Training Manual for Long-term Monitoring of

RANGELANDS

Wildlife Conservation Society

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Training Manual for Long-term Monitoring of Rangelands

Contributors

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With reference to methodologies described by

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Elsen, P. R., Poya Faryabi, S., Surya, G., Grantham, H. S. (2021). *Indicators assessment protocol vulnerability assessment for the Panj-Amu River Basin*. Unpublished report. Wildlife Conservation Society, Bronx, NY.

Zandler, H. (2018). *Wakhan rangeland assessment report*. Wildlife Conservation Society, Afghanistan.

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CONTENTS

1 INTRODUCTION

Climate change threatens biodiversity by altering the climate conditions under which species have evolved, forcing species to adapt, shift their ranges, or face local extinction[1]. Over the last few decades, climate change has already led to widespread range shifts[2], declines in species abundances[3], and full species-level extinctions[4]. These biodiversity losses have profound impacts on ecosystem structure, processes, and services, as well as multiple aspects of human well-being[5]. Wildlife species with ranges tightly linked to climate variables will be most impacted by climate change, and these species can serve as important indicators of changing climate conditions on the ground. Monitoring these species in the wild, and the habitats on which they depend, is thus essential for optimizing conservation planning to mitigate environmental, economic, and social vulnerabilities to climate change.

Ecosystems are important for biodiversity conservation, especially in the face of climate change. Well-managed, intact ecosystems are more likely to be resilient to climate change and provide more benefits to biodiversity and people. Healthy rangelands provide critical resources for both people and wildlife in Afghanistan, and the condition of rangelands can serve as an early warning of climate-induced changes in the environment. Rangeland health deteriorates before livestock production or other uses decline, and changes in rangeland health occur at a relatively slow pace. People often cannot detect such gradual changes in the ecosystem over long time periods, and thus rangeland monitoring can provide a useful record of the state of the environment and how it changes over time.

Survey objectives

The rangeland monitoring protocol in this manual has been developed to track how the state of rangeland habitat conditions change in response to climate change. The methodology consists of standardized practices for recording vegetation coverage, disturbance, and carbon sequestration, and has been designed to ensure reproducibility across survey teams and geographic areas.

Important considerations

When conducting long-term monitoring of rangelands, some foundational expertise is required. This training manual is not a replacement for a field guide. It is expected that at least one person conducting the surveys is skilled at identifying different types of vegetation found in shrublands (e.g., grasses, forbs, shrubs), and different types of habitat disturbance (e.g., erosion, grazing, human use).

[1] Araujo, M. B., Science, C. R. (2006). How does climate change affect biodiversity? Science 313: 1396-1397.
[2] Chen, I., Hill, J., Ohlemüller, R., Roy, D., Thomas, C. (2011). Rapid range shifts of species associated with high levels of climate warming. Science 333: 1024-1026.
[3] Root, T., Price, J., Hall, K., Schneider, S., Rosenzweig, C., Pounds, J. (2003). Fingerprints of global warming on wild animals and plants. Nature 421: 57-60.
[4] Pounds, J., Fogden, M., Campbell, J. (1999). Biological response to climate change on a tropical mountain. Nature 398: 611-615.
[5] Díaz, S., Fargione, J., Chapin, F. S., III, Tilman, D. (2006). Biodiversity loss threatens human well-being. PLoS Biology 4: 1300-1305.

While this manual has been generalized for all rangelands, some habitats will require slightly different methods. For example, the line intercept method is most appropriate for shrublands, while the point intercept method is preferred for meadows or wetlands. Both methods are described in this manual, and the surveyors should use the appropriate method for their study area.

How to use this manual

This manual provides step-by-step instructions for conducting rangeland surveys in the field.

Chapter 2, "Selecting a Site," outlines important considerations for choosing where to conduct the survey and how to create appropriate transects.

Chapter 3, "Preparations," discusses what surveyors should know before going into the field, such as the time and frequency of surveying, and necessary equipment.

Chapter 4, "Field Setup," instructs surveyors on what to do once they arrive to the survey site and prepare to start the survey.

Chapter 5, "Field Methodology," provides step-by-step instructions for conducting the survey.

Chapter 6, "Reporting," gives additional detail on how to properly record the necessary data, such as how to measure foliar cover and rate the intensity of habitat disturbance.

