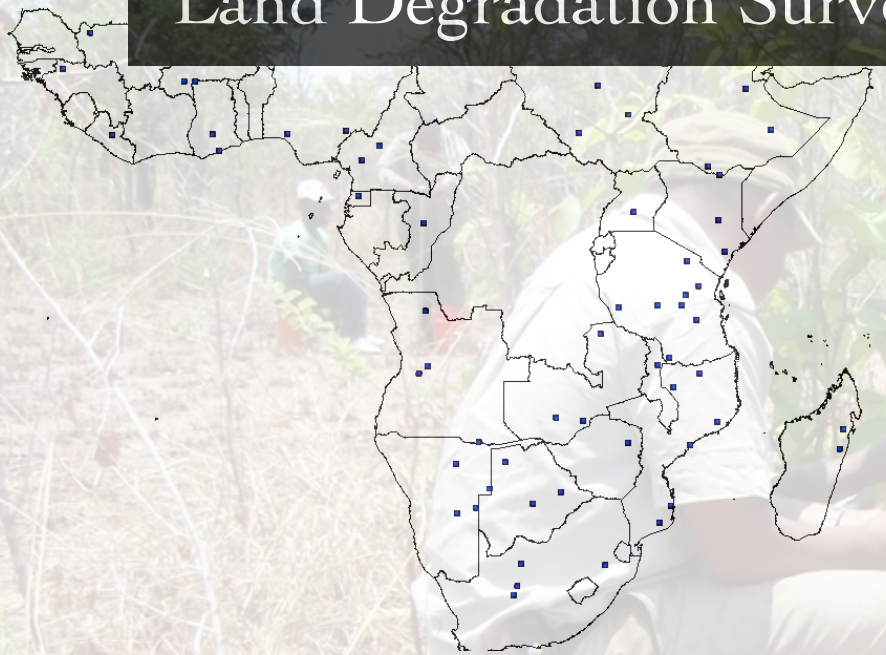
Land Degradation Surveillance Framework (LDSF)



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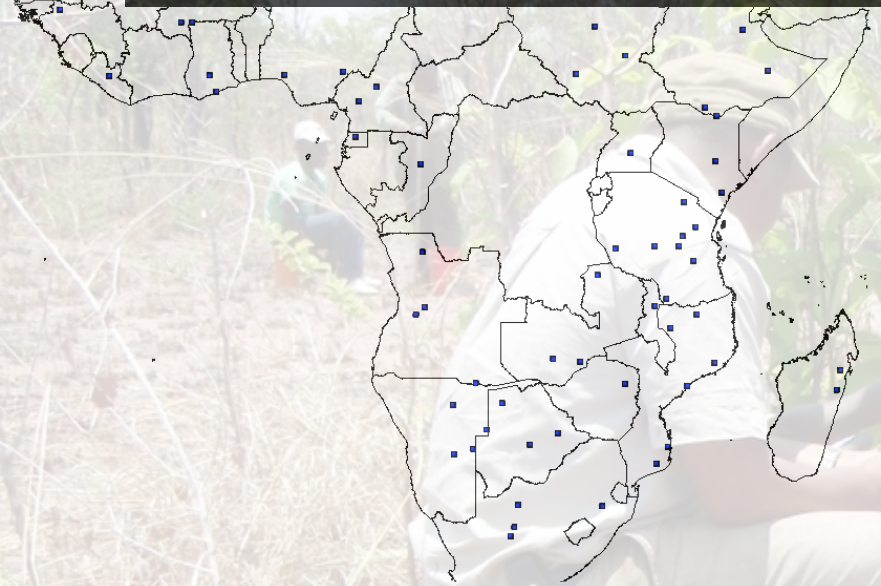
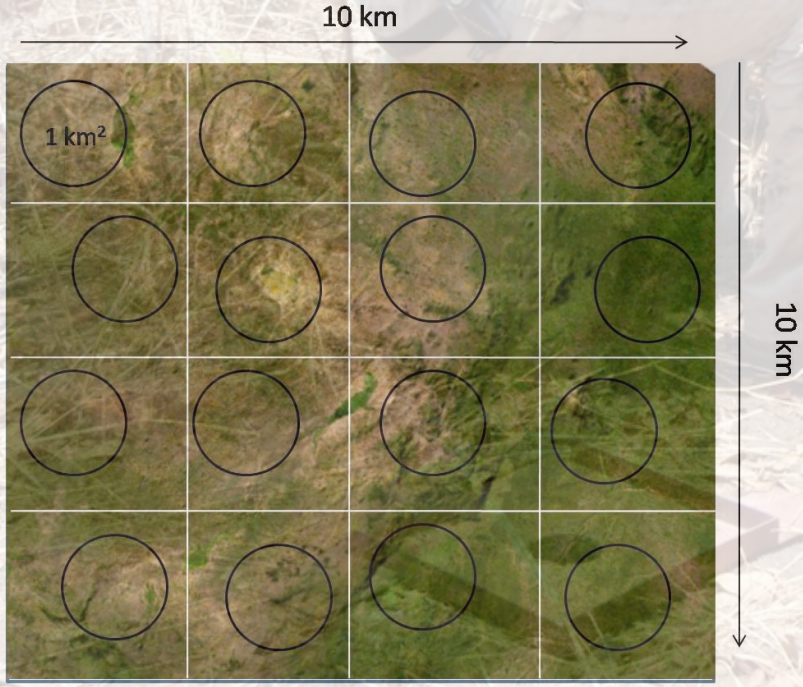
Land Degradation Surveillance Framework (LDSF)





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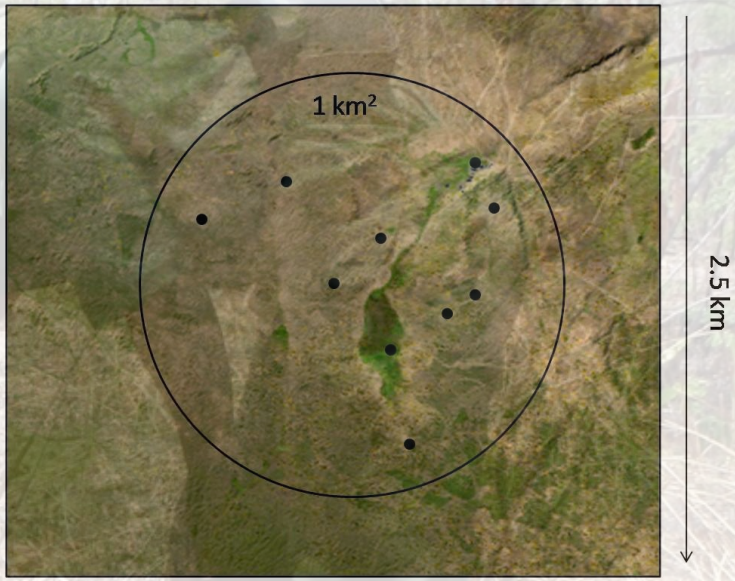

