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Sustainable Management of Biodiversity, South Caucasus

Monitoring Manual for Highland Pastures in the Caucasus

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Contents

1 Preface

1.1 What is the purpose of this manual?

Summer pastures in Azerbaijan are an important resource for livestock keeping and have outstanding value for biodiversity. However, the conservation of this resource is challenged since livestock numbers have increased in Azerbaijan most rapidly in the last 15 years. Therefore, Azerbaijan has much to gain and much to loose in making management and policy decisions for pastures. However, the basis for informed decisions is sound knowledge about the current condition of pastures and their management.

But, what is the condition of a summer pasture in Azerbaijan like? If you ask this question to different people in Azerbaijan – scientists, herders, villagers, nature conservationists – you will probably get very different answers. Some people will say pastures are heavily degraded; some people will answer they are in a very good condition; some will have a more differentiated opinion. Which answer is right and should be the basis for pasture management? Even scientists currently do not agree on the meaning of the term degradation.

This manual is designed to give guidance for a comprehensive and objective monitoring of pasture conditions developed on the basis of scientific knowledge. Furthermore, it provides management recommendations for sustainable pasture use in order to maintain and enhance the condition of pastures in the future.

1.2 What is degradation on pastures?

In this chapter we clarify our understanding of the term degradation. Pastures start getting degraded where overstocking occurs and where unadjusted grazing management is practiced. This degradation has two main components:

a) Degradation means on the one hand side a reduction of the fodder production potential of pastures for livestock.

b) On the other hand side the ecosystem “pasture” is degrading when a significant decline of the number of its species occurs (i.e. a decline of biodiversity).

Explanation to a)

Where browsing intensity and trampling is too strong, the vegetation cover becomes weakened or hurt. The consequence is open soil which is the point of attack for erosion processes. Due to the high relief energy in mountains, these erosion processes can proceed very fast. Of course, also natural erosion occurs, mainly on very steep or dry slopes, on soft bedrock or in high altitudes, where vegetation cover hardly establishes. Hence, these areas are especially vulnerable to additional disturbance by animals. Once the topsoil has been eroded, the “resource pasture” is strongly depleted as it now provides less fodder. This form of degradation of a pasture is virtually irreversible as it takes a very long time to return the grassland system to its original, more productive state. In consequence, the more degradation occurs on the pasture the less successful will be livestock production as the animals will find less and less fodder.

Less advanced degradation processes, as the mere decline of the vegetation cover, can be stopped or are even reversible if you allow the pasture to recover. Depending on the level of

degradation and the natural potential of the vegetation to recover, suitable measures are the complete exclusion of grazing or the decrease of the stocking rate for a certain time.

Explanation to b)

Grasslands are habitats for many organisms. The Caucasus region and especially its mountain ranges with their predominating grasslands are very rich in species. Many of them are endemic to the region, i.e., Caucasus grasslands are of special importance for the preservation of biodiversity. For example plant species: scientists found less of them on sites that were facing strong livestock pressure compared to less grazed sites. An increase of browsing, trampling and the subsequent opening of the vegetation canopy which leads to less favorable microclimatic conditions, means that the stress for plants rises. Fewer plant species are capable to withstand this stress. Some plant species developed defense mechanisms (e.g. thorns, hairs, poisons) which protect and even allow them to gain dominance. However, the greater proportion of plant species needs to withdraw as they are not able to compete under these harsher conditions. We regard the number of plant species as one indicator for the level of degradation of a pasture.

1.3 How to monitor pasture condition?

Degradation is a creeping process. To maintain the productivity of a pasture, the point when degradation turns to be irreversible should be prevented. An initial assessment and consecutive monitoring of the pasture condition are indispensable for detecting and observing this point of degradation. This manual is suitable for the first assessment of the condition of pastures, as well as for the continuous monitoring.

Monitoring in general means observation of an object over time. In our context these objects could be, e.g., landscapes, ecosystems, animal or plant populations, development of livestock numbers or the condition of a pasture.

The aim of monitoring is to identify trends, may they be positive (=increase of quality or quantity), negative (=decrease) or that there is no change (stable state).

The chronology of a monitoring is as follows: you first need to assess the status-quo on a certain place. For our aims we call this place in the following *plot*. For the explanatory power of your assessment it is necessary to conduct it on several plots. The plots are selected on basis of your sampling design. For this manual we chose a "*preferential sampling design*" method, i.e., you decide subjectively according to certain criteria on the position of your plot. Other sampling methods are "*random designs"*; they are usually developed on the basis of satellite images and the selection of plots is done randomly by Geographic Information Systems (GIS).

The further steps of the monitoring are that you repeat this assessment at the same plot after a certain time (e.g. every 2 years). Hereby is important that you always apply the *identical set of methods*. In the case of assessing pasture condition it is also important to conduct the repetition at approximately the same time of the year.

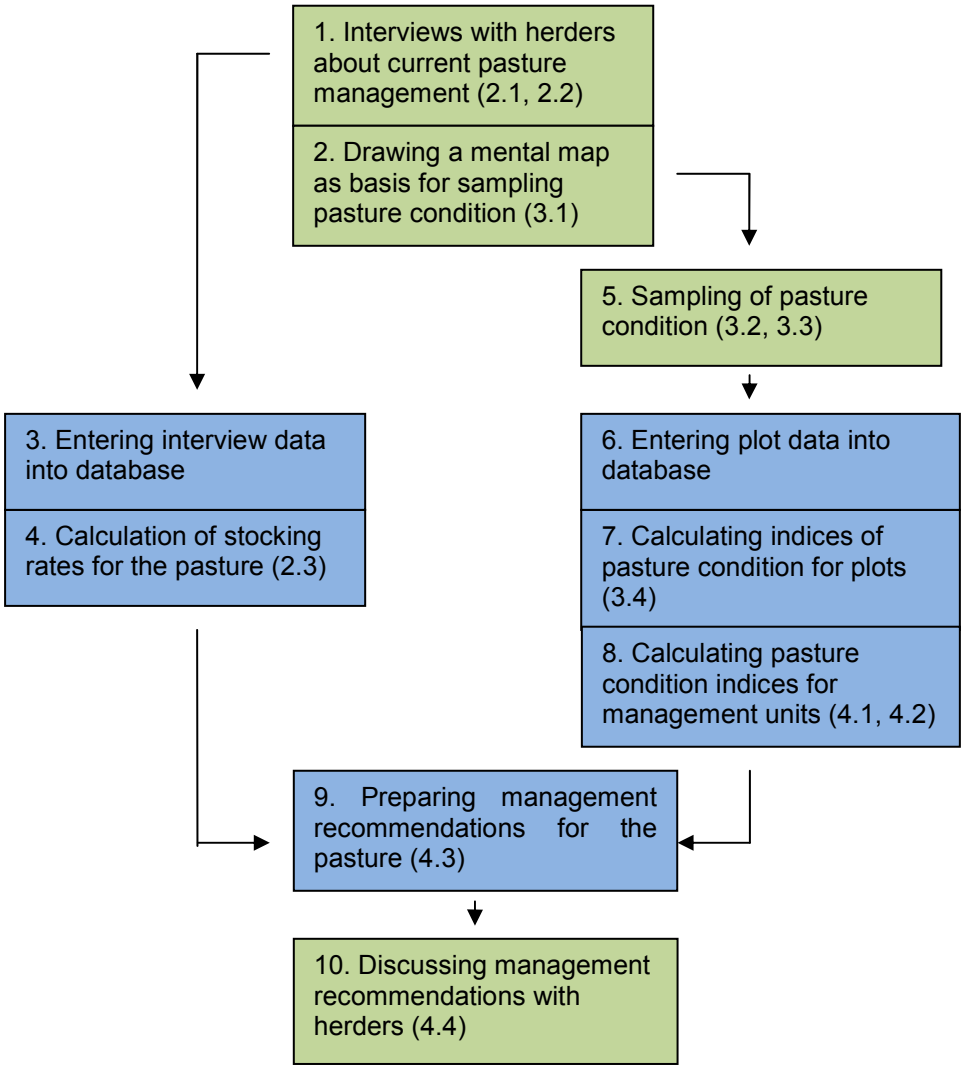
The longer you run a monitoring project (many repetitions) the better you understand the development of your object (i.e. here the pasture condition). When in evaluation of a monitored object changes are detected, decisions may be taken to adapt measures to fulfill a certain goal. In the case of monitoring the pasture condition you can identify those areas with the severest

problems and derive or adapt recommendations for a sound management that prevents or stops degradation of a pasture.

1.4 Monitoring tasks described in this manual

The monitoring described in this manual reaches from the initial assessment of pasture condition over data analysis to the derivation of management recommendations which can be discussed with the herders. It consists of several distinctive tasks which can be carried out by different people, but have to be combined to arrive at management recommendations.

The figure below gives you a first overview of the separate tasks. Colours indicate field work (green) or office work (blue). The chapters in the manual explaining the specific task are given in brackets.



For the different tasks the person in charge needs appropriate skills and knowledge about other tasks in the work flow. The table below shows the required skills and possible persons in charge. It is especially important to have a person responsible for task 1 and 10 who can engage in a longer lasting dialogue with the herders to build trust and cooperation between the protected area management/National park and the herders.

Task	Required skills	Possible person in charge
1. Interviews with herders about current pasture management	Strong social skills, familiar with rural life	Head ranger/ NGO-employee *Same person as Task 10*
2. Drawing a mental map as basis for sampling pasture condition	Strong social skills	Head ranger/ NGO-employee *Same person as Task 1* *Person responsible for Task 5 participates*
3. Entering interview data into database	Computer skills	Resource management specialist of National Park/ NGO-employee/ external expert
4. Calculation of stocking rates for the pasture	Computer skills	Resource management specialist of National Park/ NGO-employee/ external expert
5. Sampling of pasture condition	Familiar with Data Sheet II, good physical fitness	Ranger of National Park/ NGO-employee *Person participated in Task 2*
6. Entering plot data into database	Computer skills	Ranger of National Park/ NGO-employee/ Secretary
7. Calculating indices of pasture condition for plots	Computer skills	Resource management specialist of National Park/ NGO-employee/ external expert
8. Calculating pasture condition indices for management units	Computer skills	Resource management specialist of National Park/ NGO-employee/ external expert
9. Preparing management recommendations for the pasture	Computer skills	Resource management specialist of National Park/ NGO-employee/ external expert
10. Discussing management recommendations with herders	Strong social skills, familiar with rural life; information about Tasks 1-9	Head ranger/ NGO-employee *Same person as Task 1*

1.5 Scientific background

Both authors worked 2007 to 2010 for the project “Proper Utilisation of Grasslands in Azerbaijan’s Steppe and Mountains: an Ecological and Socio-Economic Assessment to Avoid Overgrazing and to Ensure Sustainable Rural Development” funded by the Volkswagen Foundation. The authors intensively studied the summer pastures in Shahdag region from ecological and socio-economic sides.

The elaboration of this pasture monitoring manual is inspired by Cahyat et al. (2007)[1]. This manual is developed for the Shahdag region. As this area is partially protected as a national park, questions on the situation of the biodiversity are especially considered. With smaller adaptations the manual is also applicable for pasture monitoring and management in other mountainous regions of the Caucasus.

Socio-economic assessment and management recommendations are based on a thorough investigation of sheep production, farm organization and regulations for land tenure. For further information see Neudert & Allahverdiyeva (2009)[2] and Allahverdiyeva (2009)[3]. Management recommendations for the summer pastures are based on the maximal stocking rate of 8 sheep/ha, as mentioned in the corresponding law of the Cabinet of Ministers (2000)[4].

Analyses of 160 pasture plots helped to choose and weight the variables that are used for calculating the indices of the presented pasture monitoring approach. The indices were developed on the basis of the Topographic Relative Moisture Index (TRMI, Parker 1982)[5], which itself became part of one of the two indices, as plant available moisture is an important factor for the regeneration potential of the vegetation. The desirable use of its extension Relative Site Moisture Index (RSMI, Van de Grift 1996)[6] was skipped, as an unreasonable amount of training efforts for monitoring staff would be required.

Experiences from trainings in Azerbaijan and Georgia on this manual from 2010 to 2013 led to minor improvements in the methodology.

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1 Cahyat A, Gönner C, Haug M. 2007: Assessing Household Poverty and Wellbeing – A Manual with Examples from Kutai Barat, Indonesia: Center for International Forestry Research Jl. CIFOR, Situ Gede, Sindang Barang.

2 Neudert R., and N. Allahverdiyeva 2009: The economic performance of transhumant sheep farming in Azerbaijan and prospects for its future development: South Caucasian Annals of Agrarian Science, v. 7, p. 153-157.

3 Allahverdiyeva, N. (2009): Kooperasiyanın köçəri ekoloji qoyunçuluq təsərrüfatlarının inkişafında əhəmiyyəti: Ekoloji Kənd təsərrüfatı, No 1-3: Gəncə Aqrobiznes Assosiasiyası (GABA), p. 18-19.

4 Resolution of the Cabinet of Ministers of the Azerbaijan Republic No. 42 of March 15, 2000: Rules of Allocation and Use of Pastures, Commons and Hayfields, III.13.

5 Parker A. J. 1982: The topographic relative moisture index: an approach to soil-moisture assessment in mountain terrain: Physical Geography 3(2):9. Variables used are inclination, aspect, topographic position and slope configuration.

6 Van de Grift J. 1996: The Relative Site Moisture Index: an Expansion of the Topographic Relative Moisture Index: Senior thesis, Geography, University of Wisconsin-Madison. Variables used additionally to the TRMI are soil depth and texture.

2 Assessing pasture management

In this chapter, you find the guidelines for conducting interviews with herders to assess the current pasture management. The interviews are conducted and recorded with the help of Data Sheet I (see Chapter 5.1). As pasture management decisively influences pasture condition, the interviews provide detailed information where degradation problems on specific summer pastures may root. Furthermore, the information helps to develop recommendations for improved pasture management and to discuss them with herders.

2.1 Interview guidelines

Finding camps

- The questionnaire is designed for one summer camp as management unit. You can easily identify visually the first camps to approach.
- When an assessment of all summer camps in one region is required, ask your respondents or local authorities if more camps are located in places difficult to find.

Approaching camps

- Be careful in approaching a summer camp especially by foot as shepherd dogs can be very dangerous!
- If you see a shepherd somewhere on the pasture it is better to approach him rather than going directly to the camp.

Selecting respondents

- Introduce yourself and explain what the interview will be about.
- Ask for a person who is responsible for this summer camp and feels in the position to answer the questions. The questionnaire can be answered by knowledgeable shepherds or managers. The questionnaire must not be answered by a visitor or guest.

