Sustainable Management of Biodiversity, South Caucasus

Manual for Monitoring of Pastures, Armenia

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Recommendations on sustainable pasture use (management) are provided as the final output of the manual. They will allow not only improving pasture productivity, resulting in increased production of livestock products, but will also significantly impact preservation and restoration of natural grasslands, as well as reduction of biodiversity risks and sustainable development of biocenosis and ecosystems in the future.

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The "Manual for Monitoring of Pastures, Armenia" has been developed and published in frame of Sustainable Pasture Management subcomponent of the
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The abovementioned manual has been adopted according to the needs of pasture monitoring of the Republic of Armenia (legislation, local conditions, peculiarities of pasture monitoring and management system) by Prof. G. Tovmasyan, based on the "Monitoring Manual for Summer Pastures in the Grater Caucasus in Azerbaijan" developed by the J. Etzold and R. Neudert on 2011 in frame of the GIZ "Sustainable Management of Biodiversity, South Caucasus" Program.

CONTENT

1.0 INTRODUCTION

1.1 GOAL OF THE MANUAL

Unique features and development of different branches of agriculture in this region are determined by biodiversity of the Armenia. Thanks to the features of local natural conditions and availability of large fodder areas, livestock keeping is one of the most ancient and important branches of agriculture in Armenia. Provision of forage base is one of the pressing present-day issues, necessary for the appropriate development of livestock keeping. Natural fodder areas (pastures, grasslands) are of utmost importance for provision of the forage base. Apart from being the most important resource for establishment of forage base, fodder areas are also a very valuable biodiversity resource.

Provision of high value and sufficient quantity of winter and summer pasture forage in Republic Armenia has always been a very critical issue. The key to successful solution of this problem is a scientifically grounded and balanced policy on management of natural fodder areas that will ensure preservation of these resources and increase the possibility of their natural regeneration.

Republic of Armenia is a highland country, situated in the Caucasus. It is rich with bio-climatic conditions, due to altitudinal zoning of soils and plants, which have formed diverse and rich vegetation covers that differ from one zone to another. Natural fodder areas constitute around 52% of agricultural lands, itemized as the Republic's administrative territory. Pastures prevailing among these areas are a vital source for livestock keeping and valuable resource from biodiversity point of view. Livestock has decreased significantly in the last 20-25 years, as a result of new economic conditions. Yet, grasslands became endangered, as a result of acute degradation caused by unjustified uses and absence of conservation and improvement activities.

This implies that Armenia has to make balanced decisions regarding pasture management and its policy on pasture management. The latter implies knowledge of the present-day situation of pastures and their management, which underlies the correct decision making.

The Government of Armenia has approved Pasture and Grassland Use Procedure by its decrees N1477, dated 28.10.2010 and N389, dated 14.04.2011, on Sustainable Pasture Management. The latter was developed based on the results of partial monitoring, analysis and study of multi-year data's measures of the averages. It is worth mentioning that the abovementioned procedure, approved by the Government of the Republic of Armenia, which in fact, has not been largely applied/has not become a mainstream yet, and is not justified for all cases, because of the simple reason that degradation level is not clear and not recorded for all natural pastures.

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Recommendations on sustainable pasture use (management) are provided as the final output of the manual. They will allow not only improving pasture productivity, resulting in increased production of livestock products, but will also significantly impact preservation and restoration of natural fodder areas, as well as reduction of biodiversity risks and sustainable development of ecosystems and biogeocoenosis in the future.

1.2 WHAT IS PASTURE DEGRADATION?

Preservation of natural pastures and use of their resources should not contradict one another; on the contrary these two activities have to be combined. Along with use of the pastures' vegetation cover as the natural resource, measures have to be undertaken to ensure its self-regeneration and enrichment. The mode of pasture use must prevent or significantly reduce harmful effects of grazing. In this respect, it is important to keep the basic parameters of grazing, such as terms, duration, frequency and order. The most important prerequisite for efficient use of a pasture has always been high productivity of its vegetation cover, good characteristics of forage and preservation of vegetation cover's valuable composition.

Unjustified and irregular use of pastures, when basic parameters of grazing are not kept, results in diminishing of the vegetation cover, and breach of botaical economic elements' proportions. These factors reduce productivity of pastures. Developments deriving from this kind of a negative process contribute to pasture degradation. On pastures where large quantities of animals gather for grazing and where grazing process is not controlled, situation worsens more rapidly. Two main types of degradation are possible on natural pastures' feeding grounds.

1. **Natural degradation;**
2. **Antropogenic degradation.**

Natural degradation is a slow process that inevitably takes place in the nature. It is conditioned by turf-cladding processes, when soil aeration changes over centuries, because of natural-environmental factors, and this change causes slow qualitative changes in the composition of vegetation cover – a successive change of the rhizomatous, loss of bunch grasses and tussock grasses. As a result grassland undergoes 3 main stages of natural development: adolescence, adulthood and old age. Composition of vegetation cover changes slowly during each of the development stages, along with gradual change of the symbioses. This process has self-restoration evolution-based capacity.

Antropogenic degradation is caused by intervention of economic factors; it is much more rapid and causes decomposition and degeneration of pastures' feeding grounds. Antropogenic degradation develops on overused and irregularly used pastures, where overstocking occurs.

This type of degradation has two main components:

a. Degradation occurs as a result of certain activity, which brings to reduction of pasture potential to produce grass.
b. The pasture ecosystem degrades, when a significant reduction in the number of its species occurs (i.e. a decline of biodiversity).

EXPLANATION TO A)

Where grazing intensity and trampling is too strong, the vegetation cover becomes weak or harmed. The consequence is open soil, which is the point of attack for erosion processes. Due to high relief energy in mountains, these erosion processes can proceed very fast. Of course, erosion occurs also naturally, mainly on very steep or dry slopes, on soft bedrock or at high altitudes, where vegetation cover hardly ever appears. Hence, these areas are especially vulnerable to additional disturbance by animals. Once the topsoil is 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. As a consequence, the more degradation occurs on the pasture the less successful will be livestock production and reproduction capacities, 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 by not using it for some period or by applying rotational use of pastures. Depending on the level of degradation and the natural potential of the vegetation to recover, suitable measures are for a certain time (1-2 years) the complete exclusion of grazing or the decrease of the stocking rate.

EXPLANATION TO B)

Natural pastures are habitats for many organisms. Armenia 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 grazing, trampling and

the subsequent opening of the vegetation cover, which leads to less favorable microclimatic conditions, soil compaction and aeration reduction means that the stress for plants rises. Fewer plants can withstand trampling and reduction of the soil aeration. Some plant species developed defense mechanisms (e.g. thorns, hair, 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 PASTURE CONDITIONS' MONITORING

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

Monitoring in general means observation of an object over time. In our context these objects could be e.g. landscapes, ecosystems, 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 unchanged (stable state).

The chronology of 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 the basis of your sampling design. For this manual we chose a preferential sampling design, 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 monitoring are to repeat this assessment at the same plot, after a certain time (e.g. every 2 years). Hereby, it is important to always apply the identical set of methods. In 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), and changes that take place with that object. When in evaluation of a monitored object changes are detected, decisions may be taken to adapt measures to fulfill a certain goal. In case of monitoring the pasture condition, you can identify those areas with the severest degradation 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, and over data analysis to the derivation of management recommendations, which can be discussed with the pasture users and representatives of the Local Self-Government Bodies (LSGB). It consists of several distinctive tasks, which can be carried out by different people, but have to be combined to arrive at management recommendations and to develop sustainable management plans. The figure below gives you a first overview of separate tasks. Colors indicate field work (green) or office work (blue). The chapters in the manual explaining the specific task are given in brackets.

1. Interviews with herders about current pasture management (2.1, 2.2)
2. Drawing a mental map as a basis for sampling pasture conditions (3.1)
3. Entering interview data into database
4. Calculation of stocking rates for the pasture (2.3)
5. Sampling of pasture condition (3.2, 3.3)
6. Entering plot data into database
7. Calculating indices of pasture condition for plots (3.4)
8. Calculating pasture condition indices for management units (4.1, 4.2)
9. Preparing management recommendations for the pasture (4.3)
10. Discussing management recommendations with pasture users and representatives of the LSGB (4.4)
11. Developing sustainable pasture management procedure (plans) with participation of the pasture users and LSGBs' representatives (4.6).

Different tasks need the person in charge to have appropriate skills and knowledge about other tasks in the work flow. Table below shows the required skills and possible persons in charge. It is especially important to have a person responsible for tasks 1, 10 and 11, who can engage in a longer lasting dialogue with the pasture users and build trust and cooperation between those pasture users that use community pastures, and Local Self-Government Bodies' representatives engaged in pasture management.