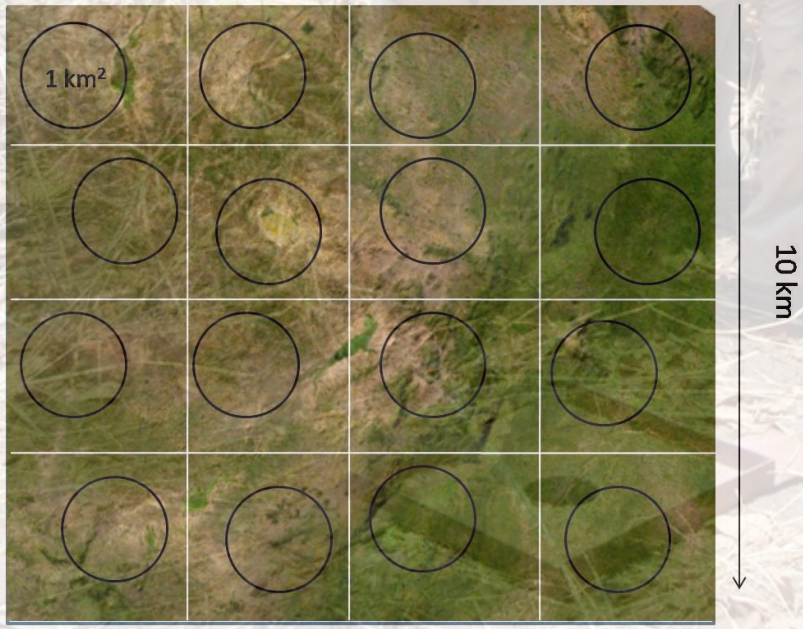

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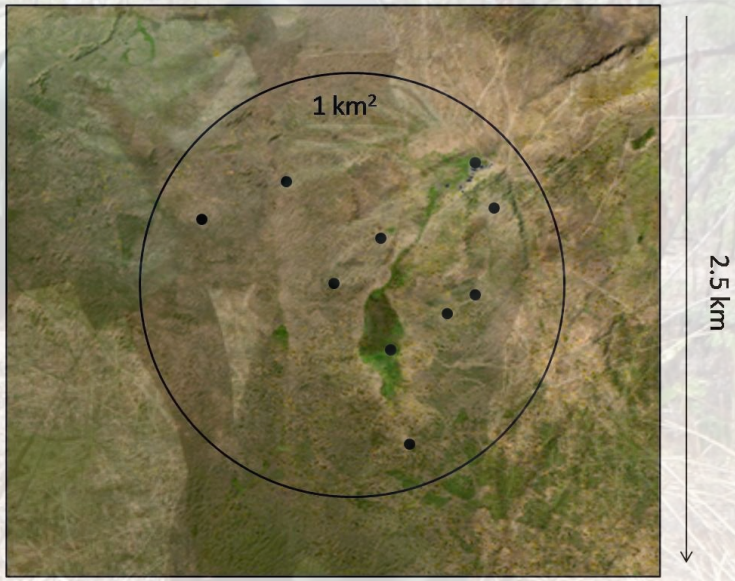