Chapter 7, "Resources," lists some useful data, tools, and other resources available to surveyors for conducting the survey.

Finally, the Appendix contains copies of rangeland datasheets that surveyors can print and use in the field to record the necessary data in their study area.

2 SELECTING A SITE

The survey sites should be selected based on the sensitivity and vulnerability of rangelands to climate change in the study area.

NOTE: Maps of habitats, land cover, and climate change risk are necessary for determining where to establish survey sites. If these resources are unavailable or unknown to the team, it may be useful to refer to data layers included in the Adapt Afghanistan web platform (https://adaptafghanistan.com; see Chapter 7). Site selections based on vegetation growth habits should be determined by consulting "Field Guide Afghanistan: flora and vegetation" (see Chapter 7).

1. Generate random points within the selected rangeland to be surveyed. It is useful to use a stratified sampling approach using a land cover map, if available, to ensure each land cover type is sufficiently sampled.

The preferred approach would be to create random points using GIS (e.g., using the "Create Random Points" tool in ArcGIS Pro or an equivalent tool in QGIS, R, etc.; see Chapter 7). You can specify stratified sampling using the "Constraining Extent" parameter of this tool.

2. From these random points, select the sites to survey, keeping in mind the following requirements:

Survey sites should include a representative sample of vegetation growth habits.

Survey sites should be located at different elevations, slopes, and aspects in comparable numbers.

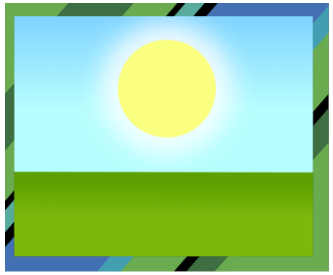
Survey sites should be located across a gradient of land use intensity (including pristine, moderately degraded, and heavily degraded sites).

Survey sites should be located in areas that are easily accessible with safe terrain for surveyors.

Survey sites should be at least 2 km from villages, roads, or other paths.

NOTE: This can introduce some sampling bias (particularly for roads).

3 PREPARATIONS



Time

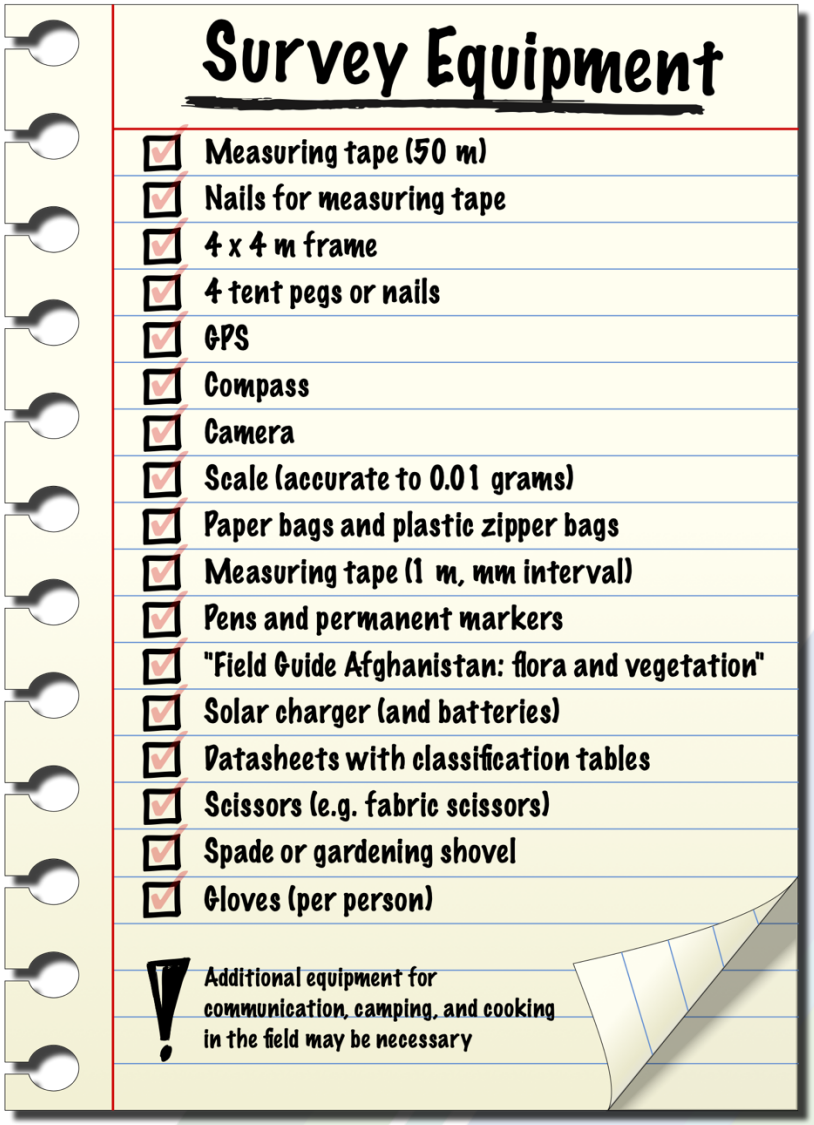
The survey should be conducted during the day, between 7:00am and 5:00pm.