3. Tasks	Required skills	Possible person in charge
1. Interviews with pasture users and LSGB's representatives about current pasture management	Strong social skills, familiar with rural life	Natural resources management specialist, agronomist or invited expert
2. Drawing a mental map as basis for sampling pasture conditions	Strong social skills, skills to assess vegetation cover and its composition	Agronomist, person involved in implementation of task 1.
3. Entering interview data into database	Computer skills	Natural resources management specialist / NGO employee/ invited expert
4. Calculation of stocking rates for the pasture	Computer skills	Natural resources management specialist / NGO employee/ invited expert

5. Sampling of pasture conditions	Familiar with Data Sheet II	Natural resources management specialist / NGO employee/ grassland/ meadow specialists
6. Entering plot data into database	Computer skills	Natural resources management specialist, agronomist
7. Calculating indices of pasture conditions for plots	Computer skills	Natural resources management specialist, invited expert
8. Calculating pasture conditions indices for management units	Computer skills	Natural resources management specialist / NGO employee / invited expert
9. Preparing management recommendations for the pasture	Computer skills	Natural resources management specialist / invited expert
10. Discussing management recommendations with pasture users and LSGB's representatives	Strong social skills, familiar with rural life, well-informed on tasks 1-9	Natural resources management specialist, agronomist or invited expert
11. Developing sustainable pasture management procedure (plans) with participation of the pasture users and LSGBs' representatives	Well-informed on task 2;8;10	Natural resources management specialist or invited expert

1.5 SCIENTIFIC BACKGROUND

Determining and revealing reasons of negative environmental impact becomes more difficult, as various anthropogenic factors are involved both on local, regional and global levels. Humanity has wasted a lot of time by avoiding/failing to see the deepening degradation processes going on in nature, to prevent concerning tendencies and implement radical preventive measures. Natural-historical processes taking place in the biosphere expedite and natural disasters are obviously much more powerful, biotic habitats become smaller.

At the moment it is difficult to reveal and predict precisely what kind of changes take place in nature and how they are going to develop due to the difficulty of specifying impacts, caused by economic and historical factors. These impacts are numerous and different. Thus, the solution to the problem is to alleviate all anthropogenic influences on nature and eliminate all obvious treats.

The assessment system of anthropogenic changes to the nature and its components is based on permanent and various researches that reveal degradation reasons and level of biota's bioactivity conditions. Deterioration of the environment, including grasslands, is often caused by irregular and inefficient use of natural resources (vegetation cover). Implementation of efficient management is one of preconditions for preservation and restoration of natural resources. It is based on assessment and study of the resources' potential and condition. Monitoring is usually used as the basic process to collect data on anthropogenic

(human) impact on the environment, for the purposes of study and conditions' assessment.

Elaboration of this pasture monitoring manual is inspired by Cahyat et al. 2007. The main purpose of this manual is to develop and put into practice a monitoring procedure of highland pastures of the Caucasus that will serve as the ground for development of recommendations on natural pastures' efficient management.

In the process of revising, the manual was amended and supplemented in accordance with the procedures of the Republic of Armenia, and these amendments and supplements were reflected in the monitoring system for the Armenian pastures.

The social-economic assessment together with management recommendations are based on the detailed study of regulations/procedures on livestock keeping and land management/survey. Recommendations on pasture management are based on the Maximal Stocking Rate (MSR) calculations or Allowable Grazing Pressure (AGP) calculations defined in the Republic of Armenia Government Decree "On Procedures of Pastures' and Grasslands' Use", N1477, dated 28.10.2010 and N389, dated 14.04.2011.

Based on the analysis of data collected from the pasture's plots, variables will be selected, to calculate monitoring indices. Topographic Relative Moisture Index (TRMI, Parker 1982) became a ground for elaboration of one or two indices, as far as moisture is one of the important factors for vegetation regeneration.

2. 0
ASSESSING PASTURE MANAGEMENT

Pasture efficiency is conditioned by not only economic elements of the vegetation cover, vegetation level and composition, but also by application of sustainable maintenance and use methods.

The main precondition for efficient use of pasture, level of pasture productivity and good fodder characteristics has always been the preservation of valuable composition of plants, which can be ensured by sustainable and thorough management.

Interview guidelines with pasture users and LSGBs on pasture management assessment are presented in this chapter. Data Sheet I was used to conduct and record interviews (see Chapter 5.1). Pasture management impacts pasture conditions and it is through the interviews that it becomes possible to collect detailed data on reasons of pasture degradation. Furthermore, this data is used to develop recommendations on efficient pasture management and to discuss them with pasture users.

2.1 INTERVIEW GUIDELINES

Interviews with LSGB representatives and pasture users in the communities aim at collecting information on the organization of the grazing period in a community and pasture management implemented. It is also intended to find out whether all pastures belonging to a certain community are accessible to all users, what are the opinions of pasture users on degradation level and pasture conditions, what is the principle for cattle herds' and sheep flocks' rotation on the grasslands. Data is also collected on other issues, like if there is necessary infrastructure (roads, water points, lodgings) at place in the communities.

Interview guideline is developed for separate pastures as separate management units.

In case there is necessity to assess all the pastures belonging to the community, one should clarify with the LSGB representative (village mayor's office), if all the pastures are accessible to the pasture users. Is there sufficient infrastructure to organize seasonal grazing also on remote pastures?

2.2 GUIDELINES FOR COMPLETING DATA SHEET I

1. BASIC DATA

- Make sure that you clearly name and number the data sheet
- Do not forget to take a GPS and fill in the data.

2. INDOOR WINTER FEEDING OF THE LIVESTOCK

- In highlands and piedmont zones the majority of livestock that graze on the pastures during summer, stay in barns for late autumn and winter. They stay and feed in the cattle-shed.
- In lowlands animals, particularly sheep and goats, go for grazing to the winter pastures even in winter time, because these pastures, as a rule, do not have permanent snow cover.

It is necessary to find out duration of winter maintenance period in the communities for animals of different age and species.

3. PASTURE MANAGEMENT

- You should have gained an understanding, how the grazing period in the community is organized and managed and who makes the major decisions.
- Fill in the table according to the instructions in the questionnaire.

4. PASTURE ACCESS

- In case you conduct the interview with a shepherd, he would probably not be able to give information about

lease contracts. In this case the question should be addressed to the representative of the Local Self-Government Body or to the leader of a large farm.

- Find out what part of the community pastures is not being used and why; whether there is necessary infrastructure in close and remote pastures; what is the condition of the infrastructure?

5. LIVESTOCK

- Livestock numbers are crucial to the calculation of stocking rates and Allowable Grazing Pressure. It must be mentioned that people tend to record fewer animals than they actually have. That is why one should cross-check livestock numbers with own computation.

6. HERDS AND FLOCKS

- The following information should be collected when talking about herds and flocks: their number in the community, how animal maintenance is organized, terms to start and finish the grazing period, access to the pastures, duration of the grazing period for the livestock, which serves as a ground to calculate Allowable Grazing Pressure (AGP).

7. SPATIAL ORGANISATION OF PASTURE USE

- As a 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 homogeneous parts of the pasture.
- If you have access to the cadaster maps of pastures you can use them as the basis for filling in details of the mental map. Also they can serve as the grounds for selecting your plots and management units. The latter will be used to make the management plans and set rotation order of the plots' use.

8. PASTURE CONDITION

- Pasture user should express his opinion about the pasture condition.
- The other question to ask is whether there are steps undertaken to improve the most degraded pastures.
- Which pastures are used more often, those located close to a community or the remote ones, what is the reason for that? What is the productivity of the pasture, and average grass yield for 1ha (conventional). This part clarifies opinions of the respondents on degradation issues and their reasons.

9. ORGANIZATION OF LIVESTOCK CARE

- Collect information on organization of herds' and flocks' care in the village. These are important issues for development of the management recommendations.

10. PRODUCTIVITY

- Clarification of this issue is important, because one can find out how the grazing period is organized and maintained by comparing and analyzing average indexes in the community. One can also estimate pastures' productivity based on this data.

2.3 CALCULATING ACTUAL CATTLE UNITS AND ACTUAL STOCKING RATES

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

The data you need:

- Livestock numbers of the farm or community recorded in Question 5.1
- Pasture area (effective area) (ha), recorded in Question 4.6.

For this calculation the all livestock of the community or a farm (different kinds of livestock and different age groups) needs to be multiplied by corresponding indexes (see annex 5.4) and transformed into cattle units.

Calculate actual cattle units as indicated in the table below.

	Number from questionnaire		Conversion factor[1]		Cattle units
Cows		X	1	=	
Cattle of any age, average			0.75		
Sheep and goats of any age, average			0.14		
				Sum	

The actual stocking rate is calculated as follows.

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

3.0

ASSESSING PASTURE CONDITION (INVENTARIZATION)

This chapter explains all the steps, needed to assess the ecological condition of a pasture. The first part of Chapter 3.3 is field work, while the rest is office work.

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 one calculates two indices in Chapter 3.4, which gives a clear idea of the pasture condition.