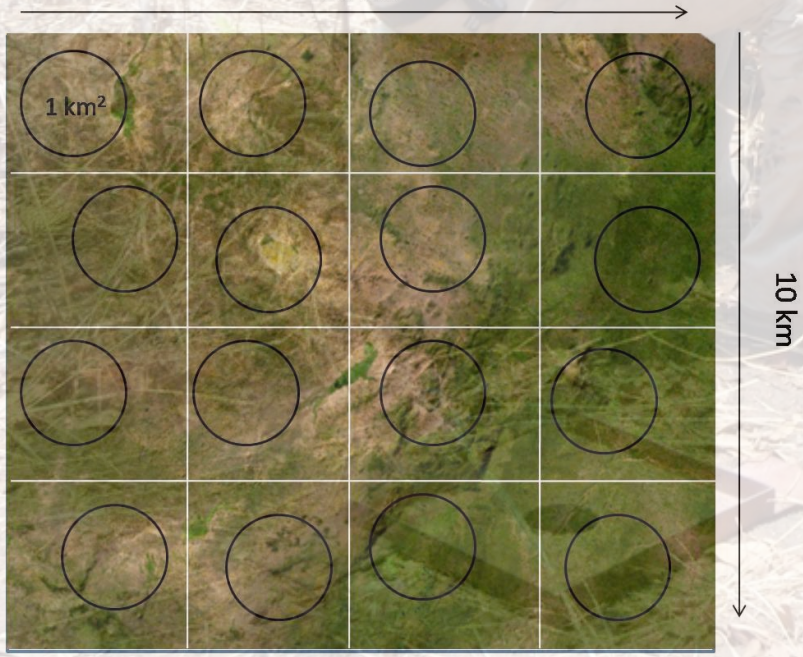

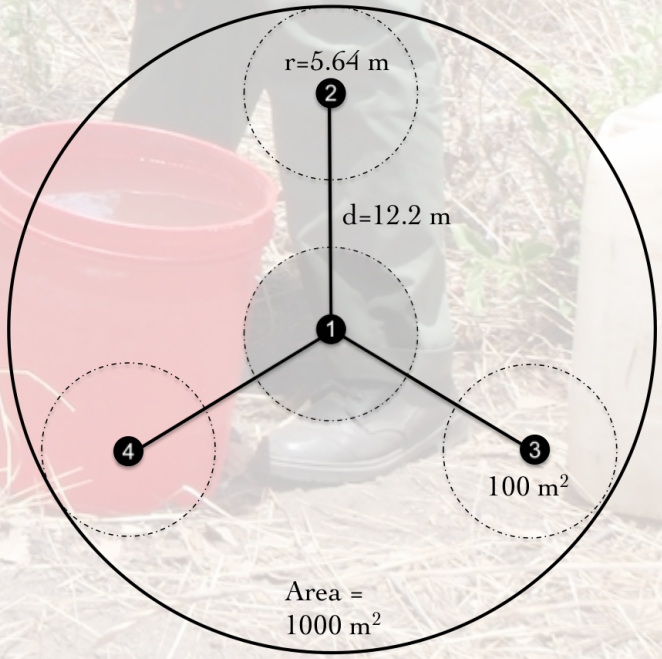

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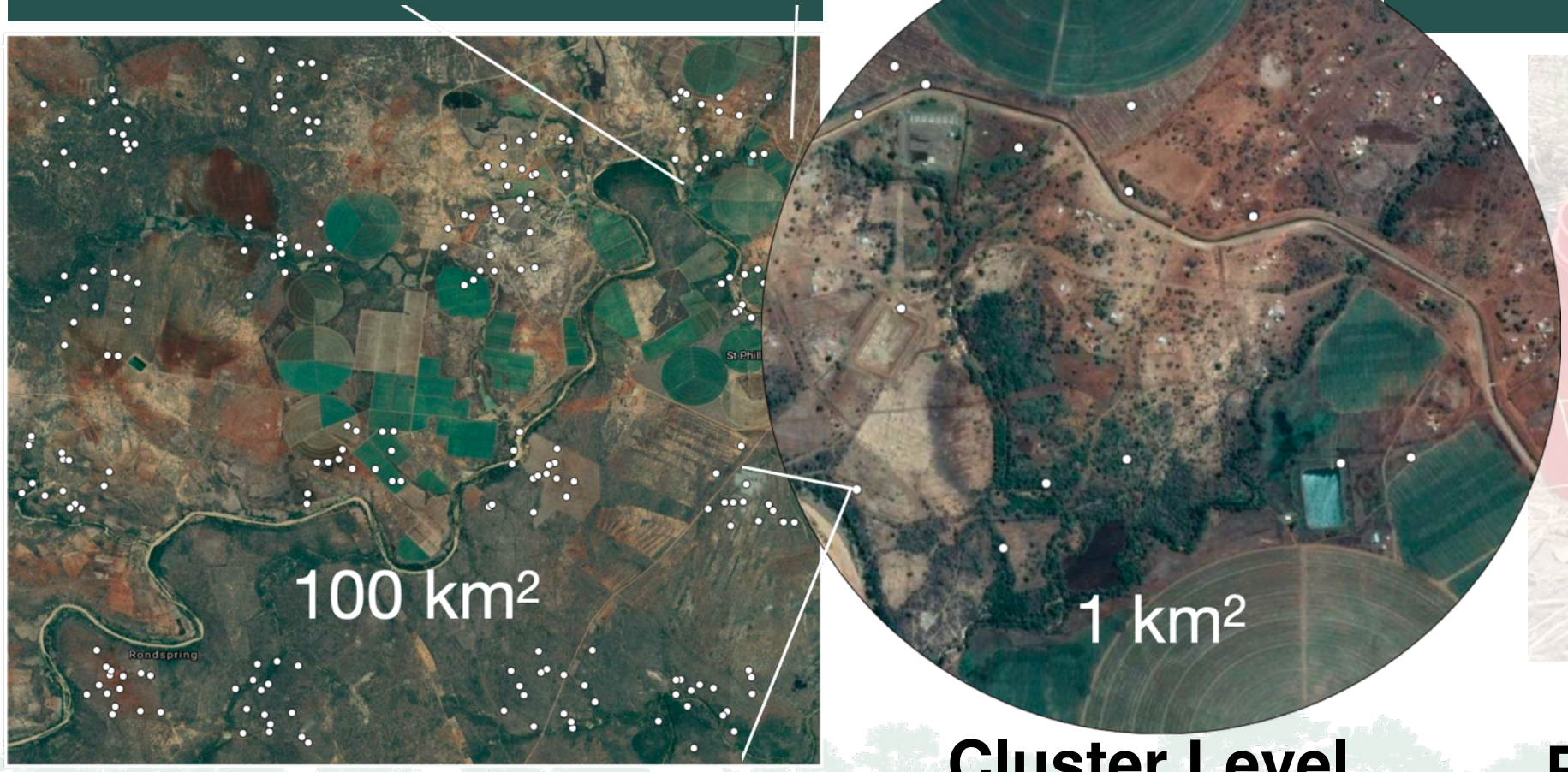
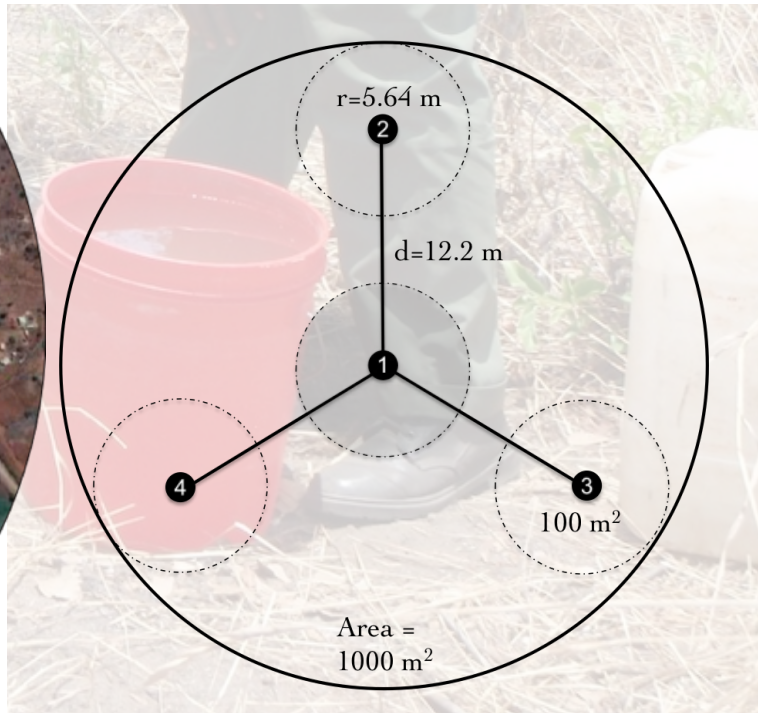
LDSF: Nested Sampling Scales

Unbiased sampling – capturing landscape variability





Site Level (10km * 10km)