Before an interview

- Ask, if the respondent has time for the interview. It will take not more than 45 min.
- If you see that the respondent is busy with other tasks, return another time or make an appointment.
- Ensure that no other persons except those belonging to the camp are present during the interview.
- Make sure that the respondent understands the purpose of the interview.

During an interview[7]

- Be polite, friendly and patient.
- Do not provide the respondent with answers or direct responses in any way.

[7] After Cahyat et al. (2007): Assessing Household Poverty and Wellbeing – A Manual with Examples from Kutai Barat, Indonesia: Center for International Forestry Research Jl. CIFOR, Situ Gede, Sindang Barang.

- Avoid suggestive questions.
- Give the respondent time to think, listen attentively to what he or she says.
- Be attentive to any worries a respondent may have. Be sensitive.
- If a respondent's answer is too long-winded or unrelated to a question, interrupt at an appropriate moment, but do not be rude - be tactful and sensitive when interrupting.
- If information in one topic seems contradicting, ask if you understood the answers correctly, but never blame a respondent for giving false information!

Closing an interview

- End the interview by asking if there is anything the respondent would like to know about the pasture monitoring activities.
- Thank the respondent.
- Take time for discussing something informal rather than leaving immediately.

2.2 Guidelines for completing Data Sheet I

1. Basic data

- Make sure that you clearly name and number the data sheet.
- Don't forget to take a GPS-Point and fill in the data.

2. Winter pasture

- The majority of livestock on the summer pasture goes to winter pastures, as well. However, in some cases the livestock stays in villages near the summer pastures and is stall-fed or goes to the common village pasture.
- If the livestock is split up and goes to different locations, ask where the majority of sheep is kept.

3. Farm organisation:

- When this part is completed you should have gained an understanding, how the farm is organised and who makes the major decisions.
- Fill in the table according to the instructions in the questionnaire.
- The contact person to be identified in Question 3.5 should be involved in management tasks of the farm.

4. Pasture access

- In case you conduct the interview with a shepherd he probably cannot give information about lease contracts. Then you should ask your respondent to name another person, who can provide this information. Ask the respondent when and where the person is available for an interview or for a telephone number.
- Sublease contracts for pasture are prohibited in most regions of Azerbaijan. Nevertheless, sometimes people rely on these agreements.

- Other forms of legal agreements of pasture access or their non-existence can be marked as well.
- The leased pasture area is indicated in the lease contract. The area of fertile land is indicated there as well. Usually, this information should also be shown on a map attached to the lease contract. If you are not shown such documents and you have for some reasons doubt on the correctness of the pasture size mentioned by your respondent, up to now the best reliable information you should receive from the responsible branch of the State Committee of Land and Cartography. Possibly in the future, with technical means like tablet PCs and via satellite images and GIS functions, we should be able to calculate the pasture size ourselves by means of the pasture borders shown in the field.

5. Livestock

- The livestock numbers are crucial to calculate stocking rates. However, people tend to record fewer animals than they actually have. That is why you should cross-check livestock numbers with your own counts (for advice see: 9. Cross-checking livestock numbers)

6. Use of shepherd dogs

- Information about shepherd dogs is needed as straying dogs may disturb and predate wild animals.

7. Spatial organisation of pasture use

- As consequence of the sampling design (see chapter 1.3 and 3.1) the hand-drawn map is the basis for delimiting management units. As your respondent knows his pasture best, ask for his assistance. Ask your respondent for his understanding of homogenous parts of the pasture (e.g. güney, kusey, pasture quality).
- If you have access to the cadastral maps of pastures of the State Committee of Land and Cartography or if the respondent is able to show it to you during the interview, you can use it as the basis for filling in details of the mental map.
- Ask the respondent, if he can draw the map himself. Add yourself only notes needed to understand his drawings.
- If you are sitting inside a tent go outside with the respondent and discuss which ridge or valley is represented by which sign in the map.

8. Pasture condition

- The respondent should express his own opinion about the pasture condition. Please beware of expressing your opinion before.
- This part also provides information about the general perception of degradation problems and their causes by the respondent.

9. Cross-checking livestock numbers

- If your task is also to assess pasture condition with Data Sheet II, you have time to observe herds while you are on these plots. Alternatively a possibility might occur while you are approaching or leaving the camp. You might also count all the livestock from a certain distance when they are, usually at noon time, resting in the summer camp.

- During cross-checks keep in mind that the animals may be split up into several herds which move to different directions. To estimate the total number of livestock on the farm you have to observe all herds at nearly the same time.
- A reliable and quick method is to count in steps of 10 individuals. You may use the mechanical counter included in the equipment for filling in Data Sheet II. First count 10 animals one by one, then always add another group of approximately the same size. For each group of 10 animals you click once on your counter. The final flock number you receive by multiplying your counter result by 10.
- While cross-checking be aware of the following variation of livestock numbers: The total number of sheep, goats or cattle consists of females, males and young stock. While the number of females and males stays normally constant during the year, the number of young stock varies: When, e.g., roughly all ewes give birth to one lamb the total number of livestock doubles after all lambs are born. For migrating stock most lambs are born in autumn and sold successively during the summer months. That means, the summer pasture can have 800 sheep in June and 600 in August – and both figures are correct, because meanwhile 200 lambs were sold.
- Compare your cross-check counts and the information given in the interview. If the figures deviate strongly, it is best to discuss these deviations with the decision-maker identified in Question 3.5. The responsible person from the camp has to agree with the livestock number used for the data analysis, as it is the basis for discussing management recommendations.

2.3 Calculating actual sheep units and actual stocking rates

Stocking rates are the indicator to measure grazing pressure on the pasture. They are an important tool for reducing degradation and improving pasture management, as well (Chapter 4.3).

You need:

- Livestock numbers recorded in Question 5.1
- Fertile land of the summer pasture (ha) recorded in Question 4.6

Calculate *actual sheep units* as indicated in the following table:

	Number from questionaire		Conversion factor[8]		Sheep units
Sheep		x	1	=	
Goats			0,7		
Cattle			6		
				Sum:	

Calculate the *actual stocking rate* as follows:

Actual stocking rate = sum of actual sheep units / area (ha)

[8] Conversion factors are calculated based on the weight ratios of livestock. Sheep: 50 kg, Cattle: 300 kg, Goat: 35 kg

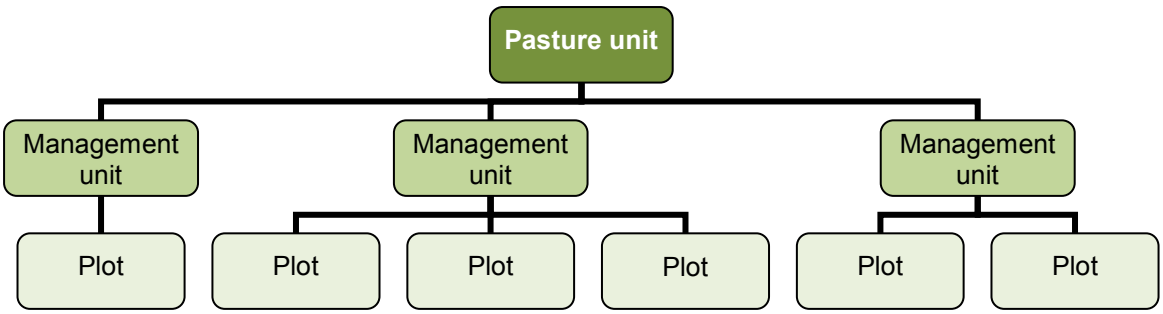
3 Assessing pasture condition

This chapter explains all steps needed to assess the ecological condition of pastures. The first part of Chapter 3 including 3.3 is field work, while 3.4 describes work done in the office.

With the help of Chapter 3.1 and 3.2 you can locate your plots on the pasture. Chapter 3.3 gives advice for filling out Data Sheet II (from chapter 5.2) in the field. With this information you calculate in Chapter 3.4 two indices which give you and other people a clear idea of the pasture condition.

3.1 The sampling design

When you are standing on the pasture you can see that the pasture condition is not the same everywhere. It is impossible to assess the pasture condition in detail on all parts of the pasture, so you need a sampling method: you look at the pasture condition in detail on some plots and extrapolate the results later. The figure below shows how the sampling design used here works.



Your largest unit is the *pasture unit* which is the pasture managed by one farm. You collected information about this pasture unit in the interviews with the herders (Chapter 2). You use this information to determine 2 to 5 relatively homogeneous *management units* on each pasture unit. For each management unit you gather data about pasture condition on 1 to 3 *plots*. The next parts explain how you apply this sampling design.

Determining management units

As you need assistance of the herders for this task, you should conduct it after completing the interview with the herder (Chapter 2). It is advantageous when you have a general overview about the pasture as well. If possible, visit a point where you can see as much of the pasture as possible.

- Prepare a map with the outline of the pasture by copying the outline of the mental map from Part 7 of Data Sheet I (see Chapter 2.2).
- Note the total size of the pasture and the fertile land in ha as given by the lease contract (Question 4.6 in Data Sheet I) and calculate the area of non-fertile land. For this purpose subtract the fertile land from the total area.
- Identify together with the herder, where fertile and non-fertile areas of the pasture are located.
- Estimate the share of non-fertile land on the map and judge if it is consistent with the figure given in the lease contract. If data is consistent, proceed with the next point. If the figures are inconsistent, proceed as follows:

    - Estimate the share of non-fertile land on the map in percent as precisely as possible.
    - Multiply this figure with the total area and divide by 100. Your result is the new area of non-fertile land in ha.
    - Replace the figure given in the lease contract with this one and calculate the new area of fertile land.

- Now continue only with the fertile land indicated in the map: Identify together with the herder areas which are relatively homogeneous regarding the following criteria (one after another):
    - exposition and inclination
    - bedrock
    - vegetation productivity

  The mental map may give you a first idea, where homogenous areas might exist. As described in Chapter 2.2 (Part 7 of Data Sheet I) herders often have clear ideas about different parts of their pasture and their distinctive features. It is not unusual if they mention to you already “management units” where they conduct different grazing regimes (güney, kusey, etc.)
- By combining these criteria, you should be able to identify 2 to 5 homogeneous units which are now your management units (MU). If you arrive at more than 5 units, try to combine two areas where the difference is not that large or discard very small areas.
- Name each management unit with a clear name or number and mark it in the map and in a table.
- Estimate the share of each management unit (MU in %) of the area of fertile land (the fertile land is taken as 100 %). Calculate the size of each management unit by multiplying the estimated share in percent with the area of fertile land divided by 100.

$$MU(ha) = \frac{MU\ (\%)\ X\ Total\ fertile\ land\ (ha)}{100(\%)}$$

3.2 Criteria for selecting plots

Each of your management units now has to be sampled with plots. These plots should be representative examples for their management unit. Small management units, especially if they are very homogeneous in terms of the criteria given above, need to be sampled with only one plot. Larger management units still show, despite their relative homogeneity, some variations. These can be covered more or less by choosing three different plots spread over the whole management unit. In medium sized or smaller, less homogeneous management units two plots might be sufficient. With 2 to 5 management units with each 1 to 3 plots you will have to work on maximum 15 plots per pasture unit. The minimum number of plots will be five or six. The average pasture unit will need around 10 plots for its sufficient assessment.

If you now already have a good overview of the pasture and its management units you can fix the number of plots required. Otherwise you can flexibly adapt the number of necessary plots when walking on each management unit.

The plot area should be a circle with a radius of 50 m. It should as well be a representative example of its surrounding territory and fulfill the criteria of homogeneity. This means that the plot should be homogeneous in terms of inclination, aspect and the kind of vegetation cover. Due to the varied relief in the mountains it is often difficult to find such a large homogeneous circle. If you fail to find one, then please note the shortest radius of a homogeneous circle around you. However, the favoured version is r = 50 m.

3.3 Filling out Data Sheet II

You have to carefully fill out Data Sheet II (see chapter 5.2) to gather all information that is needed for assessing the site conditions and the state of the pasture on a plot. This procedure will take you less than one hour, when you have gained some routine. This means you most likely will be able to examine several plots per day. In the ideal case you will be able to complete all plots belonging to one summer camp in one day.

For this field work you need to take with you:

- Clipboard for the data sheets and pen
- Rain clothes and/or an umbrella. The latter will help you keeping dry the paper you are writing on. Beware of quickly changing weather conditions in the mountains.
- GPS
- Inclinometer
- Compass
- Folding rule or a measuring tape
- Mechanical counter (“counting clock”)
- Digital camera

In the following you find instructions to every step on Data Sheet II.

1.1 Location

Question 1.1.1 “Description of region (valley, nearest mountain, nearest village)” is very important, as it is needed for a better orientation, either for yourself, when you need to return to the site after a certain period of time (e.g. in the next monitoring cycle), or for any other person processing the data that you have assessed.

A GPS device is needed for the sub-points 1.1.2 (GPS-Point) and 1.1.3 (Altitude). Save the coordinates of the centre of your plot circle with a clear name, e.g., the sheet number and your name. Then note the coordinates and the altitude given by the GPS in their corresponding fields.

As each plot belongs to a certain summer camp or a village territory, note the GPS-name you have saved before and measure with your GPS the distance to this camp or the respective village (1.1.4). This has some explanatory value for the grazing intensity on your site.

At the plot you might also recognize other types of land use than pasturing, e.g. wood cutting or herbs collection (1.1.5)

1.2 Slope

These four sub-points are of high importance to determine the susceptibility to erosion of the site. You find more explanations on the importance of these sub-points in chapter 3.4.

For measuring the *steepness* (1.2.1) of a slope you need an inclinometer. You achieve best results when looking uphill and targeting a fixed point that is in the same height from the ground as your eyes, so that you look parallel to the slope. Either you focus on a body part of a helper standing uphill from you in the height of your eyes (e.g. mouth, nose, eyes) or you fix a hiking stick above you and focus on a certain point of it (for this you maybe need to hunker down). Try to read the scale as exact as possible.

When measuring the *aspect* (1.2.2) with a compass, try as well to be as exact as possible and note the value. Assign also the aspect category. This can help you to better understand the slope you are standing on and its ecological features.

You can easily determine the *topographic position* (1.2.3) and *slope configuration* (1.2.4) with help of the sketch in-between both sub-points.