Season

Surveys should be conducted during the summer when there is no snow cover and, ideally, during the peak period of greenness.

Team

The rangeland survey methodology described in this manual will require four people at each site. Surveyors 1 and 2 will be responsible for conducting measurements along the transect. Surveyors 3 and 4 will be responsible for conducting biomass measurements. Surveyors 3 and 4 must ensure that they have recorded the weight of the empty biomass bag(s) prior to surveying.



4 FIELD SETUP

1. Navigate your GPS to the selected point.

2. Randomly toss a pen in the air and let it fall onto the ground. The direction of the tip of the pen is the direction of the transect line.

If the transect is facing towards inaccessible terrain, toss the pen again.

3. Establish a 50 m transect using the measuring tape.

4. Take a photo in the direction of the transect at the start and end of the transect. Record the photo numbers on your datasheet.

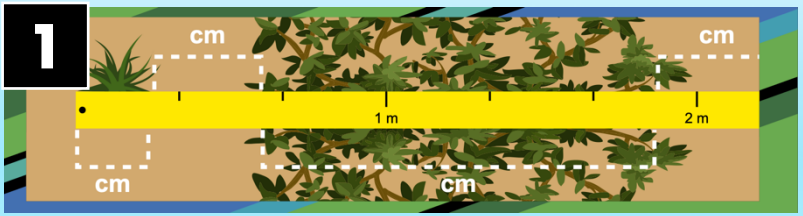
5. Before you begin, record the basic information about the survey location:

- Date
- Site number
- Name of surveyors
- Start time of the survey
- GPS location of the transect start point
- Direction, aspect, and slope of transect (in degrees)
- Elevation (in meters)
- Vegetation growth habit (*see Chapter 6*)