Cluster Level
16-1km² per site

Plot Level
10-1000m² per cluster

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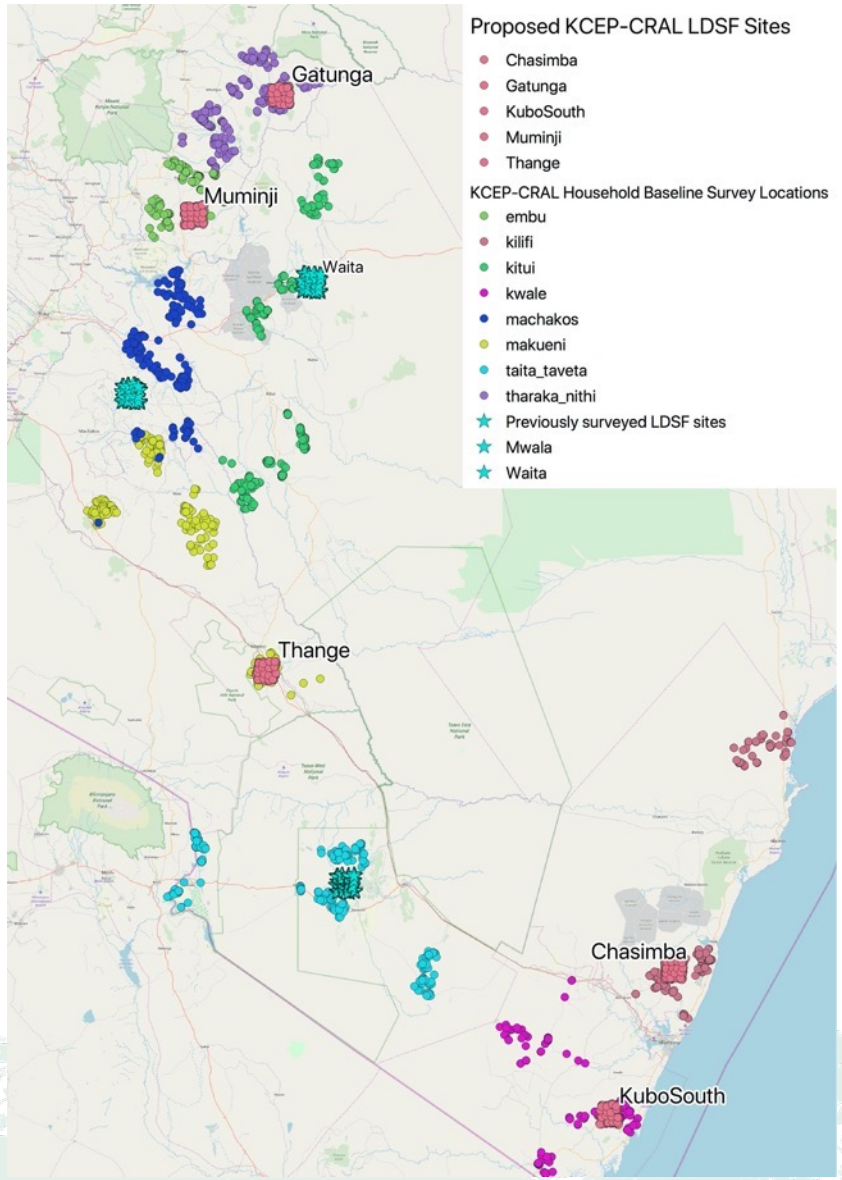
LDSF site co-location with HH Baseline surveys

- Partner meeting with KCEP & FAO on survey methodology
- Methodology was agreed on in September LDSF site co-location with HH Baseline surveys approved in Nov 2018
- Baseline HH survey coordinates were plotted on the map on the right
- Five LDSF sites were co-located with the KCEP-CRAL HH survey
  - For overlap with existing interventions & collaboration
- Procurement of equipment from Aug- Dec 2018



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LDSF Field Surveys Completed by June 2019

Site Name	Date of Field Survey
Muminji, Embu	November 2018
Gatunga, Tharaka Nithi	January 2019
Thange, Makueni	Feb-March 2019
Kubo South, Kilifi	April 2019
Chasimba, Kwale	June 2019

Thange Field Team

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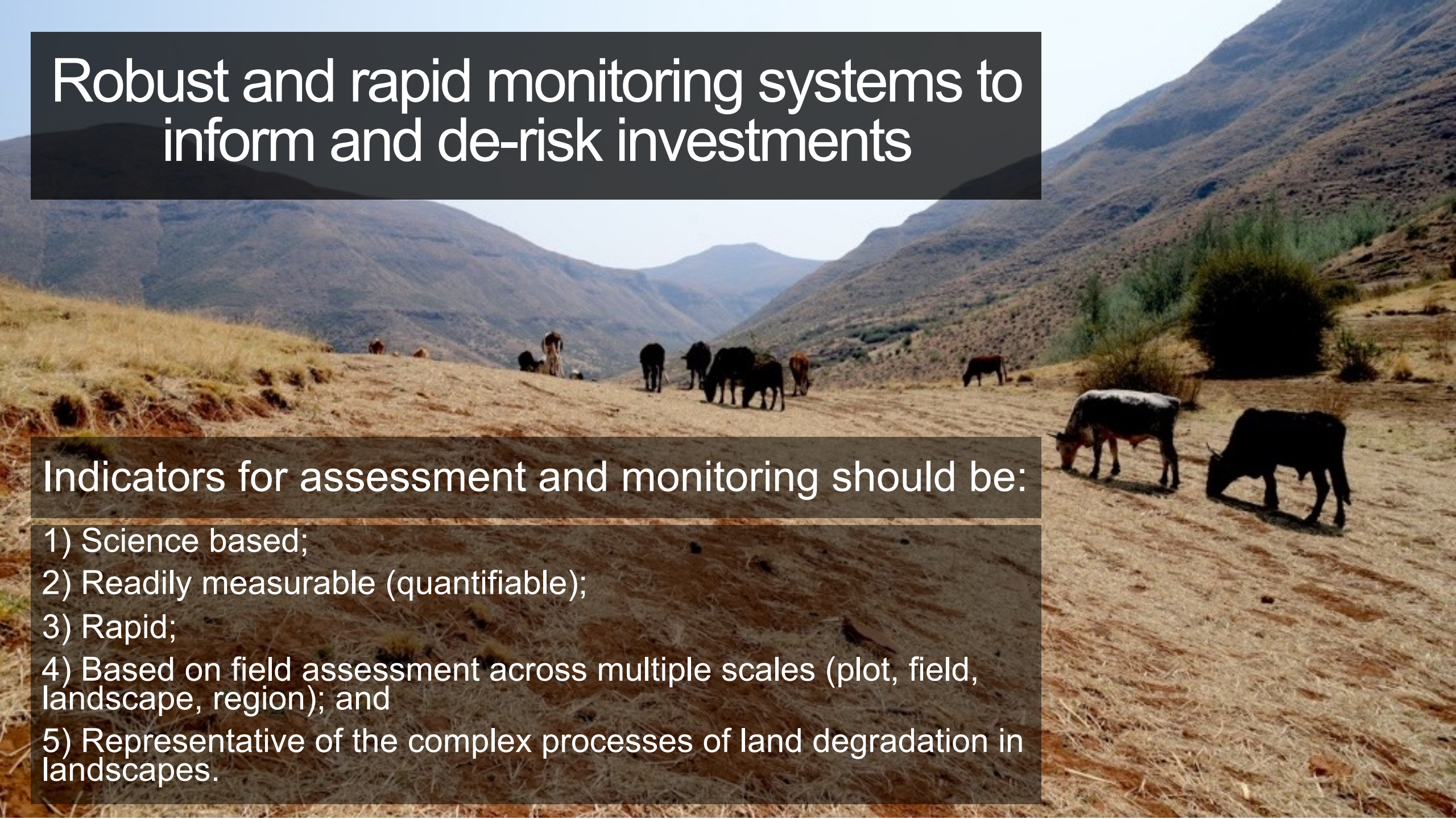
Robust and rapid monitoring systems to inform and de-risk investments



Indicators for assessment and monitoring 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 landscapes.