1.3 Underground

It is important to determine *bedrock* (1.3.1), the geological underground, as different bedrocks have different characteristics in terms of their susceptibility to erosion, i.e., their “softness” or “hardness”. Many regions are usually made up of different bedrocks, i.e. you might encounter different grades of rock strenght. Search on your plot for stones or little rocks which can be used for our rock strength test. If you cannot find any rock on your very plot, search in the nearer surrounding. It is very likely that there the same bedrock prevails as on your plot. We distinguish three grades:

- A **solid bedrock**: the stone in your hand cannot be broken by your own hands and it neither brakes when you throw it on another stone or rock on the ground. Examples for solid bedrocks are *white limestones*, *granites* or many volcanic stones like *basalts*. Due to their “hardness” these kind of bedrocks are usually not very susceptible to erosion and often form gentle slopes with dense vegetation cover interrupted by steep cliffs.
- A **medium solid bedrock:** the stone in your hand cannot be broken by your own hands but it brakes when you throw it on another stone or rock on the ground. Examples for medium solid bedrocks are slates with not very thin layers, sand stones or some volcanic stones. We could also talk of medium solid bedrocks when you find as well hard stones (e.g. white limestone) together with soft stones (see below). This often occurs when zones of hard and soft bedrocks are neighboring and in a transition zone e.g. hard rocks are lying on top of soft bedrock. As the first have a certain stabilizing effect, this transitionzone is mostly a bit less susceptible to erosion than pure areas of soft bedrock.
- A **soft bedrock:** the stone in your hand can be broken by your own hands. Typical soft stones are black or dark grey, relatively soft slates made up of thin layers of clayish material or chalk-like stones (white and soft). This means that due to “softness” the susceptibility to erosion is high. Slopes are often relatively steep and show often – also naturally – patches free of vegetation. A similar erosive/soft character mostly have moraines or old river terraces in the valleys that are made up of conglomerates of many smaller stones (pebbles/rubbles), which causes less stability than uninterrupted bedrock layers.

For examining *soil moisture* (1.3.2) stick your finger some cm into the loose soil; if necessary use a knife. Soil is “dry” if it stays dusty between your fingers. “Moist” means you feel a cooling effect on your fingers. If you squeeze “wet” soil between your fingers water will drop from them or the soil glides paste-like through your fingers.

2 Erosion

The five questions in this section help to determine the extent of erosion on your plot. First find an area of 10 x 10 m which is a representative example of your circle. You can measure this quadrate with steps and mark the corners with sticks, clothes, your backpack etc.

For each of the five sub-points you need to estimate the percentage cover on these 100 m². The second sketch in Data Sheet II should help you. If you look at, e.g., the cover of all *bare soil* (2.1.1) – that means all ground not covered by plants and stones – imagine shifting all pieces of this bare soil in one corner of your square. Then decide whether all pieces together cover only 1 % (1 x 1 m), 2-5 % and so on. Continue with estimating the cover of *rubble* (2.1.2) and of *rocks* (2.1.3).

It can be useful to cross-check the reasonability of the cover of all three fractions of 2.1, as they are often estimated too high. Together they cover all ground without vegetation. You can already now estimate the cover of the vegetation (3.1.6.1) and compare it with the sum of 2.1.1 to 2.1.3. If necessary, correct the three fractions of 2.1.

Proceed with the estimation of the *livestock tracks* (2.2). Livestock tracks are small paths, mostly running parallel to a slope, caused by the trampling of livestock. They often cause open soil and are therefore often the beginning of erosion processes. On steeper slopes you often find more livestock tracks, also with open soil, as here the pressure of animal hooves affects the slope more severe. Thereagainst, on less inclined slopes often less livestock tracks are visible, and often they are still covered by vegetation; hence they are less dangerous for beginning erosion processes.

When estimating the *erosion tracks* (2.3), you need to combine bare soil, bare rubble and visible erosion processes. Such erosion processes can be signs of soil washed or trampled away, e.g., rills or gullies or sharp edges between intact sods (topsoil with vegetation) and bare rock or soil. Sometimes you will even see larger pieces of sods sliding downhill.

3 Vegetation

In this section you assess different aspects of the state of the vegetation, especially whether strong alteration caused by livestock is detectable. Continue with the following tasks on your 100 m²-plot.

With *physiognomic feature* (3.1.1) you roughly try to describe the vegetation with the categories given. Three categories you find mainly in the montane and subalpine belt (“Bushland (bush cover > 30 %)”, “Meadow-like (regularly high grown)”, “Tall herbs, > 50 cm”), in the subalpine and alpine belt “Tussock (bunches of dominating grasses)” and mainly only in the alpine belt “Short growing lawn”. In some cases you may decide that two categories are fitting. That will be mostly one of the first five categories combined with the last, “Scattered vegetation”, i.e., you often have an already strongly degraded variation of one of the first five, with a high proportion of not-vegetated area.

For measuring *vegetation height* (3.1.2) it is best to have a folding rule or a measuring tape. For the maximum height you look for the highest halms or stems on your plot. For estimating average

height consider the heights of the most common plants. When there are higher and lower parts of vegetation, average both heights according to their coverage.

Standing crop (3.1.3) means the amount of phytomass (i.e. plant mass) standing at this moment on your pasture site. If you have problems answering this question in the beginning, you will quickly have an overview from different pastures, how “a lot”, “medium” and “few” look like. The same applies to the item *vegetation provided with water* (3.1.4). Here you decide on the vitality of the vegetation. For *browsing tracks* (3.1.5) you need to have a close look on the plants to your feet. Decide on the proportion of plant individuals that have browsing tracks. This means that they are hurt by livestock, tips of leaves are bit-off, whole leaves or flowers on stems are browsed.

With the section *vegetation composition* (3.1.6) we can describe the vegetation on the plot in a more detailed way. Together with the information of the following section (3.2) this allows for drawing certain conclusions on the quality of the grassland for pasturing.

Estimating the total vegetation cover (3.1.6.1) is on the one hand useful for cross-checking the estimations of parts of the plot not covered by vegetation (see 2.1.1-2.1.3), i.e. the non productive area. And, of course on the other hand, a high vegetation cover is one of the important features preventing erosion, i.e. pasture degradation.

With the following seven “pasture ecological groups” ((3.1.6.2-8) the plot is described in more detail. *Sweet Grass/ Poaceae* (3.1.6.2), mostly rather soft gramineous plants with roundish stems, are usually regarded to provide high-quality fodder to livestock. Thereagainst *fen-sedge/ Cyperaceae* (3.1.6.3) look also grass-like, but feature triangular stems and due to their often sharp edges are mostly seen as less favourable to livestock. Many *herbs* (3.1.6.4) display colourful flowers and contain all non-gramineous, not woody plants, apart from a special group of herbs, the *Legumes* (3.1.6.5). The latter are usually soft herbs with trifoliate leaves (like *Trifolium* sp./ clover) or pinnate leaves (like *Vicia* sp./ vetch), and are particularly valuable as fodder, as they contain a high amount of proteins.

Semi-shrubs (3.1.6.6) are chameaphytes, which means they are small woody plants with buds borne close to ground. Some chamaephytes are eaten by livestock (e.g. blueberry) while others are poisonous (e.g. *Daphne* sp.). Furthermore, we estimate the cover of higher woody species, i.e. *bushes* (3.1.6.7, smaller than 5 m height) and *trees* (higher than 5 m height). Usually, both groups are not of high importance in the diet of livestock.

The presence of *grazing indicator species groups* (3.2) gives hints on the intensity of grazing. These groups represent plant species that benefit from grazing, as livestock does not like to eat them. If these species increase, such species that are better palatable have less space. Look for the presence of one or more of the given grazing indicator species groups and estimate their cover on 10 x 10 m the same way as you did above.

In case you found more than one of the groups, estimate the *cover sum* (3.2.6) of all of them. Look at the cover of each grazing indicator species group and add one to another. Decide in which category the sum fits. Example: the first group you assigned with 1 % cover, the second with 2-5 % (could be 2, 3, 4 or 5 %). Now you have to decide whether the sum is in the category 2-5 % or 6-10 %. This step is very important, because it is easier for you to assign the sum category as for someone in an office dealing with your data. For him/her it would often not be clear to which category the sum of all groups would belong.

The questions on *plant diversity* (3.3) are meant to tell something about the value of your plot for nature conservation.

The number of *flowering plants* (3.3.1) is important for many other organisms like insects (e.g. honey bees) or birds. As in 3.1.3 and 3.1.4 you soon have a relation what “a lot”, “medium” and “few” on a pasture means.

The *number of plant species* (3.3.2) in the Caucasus is extraordinarily high and of immeasurable value. The number of species on a certain territory provides important information. For counting all different plant species look for a representative example of your plot, best near the circle’s centre, where you have taken the GPS-coordinates. This small plot has the size of ca. 10 m² (ca. 3 x 3 m). A good method to count all different plant species which you can distinguish is that you slowly move from one corner of your plot to the other and collect a bunch of all these species. You do not need to know the plant names! Then you sit down, put all plant species on a white paper and count one after the other. A mechanical counter would be of good help; otherwise just use a tick list. Note your final number of plant species.

4 Visual appraisal of state of pasture

You have had a close look at this plot. Please give your own impression of the state of this pasture, based on your own experience.

5 Representative picture taken

It is important to have a digital picture of each plot you are working on. Please take at least one picture that gives an overview of your plot or shows a representative part of your plot. As you have chosen already your 10 x 10 m square with the precondition that it is representative for your plot circle of r = 50 m, it is most likely the best target for your picture. Please note the picture number given by your camera. When you later hand over your material to the person processing the data or you continue to work with it yourself, please make sure that your pictures are safely stored on a computer. It would be best if you (or together with the computer operator), give each picture a new name that contains the GPS name given in the beginning when filling out the data sheet.

3.4 How to calculate the indices on plot level

On basis of the information collected with **Data Sheet II** (Chapter 5.2) two indices are created**.** They each consist of several variables. Without the aim of further implications (management recommendations) a pasture monitoring could be restricted to these two indices.

In brackets, the variables refer to the numbering of **Data Sheet II** "(from X.X.X)"**.** Under 5.3.5 you find an example calculation.

3.4.1 Susceptibility to Erosion-Index

The first index is called **Susceptibility to Erosion-Index (SEI).** It is created from "physical" site conditions that are independent from the impact of livestock. The index therefore reflects the potential erosion on a site.

Variables

SEI is calculated based on seven variables:

Var 1 Inclination

Var 2 Altitude

Var 3-6 Group of four variables forming the Topographic Relative Moisture Index (TRMI, Parker 1982)

Var 7 Bedrock

Var 1 Inclination a (from 1.2.1)

Inclination a is weighted from 0-60, as it is the most important in all regression models explaining erosion tracks. The steeper a slope is, the stronger is the gravitation as driving power for soil dislocation (= erosion). Ranges are based on those of Parker (1982, see Var. 3); in contrast steeper slopes are added.

Slope steepness (degrees)	**Value**
0-11.9°	60
12-20.9°	45
21-29.9°	30
30-39.9°	15
more than 40°	0

Var 2 Altitude (from 1.1.3)

Regression analyses showed that with increasing altitude the probability of erosion tracks increases. Lower temperatures in the higher zones diminish the regeneration potential of the vegetation after disturbances. Altitude was weighted from 0-20, equally to the two more important variables in the TRMI. Additionally, it occurred in the 2nd or 3rd place in regression models explaining erosion tracks.

Ranges (in m asl)	Value
Below 2,250	20
2,251 – 2,500	15
2,501-2,750	10
2,751 – 3,000	5
Above 3,000	0

Variable group forming the Topographic Relative Moisture Index (TRMI)

This group consists of the four variables that form together the Topographic Relative Moisture Index (TRMI, Parker 1982). The ranges and weighting of the variables follow this original source.

Plant available moisture is besides altitude the most important factor for the regeneration potential of the vegetation. Where this potential is low, erosion can strike quicker. After a disturbance (e.g. grazing, trampling) it is difficult for plants to recover, when they do not have sufficient water available for "repairing" their destroyed parts. If they cannot recover, they die. Open soil instead of vegetation cover is more susceptible to erosion.

Var 3 Inclination b (from 1.2.1)

To use inclination twice in the index is justified, as here water availability (water movement + insolation angle influencing evapotranspiration) is considered, while in *Var. 1 Inclination a* the gravitation as driving power for soil dislocation (= erosion) is emphasized. The steeper a slope is, the faster water can flow-off and has "less time" to infiltrate to the soil, where it can get absorbed by the roots of plants. Insolation angle means the angle in which the sun energy reaches the earth's surface. In our latitudes the sun energy "arriving" on a steeper slope is higher than on a flat slope, i.e. here it becomes warmer and the evapotranspiration, i.e. the loss of water from the soil (evaporation) and from the plants (transpiration) is higher. In sum this means that on steeper slopes less water is available to plants than on flatter slopes and hence, their ability to regenerate after a disturbance is lower.

Slope steepness (degrees):	Value
<3.0°	10
3.0 to 5.9°	9
6.0 to 8.9°	8
9.0 to 11.9°	7
12.0 to 14.9°	6
15.0 to 17.9°	5
18.0 to 20.9°	4
21.0 to 23.9°	3
24.0 to 26.9°	2
27.0 to 29.9°	1
>30.0°	0

Var 4 Aspect (from 1.2.2)

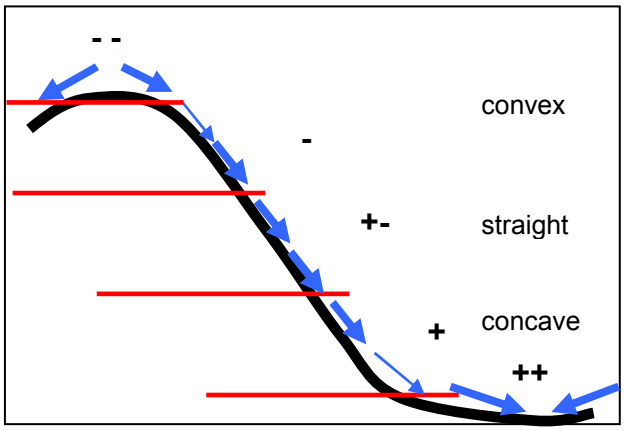
The reason for weighting the aspect from 0-20 is that it is regarded as one of the most important parameters influencing water availability. The amount of sun energy reaching a slope is strongly dependent on the aspect. A southern slope receives more sun energy than a northern slope; western and eastern slopes receive almost the same amount of sun energy. Hence, evapotranspiration, i.e. water availability to the plants, is different on slopes of different aspect.