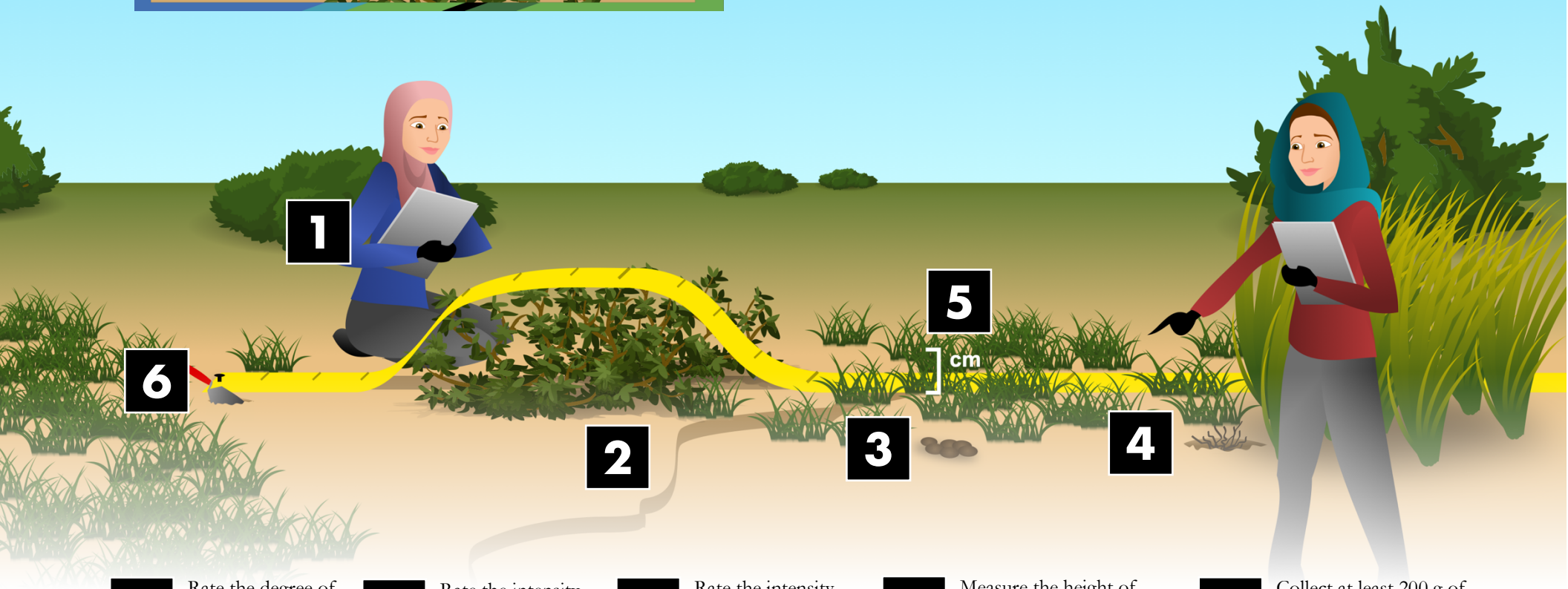
NOTE: If you are in a meadow or wetland, follow the steps of the point intercept method for the transect measurement. For all other types of rangelands, follow the steps for both the line and point intercept methods for the transect measurement.

5 FIELD METHODOLOGY

Transect Measurement (Line Intercept Method)



Record the total foliar cover (in cm) of each cover type from the start to the end of the transect. Record the first type starting from the 0 cm mark of the measuring tape until you reach a new cover type. Measure the length of the cover type. Repeat the process with the next cover type and continue until all 50 m are covered. Once finished, sum the total length covered by each cover type; the total of all types should equal 50 m.



2 Rate the degree of erosion for the entire transect.

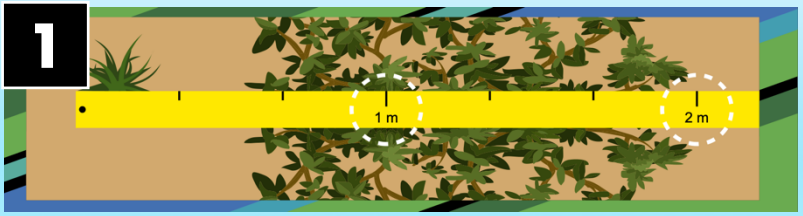
3 Rate the intensity of grazing for the entire transect.