Soil organic carbon (SOC) is a key indicator of soil health

- **It influences many key processes** such as water holding capacity of the soil, overall soil fertility, and it also influences land (and agricultural) productivity.
- In addition, **it responds to management.** For example**,** poor agricultural management can decrease organic carbon in the soil, while regenerative ag practices can increase SOC.
- It is quantifiable and rapid to measure (and we can map it spatially).
- It is not the only indicator, and hence monitoring frameworks must assess multiple indicators simultaneously.

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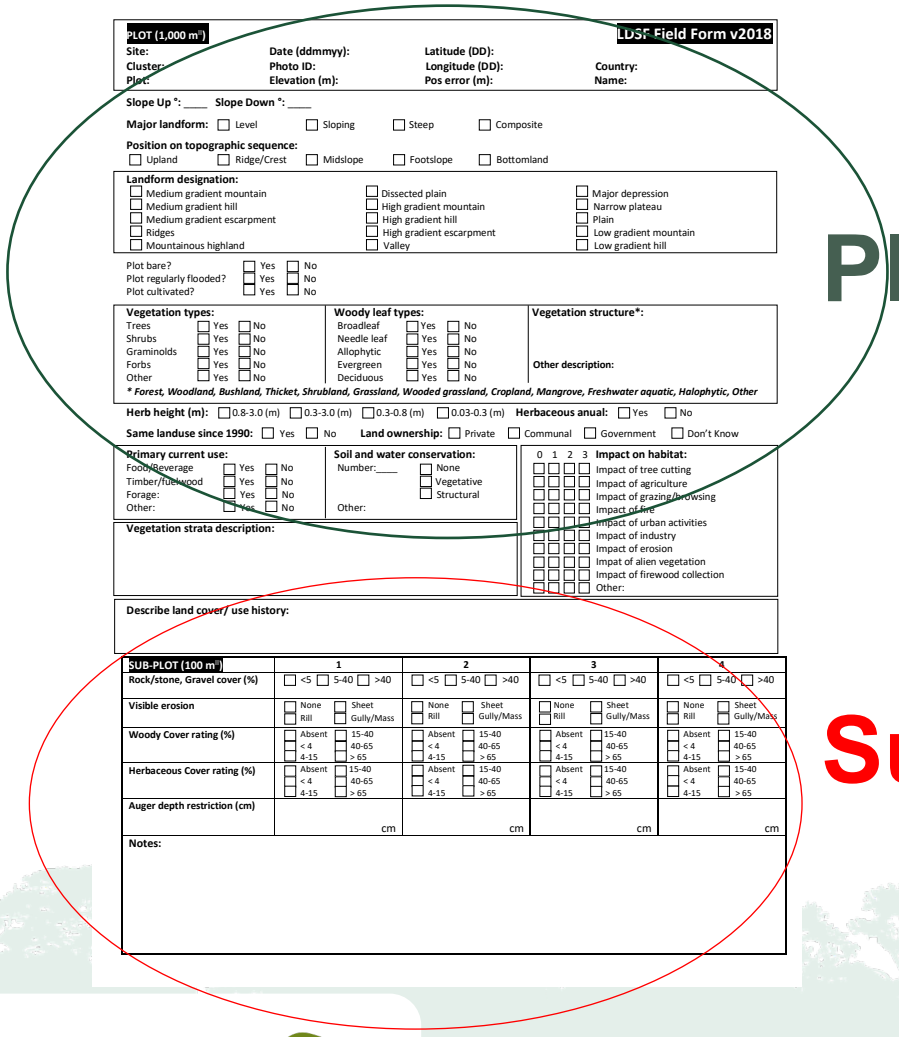
Plot and Subplot Level Indicators Measured in LDSF



PLOT (1,000 m²) — LDSF Field Form v2018

Site: | Date (ddmmyy): | Latitude (DD):
Cluster: | Photo ID: | 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? ☐ Yes ☐ No
Plot regularly flooded? ☐ Yes ☐ No
Plot cultivated? ☐ Yes ☐ No

Vegetation types:

Trees	☐ Yes	☐ No
Shrubs	☐ Yes	☐ No
Graminoids	☐ Yes	☐ No
Forbs	☐ Yes	☐ No
Other	☐ Yes	☐ No

Woody leaf types:

Broadleaf	☐ Yes	☐ No
Needle leaf	☐ Yes	☐ No
Allophytic	☐ Yes	☐ No
Evergreen	☐ Yes	☐ No
Deciduous	☐ Yes	☐ No

Vegetation structure*:

Other description:

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

Herb height (m): ☐ 0.8-3.0 (m) ☐ 0.3-3.0 (m) ☐ 0.3-0.8 (m) ☐ 0.03-0.3 (m) Herbaceous anual: ☐ Yes ☐ No

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

Primary current use:

Food/Beverage	☐ Yes	☐ No
Timber/fuelwood	☐ Yes	☐ No
Forage:	☐ Yes	☐ No
Other:	☐ Yes	☐ No

Soil and water conservation:
Number:____ ☐ None ☐ Vegetative ☐ Structural
Other:

Impact on habitat:

0	1	2	3	
☐	☐	☐	☐	Impact of tree cutting
☐	☐	☐	☐	Impact of agriculture
☐	☐	☐	☐	Impact of grazing/browsing
☐	☐	☐	☐	Impact of fire
☐	☐	☐	☐	Impact of urban activities
☐	☐	☐	☐	Impact of industry
☐	☐	☐	☐	Impact of erosion
☐	☐	☐	☐	Impat 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/Mass	☐ None ☐ Sheet ☐ Rill ☐ Gully/Mass	☐ None ☐ Sheet ☐ Rill ☐ Gully/Mass	☐ None ☐ Sheet ☐ Rill ☐ Gully/Mass
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)	cm	cm	cm	cm

Notes:

Plot

Subplot

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Soil health variables

- Organic carbon (OC)
  - Concentrations
  - Stocks
- Acidity (pH)
- Total Nitrogen (TN)
- Base cations (Mg^{2+}, Ca^{2+}, K^{+}, Na^{+})
- Soil texture (% sand, silt and clay)
- Soil biological indicators
  - Mycorrhizal spores
  - Bacteria: fungi