Slope aspects [°]	Value	Slope aspects [°]	Value	Slope aspects [°]	Value
19-26	20	81-89; 316-324	13	144-152; 253-261	6
27-35; 10-18	19	90-98; 307-315	12	153-161; 244-252	5
36-44; 1-9	18	99-107; 298-306	11	162-170; 235-243	4
45-53; 352-360	17	108-116; 289-297	10	171-179; 226-234	3
54-62; 343-351	16	117-125; 280-288	9	180-188; 217-225	2
63-71; 334-342	15	126-134; 271-279	8	189-197; 208-216	1
72-80; 325-333	14	135-143; 262-270	7	198-207	0

Var 5 Topographic position (from 1.2.3)

As well this variable is weighted from 0-20 as it is one of the most important parameters influencing water availability. The blue arrows in the figure to the right indicate water running downhill. From an ridge top water only flows away. There, least water is available (“- -“). On an upper slope more water is flowing away than can arrive from above which means also a deficit of water (“-“). On a middle slope as much water is arriving than leaving; the water regime is balanced (“+-“). On lower slopes and valley bottoms more water arrives than leaves; the water balance is positive (“+” and “++”).

Topographic position	Value
Valley bottom	20
Lower slope	15
Middle slope	10
Upper slope	5
Ridge top	0



Var 6 Slope configuration (from 1.2.4)

The way a slope is formed influences the water availability significantly, though after Parker (1982) less than the position on the slope (maximum score for the highest water availability 10). With the upper sketch you can understand, why on convex (curved outwards) slopes less water (“-“) is available than on concave (curved inwards like a bowl) slopes (“+”).

Slope configuration	Value
Concave	10
Concave/straight	8
Straight	5
Convex/straight	2
Convex	0

Most of the sub-points above not only influence the water availability to plants, but also the strength and speed of movement of the water which is important for erosion processes. As example, the steeper a slope is, the more power water gains (due to gravitation) to move soil material.

Wind is another, in the humid Caucasian mountains less important agent for soil dislocation. As well, different wind speeds affect the water availability to plants due to different rates of the so called evapotranspiration (explanation see above at Var 3). For example, on a wind-exposed ridge top plants have more water stress, as they are forced to transpirate more water and as well the soil, which provides their roots with water, evaporates more.

For many reasons, we are not able to assess the wind strength on our plots, as it is dependent from factors like main wind direction and relief. However, the *topographic position* and s*lope configuration* already indirectly consider wind exposure: a ridge top is more prone to wind attack (i.e. possible soil location and higher evapotranspiration rate) than the bottom of valley; any convex slope is more exposed to wind than a concave one.

For cross-checking reasons we need to sum up this *Variable group forming the TRMI.*

Nr.	Variable	Values	Min	Max
Var 3	Inclination b	0-10	0	10
Var 4	Aspect	0-20	0	20
Var 5	Topographic position	0, 5, 10, 15, 20	0	20
Var 6	Slope configuration	0, 2, 5, 8, 10	0	10
Total sum			**0**	**60**

The maximum value of the TRMI is 60.

The question on *soil moisture* (from 1.3.2) is only considered to cross-check the plausibility of the TRMI. In certain (rare) cases the TRMI has to be adopted. Such a case is, e.g., that TRMI has a very low value but soil moisture is given as “wet”. This could occur if a plot site is situated on a (usually dry) southern slope, but due to orographic reasons the site is wet by a spring or is located on a peatland. Then you should switch the component “Topographic position” to the potentially moistest value 20 (Valley bottom).

Var 7 Bedrock (from 1.3.2)

Bedrock is weighted with 40 (compare with Var. 1), as it is not the most important in the regression models, but at the second level of importance, together with altitude (Var. 2). Var. 7 was regarded as the more important one influencing erosion and therefore given more weight, compared to Var. 2 weighted only from 0-20. The categories are adapted to the main bedrocks in the Shahdag region. For other regions, geological knowledge and maps would help adapting these categories to the local situation.

Categories	**Value**
Limestone (solid)	40
Other, solid	40
Mix (Slate bedrock with rubble/rocks of limestone)	20
Other, medium solid	20
Slate (soft)	0
Other, soft	0

Calculation

The Susceptibility to Erosion-Index (SEI) is calculated the following way:

Code	**Variable**	**Values**	**Min**	**Max**
Var 1	Inclination a	0, 15, 30, 45, 60	0	60
Var 2	Altitude	0, 5, 10, 15, 20	0	20
Var 3	Inclination b	0-10	0	10
Var 4	Aspect	0-20	0	20
Var 5	Topographic position	0, 5, 10, 15, 20	0	20
Var 6	Slope configuration	0, 2, 5, 8, 10	0	10
Var 7	Bedrock	0, 20, 40	0	40
Total sum			**0**	**180**

In this overview you see again that the results from the own regression models are given, according to their ranking, the most weight: - Inclination a: max. **60**

- Altitude and Bedrock: together max. **60**

and the additional TRMI: together max. **60**

Sum of maximum scores **180**

You need to sum up the scores obtained for the seven variables**.**

The index is **normalized** using the formula:

$$SEI = \frac{\text{Sum of scores obtained}}{\text{Sum of maximum scores}} \times 100$$

According to this formula SEI ranges between 0 and 100.

SEI is more vividly expressed in the colors of a **traffic light**. The alignment to such a traffic light works as follows:

Index range	**Risk to erosion level**	**Traffic light**	**Traffic light as numerical figure**
68-100	Low risk	Green	5
34-67	Medium risk	Yellow	2.5
0-33	High risk	Red	0

3.4.2 Pasture Degradation-Index

Traces of erosion and the state of the pasture vegetation contribute to the *Pasture Degradation-Index (PDI).* The presence of livestock directly impacts all nine variables recorded. The index therefore reflects the *current state of a pasture site.*

Except Var 10 and Var 15 all variables are weighted equally with 0-10.

Part 1 of the PDI: Erosion (from 2)

All five variables in this part of the PDI represent different aspects of erosion. They cannot be analyzed separately.

Var 8 Bare Soil (from 2.1.1)

The proportion of bare soil is relevant for ongoing erosion processes. Here, no vegetation protects the soil surface and erosion can attack.

Cover percentage on 10x10m	**Value**
non visible	10
1 %	9
2-5 %	8
6-10 %	6
11-25 %	4
26-50 %	2
more than 50 %	0

Var 9 Rubble/scree (small stones) (from 2.1.2)

The proportion of rubble/scree is relevant for ongoing erosion processes. These small stones, also not stabilized by vegetation, can be moved by running water or trampling animals.

Cover percentage on 10x10m	**Value**
non visible	10
1 %	9
2-5 %	8
6-10 %	6
11-25 %	4
26-50 %	2
more than 50 %	0

Var 10 Rocks (big, stable) (from 2.1.3)

Rocks are not relevant for ongoing erosion processes, as they are too big to be moved by water or trampling animals. In opposite, they might even have a stabilizing effect, preventing soil to be washed away. However, they may indicate former loss of topsoil. Also, together with the two variables before they sum up to all ground that is not covered by vegetation, hence to the unproductive area, which does not provide fodder. Therefore, it is reasonable to include rocks in the index, though carefully weighted with only the half possible scores.

Cover percentage on 10x10m	**Value**
non visible	5
1 %	4.5
2-5 %	4
6-10 %	3
11-25 %	2
26-50 %	1
more than 50 %	0

Var 11 Livestock tracks (from 2.2)

Livestock tracks are the most important indicator for livestock caused alteration of the pasture surface. They are mostly highly correlated with erosion tracks, but not necessarily equivalent with them as livestock tracks often can be covered by vegetation. In this state they are less susceptible to erosion**.**

Cover percentage on 10x10m	**Value**
non visible	10
1 %	9
2-5 %	8
6-10 %	6
11-25 %	4
26-50 %	2

more than 50 %	0

Var 12 Erosion tracks (from 2.3)

Erosion tracks are defined as estimated cover [%] on 10 x 10 m of in combination bare soil, bare rubble *and* visible erosion processes. They are not necessarily the sum of the variables 8 and 9, as e.g., on flat slopes with a certain cover of bare soil erosion processes do not need to be strong. Another extreme example would be that on steeper slopes with high vegetation cover (i.e low cover of bare soil and rubble) erosion processes might be the sliding of larger intact pieces of sods (topsoil with vegetation). A distinction of different types of erosion (sheet, rill, gully etc.) does not need to be considered here:

Cover percentage on 10x10m	**Value**
non visible	10
1 %	9
2-5 %	8
6-10 %	6
11-25 %	4
26-50 %	2
more than 50 %	0

Part 2 of the PDI: Vegetation (from 3)

In 3.1 *State of vegetation cover* the first four sub-points (3.1.1-3.1.4) are merely to describe the kind of vegetation in order to give a more comprehensive impression besides the photograph. They are hardly suitable for judging the quality of a pasture, i.e., for their inclusion as variables for calculating an index. For example, a high vegetation or such with a high standing crop is not necessarily a high quality or favored pasture. The question on *Vegetation provided with water* (3.1.4) is meant to roughly reflect the vitality of the vegetation. Including it into the index was given up, as weather conditions of course strongly contribute as does the date of research within the summer season.

Var 13 Browsing tracks (from 3.1.5)

Browsing tracks reflect best the season's grazing intensity. In addition to the browsing tracks after Klötzli (1965)[9] used in former own research the range of the most intensive browsing was split up into two categories.

Percentage of plants browsed on 10x10m	**Value**
0-5 % of plants browsed	10
6-20 % of plants browsed	8
21-50 % of plants browsed	5
51-80 % of plants browsed	2
more than 80 % of plants browsed	0

[9] Klötzli F. 1965: Qualität und Quantität der Rehäsung in Wald- und Grünland-Gesellschaften des nördlichen Schweizer Mittellandes. Bern: Huber

Another indicator often used as proxy for grazing intensity, the *cover percentage of faeces*, proved not to be suitable for the mountains. On the steeper slopes dung is quickly dislocated by run-off water; dried up it gets blown by the wind. Therefore, the use of this indicator was given up.

As well mainly included for descriptive reasons, the section of *vegetation composition* (3.1.6) is not directly suitable for contributing to the calculation of this index, as the higher or lower contribution of one or another of these rough groups does not automatically tell something on the pasture quality. Therefore, one would need to assess the cover of separate species, which is very time consuming and not feasible in this approach.

Var 14 Cover sum of all recorded grazing indicator species groups (from 3.2.6)

The presence of grazing indicator species reflects in a certain way the grazing intensity over a longer period (for details see Chapter 3.3, part *3 Vegetation*).

Cover percentage on 10x10m	**Value**
non visible	10
1 %	9
2-5 %	8
6-10 %	6
11-25 %	4
26-50 %	2
more than 50 %	0

Plant diversity (from 3.3) was included in the PDI, as one aim of an improved pasture management should also help to halt the loss of biodiversity.

Var 15 Flowering plants (from 3.3.1)

The number of *flowering plants* is negatively correlated with the grazing intensity, that means less plants have flowers (often the most tasty parts of the plants) where many animals are grazing, and vice versa. However, in case of strong browsing a reasonable number of not or less palatable plant species and hence their flowers might remain on a pasture. Therefore, weighting of this factor is only 0-5. Here, the number of flowering plants is meant to roughly indicate the habitat function of a grassland for other organisms like insects (also honey bees!) or birds.

Flowering plants	**Value**
a lot	5
medium	2.5
few	0

Var 16 Number of plant species (from 3.3.2)

With the number of plant species (count on 3 x 3 m) a comparison of species richness at the same site between two monitoring dates is possible. By this one could find out that after a changed pasture management (e.g. less sheep allowed on one ha) more plant species are recorded at the second monitoring date. The categories were formed on the basis of species numbers on 10 m² from 160 pasture plots in the Shahdag region in Azerbaijan. According to regression models, the

species numbers on strongly degraded/eroded pasture sites are significantly lower than on less disturbed pastures. Therefore, the number of plant species is a suitable indicator for the state of a pasture, too.

Number of plant species	**Value**
less than 12	0
12-22	2
23-33	5
34-44	8
more than 44	10

Calculation of PDI

The Pasture Degradation Index (PDI) is calculated the following way:

Code	Variable	Values	Min	Max
Var. 8	Bare Soil	0, 2, 4, 6, 8, 9, 10	0	10
Var. 9	Rubble/scree	0, 2, 4, 6, 8, 9, 10	0	10
Var. 10	Rocks	0, 1, 2, 3, 4, 4.5, 5	0	5
Var. 11	Livestock tracks	0, 2, 4, 6, 8, 9, 10	0	10
Var. 12	Erosion tracks	0, 2, 4, 6, 8, 9, 10	0	10
Var. 13	Browsing tracks	0, 2, 5, 8, 10	0	10
Var. 14	Cover grazing indicator species groups	0, 2, 4, 6, 8, 9, 10	0	10
Var. 15	Flowering plants	0, 2.5, 5	0	5
Var. 16	Number of plant species	0, 2, 5, 8, 10	0	10
Total sum			**0**	**80**

You need to sum up the scores obtained of the nine variables**.**

The index is **normalized** using the formula:

$$\text{PDI} = \frac{\text{Sum of scores obtained}}{\text{Sum of maximum scores}} \times 100$$

According to this formula PDI ranges between 0 and 100.

As for SEI the PDI is expressed in the colors of a **traffic light:**

Index range	Degradation of Pasture	Traffic light	Traffic light as numeric figure
68-100	Low	Green	5
34-67	Medium	Yellow	2.5
0-33	Strong	Red	0

4 Giving management recommendations

This part helps to develop and implement recommendations for improved pasture management. Chapters 4.1 to 4.3 explain the steps from the monitoring results to management recommendations which are mainly office work. In Chapter 4.4 and 4.5 you find advice, how to discuss management recommendations with the herders on their pastures.

4.1 Extrapolating results from plots to management units

Chapter 3 closed with the calculation of SEI and PDI indices and their translation into traffic lights for easy visual accessibility. However, both indices are only valid for the plot level, i.e., a circle of r = 50 m (ca. 0.8 ha).

Implications derived from the two indices should be feasible management recommendations. But management recommendations are reasonable only for pasture management units in a grazing regime or for whole pasture areas used by one farm. In order to extrapolate the results from plots to management units you use the sampling design developed in Chapter 3.1. In this part you selected manually relatively homogenous management units (MU) of which several plots are representative examples.

For extrapolation you need:

- Map and table with information about management units (Chapter 3.1)
- Results of SEI and PDI on plots (Chapter 3.4)

Both indices, SEI and PDI, first need to be extrapolated to MU-level.

Add the SEI of all plots within one MU and divide them by the number of plots. The result is the index on management-unit level, SEI-MU.

For example, if you have three plots in one management unit:

$$\frac{SEI\,1 + SEI\,2 + SEI\,3}{3} = \textbf{SEI-MU}$$

As the simple SEI also SEI-MU gets aligned to the colors of a **traffic light**.