3.1 SAMPLING DESIGN

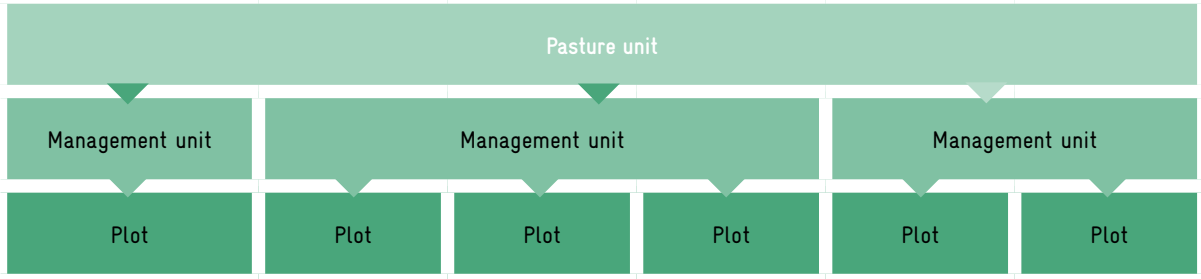
When standing on a pasture, you can see that pasture conditions are not the same everywhere. It is impossible to assess the pasture conditions in detail on all parts of the pasture, so you need a sampling method: assess pasture conditions in detail on some plots and extrapolate the results later. The 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 or herd. You collected information about this pasture unit in the interviews with the pasture users (Chapter 2). You use this information to determine 2-5 relatively homogeneous management units on each pasture unit. For each management unit you gather data about pasture conditions on 1-3 plots. The next parts explain how you apply this sampling design.

DETERMINING MANAGEMENT UNITS

As you need assistance of the pasture user or Local State-Government Body (LSGB) representative for this task, you should conduct it after completing the interview (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 where fertile and non-fertile areas of the pasture are located.
  - **Estimate the share of non-fertile land on the map in percentage, as precisely as possible.**
  - **Multiply this figure by the total area and divide by 100. Your result is the new area of non-fertile land in ha.**
- Now continue only with the fertile land indicated on the map. Identify together with the herder areas which are



relatively homogeneous per the following criteria (one after another):

- **exposition and inclination**
- **bedrock**
- **vegetation productivity**
- **composition of the vegetation cover (economic units) in %:**

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 don't 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.

- By combining these criteria, you should be able to identify 2-5 homogeneous units, which are now your management units. 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 on the map and in a table.
- Estimate what share of the total fertile land each management unit comprises. Calculate the size of each management unit by multiplying the estimated share in % divided by 100 with the area of fertile land.

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 more or less covered 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 two to five management units with each 1-3 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 50m. 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 varying topography of 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 yourself. However, the r = 50m is the favored version.

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. For this field work you will need to be equipped with:

- Clipboard to fill in the Data Sheet II and pen;
- GPS;
- Inclinometer;
- Compass;
- Folding ruler or a measuring tape;
- Mechanical counter ("counting clock");
- Digital camera;
- Plant atlas.

Below you will find instructions to every step on Data Sheet II.

1.1 LOCATION

Question 1.1.1 "Description of the region (valley, nearest mountain, slope)" 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 center of your plot circle with a clear name, e.g. the sheet number and some code name. Then note the coordinates and the altitude given by the GPS in their corresponding fields.

As each plot belongs to a certain pasture, note the GPS-name you have saved before and measure with your GPS the distance to the community or water point (1.1.4). This has some explanatory value for the grazing intensity on your site.

1.1.5 Pasture classification is one of the most important factors for the management to be implemented. For classification one must find out the rank and type of the pasture, the productivity of a pasture, terms and duration of use. To determine the type of a pasture one must study the conditions of the composition of the plant communities there. It will be possible to unite them in larger groups, taking into account their botanical and ecological-morphological features (for instance, meadowgrass-versigrass). Classifications by phyto-topology and phyto-geneology complement each other and provide with description of the grassland.

1.2 SLOPE

For measuring the steepness (1.2.1) of a slope you need an inclinometer. Try to read the scale as exactly as possible and additionally assign the inclination category.

When measuring the aspect (1.2.1) 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 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

For examining soil moisture (1.3.1) 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 will glide paste-like through your fingers.

It is important to determine bedrock (1.3.2), the geological underground, as different bedrocks have different characteristics in terms of their susceptibility to erosion, i.e. their "softness" or "hardness". -

- White solid limestone is the dominating bedrock around.
- Basalt is grey and solid bedrock, which has stabilizing function.
- Slate is mainly black or dark grey, relatively soft and made of thin layers of clayish material (not carbonates).
- Where these three bedrocks (limestone, basalt and slate) are neighboring (usually the limestone and basalt are situated above the slate) you find a transition zone.

In this mixed area, white limestone and basalt rocks as well as rubble are lying on top of dark slate bedrock. As the first have a stabilizing effect, this zone is mostly a bit less susceptible to erosion than pure slate areas.

- You are likely to meet also other kinds of bedrock, such as soft bedrocks, like chalk-like stones (white and soft), differently colored tufa, or old river terraces in the valleys made up of conglomerates of pebbles/rubbles (having erosive/soft character).

You should also determine soil type, which is crucial for vegetation cover and plants growth. Soil type also impacts level of soil aeration in case of trampling and development of erosion processes.

2. EROSION

The questions in this section help determining the extent of erosion on your plot. First find an area of 10x10m, which is a representative example of your circle.

For each of the five sub-points you need to estimate the percentage cover on these 100m. 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% (1x1m), 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. Together they cover all ground without vegetation. Just estimate the cover of the vegetation and compare it with the sum of 2.1.1 to 2.1.3. Proceed with the estimation of the cattle tracks (2.2). Livestock tracks are caused by the trampling of animals and mostly run parallel to a slope. They often cause open soil and are therefore often the beginning of erosion processes.

When estimating the erosion tracks (2.3), you need to combine bare soil, bare rubble, areas without vegetation 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 100m² plot. With physiognomic feature (3.1.1) you try to describe the vegetation with the categories given. In some cases you may decide that two categories are fitting. That will be mostly one of the first six categories combined with the last, "Scattered vegetation", i.e. you often have an already strongly degraded variation of one of the first four. 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 halm 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 that 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.

- Natural development process of the pasture is determined by the level of turf-cladding (3.16), which helps understanding the stage of vegetation cover development. This criterion helps understanding what the potential productivity of the pasture is. Turf-cladding also help understanding the natural degradation process of the pasture that is an important factor to be taken into account in the management recommendations and in the newly developed pasture management plans. Grazing indicator by types (3.2) allows forming an idea regarding grazing intensity.
- Study of the grazing indicators' types will allow having better understanding of the real situation on the pasture. Plants known as pasture weeds are not affected by grazing, since they are not palatable for animals. For these kinds of plants grazing is beneficial. Increased quantities of these plants prevent growth of the high-value fodder plants by limiting areas where they can grow. Watch for the presence of one or more of the given grazing indicator species' groups and estimate their cover on 10x10m, the same way as you did above.

In case there is more than one of the groups, the estimate covers the sum of them all (3.2.6). Look at the cover of each grazing indicator species' group and add one to another. Define to which category this sum fits. For instance: the first group you assigned with 1% cover, the second with 2-5% (could be 2, 3, 4 or 5%).Then you have to decide to which category the sum refers to, 2-5% or 6-10%. This step is very important, because it is easier for you to assign the sum category. Questions related to the plant diversity (3.3) will make it possible to assess the value of the pasture for nature conservation.

The number of flowering plants is important for many other organisms, like insects (for instance honey bees) and birds. Analogically with points 3.1.3 and 3.1.4 here you have to understand what "a lot", "medium" and "few" mean on that pasture.

Number of plant species on Armenian natural fodder areas (3.3.2) 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. 10m² (ca. 3x3 m). A good method to count all different plant species that 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 and plants atlas would be of good help. Note your final number of plant species and mark the corresponding category.

After counting plant species, assign each of them to four different economic categories (true grass, legumes, versigrass, sedges and rushes) (3.3.3). Estimate the percentage of each category of the total. This is an important indicator for vegetation cover and pasture quality interpretation.

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. Main attention should be paid to conditions of areal and vegetation cover, percentage of the botanical

economic groups that vegetation cover contains and level of being covered by vegetation/plants.

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 10x10m square, with the precondition that it is representative of your plot circle of r=50m, 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 continue to work with it yourself, please make sure that your pictures are safely stored on a computer. It would be best if you 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 THE 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)".

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. 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 analysis 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. It was weighted from 0-20, equally to 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
2251-2500	15
2501-2750	10
2751-3000	5
Above 3000	0

VARIABLE GROUP FORMING THE TOPOGRAPHIC RELATIVE MOISTURE INDEX (TRMI)

This group consists of four variables that form together the Topographic Relative Moisture Index (TRMI, Parker 1982). Save for altitude, plant available moisture is the most important factor for the regeneration potential of vegetation. Where this potential is low, erosion can strike quicker.

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.

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

VAR. 4 ASPECT (FROM 1.2.2)

This variable is also weighted from 0–20, as it is one of the most important parameters influencing water availability.

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)

This variable is also weighted from 0–20, as it is one of the most important parameters influencing water availability.

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

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

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

N	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 1.3.1) 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 sample site is situated on a (usually dry) southern slope, but due to topographic reasons the site is wet by a spring or is located on a peat land. Then you should switch the component "Topographic position" to potentially the moistest value 20 (Valley bottom).

VAR. 7 BEDROCK (FROM 1.3.2)

Bedrock is weighted with 40 (compare with Var. 1), as it is 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. This variable may vary in different climatic zones because of local features of the subsoil. In this case geological knowledge and maps would help adapting these categories to the local situation.