Land Management

- Agricultural practices
- Land cover classification
- Land use (history)
- Landform designations
- Impact on habitat
- Soil and water conservation measures

Land degradation

- Soil erosion prevalence
- Root-depth restrictions

Soil Hydrology

- Infiltration capacity
  - Saturated hydraulic conductivity

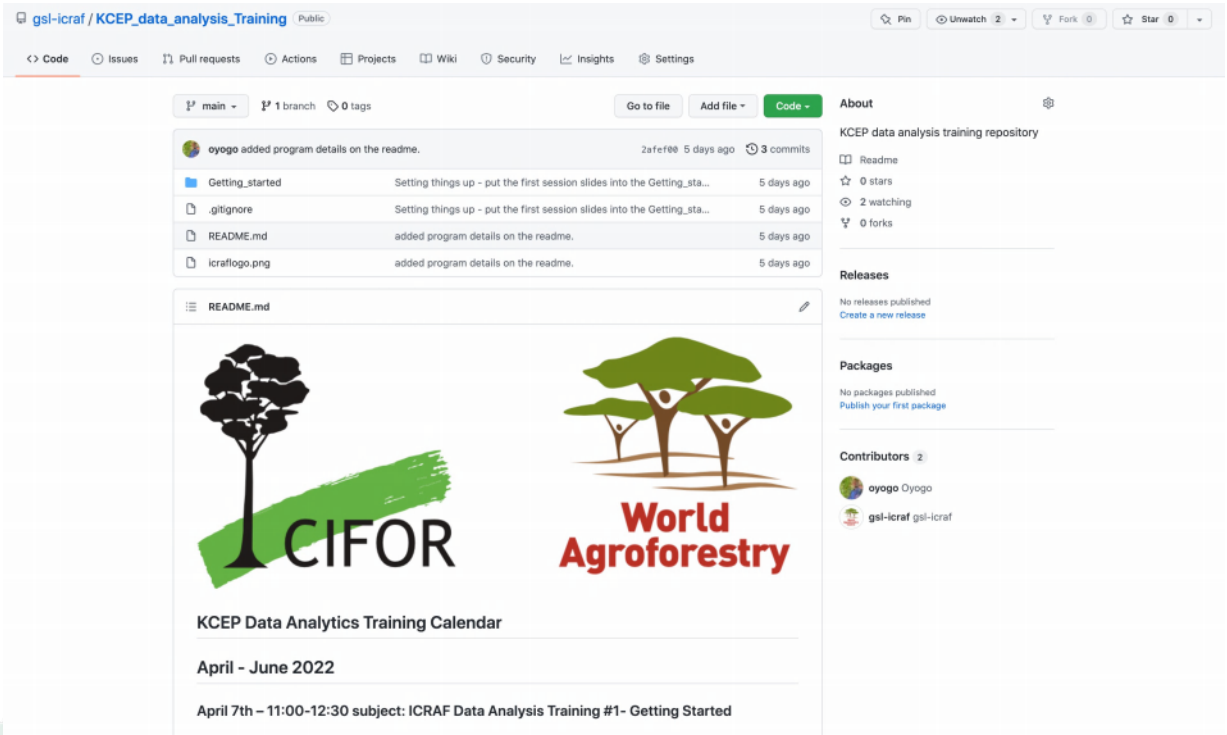
Vegetation Assessments

- Tree density
- Shrub density
- Vegetation structure
- Vegetation distribution
- Tree biodiversity
- Shrub biodiversity
- Herbaceous cover
- Rangeland Health
  - Grass & forb biodiversity
  - Perennial: annual

Now let's get started with R

1. Today we will use GitHub

- Copy the following URL and paste in web browser like Chrome/Firefox (once the page is loaded, you should be able to see contents similar to the image below).
    - https://github.com/gsl-icraf/KCEP_data_analysis_Training



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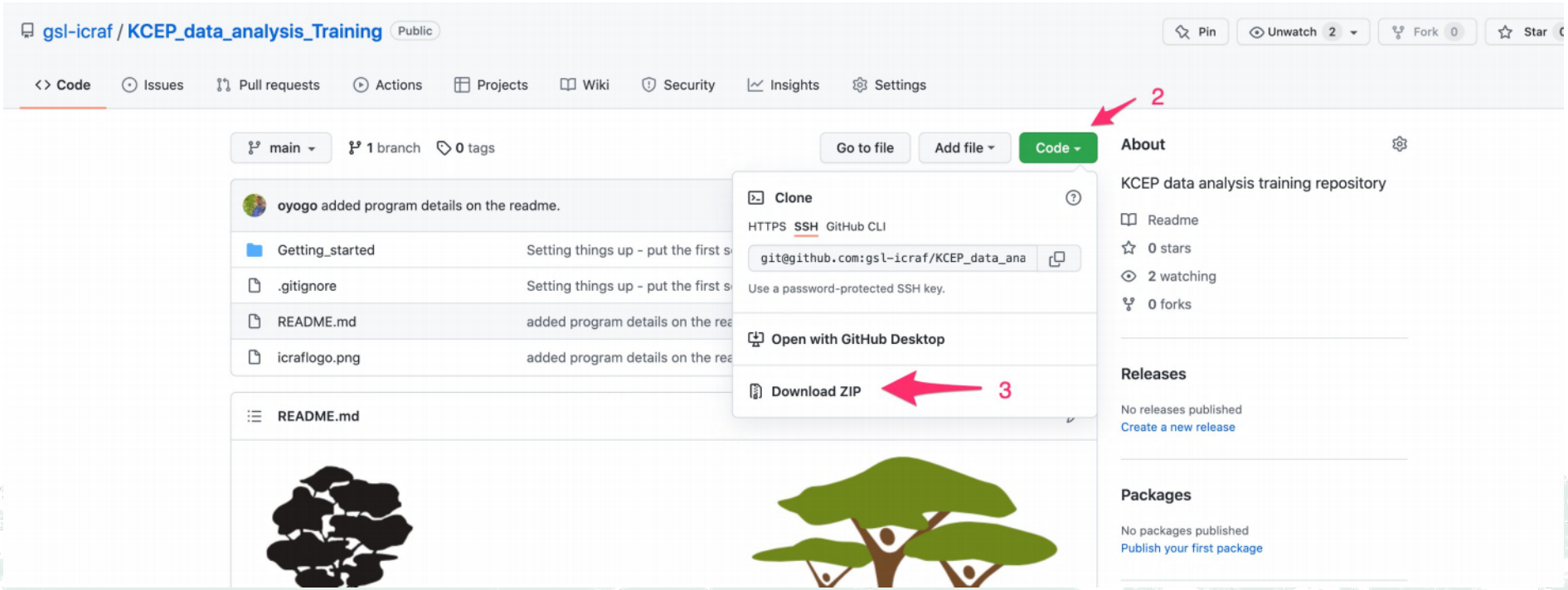
2. We will need to:

- Press the Code button (as shown in the image below)
- Press "Download" to download the contents to your computer.