Index range SEI -MU	**Degradation of Pasture on MU**	**SEI-MU in Traffic light**	**Traffic light as numeric figure**
68-100	Low	Green	5
34-67	Medium	Yellow	2.5
0-33	Strong	Red	0

The same you do for the PDI of all plots within one MU (here again the example with three plots):

$$\frac{\textbf{PDI 1 + PDI 2 + PDI 3}}{\textbf{3}} = \textbf{PDI-MU}$$

Index range PDI -MU	Degradation of Pasture MU	PDI-MU in Traffic light	Traffic light as numeric figure
68-100	Low	Green	5
34-67	Medium	Yellow	2.5
0-33	Strong	Red	0

The last columns (SEI-MU and PDI-MU in traffic light as figures) are needed for further operations.

4.2 Calculating the State of Pasture-Index of one management unit (SPI-MU)

For giving management recommendations you combine both indices to calculate the *State of Pasture-Index of one management unit (SPI-MU).* This index is calculated as the sum of SEI-MU and PDI-MU which in their traffic lights had been assigned the following values: green -> 5, yellow -> 2.5, red -> 0.

SEI-MU + PDI-MU = SPI-MU

Depending on the five possible SPI-MU values the following stocking rates (sheep units per ha (SU/ha)) are recommended:

SEI –MU	PDI –MU	SPI-MU	Recommended stocking rate
5 (green)	5 (green)	10	8 SU/ha
5 (green)	2.5 (yellow)	7.5	6 SU/ha
5 (green)	0 (red)	5	4 SU/ha
2.5 (yellow)	5 (green)	7.5	6 SU/ha
2.5 (yellow)	2.5 (yellow)	5	4 SU/ha
2.5 (yellow)	0 (red)	2.5	2 SU/ha
0 (red)	5 (green)	5	4 SU/ha
0 (red)	2.5 (yellow)	2.5	2 SU/ha
0 (red)	0 (red)	0	No grazing

In the following table the four management options are given in a condensed way.

SPI-MU	Recommended stocking rate
10	8 SU/ha
7.5	6 SU/ha
5	4 SU/ha
2.5	2 SU/ha
0	No grazing

4.3 Preparing management recommendations

Calculating the recommended livestock number for a pasture

During the previous chapter you identified the *recommended stocking rate* for each management unit. It says, how many animals are allowed to be kept on one hectare of pasture land of a certain condition. It can be transformed into *recommended sheep units (MU).* They indicate how many sheep units are allowed on the specific management unit.

Calculate the recommended sheep units for each management units according to the instructions in the table.

However, the only reasonable unit for recommending livestock numbers is a pasture. Sum up the numbers of all management units to obtain the *recommended sheep units for the pasture.*

Name of MU	**Size (ha)**		**Stocking rate (SU/ha)**		**Recommended sheep units**
MU 1					
MU 2		**x**		**=**	
MU 3					
MU 4					
Sum (Recommended sheep units for the pasture)					

Calculating required change in livestock numbers

You calculated the actual sheep units currently stocking on the pasture in Chapter 2.3.

Now you can calculate the required *change in sheep units.* It says how many sheep units you can keep more or have to keep less to arrive at the recommended sheep units on a certain pasture.

Change in sheep units = Recommended sheep units for the pasture – actual sheep units

Three cases are possible:

Case 1: Change in sheep units is positive: The pasture condition allows you to keep more livestock on the pasture than the farm actually has.

Case 2: Change in sheep units is zero: The pasture condition allows you to keep just as much livestock as the farm currently has.

Case 3: Change in sheep units is negative: The pasture condition allows you only to keep fewer animals on the pasture than the farm actually has.

Note these results on the recommendations data sheet (see below).

Preparing grazing regime recommendations

Different management units of one pasture may have different recommended stocking rates, but they are grazed by one herd consisting of all animals together. Therefore, the different units have to be grazed in different shares of the grazing time to ensure appropriate use.

Share of grazing time (MU) says which percentage of the grazing time in one summer the whole herd should use this management unit. Calculate it for each management unit as follows:

$$\text{Share of grazing time (MU) (\%)} = \frac{\text{Recommended sheep units for a management unit} \times 100}{\text{Recommended sheep units for the pasture}}$$

The figure is always below 100 and the sum of all shares is 100. How these figures are translated into grazing regimes depends on the decision of the herder. You should discuss this together with the herders on the pasture.

Preparing a recommendations data sheet

A pasture management *recommendations data sheet* has to be prepared which can be used during the discussion of management recommendations with herders. It should contain the following information:

- Map with pasture and management units
- Current pasture management
    a) Actual sheep units
    b) Size of the pasture in ha
- Pasture condition
    a) SEI-index traffic light
    b) PDI-index traffic light
- Pasture management
    a) SPI: Resulting recommended stocking rate
    b) Recommended sheep units for each management unit
    c) Total recommended sheep units
    d) Change in sheep units
- Grazing regime
    a) Share of grazing time for each management unit
- Conversion key for transforming sheep units into livestock heads (see Chapter 2.3)

The recommendations data sheet needs to be as comprehensible as possible. It is also meant to be stored by the herders for their own documentation, so they should be able to read and understand it without your help.

4.4 Implementing improved pasture management

After completing the calculations you can start to discuss the management recommendations with the herders. Recall the results given in the pasture management recommendations sheet and the notes from the initial interview (Data Sheet I).

Do not try to achieve complete agreement with the herders at once and set the aims low at the beginning of discussion. Rather see the implementation of improved pasture management as a process of working with the herders over several years and set achievable goals from year to year

together with the herder. At best, the same person (you) should work with the herders over several years and also return after a certain time to evaluate the results of the changed practices.

General rules for discussions of pasture management

- Discuss the management recommendations with the responsible persons. You identified the person in Question 3.5 in Data Sheet I.
- Make sure that the person has sufficient time and is not in a hurry during your discussion.
- Stay objective and patient throughout the conversation.
- Listen carefully and try to understand the situation from the herder's point of view.
- Try to convince the person with objective arguments.
- Let the person understand, how these management recommendations were derived.
- Assure the herder that you and your organisation will assist and accompany the implementation of improved pasture management in the future.

Arguments for improved pasture management

Herders may ask, why all this is necessary and why they have to change their behaviour. The only way to achieve lasting changes in behaviour is when you can convince herders that sustainable pasture management is for their best. Here are some arguments you can use:

1. Pasture land is a valuable but fragile resource. Herders have the power to destroy this resource, but the responsibility to preserve it. You can irreversibly destroy the pasture when you keep too much livestock on it. If the soil on a steep slope is washed away once, it may take thousands of years until a new productive lawn can grow there. Your children and grandchildren will not be able to use this resource in the future if it is damaged.
2. Some areas are by nature more fragile than others. The SEI-Index of a particular area indicates this natural susceptibility to erosion (chapter 3.4). If the index is "red" or "yellow", it says, e.g., that the slopes are very steep or that the bedrock is unstable. Here, decreased stocking rates are necessary just because of the natural conditions.
3. Some areas show already signs of degradation. You can observe this, e.g., by livestock tracks and bare soil on the pastures which is indicated in the PDI-index (Chapter 3.4). If this index is "red" or "yellow", try to let the herders see these signs of degradation. Every square inch of bare soil means that there is no grass for the livestock to graze. Therefore, the productivity of a pasture is highest, where the area covered with grass is highest. Of course, you cannot avoid bare soil completely, as some erosion occurs naturally in the mountains. Your aim is to keep the erosion at a minimum level.
4. If the PDI-index is "red" or "yellow", it is necessary to improve the condition of the pasture which is only possible with an improved grazing regime or less animals. The reduction of livestock may be only temporarily, when the pasture condition improves in the future. The herder will benefit himself, if the pasture recovers and is more productive in the future. Sustainable pasture management should lead to a "green" result.
5. Ask old people how the condition of pastures was 50 years ago. Probably they will tell you that you could find more plant and animal species on the pastures at this time. This is a

result of the high livestock numbers today which make those plants and animals species disappear that are sensitive to disturbance. Some of these species are valuable medicine for livestock. They are valuable for the herders and their families, as well.

6. In the villages bee-keeping is an important economic activity, but it depends on flowering plants as bee-pasture. On a slightly grazed pasture many flowers blossom, but on a heavily grazed pasture most flowers are grazed by livestock. Few flowers mean less honey for the bee-keepers.
7. If you compare the situation of livestock on one heavily grazed and one lightly grazed pasture, you will probably recognize that the livestock gains weight more rapidly on the lightly grazed pasture. The fatter the animals are in autumn, the better they can survive the winter. Fatter animals make the work of the shepherds easier in winter and need less barley and hay which cost a lot of money. Isn't it then in the interest of every herder that their animals are as fat as possible? Three fat animals can yield more money than four thin ones.
8. Every herder will agree that sheep farming is risky, because of the variable weather conditions. With fewer animals on the pasture you are better secured against environmental risks. If a drought occurs one summer and less fodder grows, on a lightly grazed pasture the livestock still has enough grass, while on a heavily grazed pasture the animals would stay hungry. If heavy rains occur, on a heavily grazed pasture the risk for landslides is much higher than on lightly grazed pastures.

Discussing recommended livestock numbers and destocking

Give all herders the following explanation how sheep units can be transformed into livestock heads:

- Imagine the recommended sheep units as an amount of tokens the herder can allocate to different livestock according to the conversion key (Chapter 2.3). The herder is free to choose, how many individuals from each livestock he wants to keep.

Livestock	**Sheep units**
1 sheep	1 sheep unit
1 goat	0.7 sheep units
1 cow	6 sheep units

Explain to the herders, what the "change in sheep units"-figure means:

- *Case 1:* Change in sheep units is positive. This means, the pasture condition allows keeping more livestock on the pasture than the farm actually has – The herder will be glad to hear this. Nevertheless, tell him, how much more livestock he is allowed to keep.
- *Case 2:* Change in sheep units is zero: The pasture condition allows keeping just as much livestock as the farm currently has. – The herder should not keep more livestock on the pasture in the future.
- *Case 3:* Change in sheep units negative. The pasture condition allows only keeping fewer animals on the pasture than the herder actually has. – The herder has to bring less

livestock to the pasture in the future. You will probably have to convince the herder, why less livestock is necessary for sustainable pasture management and discuss strategies, how this reduction in livestock numbers can be achieved. Refer to the proposals given below for this discussion.

Ways of mitigating economic hardships of decreased livestock numbers

Herders may argue that they have to earn money and that they cannot earn sufficient income with reduced livestock numbers. Indeed, fewer ewes mean fewer lambs and decreased overall income for one herder. But this is not inevitable. What about the following proposals?

- Herders can decrease livestock numbers on the summer pasture by selling lambs before coming to the summer pasture. Experienced herders can manage lamb birth and feeding in such a way that more lambs are already fat enough for sale in spring. By doing so the herder benefits from increased weight gains of the remaining lambs on the summer pasture which he can sell in autumn and winter.
- Sometimes livestock numbers are very high in one year because one shepherd or a friend of the owner brought many animals. You can discuss with the herder if somebody can send animals to another summer pasture where livestock numbers are not that high. Many herders have friends and relatives working on other pastures or some herders even lease two or more or more summer pastures and can shift animals easily. In some cases a shepherd with many animals may shift to another pasture, while a shepherd with few animals comes to this pasture.
- On some farms economic problems root in insufficient knowledge about sheep production or insufficient veterinary care which lead to low rearing rates of livestock. If herders mention such problems, try to assist with organising information material or the contact to an agricultural extension service to improve the situation.

Discussing grazing regimes

The *share of grazing time* is the most important figure to design grazing regimes. It says which share of the grazing time in one summer the whole herd should use this management unit. Different opportunities exist to design grazing regimes according to these shares.

For example, if the share of grazing time is 80 % for MU 1 and 20 % for MU 2, these opportunities are possible:

- The herd can graze four days on MU 1 and go one day to MU 2, when one rotation is five days.
- The herd can graze two days on MU 1 and a half day on MU 2, when one rotation is two and a half days
- The herd can graze 8 hours on MU 1 and two hours on MU 2, when one rotation is one day with 10 grazing hours.

The herder can decide himself which grazing regime he chooses. It is only important that the shares of total grazing time are ensured. Using the example above, explain the herder to graze 4/5 of the time on MU 1 and 1/5 on MU 2.

If you have problems to understand the share of grazing time in percent you can translate this figure into *grazing days (MU).* You only need the length of the *summer pasture period* in days, i.e., the number of days the herd stays on the summer pasture altogether. Calculate:

Grazing days (MU) = (Share of grazing time (%) / 100) x Summer pasture period (days)

Especially when you have very low percentage values, grazing days (MU) may lead to a better understanding.

4.5 Improving the framework for pastoral farms

Herders may have other problems with their farm which prevent the implementation of improved pasture management.

Insecurity of lease contracts:

If the rights for pasture access are insecure, herders have no incentive to think of their children and grandchildren regarding their own pasture. Rather, they think from day to day or from season to season. Information about the lease contract of the herder is provided in Part 4 of Data Sheet I.

Lease contracts are insecure if:

- The duration of the lease contract is less than 5 years (Question 4.5)
- The contract is oral or a sublease agreement (Question 4.2)
- The herders estimate the security of the lease contract as insufficient (Question 4.7, try to identify the cause in an informal discussion.)

If you want to implement sustainable pasture management in the long run, secure rights for the herders are indispensable. It is also to your advantage, because you work with only one or few herders, rather than convincing every year somebody else. If you have the opportunity, try to convince the responsible administration that long-term lease contracts are to the benefit of all sides.

Problems with awareness of degradation:

Herders may not see changes to the worse on the pastures or may not link them to overstocking with livestock. They may blame climate changes or bad fate.

If the decision maker with whom you are discussing is not the person interviewed for Data Sheet I, try to assess his opinion of pasture condition and degradation problems. Use questions from Part 8 in Data Sheet I in an informal conversation.

If on one summer pasture the decision-maker on livestock numbers rarely visits the pasture, he is probably not familiar with the pasture condition. Explain the results of your assessment of pasture condition. If degradation problems are already apparent, show them on the pasture.

Indicators of awareness problems:

- The herder does not understand the question related to “degradation”. Or he does not see problems at all, while for other persons the problems are obvious (Question 8.5).

- The herder does not see that keeping too much livestock on the pasture leads to negative effects for livestock and the pasture (Question 8.6).

If awareness-problems exist, try to use Arguments 3 and 7 in Chapter 4.4. Be aware that ways of thinking change slowly. In this case, it is better to provide food for thought in one conversation and to return another time for continuing the discussion.

5 Annex

5.1 Data Sheet I: Questionnaire for assessing pasture management of highland pastures

Interviewer: Date: *Sheet No.*

---

1. Basic data of summer pasture

1.1 GPS-Point (Name):

N (Latitude): E (Longitude): Altitude [m above sea level, from GPS]:

1.2 Name of summer pasture:

1.3 Name of interview partner:

For how many years do you personally come to this summer pasture?

years

When do you usually arrive on this summer pasture and when do you leave?