4 Rate the intensity of human usage for the entire transect.

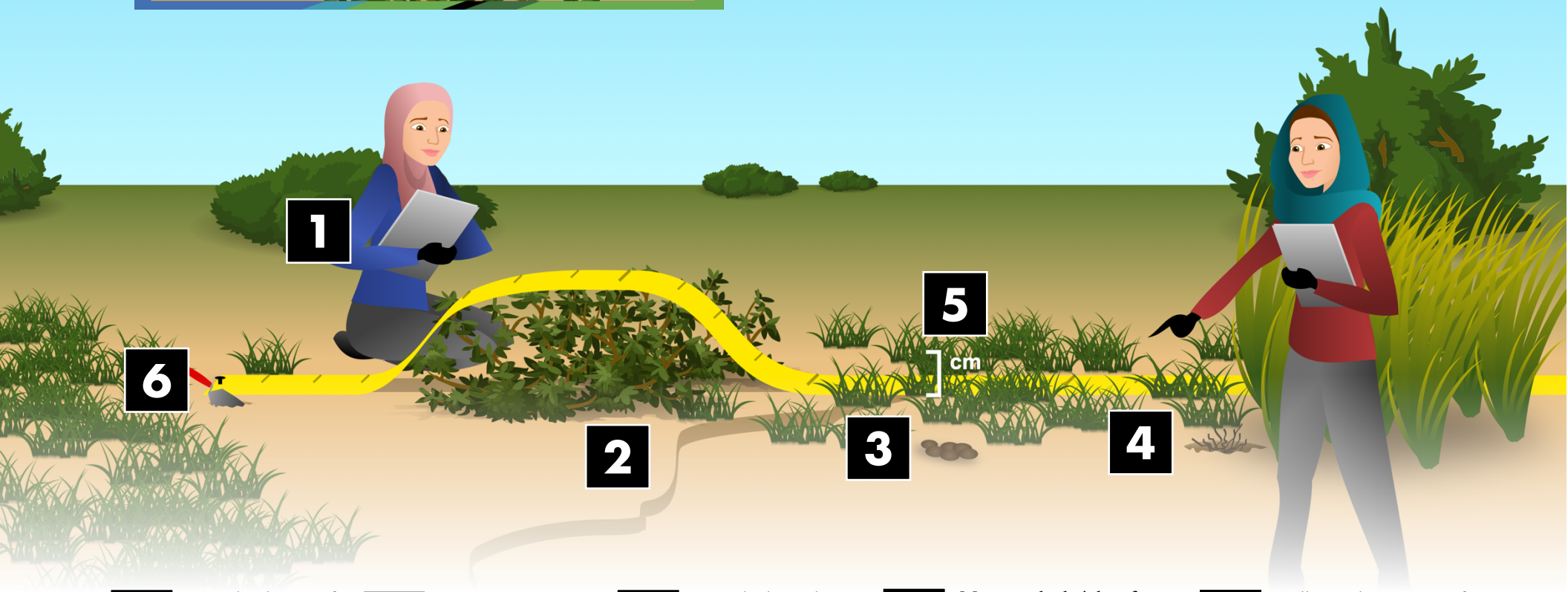
5 Measure the height of grass (in cm) at 5 random points along the transect and record the average height.

6 Collect at least 200 g of soil (5-15 cm deep) at the beginning of the transect. Store in plastic bag and label with Plot ID.

Transect Measurement (Point Intercept Method)



Starting from the 1 m mark of the measuring tape, look vertically down and record the cover type that occurs at the 1 m mark. Move forward along the transect to the 2 m mark and record the cover type. Repeat this process for all 50 m of the transect, resulting in 50 total cover type observations.



2 Rate the degree of erosion for the entire transect.

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4 Rate the intensity of human usage for the entire transect.

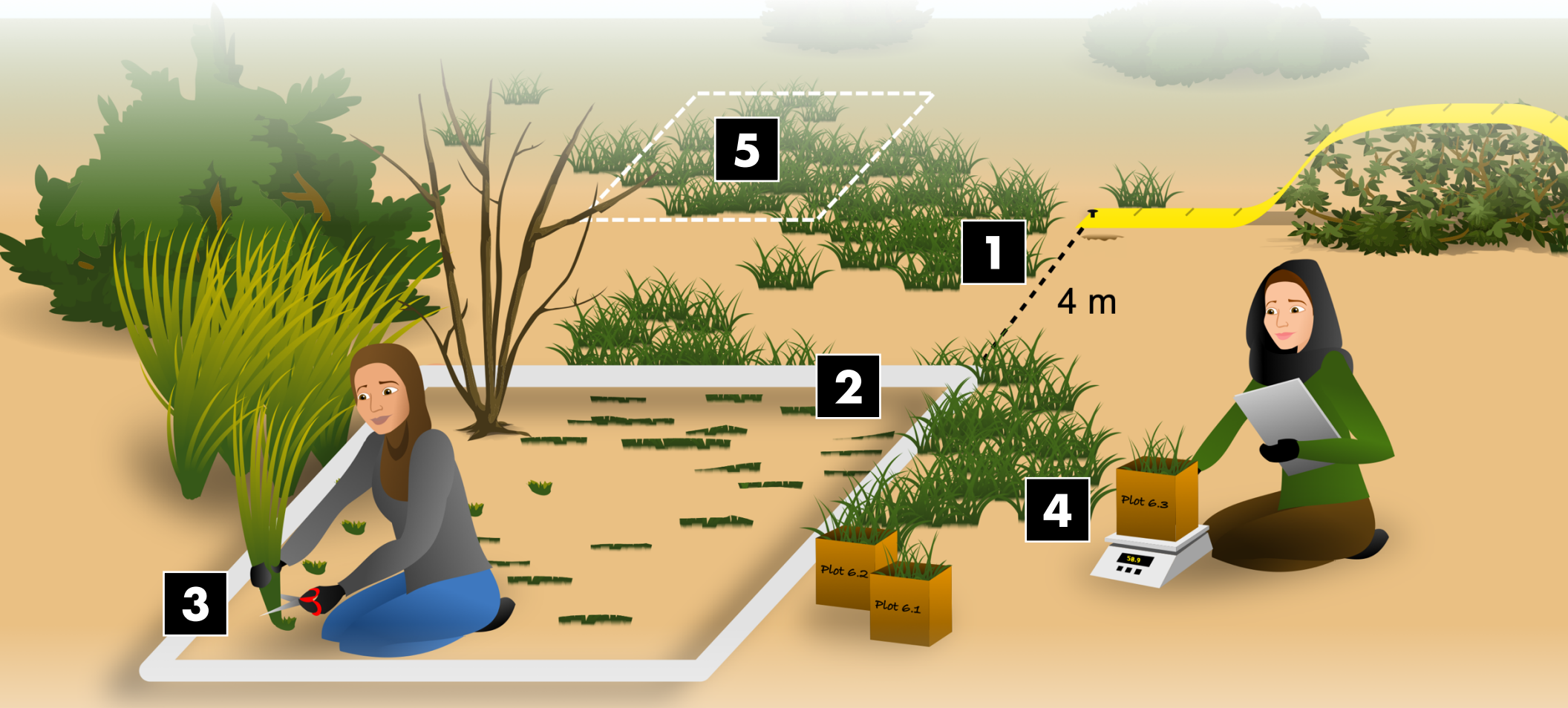
5 Measure the height of grass (in cm) at 5 random points along the transect and record the average height.