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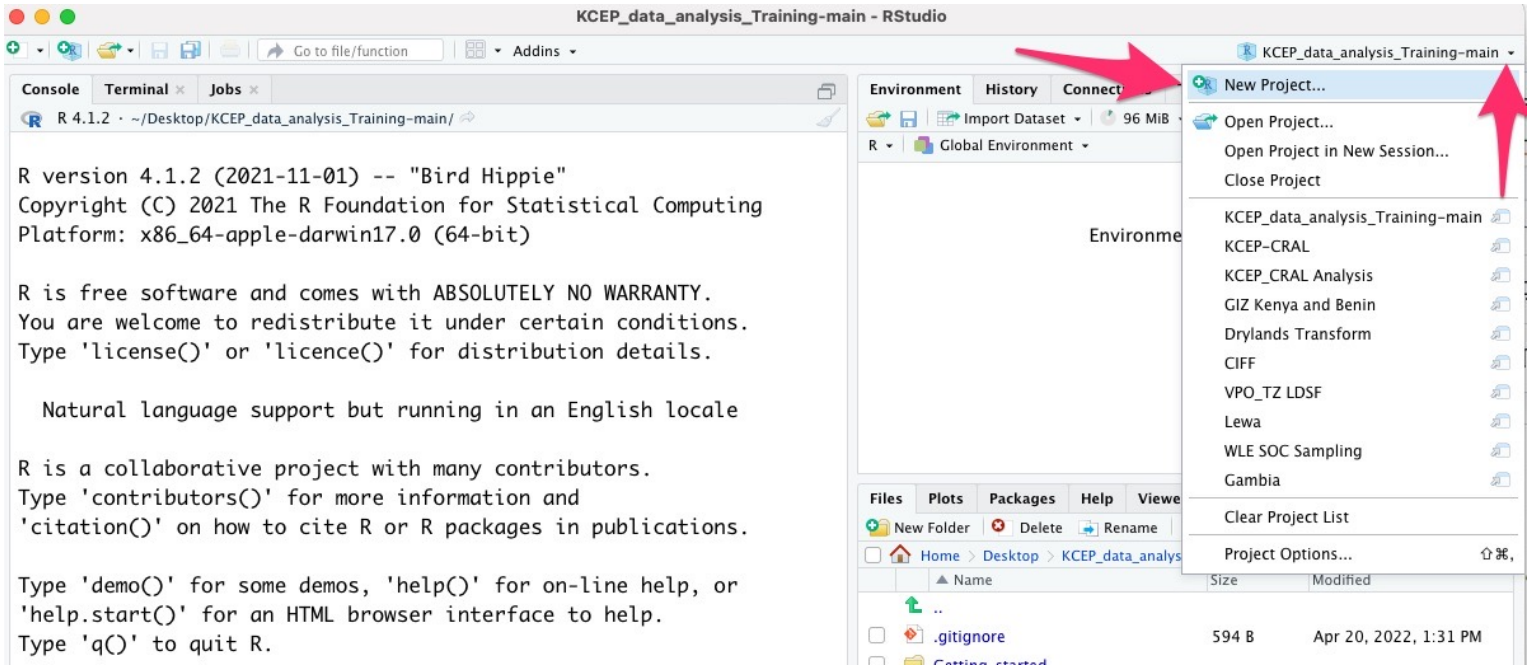
3. We will need to:

- The file downloaded on to your computer is called "KCEP_data_analysis_Training-main.zip".
    - The file is usually downloaded in "Download" folder unless another location is specified.
- You must download the latest copy of this repository before each session.