Arrival date: Departure date:

1.4 Related sheet numbers of data sheets for pasture condition (Data Sheet II):

---

2. Winter pasture

2.1 Where does the livestock kept on this pasture stay in winter?

☐ Winter pasture: Name of rayon:
Near which village/town/mountain:

☐ Village Name of rayon:
Name of village:

---

3. Farm organisation

3.1 Who is responsible for herding on this summer pasture?

Fill in the names in the table and mark "herding tasks" and "presence on the summer pasture"

No.	Name	Herding tasks	Management tasks	Livestock ownership	Presence on summer pasture
1.		☐	☐		☐
2.		☐	☐		☐
3.		☐	☐		☐
4.		☐	☐		☐
5.		☐	☐		☐
6.		☐	☐		☐
7.		☐	☐		☐
8.		☐	☐		☐

3.2 Who is responsible for the management of this summer pasture?

Mark "management tasks" in the table.

In case the persons were not mentioned yet, fill in additional names and their tasks in the table. To fill in the last column ask:

Do these additional persons stay on the summer pasture at least one month each summer?

Mark "presence on the summer pasture" in case the answer is "yes".

3.3 Who are the three most important livestock owners on this summer pasture?

Mark the most important livestock owner with "1", the second most important with "2" and the third most important with "3".

In case the persons were not mentioned yet, fill in additional names and other information in the table as described in Question 3.2.

3.4 Who decides about the following issues?

Write down the No. of the persons as indicated in the table.

In case other persons are responsible, add them to the table.

a.) Daily organisation of herding

b.) Veterinary care for livestock

c.) Time and organisation of seasonal migration

d.) Number of livestock on the summer pasture

3.5 With whom can we discuss management recommendations for your pasture?

Write down the No. of the person as indicated in the table

---

4. Pasture access

4.1 Can you give information about the legal agreement to this summer pasture?

☐ Yes, *Proceed with Question 4.2.*

☐ No, Who can give information? When and/or where is the person available for an interview?

Proceed the interview with Question 5.1

4.2 Which form of legal agreement secures the access of your farm to this summer pasture?

☐ Lease agreement:

- ☐ Written contract with administration *Proceed with Question 4.3.*
- ☐ Oral agreement with administration *Proceed with Question 4.3.*

☐ Sublease agreement:

☐ Written sublease contract with original leaseholder *Proceed with Question 4.3.*

☐ Oral sublease agreement with original leaseholder *Proceed with Question 4.3.*

☐ Privatized land *Proceed with Question 4.6.*

☐ Open access (no lease agreement, no sublease agreement, not privatized land)

☐ Pasture used only by this farm *Proceed with Question 4.6.*

☐ Pasture used also by other farm *Proceed with Question 4.7.*

4.3 Who holds this lease contract/agreement?

Name: If applicable: No. from table in Topic 3:

Else: Relationship to persons involved in the farm:

4.4 Which administration issued the original lease contract/agreement?

☐ district administration ☐ municipality

☐ other

Name of administration:

4.5 For how many years is the contract/agreement valid?

☐ years ☐ only for this year

4.6 According to the legal agreement or according to your estimation (if no legal agreement), how many hectares do you use?

Total: Fertile land:

4.7 How do you estimate the security of your rights to this summer pasture?

☐ secure ☐ medium ☐ insecure

---

5. Livestock

5.1 How much livestock is kept on the summer pasture?

Fill in total number.

Sheep:

Goats:

Cattle (older than 6 months):

5.2 How did the number of livestock develop in the last years?

☐ Became more ☐ Stayed the same ☐ Became less

Cross check livestock data with your own counts/estimations.

6. Use of shepherd dogs

6.1 How many adult dogs do you keep on your summer pasture?

Number:

6.2 Do you take dogs with you during herding?

☐ Always ☐ Sometimes ☐ Never

6.3 Where do your dogs go during the day?

☐ Stay in camp ☐ Go max. 200 m radius ☐ Go further than 200 m

6.4 What do you feed regularly to your dogs?

☐ barley ☐ barley and meat ☐ other:

---

7. Spatial organisation of pasture use

*Space for drawing a **mental map** is provided on the last page of the data sheet.*

If your interview partner can show you the map belonging to the lease contract (or other legal agreement), you can use it as the basis for filling in details of the mental map.

7.1 Can you draw a simple map of your summer pasture?

Show the location of streams/valleys and ridges.

Show the location of the camp and access roads.

Where can you find much fodder?

Where is the fodder scarce?

Which places does the livestock like/dislike?

7.2 Do you use a spatial and/or temporal pattern of herding?

Please explain it by using your map.

Are there places, where the livestock does not go/goes only infrequently?

Please make sure that all aspects of the discussion are recorded on the map.

8. Pasture condition

8.1 How do you appraise the condition of this pasture compared to neighbouring pastures?

☐ Better ☐ same ☐ worse

If the pasture condition is better or worse, please explain why.

8.2 Did the condition of this pasture change during the last 10 years?

☐ Better ☐ same ☐ worse

8.3 Is the pasture area enough for the livestock kept here?

☐ More than enough ☐ just enough ☐ not enough

8.4 What measures do you use to improve the condition of this pasture?

8.5 In general: Are there degradation problems on summer pastures in this region?

☐ Not at all ☐ few problems ☐ severe problems

8.6 When you keep too much livestock on a pasture…

a.) …what happens to the livestock?

b.) …what happens to the pasture?

---

9. Cross-checking of livestock numbers

9.1 Sheep and goats

9.2 Cattle

Please draw map here. After finishing mark the northern direction with an arrow: :

5.2 Data Sheet II: Site conditions and state of highland pastures

Investigator: *Date:* *Plot No.*: _____

1 Site conditions (within radius = 50 m)

Find a slope that is ± homogeneous within a circle of 50 m radius. If you do not find such a large circle, then please note the shortest radius of a homogeneous circle around you: _____ m

1.1 Location

1.1.1 Description of region (valley, nearest mountain, nearest village): _____

1.1.2 GPS-Point (Name): _____ N (latitude)/ X: _____ E (longitude)/ Y: _____

1.1.3 Altitude [m above sea level, from GPS]: _____

1.1.4 Distance to Village/ camp [m]: _____ GPS-Name of Village/ camp: _____

1.1.5 Current land use (as visible and/or mentioned by villagers/ herders; e.g. pasture, hay meadow, wood cutting, herbs collection, none): _____

1.2 Slope

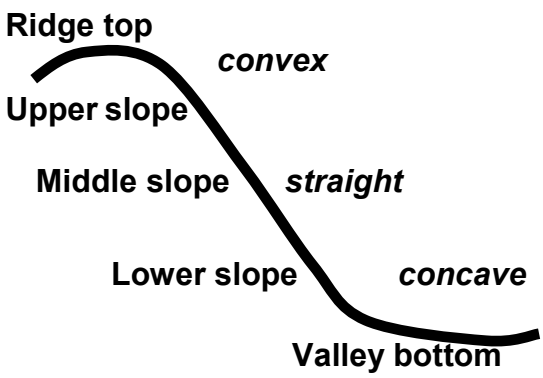
1.2.1 Slope Inclination/ Steepness [°]: _____ (exact figure) _____

1.2.2 Aspect [°]: _____ (exact figure) _____

Aspect category: ☐ N (345-75°) ☐ E (75-165°) ☐ S (165-255°) ☐ W (255-345°

1.2.3 Topographic position:

☐	Ridge top
☐	Upper slope
☐	Middle slope
☐	Lower slope
☐	Valley bottom



1.2.4 Slope configuration:

☐	Convex
☐	Convex/straight
☐	Straight
☐	Concave/straight
☐	Concave

1.3 Underground

1.3.1 Bedrock (visible around): Type, if known _____

Rock strength: ☐ Solid, not breakable by hand neither when thrown on rock (e.g. granite)
☐ Medium solid, not breakable by hand but when thrown on rock
☐ Soft, breakable by hand (e.g. thin layered clayic slate)

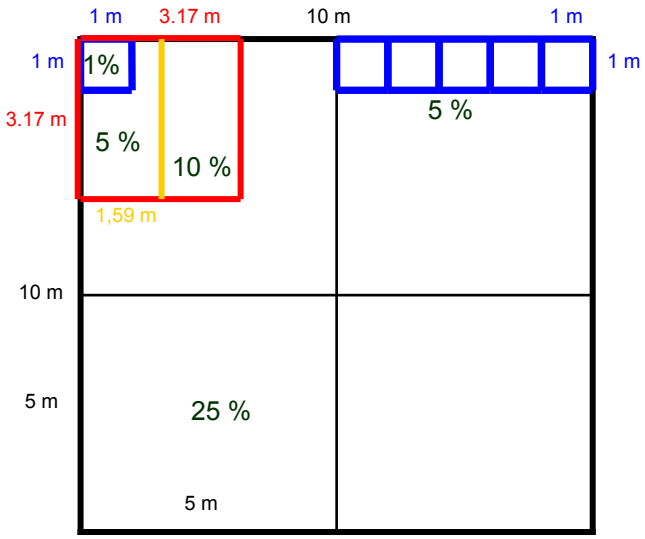
Choose a representative plot of 10 x 10 m and mark the corners with sticks, clothes, rucksack etc.

2 Erosion/ Degradation

2.1 Ground not covered by vegetation (*2.1.1-2.1.3 cross-check with 3.1.6.1*)**:**

Estimated cover [%] on 10x10 m	non visible	1	2-5	6-10	11-25	26-50	> 50
2.1.1 Bare Soil							
2.1.2 Rubble/scree (small stones)							
2.1.3 Rocks (big, stable)							
2.2 Livestock tracks (Terracettes)							
2.3 Erosion tracks, combination of bare soil, rubble+visible erosion processes							

Sketch to help with estimating cover percentage on 10 x 10 m



3. Vegetation

3.1 State of vegetation cover

3.1.1 Physiognomic feature (*2 answers possible*)**:**

☐ Bushland/Forest (bush/tree cover > 30 %)
☐ Tall herbs (> 50 cm)
☐ Tussocks (bunches of dominating grasses)
☐ Meadow-like (regularly high grown)
☐ Short growing lawn
☐ Scattered vegetation (< 50 % cover)

3.1.2 Vegetation height [cm] maximal: _____Average height [cm]: _____

3.1.3 Standing crop: ☐ a lot ☐ medium ☐ few

3.1.4 Vegetation provided with water ☐ well ☐ medium ☐ badly

3.1.5 Browsing tracks: ☐ 1-5 % of plants browsed ☐ 6-20 % of plants browsed
☐ 21-50 % of plants browsed ☐ 51-80 % of plants browsed
☐ more than 80 % of plants browsed

Plot No.: _____

3.1.6 Vegetation composition

Estimated cover [%] on 10x10 m	non visible	1	2-5	6-10	11-25	26-50	51-80	> 80
3.1.6.1 Total vegetation cover								
3.1.6.2 "Sweet Grass"/Poaceae								
3.1.6.3 Fen-sedge/Cyperaceae (grass-like with often sharp edges)								
3.1.6.4 Herbs (non-gramineous, not woody plants)								
3.1.6.5 Legumes (soft herbs with trifoliate leaves (like Trifolium/clover) or pinnate leaves (like Vicia/vetch)								
3.1.6.6 Semi-shrubs (chameaphytes, small woody plants with buds borne close to ground, e.g. blueberry)								
3.1.6.7 Bush cover (shrubs, woody species < 5m height), name/s: _____								
3.1.6.8 Tree cover (woody species > 5m) name/s: _____								

3.2 Grazing indicator species groups and their cover [%] on 10 x 10 m:

Estimated cover [%] on 10x10 m	non visible	1	2-5	6-10	11-25	26-50	> 50
3.2.1 Thistles							
3.2.2 Rhododendron							
3.2.3 Juniper or other thorny bushes (e.g. Rosa, Berberis)							
3.2.4 Other strongly hairy or thorny plants							
3.2.5 Poisonous or strongly aromatic plants (e.g. Veratrum)							
3.2.6 ! Cover sum of all recorded grazing indicator species groups !							

3.3 Plant diversity:

3.3.1 Flowering plants: ☐ a lot ☐ medium ☐ few

3.3.2 Number of plant species (count on 3 x 3 m in the upper left corner of your 10 x 10m plot):
_____ (exact figure)

4. Visual appraisal of vegetation state of site: ☐ Good ☐ Medium ☐ Bad

5. Representative pictures taken (*file name should later have the site's GPS name*)
Picture No.:_____

6. Comments (e.g. hints on instable slopes like landslides, deep gullies): _____
_____

5.3 Example calculation

5.3.1 Filled-in example of Data sheet I (see 2.1, 2.2, 5.1)

Questionnaire for assessing pasture management of summer pastures

Interviewer: Elgün Date: 20.06.2010 *Sheet No.* 11-xx

---

1. Basic data of summer pasture

1.1 GPS-Point (Name): …Camp 11

N (Latitude): E (Longitude): Altitude [m above sea level, from GPS]: 2100

1.2 Name of summer pasture: Dartlo

1.3 Name of interview partner: Givi Dabrundashvili

For how many years do you personally come to this summer pasture?

10 years

When do you usually arrive on this summer pasture and when do you leave?

Arrival date: May Departure date: September

1.4 Sheet No.'s of data sheets for pasture condition: 11

---

2. Winter pasture

2.1 Where does the livestock kept on this pasture stay in winter?

☒ Winter pasture: Name of Rayon: Dedoplistskaro

Near which village/town/mountain: Sabatlo

☐ Village Name of Rayon:

Name of village:

3. Farm organisation

3.1 Who is responsible for herding on this summer pasture?

Fill in the names in the table and mark "herding tasks" and "presence on the summer pasture"

No.	Name	Herding tasks	Management tasks	Livestock ownership	Presence on summer pasture
1.	Givi Dabrundashvili	☐	☒	1	☒
2.	Levani	☒	☐		☒
3.	Dato	☒	☒	2	☒
4.	Omgeri	☒	☐	3	☒
5.	Bidzina	☒	☐		☒
6.	Sopo	☐	☐		☒
7.		☐	☐		☐
8.		☐	☐		☐

3.2 Who is responsible for the management of this summer pasture?

Mark "management tasks" in the table.

In case the persons were not mentioned yet, fill in additional names and their tasks in the table. To fill in the last column ask:

Do these additional persons stay on the summer pasture at least one month each summer?

Mark "presence on the summer pasture in case the answer is "yes".