6 Collect at least 200 g of soil (5-15 cm deep) at the beginning of the transect. Store in plastic bag and label with Plot ID.

Biomass Measurement

1 From the start of the transect, walk 4 m to the right of the transect at a 90 degree angle.

2 Establish the biomass plot by placing the first corner of the 4x4 m frame next to your right foot.



3 Clip all the green biomass within the plot and place in paper bags labelled with Plot ID. If multiple bags are required, write Plot IDs on each bag along with the bag number (e.g., Plot 6.1, Plot 6.2).

4 Weigh the bags with fresh biomass on a zeroed (tared) scale.

5 If resources permit, collect additional samples by repeating steps 3 and 4 in a new 4x4 m plot.

6 REPORTING

Vegetation growth habits

When recording the vegetation growth habits for the transect, consult an appropriate field guide, such as the "Field Guide Afghanistan: flora and vegetation" (see Resources in Chapter 7 of this manual). Below are examples of vegetation growth habits, but there may be additional growth habits depending upon the survey location:

- Grass
- Sedge
- Forb
- Legume
- Subshrub
- Shrub
- Bare soil
- Litter
- Rock

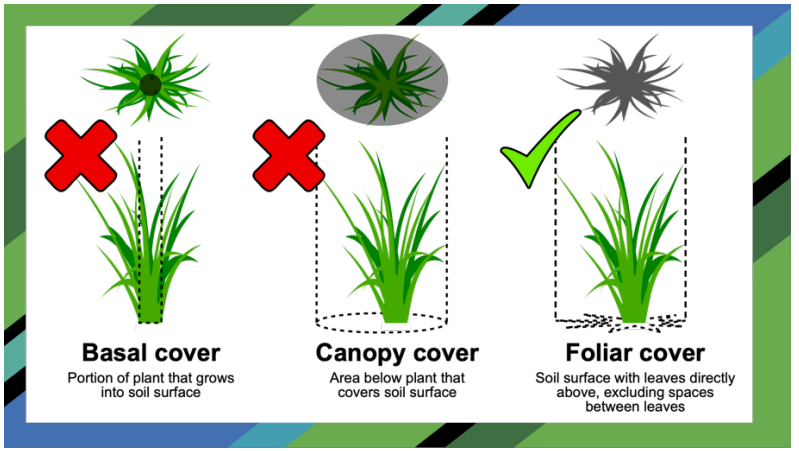
Vegetation types

When measuring foliar cover, do not combine measurements for all plants. Instead, record the foliar cover for the following types of plants:

- Graminoids: grass or grass like (may be subdivided into grasses and sedges)
- Forbs: all other non-woody plants
- Subshrubs: all woody plants 50 cm or shorter
- Shrubs: woody plants taller than 50 cm
- Trees: woody plants taller than 5 m

Measuring foliar cover

Foliar cover is the area of the ground that is covered by the vertical projection of plant parts, excluding gaps between leaves and overlaps within species.