Categories	Value
Limestone (solid)	40
Basalt (solid)	40
Mix (Basalt with rubble/rocks of lime-stone)	20
Slate	0
Other, soft	0

CALCULATION

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

Nr.	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 **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:

$$\text{Susceptibility to Erosion Index SEI} = \frac{\text{Sum of scores obtained}}{\text{Sum of maximum scores}} \times 100$$

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 Pasture Degradation Index (PDI). The presence of livestock directly impacts all twelve variables recorded. The index therefore reflects the current state of a pasture site. Except for Var. 10, Var. 15 and Var. 17, 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.

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 STONINESS (2.1.2)

The proportion of stoniness is relevant for ongoing erosion processes.

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, but together with the two variables before, they sum up to all grounds that are not covered by vegetation. However, they may indicate former loss of topsoil. Therefore, it is reasonable to include them in the index, though carefully weighted with only the half index.

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 CATTLE 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 to 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 10x10m in combination of 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

VAR. 13 TUSSOCK LAND(2.4)

Pasture surface may change under different circumstances resulting in tussock land, which can be caused by tramping, ants, moles or stones and will lead to reduction of vegetation cover and consequently to susceptibility 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

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 describing 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. E.g. 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 the date of research within the summer season.

VAR. 14 BROWSING TRACKS (FROM 3.1.5)

Browsing tracks reflect best the season's grazing intensity.

Percentage of plants browsed on 10x10m	Value
1-5% 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

VAR. 15 TURF-CLADDING (surface) (3.1.6)

Pasture turf-cladding is a natural process, when half-dilapidated organic mass accumulates on the soil surface and worsens aeration process, which results in aging and degradation of the grassland. Turf-cladding may also develop and worsen on underused and degraded pastures, where significant quantities of plant residues remain on the soil surface. Pasture conditions can be described with the use of this factor.

Turf-cladding	Value
Low	5
Medium	2.5
High	0

VAR. 16 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 improved pasture management should also help to halt the loss of biodiversity.

VAR. 17 FLOWERING PLANTS (FROM 3.3.1)

The number of flowering plants is negatively correlated with the grazing intensity. 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 grassland for other organisms like insects (also honey bees!) or birds.

Flowering plants	Value
a lot	5
average	2.5
a few	0

VAR. 18 NUMBER OF PLANT SPECIES (FROM 3.3.2)

With the number of plant species (count on 3x3 m) a comparison of species' richness at the same site between two monitoring dates may be possible under a changed pasture management. 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 also a suitable indicator of the state of a pasture.

Number of plant species	Value
Less than 12	0
12-22	2
23-33	5
34-44	8
More than 44	10

VAR. 19 PERCENTAGE OF ECONOMIC ELEMENTS (3.3.3)

Percentage calculation and ration clarification of economic elements/units of the plant cover, on the plot of 3x3 m during each monitoring visit, is an important indicator, which makes it possible to see what the state of pasture is.

Bothanical-economic elements/ units on the 3x3 meter plot (%)		Values
Meadowgrass and Legumes	40-50 % and more	10
Palatable plants	60-70 % and more	6
Sedges	65-70 % and more	2
Not palatable plants (dangerous and poisonous)	50 % and more	0

Calculation of PDI

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

Variable code	Variable	Value	Min	Max
Var. 8	Bare Soil	0, 2, 4, 6, 8, 9, 10	0	10
Var. 9	Rubble/scree/stoniness	0, 2, 4, 6, 8, 9, 10	0	10
Var. 10	Rocks	0, 1, 2, 3, 4, 4.5, 5	0	5
Var. 11	Cattle 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	Tussock land	0,2,4, 6, 8, 9, 10	0	10
Var. 14	Browsing tracks	0, 2, 5, 8, 10	0	10
Var. 15	Turf-cladding	0, 2.5, 5	0	5
Var. 16	Cover grazing indicator species groups	0, 2, 4, 6, 8, 9, 10	0	10
Var. 17	Flowering plants	0, 2.5, 5	0	5
Var. 18	Number of plant species	0, 2, 5, 8, 10	0	10
Var. 19	Percentage of economic elements/ units	0, 2, 6, 10	0	10
Total sum			0	105

You need to sum up the scores obtained from the twelve variables.

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

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

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

4.0

GIVING MANAGEMENT RECOMMENDATIONS

This part helps developing and implementing recommendations for improved pasture management. Chapters 4.1 to 4.3 explain the steps from 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 pasture users 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 = 50m (ca. 0.8ha).

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 herds and flocks. 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:

- Community Land Management 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. You have to sum SEI of all plots from one MU and divide it by the number of plots. The result is value of the index for the management unit (SEI MU).

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

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 is the example with three plots):

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

Index range SEI -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 cattle units per ha (SU/ha) are recommended.

SEI -MU	PDI -MU	SPI-MU	Management-Recommendation
5 (green)	5 (green)	**10**	1.0 cattle units/ha
5 (green)	2.5 (yellow)	**7.5**	0.8 cattle units/ha
5 (green)	0 (red)	**5**	0.6 cattle units/ha
2.5 (yellow)	5 (green)	**7.5**	0.8 cattle units/ha
2.5 (yellow)	2.5 (yellow)	**5**	0.6 cattle units/ha
2.5 (yellow)	0 (red)	**2.5**	0.4 cattle units/ha
0 (red)	5 (green)	**5**	0.6 cattle units/ha
0 (red)	2.5 (yellow)	**2.5**	0.4 cattle units/ha
0 (red)	0 (red)	**0**	No grazing

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

SPI-MU	Management recommendation
10	1 cattle units/ha
7.5	0.8 cattle units/ha
5	0.6 cattle units/ha
2.5	0.4 cattle units/ha
0	No grazing

4.3 ESTIMATING PASTURE ACTUAL PRODUCTIVITY (PAP)

The resource that grows on a pasture (pasture grass) serves for organization of the grazing period and providing for the fodder. From this point of view, it is important to estimate pasture productivity for the given management unit or the whole pasture area when defining quantity of the cattle units for each 1ha of the pasture. The latter is important as far as Allowable Grazing Pressure is taken into account for every management unit when making management recommendations or composing management plans. Calculation of the Pasture Actual Productivity is

based on the management unit's productive area, yield and palatability of the pasture grass.

Here is the formula for calculation of the PAP

$$PAP = (S \times PA) \times (Y \times P)$$

where PAP is Pasture Actual productivity for pasture or management unit in kg.

S – is area of a pasture or management unit (ha),

PA – coefficient for productive area (0.6–1),

Y – pasture grass yield (kg/ha),

P – pasture grass palatability coefficient (0.4–0.85)

PAP estimation is crucial for composing grazing schedules on the management units in order to clarify usage terms and to provide each of the cattle units with grazing area during the entire grazing period.

4.4 PREPARING MANAGEMENT RECOMMENDATIONS

CALCULATION OF DOMESTIC ANIMALS' STOCKING RATES FOR ONE PASTURE

In 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 according to PDI. This figure can be transformed into recommended cattle units (CU). They indicate, how many cattle units are allowed on a specific management unit.

Calculate the recommended cattle units for each management unit, 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 cattle units for the pasture.

Name of MU	Size (ha)		Stocking rate (CU/ha)		Recommended cattle units
MU 1		X		=	
MU 2					
MU 3					
MU 4					
Sum (Recommended cattle units for the pasture)					

In different climatic zones duration of the grazing period may change depending on the bioclimatic conditions of that zone. Depending on productivity of the vegetation cover, it is possible to organize 1–5 grazing periods with certain periodicity on the same management unit during the grazing period (from spring to autumn). Grazing intensity depends on outgrowing capacities of the pasture, regrowing capacity of plants on it and timing. Each cattle unit from a community or a farm needs certain grazing area for a grazing period and the grazing area is defined based on the Allowable Grazing Pressure.

4.5 CALCULATING ALLOWABLE GRAZING PRESSURE (AGP)

Allowable Grazing Pressure (AGP) or pasture capacity is the maximal number of the cattle units that can be grazed on one pasture or management unit equal to 1ha within grazing period not causing vegetation damage and overgrazing.

It is calculated as follows:

$$AGP = L/D \times T$$

Where: AGP is the load of pasture or management unit with cattle units,

L –is the average load of 1ha (centner/**ha**),

D – is the daily demand of green fodder per 1 cattle unit (kg),

T – is the duration of the grazing season (days).

AGP helps defining the area of management unit or pasture required for one grazing animal for the entire grazing season.

For instance: AGP=4500/30x160=0.9 cattle units

In order to see what area is required for one cattle/sheep unit during the whole grazing period (160 days), one has to divide the nominal 1 hectare area by AGP, thus: 1:0.9 (cattle units) = 1.1ha.

Grazing area demand for the cattle units of the community or a farm for the whole grazing period, extrapolated with conversion coefficients is calculated in the following way:

PA = Cattle units x D x T/P

Where: PA - pasture area (ha)

D – daily demand of the green fodder per 1 cattle unit (kg),

T– Duration of the grazing season (day),

P – Average productivity of 1ha 1(c/ha).