3.3 Who are the three most important livestock owners on this summer pasture?

Mark the most important livestock owner with "1", the second most important with "2" and the third most important with "3".

In case the persons were not mentioned yet, fill in additional names and other information in the table as described in question 3.2.

3.4 Who decides about the following issues?

Write down the No. of the persons as indicated in the table.

In case other persons are responsible, add them to the table.

a.) Daily organisation of herding	1,2,3,4,5
b.) Veterinary care for livestock	1
c.) Time and organisation of seasonal migration	1,3,6
d.) Number of livestock on the summer pasture	1

3.5 With whom can we discuss management recommendations for your pasture?

Write down the No. of the person as indicated in the table.

1

---

4. Pasture access

4.1 Can you give information about the lease contract for this summer pasture?

☒ Yes, *Proceed with Question 4.2.*

☐ No, Who can give information? When and/or where is the person available for an interview?

Proceed the interview with Question 5.1

4.2 Which form of legal agreement secures the access of your farm to this summer pasture?

☒ Lease agreement:

- ☒ Written contract with administration — *Proceed with Question 4.3.*
- ☐ Oral agreement with administration — *Proceed with Question 4.3.*

☐ Sublease agreement:

- ☐ Written sublease contract with original leaseholder — *Proceed with Question 4.3.*
- ☐ Oral sublease agreement with original leaseholder — *Proceed with Question 4.3.*

☐ Privatized land — *Proceed with Question 4.6.*

☐ Open access (no lease agreement, no sublease agreement, not privatized land)

- ☐ Pasture used only by this farm — *Proceed with Question 4.6.*
- ☐ Pasture used also by other farm — *Proceed with Question 4.7.*

4.3 Who holds this lease contract/agreement?

Name: Dato If applicable: No. from table in Topic 3: 3

Else: Relationship to persons involved in the farm:

4.4 Which administration issued the original lease contract/agreement?

☒ district administration ☐ municipality

☐ other

Name of administration: Dedoplistskaro Municipality

4.5 For how many years is the contract/agreement valid?

☒ 15 years ☐ only for this year

4.6 According to the legal agreement or according to your estimation (if no legal agreement), how many hectares do you use?

Total: 250 Fertile land: 200

4.7 How do you estimate the security of your rights to this summer pasture?

☐ secure ☒ medium ☐ insecure

---

5. Livestock

5.1 How much livestock is kept on the summer pasture?

Fill in total number.

Sheep: 900

Goats: 50

Cattle (older than 6 months): 100

5.2 How did the number of livestock develop in the last years?

☒ Became more ☐ Stayed the same ☐ Became less

Cross check livestock data with your own counts/estimations.

---

6. Use of shepherd dogs

6.1 How many adult dogs do you keep on your summer pasture?

Number: 5

6.2 Do you take dogs with you during herding?

☐ Always ☒ Sometimes ☐ Never

6.3 Where do your dogs go during the day?

☐ Stay in camp ☐ Go max. 200 m radius ☒ Go further than 200 m

6.4 What do you feed regularly to your dogs?

☒ barley ☐ barley and meat ☐ other:

---

7. Spatial organisation of pasture use

*Space for drawing a **mental map** is provided on the last page of the data sheet.*

If your interview partner can show you the map belonging to his lease contract, you can use it as the basis for filling in details of the mental map.

7.1 Can you draw a simple map of your summer pasture?

Show the location of streams/valleys and ridges.

Show the location of the camp and access roads.

Where can you find much fodder?

Where is the fodder scarce?

Which places does the livestock like/dislike?

7.2 Do you use a spatial and/or temporal pattern of herding?

Please explain it by using your map.

Are there places, where the livestock does not go/goes only infrequently?

Please make sure that all aspects of the discussion are recorded on the map.

8. Pasture condition

8.1 How do you appraise the condition of this pasture compared to neighbouring pastures?

☐ Better ☒ same ☐ worse

If the pasture condition is better or worse, please explain why.

8.2 Did the condition of this pasture change during the last 10 years?

☐ Better ☐ same ☒ worse

8.3 Is the pasture area enough for the livestock kept here?

☐ More than enough ☒ just enough ☐ not enough

8.4 What measures do you use to improve the condition of this pasture?

none

8.5 In general: Are there degradation problems on summer pastures in this region?

☐ Not at all ☒ few problems ☐ severe problems

8.6 When you keep too much livestock on a pasture…

a.) …what happens to the livestock? does not gain so much weight during summer

b.) …what happens to the pasture? nothing, grass grows again next spring

---

9. Cross-checking of livestock numbers

9.1 sheep and goats 1100

9.2 cattle 150

5.3.2 Example calculation of actual sheep units and actual stocking rates (see 2.3)

You need:

- Livestock numbers recorded in Question 5.1
- Fertile land of the summer pasture (ha) recorded in Question 4.6

Calculate *actual sheep units* as indicated in the following table:

	Number from questionaire		Conversion factor[10]		Sheep units
Sheep	900	x	1	=	900
Goats	50		0,7		35
Cattle	100		6		600
				Sum:	**1535**

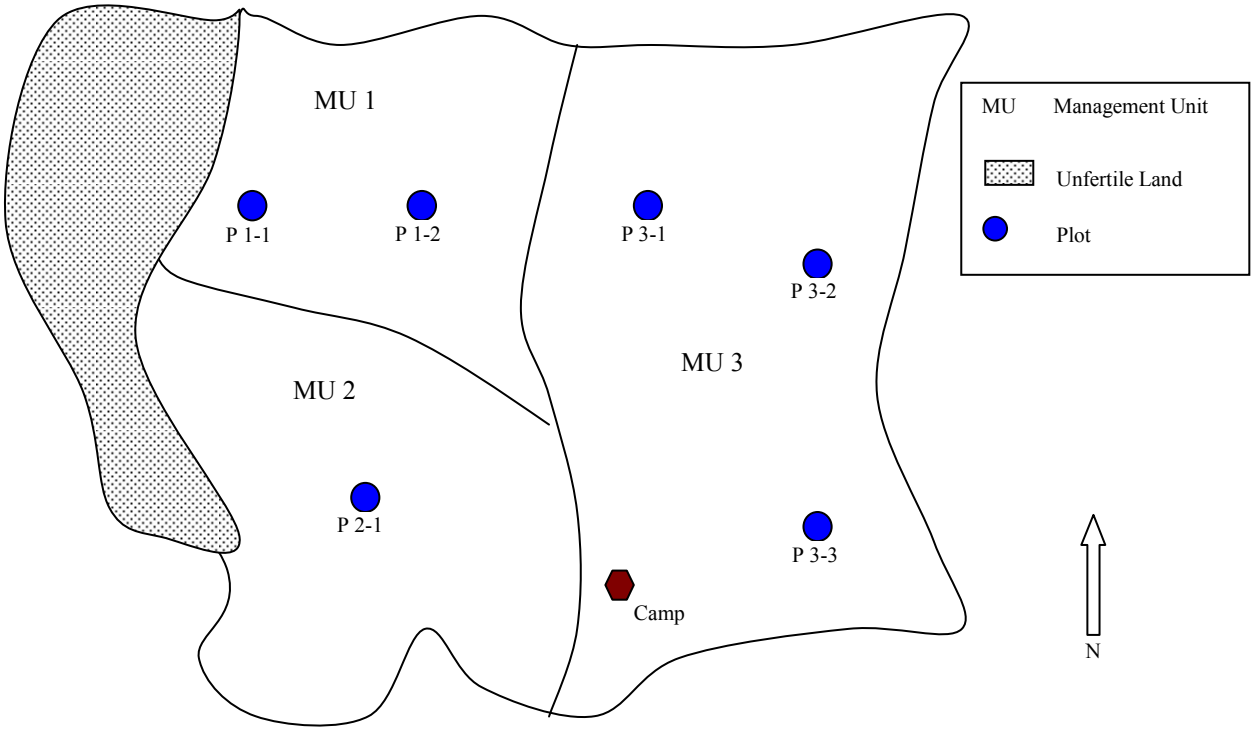
Calculate the *actual stocking rate* as follows:

Stocking rate = sum of sheep units / area (ha) = 1535 / 200 = **7.7 SU/ha**

[10] Conversion factors are calculated based on the weight ratios of livestock. Sheep: 50 kg, Cattle: 300 kg, Goat: 35 kg

5.3.3 Example mental map (see 3.1, 3.2)

Together with the herder the persons in charge derived three management units. In the management units one, two and three plots were selected. In this example MU 1 and MU 2 represent each 25 % and MU 3 represents 50 % of the total fertile land (200 ha).



5.3.4 Filled-in example of Data Sheet II: Site conditions and state of highland pastures (see 3.3, 5.2)

Investigator: Giorgi *Date:* 21.07.2016 *Plot No.*: P 1-1

1 Site conditions (within radius = 50 m)

Find a slope that is ± homogeneous within a circle of 50 m radius. If you do not find such a large circle, then please note the shortest radius of a homogeneous circle around you: 40 m

1.1 Location

1.1.1 Description of region (valley, nearest mountain, nearest village): xyz mountain over zyx valley

1.1.2 GPS-Point (Name): P 1-1 N (latitude)/ X: E (longitude)/ Y:

1.1.3 Altitude [m above sea level, from GPS]: 2729

1.1.4 Distance to Village/ Camp [m]: 1250 GPS-Name of Village/ Camp: Village/ Camp 1

1.1.5 Current land use (as visible and/or mentioned by villagers/ herders; e.g. pasture, hay meadow, wood cutting, herbs collection, none): summer pasture

1.2 Slope

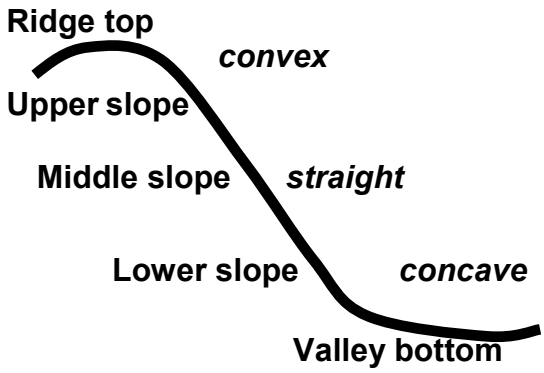
1.2.1 Slope Inclination/ Steepness [°]: 13° (exact figure)

1.2.2 Aspect [°]: 22 (exact figure)

Aspect category: ☒ N (345-75°) ☐ E (75-165°) ☐ S (165-255°) ☐ W (255-345°

1.2.3 Topographic position:

☐	Ridge top
☐	Upper slope
☒	Middle slope
☐	Lower slope
☐	Valley bottom



1.2.4 Slope configuration:

☐	Convex
☐	Convex/straight
☒	Straight
☐	Concave/straight
☐	Concave

1.3 Underground

1.3.1 Bedrock (visible around): Type, if known

Rock strength: ☐ Solid, not breakable by hand neither when thrown on rock (e.g. granite)
☒ Medium solid, not breakable by hand but when thrown on rock
☐ Soft, breakable by hand (e.g. thin layered clayic slate)

1.3.2 Soil moisture: ☐ dry ☒ moist ☐ wet

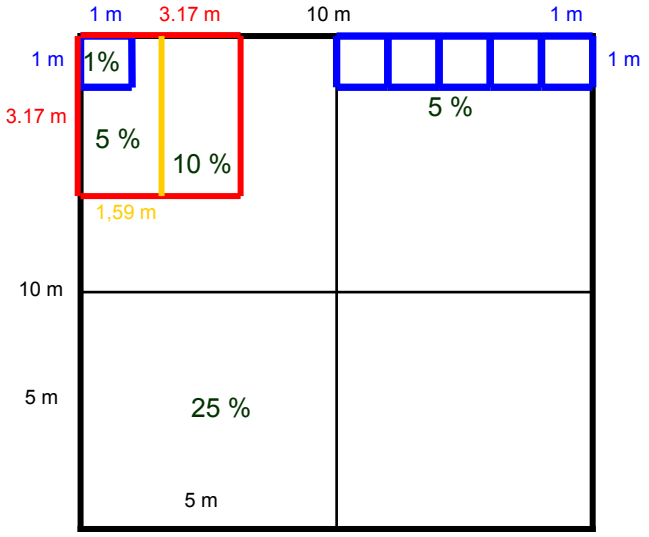
Choose a representative plot of 10 x 10 m and mark the corners with sticks, clothes, rucksack etc.

2 Erosion/ Degradation

2.1 Ground not covered by vegetation (*2.1.1-2.1.3 cross-check with 3.1.6.1*)**:**

Estimated cover [%] on 10x10 m	non visible	1	2-5	6-10	11-25	26-50	> 50
2.1.1 Bare Soil			**x**				
2.1.2 Rubble/scree (small stones)		**x**					
2.1.3 Rocks (big, stable)	**x**						
2.2 Livestock tracks (Terracettes)				**x**			
2.3 Erosion tracks, combination of bare soil, rubble+visible erosion processes		**x**					

Sketch to help with estimating cover percentage on 10 x 10 m



3. Vegetation

3.1 State of vegetation cover

3.1.1 Physiognomic feature (*2 answers possible*)**:**

☐ Bushland/Forest (bush/tree cover > 30 %)
☐ Tall herbs (> 50 cm)
☐ Tussocks (bunches of dominating grasses)
☐ Meadow-like (regularly high grown)
☒ Short growing lawn
☐ Scattered vegetation (< 50 % cover)

3.1.2 Vegetation height [cm] maximal: 10 Average height [cm]: 5

3.1.3 Standing crop: ☐ a lot ☒ medium ☐ few

3.1.4 Vegetation provided with water ☒ well ☐ medium ☐ badly

3.1.5 Browsing tracks: ☐ 1-5 % of plants browsed ☐ 6-20 % of plants browsed
☐ 21-50 % of plants browsed ☐ 51-80 % of plants browsed
☒ more than 80 % of plants browsed

Plot No.: _____

3.1.6 Vegetation composition

Estimated cover [%] on 10x10 m	non visible	1	2-5	6-10	11-25	26-50	51-80	> 80
3.1.6.1 Total vegetation cover								**x**
3.1.6.2 "Sweet Grass"/Poaceae					**x**			
3.1.6.3 Fen-sedge/Cyperaceae (grass-like with often sharp edges)				**x**				
3.1.6.4 Herbs (non-gramineous, not woody plants)						**x**		
3.1.6.5 Legumes (soft herbs with trifoliate leaves (like Trifolium/clover) or pinnate leaves (like Vicia/vetch)			**x**					
3.1.6.6 Semi-shrubs (chameaphytes, small woody plants with buds borne close to ground, e.g. blueberry)	**x**							
3.1.6.7 Bush cover (shrubs, woody species < 5m height), name/s: _____	**x**							
3.1.6.8 Tree cover (woody species > 5m) name/s: _____	**x**							