Adapted from Launchbaugh, K. (2011). Principles of Vegetation Measurement and Assessment and Ecological Monitoring and Analysis. University of Idaho.

Measuring grass height

To randomly select 5 points along the transect for measuring grass height, we recommend using a lottery system. Fill a paper bag with 50 pieces of paper, each with a number written down from 1 to 50. In the field, draw 5 pieces of paper from the bag; the numbers drawn indicate the points on the transect tape measure (in m) from which to measure grass height. *If no grass is present at the given point, record "0 cm" and proceed to the next point.*

Intensity of grazing

When evaluating the transect as a whole, rate the intensity of grazing (from 0 to 3) for three different grazing variables. The table below provides guidance on how to determine the rating for each grazing variable. When estimating percentages, consult the illustrations for estimating erosion and human use (pages 10 and 11).

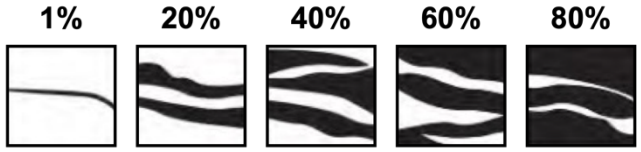
Variable	Rating			
	0	1	2	3
Trampling	No hoof tracks visible	Single hoof prints visible	Visibility of one to a number of terracettes resulting from trailing. Significant gaps of several meters between the terracettes or more than 10% of the area affected by hoof prints	Intensive trailing resulting in parallel terracettes with only small gaps in between or more than 50% of the area visibly trampled
Grazing and browsing damage	No visible signs of grazing on plants	Single plants show signs of grazing or browsing	Grazing or browsing damage on large number of plants (>50%) or whole groups of preferred plants	Nearly all species show grazing or browsing damage. Palatable plant parts are grazed or browsed to the ground (or woody parts). Root damage or dead plants are visible (digging of goats)
Dung	No dung visible	Small or single dung amounts visible	Several accumulations of dung at different locations visible	10 or more larger accumulations of dung visible

Degree of erosion

When evaluating the transect as a whole, rate the degree of erosion (from 0 to 3) for seven different erosion variables. The table below provides guidance on how to determine the rating for each erosion variable.

Variable	Rating			
	0	1	2	3
Rills	None	Single rills	5-10% cover	> 10% cover
Water flow patterns	None	Single patterns	Affecting 5-10% of area	Affecting >10% of area
Pedestals, terracettes	None	Single	Several, 10-50% cover	Large areas, >50% cover
Bare ground class (line intercept measurements from transect)	0-25% bare ground	25-50% bare ground	50-75% bare ground	>75% bare ground
Gullies	None	One small (width <50 cm), single gully with depth >50 cm	Two gullies with depth >50 cm or single gully with width >50 cm	Several gullies with depth >50 cm or single gully with width >1 m
Slope	Flat	1-15 degrees	15-25 degrees	>25 degrees
Solifluction	None	Single patterns	Affecting 10-50% of area	Affecting >50% of area

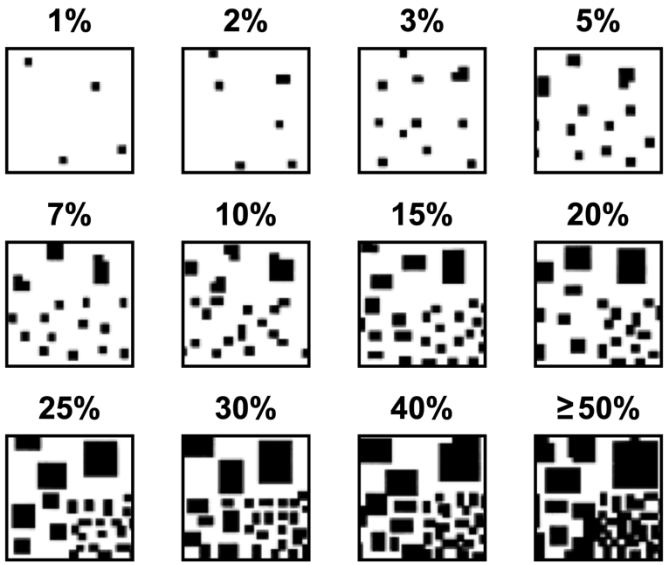
The illustration below can also be used as a guide to help estimate percentages for each erosion variable.