Calculation of the pasture area demand is an important process that helps estimating the pasture area demand for the community's or farm's livestock. Measures for preservation of this resource are elaborated based on this calculation, such as renting out pastures or other alternative option-changes in the cattle unit numbers.

CALCULATING THE REQUIRED CHANGE IN LIVESTOCK NUMBERS

You calculated the actual cattle units currently stocking on the pasture in Chapter 2.3. Now you can calculate the required change in cattle units. It says how many cattle units you can keep more or have to keep less to arrive at the recommended cattle units on a certain pasture.

Three cases are possible:

Case 1: Change in cattle units is positive: the pasture conditions allow you to keep more livestock on the pasture than the farm or community actually has.

Case 2: Change in cattle units is zero: the pasture conditions allow you to keep just as much livestock as the farm or the community currently has.

Case 3: Change in cattle units is negative: the pasture conditions allow you only to keep fewer animals on the pasture than the farm or community 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, different units have to be grazed in different shares of the grazing time to ensure appropriate use. Share of grazing time (MU) says how many days or for which percentage of the grazing time should a herd use the management unit, throughout the whole grazing season. Based on these shifts' schedule of the management units usage (grazing) and rotational scheme are developed with possible rotations.

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

The figure is always below 100. How these figures are translated into grazing regimes depends on the decision of the pasture user. You should discuss this together with pasture users and representatives of the LSGBs.

PREPARING A RECOMMENDATIONS DATA SHEET

Pasture management recommendations data sheet has to be prepared, which can be used during the discussion of management recommendations with pasture users. It will become a ground for the development of a sustainable management process. This data sheet should contain the following information:

- **Map with pasture and management units (showing the boundaries of the management units).**
- **Current pasture management**
  a. Actual cattle units
  b. Size of the pasture in ha
  c. Duration of the grazing season
  d. Average productivity of the pasture equal to 1ha
- **Pasture condition**
  a. SEI-index traffic light
  b. PDI-index traffic light
  c. PAP –pasture actual productivity
- **Pasture management**
  a. SPI: Resulting recommended stocking rate

b. Recommended cattle units for each management unit
c. AGP` Allowable Grazing Pressure area for 1 cattle unit
d. Recommended cattle units for each management unit
e. Total recommended cattle units for the length of the grazing season
f. Change in cattle units

- **Grazing regime**
  a. Share of grazing time (days) for each management unit
- Conversion key for transforming cattle units (different types of animals of different age and gender) 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 pasture users for their own documentation, so they should be able to read and understand it without your help.

4.6 IMPLEMENTING IMPROVED (SUSTAINABLE) PASTURE MANAGEMENT

After completing the calculations you can start discussing the management recommendations with the pasture users and LSGB representatives. These recommendations will become a basis for sustainable management procedure. Recall the results given in the pasture management recommendations sheet and the notes from the initial interview (Data Sheet I).

Alternate grazing should be implemented based on pasture rotation principle, in order to ensure sustainable pasture management, taking into account actual indexes/indices of the natural pastures, livestock numbers and the duration of the grazing period.

Pasture rotation principle - is a pasture sustainable management system that implies change of the pasture use method and timing with certain periodicity. This makes it possible to implement rotational grazing and ensure temporary (1-2 years) zero-use of some pastures (overgrazed and degraded) contributing to their self-recovery.

To implement rotational grazing, based on alternate use of the management units, community or farm (rented) pasture areas are divided in management units, are numbered, named and mapped. Management units' use process, timing, grazing schedule setting sequence and periodicity of the management units' rotational use (See: appendix 5.5) are developed taking into account pasture topography.

Implementation of improved sustainable pasture management is a working process with pasture users that takes several years and one should set achievable annual goals together with pasture users. At best, the LSGB representative or an expert should work with pasture users over several years and also return after a certain time to evaluate the results of the changed practices. Improvements may affect vegetation level and productivity of the pasture or productivity of the animals.

GENERAL RULES FOR DISCUSSING PASTURE MANAGEMENT

Discuss the management recommendations with the responsible persons; these will be the pasture user or the LSGB representative. You identified the person in Question 3.5 in Data Sheet I.

ARGUMENTS FOR SUSTAINABLE PASTURE MANAGEMENT

Sustainable pasture management will provide for reduction of possible erosion and degradation processes, preservation of the vegetation cover, possibility for restoration and regrowing capacity of plants of the vegetation cover. Sustainable pasture management will result in productivity increase, improvement of the pasture grass quality, long-lasting preservation of the cultural condition of the pasture (a condition when the vegetation cover of a pasture is being restored continuously), that consequently will result in sufficient fodder quantities for animals and their productivity. Besides, sustainable pasture management will also positively affect the situation with biodiversity and will allow decreasing its vulnerability.

1. Pasture land is valuable, but a fragile resource. Herders have the power to destroy this resource, but the responsibility to preserve it (in accordance with the procedures stated by the law). 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. It will not be possible to use this resource in the future for its purpose.
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 already show signs of degradation. You can observe this e.g. by livestock tracks and bare soil on the pastures, which are 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 cm of bare soil means that there is no grass for the livestock to graze. 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. For this purpose one may want to reduce Allowable Grazing Pressure or to mark this plot as "resting" in the grazing schedule and let it recover. In case of heavily degraded pastures, it is suggested to undertake improvement actions to normalize the soil, aeration and water regimes. Additional seeding may be advised to improve vegetation cover and make it denser. This kind of pastures have to rest for some period of time (for 1-2 years), no grazing should be allowed there. Reduction in livestock numbers on these pastures can be of temporary nature, until the situation on that pasture improves.
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 then. This is the result of high livestock numbers and pasture irregular usage today that make plants and animals species sensitive to disturbance and extinct and negatively impact the biodiversity
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.
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, because here qualitative and quantitative potentials of herbage are higher. The fatter the animals are in autumn, the better they can survive the winter, the more productive they are, and consequently incomes of farmers are higher.
8. Every herder will agree that livestock keeping is risky, because of 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 will still have enough grass, while on a heavily grazed pasture the animals would stay hungry that will result in sharp decrease in animal productivity. 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

Explain to all pasture users, how to change livestock of different types of animals into cattle units (Appendix 5.4). Imagine the recommended cattle units as an amount of tokens the herder can allocate to different livestock, according to the conversion key (Chapter 2.3).

Case 1: Change in cattle units is positive. This means, the pasture conditions allow 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 cattle units is zero: The pasture conditions allow 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 cattle units is negative. The pasture conditions allow 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 that reduction in livestock numbers can be achieved. Refer to the proposals given below for such a discussion.

WAYS OF MITIGATING ECONOMIC HARDSHIPS OF DECREASED LIVESTOCK NUMBERS

In cases when remote pastures are not available to the farmer, the entire load of the grazing season goes to the pastures situated close to the communities, where load of the area unit increases significantly. Here reduction of the livestock is the way out in this case. Or other alternatives should be found, such as grazing some number of animals on the other pasture.

On some farms the problem is rooted in insufficient knowledge on livestock keeping or in insufficient animal care for domestic animals, which leads to low rearing rates of livestock.

If herders mention such problems, try to assist by providing information or the contacts of the agricultural extension service to improve the situation.

DISCUSSING GRAZING REGIMES

The share of grazing time is the most important figure to design grazing regimes for every management unit. It says which share of the grazing time in one grazing season the whole herd should use this management unit and what is the reason for organization of the alternate grazing on the pasture units. Different opportunities exist to design grazing regimes according to these shares. E.g. if the share of grazing time is 80 % for MU 1 and 20 % for MU 2, the following options 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.

If you have problems understanding the share of grazing time in percentage, 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.

4.7 IMPROVING THE FRAMEWORK FOR PASTORAL FARMS

Herders may have other problems with their farms, which prevent the implementation of sustainable pasture management.

INSECURITY OF LEASE CONTRACTS

If the rights for pasture access are insecure, herders have no incentive to think of plans for the future of those pastures. They think of the pasture as something for a day or a season.

Lease contracts are insecure if:

- The duration of the lease contract is less than 3 years (Question 4.6)
- The contract is verbal or is a sublease agreement (Question 4.3),
- 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, then secure rights for the pasture users are indispensable. It is also to your advantage, because you work with only one or a few users, rather than convincing every year somebody else. If you have the opportunity, try to convince the responsible administration (representatives of the Local Self-Government Bodies) that long-term lease contracts are to the benefit of all sides.

Implementing sustainable management on farms or in communities is conditioned by not only sustainable management procedures' development and sustainable management process' initiation. It also means having necessary infrastructure on common pastures and management units, such as:

a. water points for animals,
b. roads to remote pastures,
c. temporary accommodation and water points on the remote pastures.

Absence or deteriorated condition of the necessary infrastructure can be the main reason to consider some pastures as inappropriate and unjustified technically and economically for organization of grazing there. As a result, grazing season of all the livestock is organized only on those management units, which have infrastructure at place. Here, on this limited area outnumbered livestock causes overgrazing and trampling.

PROBLEMS WITH AWARENESS OF DEGRADATION

Pasture users may not see changes to the worse on the pastures or may not link them to overstocking with livestock. They may blame climate changes. If the decision maker with whom you are discussing is not the person interviewed for Data Sheet I, try to assess his opinion on pasture conditions and degradation problems. Use questions from Part 8 in Data Sheet I in an informal conversation.