Now let's get started with R

4. Go to R Studio

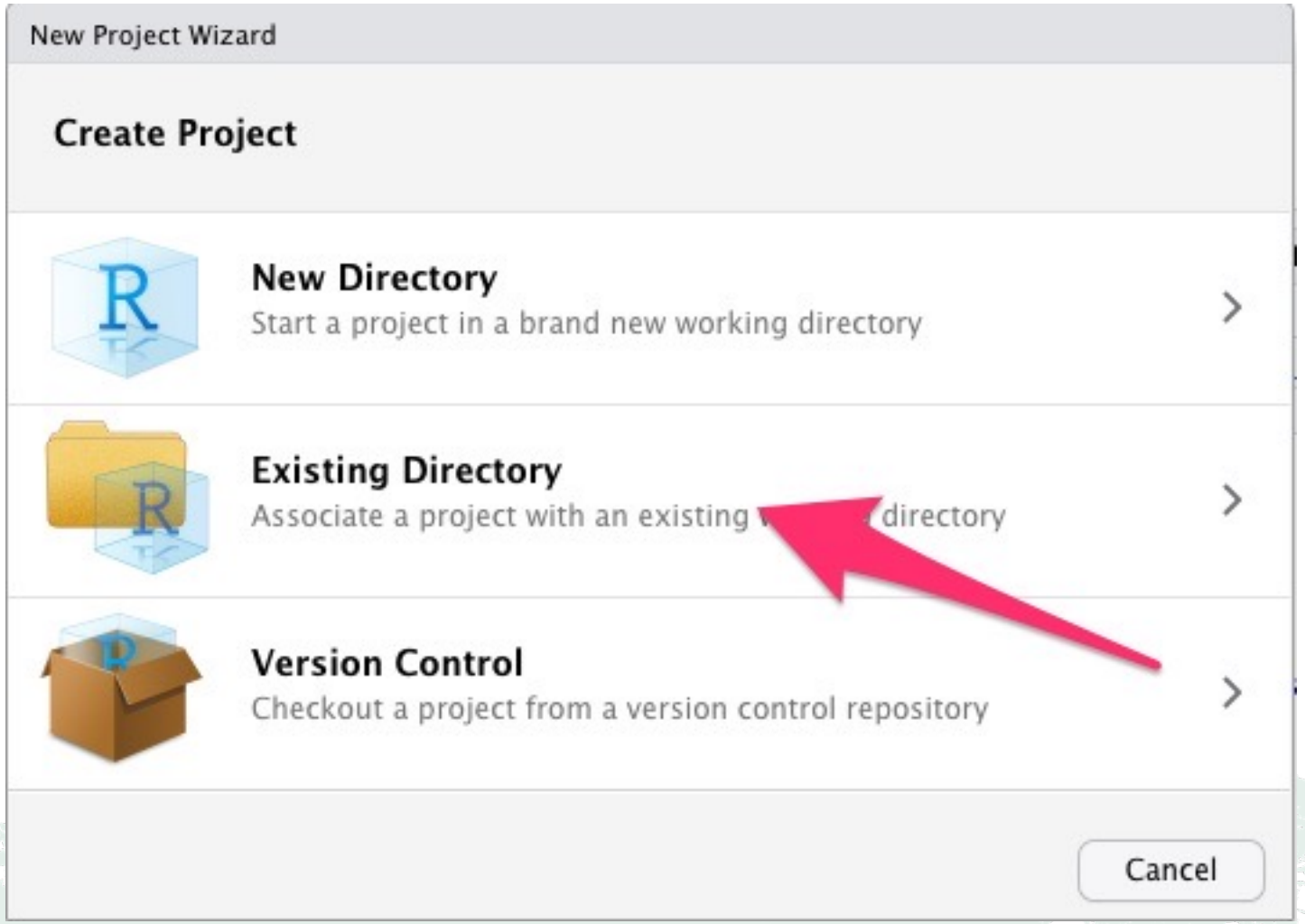
- Click on New Project



Now let's get started with R

5. Go to Existing Directory

- Navigate to where that zip file is



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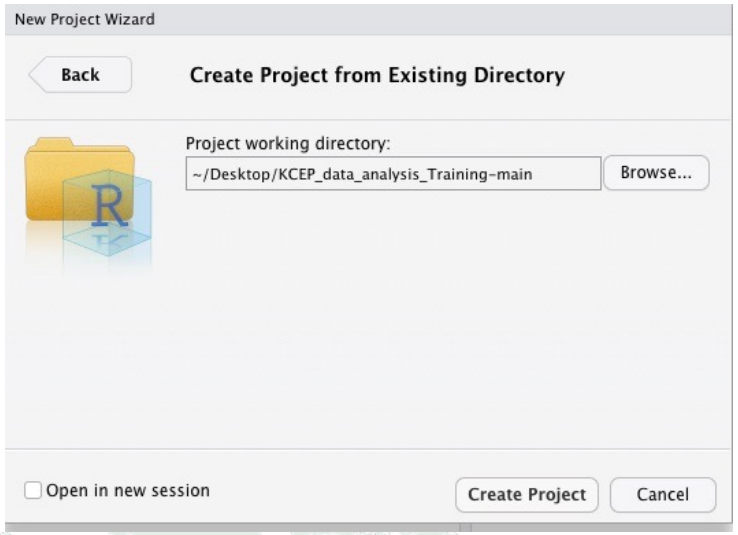

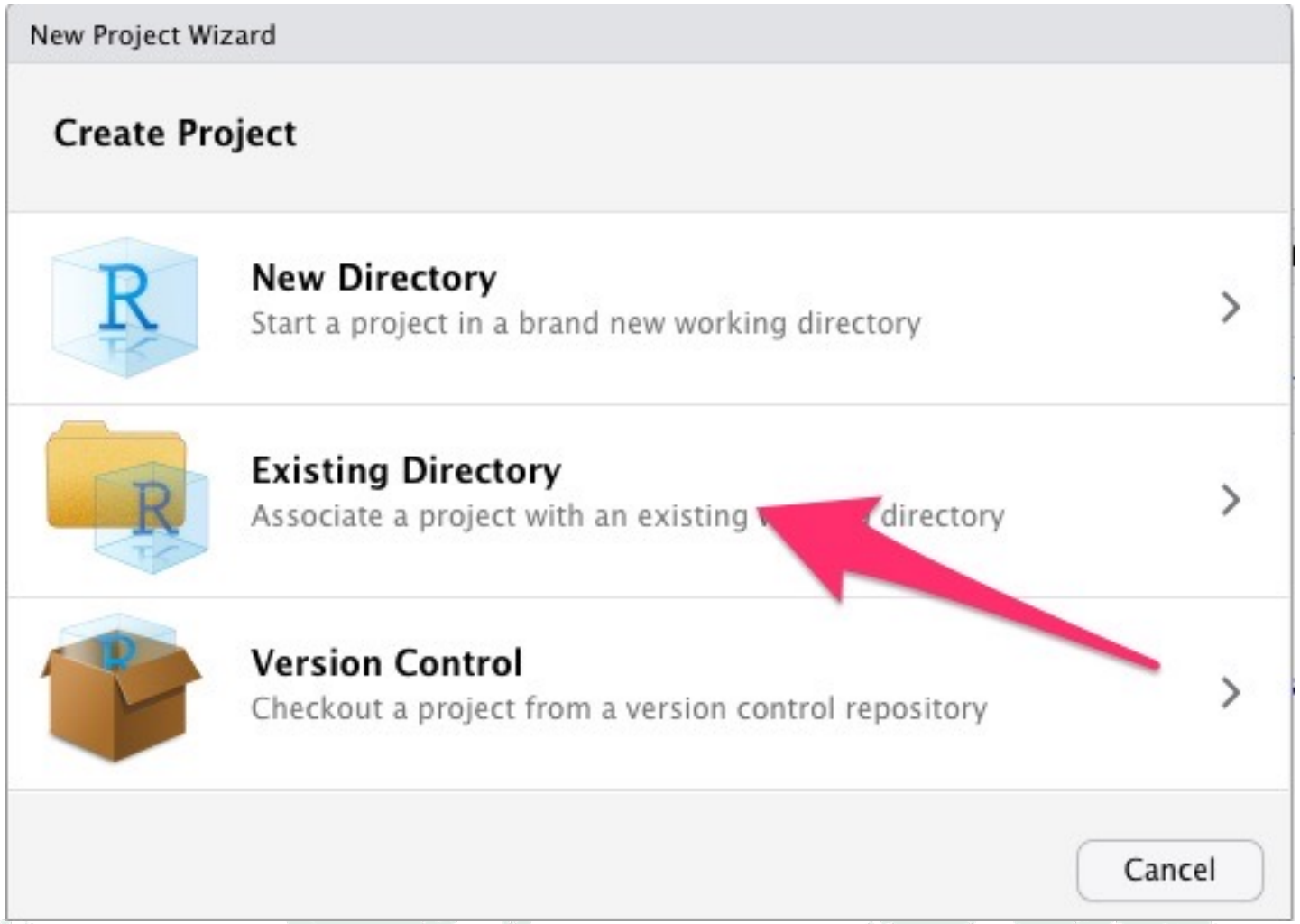

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Now all of the files are connected to your R Studio environment

Thank you!

Contact:
Leigh Winowiecki L.A.Winowiecki@cgiar.org

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