Adapted from Kansas Geological Survey (1976). Criteria for Making and Interpreting a Soil Profile Description. University of Kansas.

Intensity of human use

When evaluating the transect as a whole, rate the intensity of human utilization using the percentage levels shown in the areal cover charts below. This percentage should be based on the estimated amount of natural vegetation removed or disturbed through human or livestock activities for the entire transect.



Adapted from Kansas Geological Survey (1976). Criteria for Making and Interpreting a Soil Profile Description. University of Kansas.

Data management

When you return from the field, transfer all data from the paper datasheets into a digital spreadsheet (e.g., Microsoft Excel) and save the file.

After the surveys are finished, hand over the soil samples in the labeled plastic bags to a senior rangeland specialist for subsequent soil organic matter analyses.

Store the biomass collected in the field in a dry, ventilated place to allow it to completely dry in the paper bag to avoid mold developing in the samples; this may take multiple weeks. Continue to check the weight of the bags 2 times per week until the weight is consistent, which indicates that all moisture has been removed. Record the dry weight using the same scale.

Note: if the weight increases, this is a sign that additional moisture or other matter has entered the bag. In this case, record the weight as the lower number measured.

7 RESOURCES

Adapt Afghanistan: An online repository of over 1,000 spatial data layers related to climate change vulnerability and resilience covering climate, natural hazards, ecosystems, biodiversity, hydrology, and local community sectors. https://adaptafghanistan.com

Create Random Points: A tool for creating random points in ArcGIS Pro. https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/create-random-points.htm

Field Guide Afghanistan: flora and vegetation: A reference text describing the vegetation growth habits of Afghanistan. Full citation:

> Breckle, Siegmar-Walter, & M. Daud Rafiqpoor (2010). *Field guide Afghanistan: flora and vegetation*. Bonn: Scientia Bonnensis.

8 APPENDIX: SAMPLE DATASHEETS

The following page are sample datasheets surveyors can use to record the necessary data in the field. We recommend surveyors review the structure and content of the datasheets before going into the field. Surveyors should print as many copies of the datasheets as they might need to use based on the number of survey sites selected.

TRANSECT MEASUREMENT

Date: _____ Start time: _____ Site number: _____ Growth habit: _____

Lat: _____ , Long: _____ Elevation: _____ Direction: _____ Slope: _____ Aspect: _____

Photo (start): _____ Photo (end): _____ Surveyors: _____

Line Intercept

Foliar cover	**Grass**	**Sedge**	**Forb**	**Legume**	**Subshrub**	**Shrub**	**Tree**	**Litter**	**Rock**	**Bare soil**	**TOTAL**
Measure (cm)											
Percent											

Point Intercept

	Grass	**Sedge**	**Forb**	**Legume**	**Subshrub**	**Shrub**	**Tree**	**Litter**	**Rock**	**Bare soil**	**TOTAL**
No. of points											
Percent											

Grass Height

Point	**Height** (cm)
1	
2	
3	
4	
5	
Mean	

Erosion

Variable	**Score** (circle one)			
Rills	0	1	2	3
Water flow	0	1	2	3
Terracettes	0	1	2	3
Bare ground	0	1	2	3
Gullies	0	1	2	3
Slope	0	1	2	3
Solifluction	0	1	2	3

Grazing

Variable	**Score** (circle one)			
Trampling	0	1	2	3
Grazing	0	1	2	3
Dung	0	1	2	3

Human Use

Percent (circle one)
1%
2%
3%
5%
7%
10%
15%
20%
25%
30%
40%
50% or more

Type of use

Comments

BIOMASS MEASUREMENT

Site No.	**Plot ID**	**Lat.**	**Long.**	**Plot size**	**Empty bag weight** (grams)	**Number of bags used**	**Bag + Fresh biomass** (grams)	**Bag + Dry biomass** (grams)	**Dry biomass** (grams)	**Comments**