If the decision-maker on livestock numbers rarely visits the pasture, he is probably not familiar with the pasture condition. Explain to him the results of your assessment

of pasture condition. If degradation problems are already apparent, show them on the pasture.

INDICATORS OF AWARENESS PROBLEMS

- Pasture user 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 both for livestock and the pasture (Question 8.6).

If awareness problems exist, try using Arguments 3 and 7 in Chapter 4.6. 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. 0
ANNEXES

5.1 DATA SHEET I. QUESTIONNAIRE FOR ASSESSING PASTURE MANAGEMENT OF SUMMER PASTURES OF_____ MARZ _____COMMUNITY

Interviewer: Date: Sheet N:

1. Basic data on summer pasture

1.1 GPS-Point (Name)

N (Latitude) E (Longitude) H (Altitude)

1.2 Name of summer pasture:

1.3 Name of interview partner:

For how many years have the community or a farmer used this pasture? _____ years

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

2. Winter keeping

2.1. Where is the livestock kept in winter?

- ☐ Winter pasture
- ☐ Community (indoor maintenence)

2.2 Duration of winter keeping.

- ☐ For cattle (days)
- ☐ For sheep and goat (days)

3. Pasture management

3.1 Who is responsible for herding on this pasture?

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

N	Name	Grazing	Management task	Livestock ownership	Presence on summer pasture
1		☐	☐		☐
2		☐	☐		☐
3		☐	☐		☐
4		☐	☐		☐
5		☐	☐		☐
6		☐	☐		☐
7		☐	☐		☐

3.2 Who is responsible for 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 the following questions:

3.2.1 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 the following?

Write down the No. of the persons as indicated in the table. In case other persons or legal entities are responsible, add them to the table.

a) Daily organization of herding

b) Veterinary care for livestock

c) Organization and timing of seasonal migration (to remote pastures)

d) Number of livestock on the summer pasture

e) Start of the grazing season

f) Completion of the grazing season

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 lease contract for this summer pasture?

- ☐ Yes
- ☐ No

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

- ☐ Written contract with the LSGB
- ☐ Verbal contract (agreement) with the LSGB
- ☐ Written sublease contract with original leaseholder
- ☐ Verbal sublease contract (agreement) with original leaseholder

4.3 Who holds this lease contract/agreement?

Name: Number of the person from Question 3 in the table (if given)

4.4 Which administration issued the original lease contract/ agreement?

- Regional Governor's office (Marzpetaran)
- Local Self-Governance Body (Village mayor's office)

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

- ☐ Several years
- ☐ Only this year

4.6 According to the lease contract 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

4.8 Are there pastures that are not being used? What is the reason?

a) Absence of water points
b) Bad quality of roads
c) Long distance to cover

5. Livestock

5.1 How much livestock is kept on the summer pasture?

Fill in total number.

Sheep and goat:
Cows:
Cattle (older than 12 months)

5.2 How has the quantity of livestock changed in the last years?

- ☐ Increased
- ☐ Stayed the same
- ☐ Decreased

Cross check livestock data with your own calculations.

6. Herds and flocks

6.1 How many herds and flocks are there in the community?

- ☐ herds
- ☐ flock

6.2 When does the grazing season start in Community?

- ☐ For cattle
- ☐ For sheep and goats

6.3 When does the grazing season end in the community?

- ☐ For cattle
- ☐ For sheep and goats

6.4 How long is the grazing season for the cattle in the community?

- ☐ days

7. Spatial organization of pasture use

7.1 Can you show your community pastures on the cadastral map of your community? Separately, please draw a simple map of a pasture that is used by a farmer under a lease contract.

a) Demarcate separate pastures and indicate their names and numbering.
b) Indicate pasture and the road leading to it
c) Which of the pastures is more fertile?
d) Which of the pastures has got scarce fodder quantities?

7.2 Do you employ spatial, plotting, rotational or temporal herding model?

8. Pasture condition

8.1 How do you assess the current condition of the community pastures?

- ☐ Good
- ☐ Satisfactory
- ☐ Bad

Are the pasture conditions better or worse, please explain the reason.

8.2 How has the condition of this pasture changed in the last 10-20 years?

- ☐ Improved
- ☐ Stayed unchanged
- ☐ Worsened

8.3 Is the community pasture area enough to provide the livestock with fodder for the entire grazing season?

- ☐ More than enough
- ☐ Just enough
- ☐ Not enough

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

- ☐ None
- ☐ Alternate grazing
- ☐ Improvements

8.5 In general, are there degradation problems on community pastures?

- ☐ Not at all
- ☐ A 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?

8.7 Which pastures are used more often during the entire herding season?

- ☐ Pastures close to the communities
- ☐ Remote pastures

8.8 What is the average pasture grass productivity of 1ha of pasture?

9. Livestock keeping organization

9.1 Are there any permanent herders in the community?

9.2 What is the maintenance method during the grazing season?

- ☐ Farmers in turns
- ☐ Permanent herder

10. Productivity of domestic animals

10.1 How much pasture grass one cattle unit needs a day?

10.2 What is the productivity (milk production capacity) of 1 cow for the entire grazing period?
Please draw the map here:

5.2 DATA SHEET II: SITE CONDITIONS AND STATE OF PASTURE _____ MARZ _____ COMMUNITY

Interviewer: Date: Sheet N

1. Site conditions (radius = 50 m)

If you do not find a slope that is more or less homogeneous within a circle of the given radius, then please mention the shortest radius of a homogeneous circle around yourself:

1.1 Location

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

1.1.2 GPS-Point (Name):
N (latitude)
E (longitude)

1.1.3 Altitude H (m above the sea level, from GPS):

1.1.4 Distance to the next pasture, water point or community (m):

GPS name of the pasture:
GPS name of the community:
GPS name of the water point:

1.1.5 Type of pasture (according to the classification)

1.2 Slope

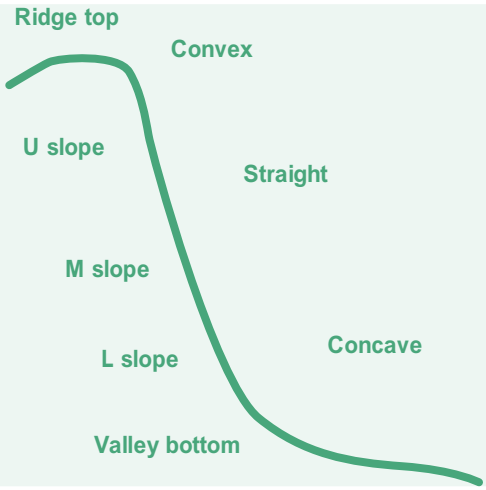
1.2.1 Slope inclination/ Steepness (°):
Inclination category

- ☐ 0–11.9°
- ☐ 12–20.9°
- ☐ 21–29.9°
- ☐ 30–39.9°
- ☐ 40° and more

1.2.2 Aspect (°)
Aspect category

- ☐ N (345–75°)
- ☐ E (75–165°)
- ☐ S (165–255°)
- ☐ W (255–345°)

1.2.3 Topographic position

☐	Ridge top		☐ Concave
☐	Upper slope		☐ Concave/ straight
☐	Middle slope		☐ Straight
☐	Lower slope		☐ Convex/straight
☐	Valley bottom		☐ Convex

1.2.4 Precipitation rate (annual)

- ☐ low
- ☐ medium
- ☐ high

1.3 Subsoil

1.3.1 Soil moisture

- ☐ dry
- ☐ moist
- ☐ wet

1.3.2 Bedrock (visible around)

- ☐ Limestone (solid, whitish)
- ☐ Basalt (solid)
- ☐ Slate (soft, dark-grey)
- ☐ Mix (Slate bedrock with rubble and limestone rocks)
- ☐ Mix (Slate bedrock limestone and rubble/rocks)
- ☐ Other; specify, if soft or solid and the color

1.3.3 Soil type

2. Erosion

2.1 **Ground not covered by vegetation,** estimated cover (%) on 10x10m:

2.1.1 Bare Soil

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

2.1.2 Stoniness (Rubble)

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

2.1.3 Rocks (big, stable)

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

2.2 Cattle tracks, estimated cover (%) on 10x10m (trampling %)

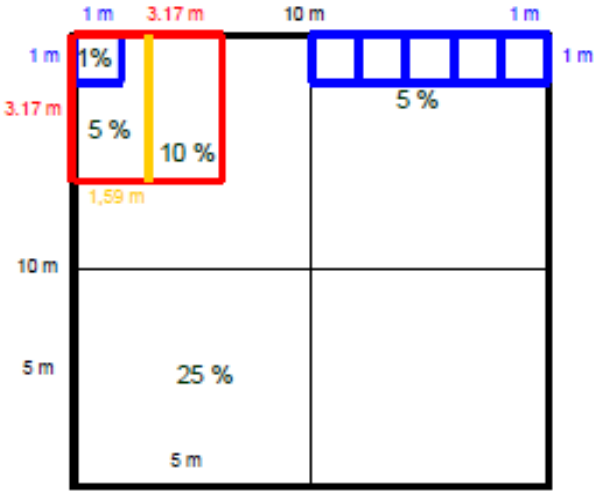
- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