3.2 Grazing indicator species groups and their cover [%] on 10 x 10 m:

Estimated cover [%] on 10x10 m	non visible	1	2-5	6-10	11-25	26-50	> 50
3.2.1 Thistles		**x**					
3.2.2 Rhododendron	**x**						
3.2.3 Juniper or other thorny bushes (e.g. Rosa, Berberis)	**x**						
3.2.4 Other strongly hairy or thorny plants	**x**						
3.2.5 Poisonous or strongly aromatic plants (e.g. Veratrum)	**x**						
3.2.6 ! Cover sum of all recorded grazing indicator species groups !		**x**					

3.3 Plant diversity:

3.3.1 Flowering plants: ☐ a lot ☐ medium ☒ few

3.3.2 Number of plant species (count on 3 x 3 m in the upper left corner of your 10 x 10m plot): 36 (exact figure)

4. Visual appraisal of vegetation state of site: ☐ Good ☒ Medium ☐ Bad

5. Representative pictures taken (*file name should later have the site's GPS name*)

Picture No.: 1234

6. Comments (e.g. hints on instable slopes like landslides, deep gullies): Polygon pattern

5.3.5 Example calculation of SEI and PDI (see 3.4)

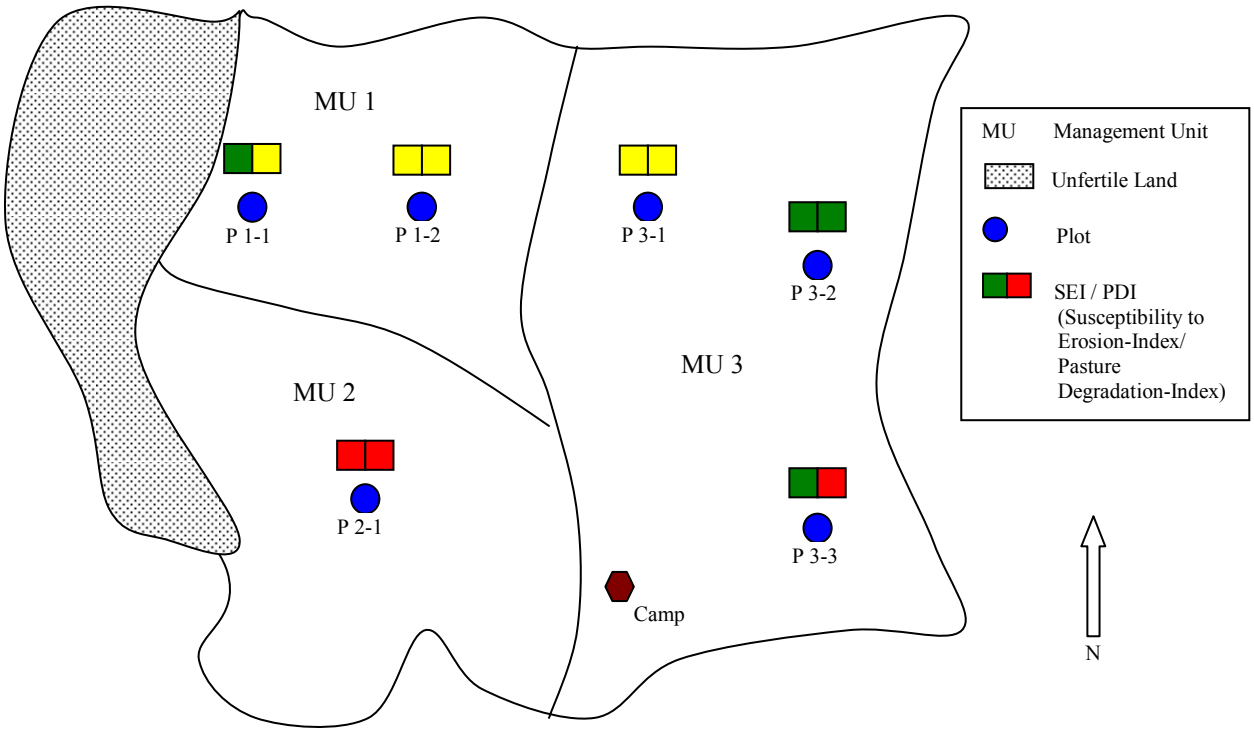
*Example calculation of **Susceptibility to Erosion-Index (SEI)** (see Chapter 3.4.1)*

					Example Data sheet II	Further example figures				
Code of variable	**Variable**	**Values**	**Min**	**Max**	**Scores obtained P 1-1**	**Scores obtained P 1-2**	**Scores obtained P 2-1**	**Scores obtained P 3-1**	**Scores obtained P 3-2**	**Scores obtained P 3-3**
Var. 1	**Inclination a**	0, 15, 30, 45, 60	0	60	45	15	0	30	45	60
Var. 2	**Altitude**	0, 5, 10, 15, 20	0	20	10	10	10	10	15	15
Var. 3	**Inclination b**	0-10	0	10	6	0	0	3	6	8
Var. 4	**Aspect**	0-20	0	20	20	15	1	13	11	10
Var. 5	**Topographic position**	0, 5, 10, 15, 20	0	20	10	10	5	10	15	15
Var. 6	**Slope configuration**	0, 2, 5, 8, 10	0	10	5	5	0	2	8	10
Var. 7	**Bedrock**	0, 20, 40	0	40	40	40	40	40	40	40
Sum of maximum scores				**180**						
Sum of scores obtained					**136**	**95**	**56**	**108**	**140**	**158**
SEI (normalized) = (Sum of scores obtained / Sum of maximum scores) x 100					**75.6**	**52.8**	**31.1**	**60.0**	**77.8**	**87.8**
Risk to erosion level					**Low risk**	**Medium risk**	**High risk**	**Medium risk**	**Low risk**	**Low risk**
Expressed as traffic light					**Green**	**Yellow**	**Red**	**Yellow**	**Green**	**Green**

*Example calculation of **Pasture Degradation-Index (PDI)** (see chapter 3.4.2)*

					Example Data sheet II	Further example figures				
Code of variable	**Variable**	**Values**	**Min**	**Max**	**Scores obtained P 1-1**	**Scores obtained P 1-2**	**Scores obtained P 2-1**	**Scores obtained P 3-1**	**Scores obtained P 3-2**	**Scores obtained P 3-3**
Var. 8	**Bare Soil**	0, 2, 4, 6, 8, 9, 10	0	10	8	4	4	6	8	4
Var. 9	**Rubble/scree**	0, 2, 4, 6, 8, 9, 10	0	10	9	4	4	8	10	8
Var. 10	**Rocks**	0, 1, 2, 3, 4, 4.5, 5	0	5	5	5	3	5	5	5
Var. 11	**Livestock tracks**	0, 2, 4, 6, 8, 9, 10	0	10	6	2	2	6	8	2
Var. 12	**Erosion tracks**	0, 2, 4, 6, 8, 9, 10	0	10	9	4	2	6	9	2
Var. 13	**Browsing tracks**	0, 2, 5, 8, 10	0	10	0	0	2	2	0	0
Var. 14	**Cover gra-zing indicator spec. groups**	0, 2, 4, 6, 8, 9, 10	0	10	9	9	4	9	9	6
Var. 15	**Flowering plants**	0, 2.5, 5	0	5	0	0	2.5	2.5	0	0
Var. 16	**Number of plant species**	0, 2, 5, 8, 10	0	10	8	5	2	8	8	0
Sum of maximum scores				**80**						
Sum of scores obtained					**54**	**33**	**25.5**	**52.5**	**57**	**27**
PDI (normalized) = (Sum of scores obtained / Sum of maximum scores) x 100					**67.5**	**41.3**	**31.9**	**65.6**	**71.3**	**33.8**
Degradation of Pasture					**Medium**	**Medium**	**High**	**Medium**	**Low**	**High**
Expressed as traffic light					**Yellow**	**Yellow**	**Red**	**Yellow**	**Green**	**Red**

Calculated SEI and PDI depicted in the example mental map (see 5.3.3)



5.3.6 Example extrapolation of results from plots to management units (SEI-MU and PDI-MU, see 4.1)

Calculation of SEI-MU according to chapter 4.1 and example mental map (see 5.3.3)

SEI-MU 1 = $\frac{SEI\,P\,1\text{-}1 + SEI\,P\,1\text{-}2 + SEI\,P\,1\text{-}2}{2}$ = $\frac{75.6 + 52.8}{2}$ = **64.2**

SEI-MU 2 = 31.1

SEI-MU 3 = $\frac{SEI\,P\,3\text{-}1 + SEI\,P\,3\text{-}2 + SEI\,P\,3\text{-}2}{3}$ = $\frac{60.0 + 77.8 + 87.8}{3}$ = **75.2**

Alignment to the colors of a **traffic light and the corresponding figures**

	SEI -MU	**Index range SEI -MU**	**Risk to erosion level**	**SEI -MU in Traffic light**	**Traffic light as figure**
SEI-MU 1	64.2	34-67	Medium risk	Yellow	2.5
SEI-MU 2	31.1	0-33	High risk	Red	0
SEI-MU 3	75.2	68-100	Low risk	Green	5

Calculation of PDI-MU according to chapter 4.1 and example mental map (see 5.3.3)

PDI-MU 1 = $\frac{\text{PDI P 1 - 1} + \text{PDI P 1 - 2}}{2}$ = $\frac{67.5 + 41.3}{2}$ = **54.4**

PDI-MU 2 = **31.9**

PDI-MU 3 = $\frac{\text{PDI P 3 - 1} + \text{PDI P 3 - 2} + \text{PDI P 3 - 2}}{3}$ = $\frac{65.6 + 71.3 + 33.8}{3}$ = **56.9**

Alignment to the colors of a **traffic light and the corresponding figures**

	PDI -MU	**Index range PDI -MU**	**Degradation of Pasture MU**	**PDI -MU in Traffic light**	**Traffic light as figure**
PDI-MU 1	**54.4**	34-67	Medium	Yellow	**2.5**
PDI-MU 2	**31.9**	0-33	Strong	Red	**0**
PDI -MU 3	**56.9**	34-67	Medium	Yellow	**2.5**

5.3.7 Example calculation of the State of Pasture-Index of one management unit (SPI-MU, see 4.2)

SPI-MU 1 = SEI-MU 1 + PDI-MU 1 = 2.5 + 2.5 = **5**

SPI-MU 2 = SEI-MU 2 + PDI-MU 2 = 0 + 0 = **0**

SPI-MU 3 = SEI-MU 3 + PDI-MU 3 = 5 + 2.5 = **7.5**

The corresponding stocking rates (sheep units per ha (SU/ha)) are recommended.

	SPI-MU	**Management recommendation**
SPI-MU 1	5	4 SU/ha
SPI-MU 2	0	No grazing
SPI-MU 3	7.5	6 SU/ha

5.3.8 Example of preparing management recommendations (see 4.3)

Calculation of the recommended livestock number for a pasture (see…)

Name of MU	Size (ha)		Stocking rate (SU/ha)		Recommended sheep units
MU 1	50	x	4	=	200
MU 2	50		0		0
MU 3	100		6		600
Sum (Recommended sheep units for the pasture)					800

800 sheep units are recommended to be kept on this pasture.

Calculating the required change in livestock numbers

Change in sheep units = Recommended sheep units for the pasture – actual sheep units

Change in sheep units = 800 – 1535 = – 735

Case 3 has occurred: The pasture condition allows you only to keep less animals on the pasture than the farm actually has. The herder has to destock 735 sheep units to improve the pasture condition. For the biggest part he could destock his 100 cattle (600 sheep units) completely.

Calculation of Share of grazing time (MU)

$$\text{Share of grazing time (MU) (\%)} = \frac{\text{Recommended sheep units for a management unit x 100}}{\text{Recommended sheep units for the pasture}}$$

$$\text{Share of grazing time (MU 1) (\%)} = \frac{200 \text{ x } 100}{800} = 25\ \%$$

$$\text{Share of grazing time (MU 2) (\%)} = \frac{200 \text{ x } 100}{800} = 0\ \%$$

$$\text{Share of grazing time (MU 3) (\%)} = \frac{600 \text{ x } 100}{800} = 75\ \%$$

One quarter of the grazing time the herd should spend on MU 1, while three quarters are allowed on MU 3. Thereagainst, MU 2 has to be abandoned for a while to facilitate its regeneration.

6 Glossary and abbreviation

Ecosystem: An ecosystem is a community of living organisms (plants, animals and microbes) in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system. These biotic and abiotic components are regarded as linked together through nutrient cycles and energy flows.
Evaporation: A meteorological term that shows the evaporation of water from free or vacant land or from water areas.
Evapotranspiration: in meteorology called the sum of transpiration and evaporation, so the evaporation of water from plant and animal world and from soil surface. The Evapotranspirations value plays an important role in the hydrological and agricultural and horticultural sector.
GIS: A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. In the simplest terms, GIS is the merging of cartography, statistical analysis, and computer science technology.
GPS: The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil and commercial users around the world. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver.
Gravitation: A natural phenomenon by which all physical bodies attract each other. It is most commonly experienced as the agent that gives weight to objects with mass and causes them to fall to the ground when dropped. Gravitation is one of the four fundamental interactions of nature, along with electromagnetism, and the nuclear strong force and weak force.
Landscape: Comprises the visible features of an area of land, including the physical elements of landforms such as (ice-capped) mountains, hills, water bodies such as rivers, lakes, ponds and the sea, living elements of land cover including indigenous vegetation, human elements including different forms of land use, buildings and structures, and transitory elements such as lighting and weather conditions.
Physiognomy: The term physiognomy (from the Greek. physis meaning "nature" and gnomon meaning "judge" or "interpreter") refers besides the assessment of a person's character or personality from his outer appearance, especially the face, also to the general appearance of a person, object or terrain, without reference to its implied characteristics, as in the physiognomy of a plant community.
Phytomass: plant biomass, any quantitative estimate of the total mass of plants in a stand, population, or within a given area, at a given time.
Regeneration: In biology, regeneration is the process of renewal, restoration, and growth.
Tablet PC: A tablet computer or simply tablet, is a mobile computer with touch screen.
Transpiration: is the evaporation of water into the atmosphere from the leaves and stems of plants.
(glossary source: www.wikipedia.org)

MU	Management Unit
P	Plots
PDI	Pasture Degradation-Index
SEI	Susceptibility to Erosion-Index
SPI	State of Pasture-Index
SU	Sheep Unit
TRMI	Topographic Relative Moisture Index