2.3 **Erosion tracks,** estimated cover (%) on 10x10m in combination of bare soil, bare rubble **AND** visible erosion processes

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

2.4 Tussock land (caused by trampling, vegetation, ants, moles) indicate the type

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%



A sketch to help estimating the cover percentage on 10x10m

3. Vegetation

3.1 State of vegetation cover

- ☐ Dense
- ☐ Medium
- ☐ Sparse

3.1.1 Vegetation cover tipe, physiological feature (2 answers possible)

- ☐ Alpine mat (short vegetation cycle)
- ☐ Tussock-stand
- ☐ Meadow-like
- ☐ High grown vegetation
- ☐ Steppe
- ☐ Low-growing plants
- ☐ Semidesert
- ☐ Scattered vegetation

3.1.2 Vegetation height (cm), maximal

- ☐ Max
- ☐ Average height of most common species

3.1.3 Yield biomass (fertility of the green mass on 1ha)

- ☐ High (25-45c/ha and more)
- ☐ Medium 15-25c/ha
- ☐ Low 10-15c/ha

3.1.4 Vegetation watering

- ☐ Good
- ☐ Average
- ☐ Bad

3.1.5 Grazing tracks

- ☐ 1-5% of plants grazed
- ☐ 6-20% of plants grazed
- ☐ 51-80% of plants grazed
- ☐ 21-50% of plants grazed
- ☐ more than 80% of plants grazed

3.1.6 Turf-cladding level (surfice)

- ☐ Low
- ☐ Medium
- ☐ High

3.2 Grazing indicator species groups and their cover (%) on 10x10$m^{2.}$

3.2.1Thistles:

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

3.2.2 Thorn cushions (Tragacanthic and astragalus vegetation)

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

3.2.3 Shrubs

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

3.2.4 Other strongly hairy or thorny plants

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

3.2.5 Poisonous plants (as stated by herders or by own knowledge)

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

3.2.6 Cover sum of all recorded grazing indicator species groups!

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

3.3 Plant diversity

- ☐ Good
- ☐ Medium
- ☐ Bad

3.3.1 Flowering plants

- ☐ a lot
- ☐ average
- ☐ a few

3.3.2 Number of plant species (counted on 3x3m)
In categories:

- ☐ less than 12
- ☐ 12-22
- ☐ 23-33
- ☐ 34-44
- ☐ more than 44

3.3.3 Composition of vegetation cover botanical/economic elements/% (estimated on 3x3m)

- ☐ Truegrass
- ☐ Versigrass
- ☐ Legumes
- ☐ Sedges and rushes
- ☐ Not palatable plants

4. Visual appraisal of the state of pasture

- ☐ Good
- ☐ Medium
- ☐ Bad

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

Picture N°:

5.3 EXAMPLE CALCULATION

5.3. 1 Filled-in example of Data sheet I (See: 2.1, 2.2, 5.1)

Syunik Marz *Tolors* questionnaire for community's summer pastures management assessment

Interviewer: *Anna* Date: *20.08.2013*

Sheet No. *11-xx*

1. Basic data on summer pasture

1.1 GPS (Name)
Chakharadzor 11
N (Latitude)
E (Longitude)
H (Altitude) 2520

1.2 Name of summer pasture:
Sander

1.3 Interview partner: *Poghos*

For how many years do you personally come to this summer pasture? *10 years*

1.4 Sheet No.'s of Data Sheets II for pasture condition: 1

2. Winter keeping

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

- ☐ Winter pasture
- ■ Community (Indoor maintenance)

2.1.2 Duration of the indoor maintenance (days)

- ■ For cattle: 180
- ■ Sheep and goat: 240

3. Pasture management

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"

N	Name	Herding tasks	Management Tasks	Livestock ownership	Presence on summer pasture
1	Poghos	☐	■	1	■
2	Armen	■	☐		■
3	Rouben	■	■	2	■
4	Ashot	■	☐	3	■
5	Gevorg	■	☐		■
6	Gourgen	☐	☐		■
		☐	☐		☐
		☐	☐		☐

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

Mark "management tasks" in the table.

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 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 organization of herding	1,2,3,4,5
b) Veterinary care for livestock	1
c) Time and organization of seasonal migration	1,3,6
d) Number of livestock on the summer pasture	1
e) Start of the grazing season	1
f) Completion of the grazing season	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

Can you give information about the lease contract for the community pastures?

- [x] Yes
- [ ] No

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

- [x] Written contract with the LSGB (village mayor)
- [ ] Verbal contract (agreement) with the LSGB
- [ ] Written sub-lease contract with original leaseholder
- [ ] Verbal sub-lease agreement with original leaseholder

4.3 Who holds this lease contract/agreement?

Name: *Rouben* No. from table in Topic 3: *3*

4.4 Which administration issued the original lease contract/ agreement?

- [x] Regional Governor's office /Marzpetaran/
- [ ] Local Self-Government Body (village mayor's office)
- [ ] Other

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

- [x] 15 years
- [ ] Only this year

4.6 According to the lease contract how many hectares do you use?

- [ ] Total: 250
- [ ] Fertile land: 200 (useful area)

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

- [ ] Secure
- [x] Medium
- [ ] Insecure

4.8 Are there pastures that are not being used? What is the reason?

- a) Absence of water points [x]
- b) Bad quality of roads [ ]
- c) Long distance to cover [ ]

5. Livestock

5.1 How much livestock is kept on the summer pasture?

Fill in the total number.

Sheep and goat	900
Cows	50
Cattle (older than 12 months)	100

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

- [x] Increased
- [ ] Stayed the same
- [ ] Decreased

Cross check livestock data with your own calculation.

6. Herds and flocks

6.1 How many herds and flocks are there in the community?

- [x] Herds: 2
- [x] Flocks: 4

6.2 When does the grazing season start in the community?

- [x] For cattle: 01/05
- [x] For sheep and goats: 01/04

6.3 When does the grazing season end in the community?

- [x] For cattle: 01/11
- [x] For sheep and goats: 01/12

6.4 How long is the grazing season for the cattle in the community?

- [x] days: 180

7. Spatial organization of pasture use

Space for drawing is provided on the last page of the data sheet.

7.1 Can you show your community pastures on the cadastral map of your community? Separately please draw a simple map of a pasture that is used by a farmer or one herd under a lease contract (pasture under assessment).

a) Demarcate separate pastures and indicate their names and numbering.
b) Indicate water point on the pasture and a road leading to it.
s) Which of the pastures is more fertile?
d) Which of the pastures has scarce fodder quantities?

7.2 Do you employ spatial, plotting, rotational or temporal herding model?

- ☐ Spatial
- ■ Rotational
- ☐ Temporal

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

8. Pasture condition

8.1 How do you assess the current condition of the community pastures?

- ☐ Good
- ■ Satisfactory
- ☐ Bad

Are the pasture conditions better or worse; please explain the reason.

8.2 How has the condition of this pasture changed in the last 10-20 years?

- ☐ Improved
- ☐ Stayed unchanged
- ■ Worsened

8.3 Is the community pasture area enough to provide the livestock with fodder for the entire grazing season?

- ☐ More than enough
- ■ Just enough
- ☐ Not enough

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

- ■ None
- ☐ Alternate grazing
- ☐ Improvements

8.5 In general, are there degradation problems on community pastures?

- ☐ 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

8.7 Which pastures are used more often during the entire herding season?

- ■ Pastures close to the communities
- ☐ Remote pastures

8.8 What is the average pasture grass productivity of 1ha of a pasture?

- 25-40c/ha of pasture grass

9. Livestock keeping organization

9.1 Are there any permanent herders in the community?

- In general, there are not

1.2 What is the maintenance method during grazing season?

- ■ Farmers in turns
- ☐ Permanent herder

10. Productivity of domestic animals

10.1 How much pasture grass does one cattle unit need a day?

- 30-40kg

10.2 What is the productivity (milk production capacity) of 1 cow for the entire grazing period?

- 1000-1200l.

5.3.2 EXAMPLE CALCULATION OF ACTUAL CATTLE UNITS AND ACTUAL STOCKING RATES:

You need

- Livestock numbers recorded in Question 5.1
- Summer pasture area (ha) recorded under 4.6

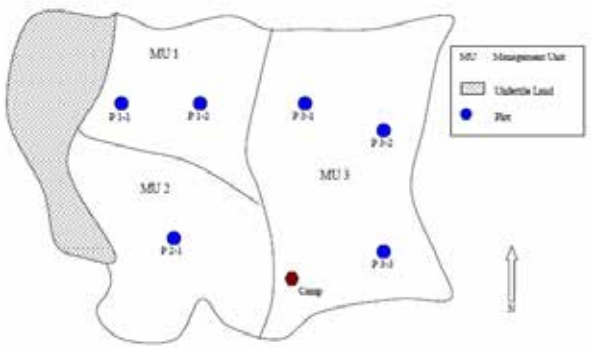
Calculate actual cattle units, as indicated in the following table:

	Number from questionnaire		Conversion coefficient		Cattle units
Of any age average Sheep	**1030**	x	**0.14**	=	**144**
Cow	**50**		**1.0**		**50**
Cattle age average	**100**		**0.75**		**75**
				Sum:	**269**

Calculate stocking rate of cattle units as follows.
Stocking rate = cattle units/area (ha) = 269/200 = 1.3 CU/ha

5.3.3 SAMPLE MENTAL MAP (SEE: 3.1, 3.2)

The responsible people together with herder have received 3 management units. Six plots were selected on management units 1, 2 and 3. On this sample MU1 and MU2 constitute 25% of the pastures each (50% together), and MU3 constitutes 50% of the pasture that has 200 ha in total (100 ha).



5.3.4 FILLED IN EXAMPLE OF DATA SHEET (SEE 3.3, 5.2)

Site conditions and state of summer pasture *Syunik*
Marz *Tolors* community

Interviewer. *Poghos* Date. *22.08.2013* Sheet N. *1U1-1*

1.Site conditions (radius = 50m)

If you do not find a slope that is more or less homogeneous within a circle of the given radius, then please note the shortest radius of a homogeneous circle around yourself: m

1.1 Location

1.1.1 Description of the region (valley, nearest mountain, nearest village)

1.1.2 GPS-Point (Name):
N (latitude)
E (longitude)

1.1.3 Altitude (m above the sea level, from GPS): 2729

1.1.4 Distance to the community (village), pasture or water point (m): 2000m

GPS name of the pasture:
GPS name of the community:
GPS name of the water point:

1.1.5 Type of pasture (according to the classification)
Truegrass-versigrass steep

1.2 Slope

1.2.1 Slope inclination/Steepness (°) 13°

Inclination category:

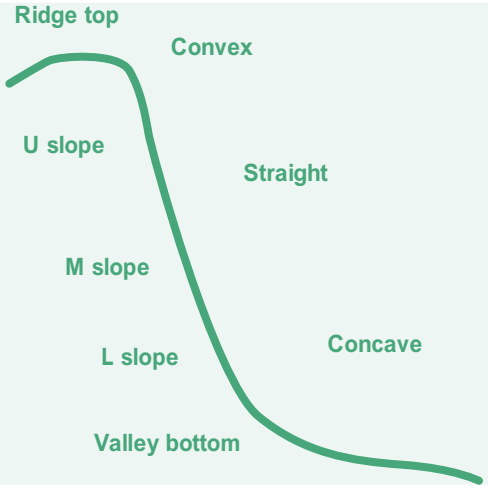
- ☐ 0-11.9°
- ■ 12-20.9°
- ☐ 21-29.9°
- ☐ 30-39.9°
- ☐ 40° and more

1.2.2 Aspect [°] 22°

Aspect category

- ■ N (345-75°)
- ☐ E (75-165°)
- ☐ S (165-255°)
- ☐ W (255-345°)

1.2.3 Topographic position

☐	Ridge top		☐ Concave
☐	Upper slope		☐ Concave/ straight
■	Middle slope		■ Straight
☐	Lower slope		☐ Convex/straight
☐	Valley bottom		☐ Convex

1.2.4 Precipitation rate (annual)

- ■ Low
- ☐ Average
- ☐ High

1.3 Subsoil

1.3.1 Soil moisture

- ■ Dry
- ☐ Moist
- ☐ Wet

1.3.2 Bedrock (visible around)

- ■ Limestone (solid, whitish)
- ☐ Basalt (solid)
- ☐ Slate (soft, dark-grey)
- ☐ Mix (Slate bedrock with rubble and limestone rocks)
- ☐ Mix (Slate bedrock limestone and rubble/rocks)
- ☐ Other; specify, if soft or solid and the color

1.3.3 Soil type – grey mountain-meadow

2. Erosion

2.1 Ground not covered by vegetation estimated cover [%] on 10 x 10 m:

2.1.1 Bare Soil

- ☐ Non-visible
- ☐ 1%
- ■ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

2.1.2 Stoniness (Rubble)

- ☐ Non-visible
- ■ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

2.1.3 Rocks (big, stable)

- ■ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

2.2 Cattle tracks estimated cover [%] on 10x10m(trampling %)

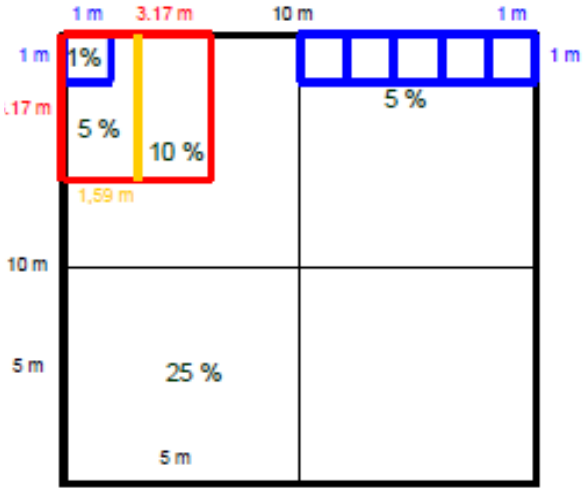
- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ☐ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ■ More than 50%

2.3 Erosion tracks, estimated cover [%] on 10x10m in combination of bare soil, bare rubble and visible erosion processes

- ☐ Non-visible
- ☐ 1%
- ☐ 2-5%
- ■ 6-10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ More than 50%

2.4 Tussock land (caused by trampling, vegetation, ants, moles) indicate type

- ☐ Non-visible
- ☐ 1 %
- ☐ 2-5 %
- ■ 6-10 %
- ☐ 11-25 %
- ☐ 26-50 %
- ☐ More than 50%



Sketch to help with estimating the cover percentage on 10x10 m

3. Vegetation

3.1 State of vegetation cover

- ☐ Dense
- ■ Medium
- ☐ Sparse

3.1.1 Type of vegetation, physiological feature (2 answers possible)

- ■ Alpine mat (short vegetation cycle)
- ☐ Tussock-stand
- ☐ Meadow-like (regularly high grown)
- ☐ High grown vegetation
- ☐ Steppe
- ☐ Low-growing plants
- ☐ Semidesert
- ☐ Scattered vegetation

3.1.2 Vegetation height (cm) maximal

Maximum 10cm; the average height of most common species is 5cm.

3.1.3 Yield biomass (fertility of the pasture grass on 1ha)

- [x] High 25-45c/ha
- [ ] Medium 15-25c/ha
- [ ] Low 10-15c/ha

3.1.4 Vegetation with watering.

- [ ] Well
- [x] Medium
- [ ] Badly

3.1.5 Grazing tracks

- [ ] 1-5% of plants grazed
- [ ] 6-20% of plants grazed
- [ ] 51-80% of plants grazed
- [ ] 21-50% of plants grazed
- [x] More than 80% of plants grazed

3.1.6 Turf-cladding level (surfice)

- [ ] Low
- [x] Medium
- [ ] High

3.2 Grazing indicator species groups and their cover (%) on 10x10m^2

3.2.1Thistles

- [ ] Non-visible
- [x] 1%
- [ ] 2-5%
- [ ] 6-10%
- [ ] 11-25%
- [ ] 26-50%
- [ ] More than 50%

3.2.2 Thorn cushions (Tragacanthic and astragalus vegetation)

- [ ] Non-visible
- [ ] 1%
- [x] 2-5%
- [ ] 6-10%
- [ ] 11-25%
- [ ] 26-50%
- [ ] More than 50%

3.2.3 Shrubs

- [ ] Non-visible
- [ ] 1%
- [x] 2-5%
- [ ] 6-10%
- [ ] 11-25%
- [ ] 26-50%
- [ ] More than 50%

3.2.4 Other strongly hairy or thorny plants

- [ ] Non-visible
- [ ] 1%
- [x] 2-5%
- [ ] 6-10%
- [ ] 11-25%
- [ ] 26-50%
- [ ] More than 50%

3.2.5 Poisonous plants (as stated by herders or by own knowledge)

- [ ] Non-visible
- [x] 1%
- [ ] 2-5%
- [ ] 6-10%
- [ ] 11-25%
- [ ] 26-50%
- [ ] More than 50%

3.2.6 Cover sum of all recorded grazing indicator species groups!

- [ ] Non-visible
- [x] 1%
- [ ] 2-5%
- [ ] 6-10%
- [ ] 11-25%
- [ ] 26-50%
- [ ] More than 50%

3.3 Plant diversity

3.3.1 Flowering plants

- [ ] A lot
- [ ] Average
- [x] A few

3.3.2 Number of plant species (count on 3x3m):

In categories:

- ☐ Less than 12
- ☐ 12-22
- ■ 23-33
- ☐ 34-44
- ☐ More than 44

3.3.3 Composition of the vegetation cover /economic units/ % (estimated on 3x3 m)

- ■ Truegrass
- ☐ Versigrass
- ☐ Legumes
- ☐ Sedges and rushes
- ☐ Not palatable plants

4. Visual appraisal of state of pasture

- ☐ Good
- ■ Medium
- ☐ Bad

5. Representative picture taken

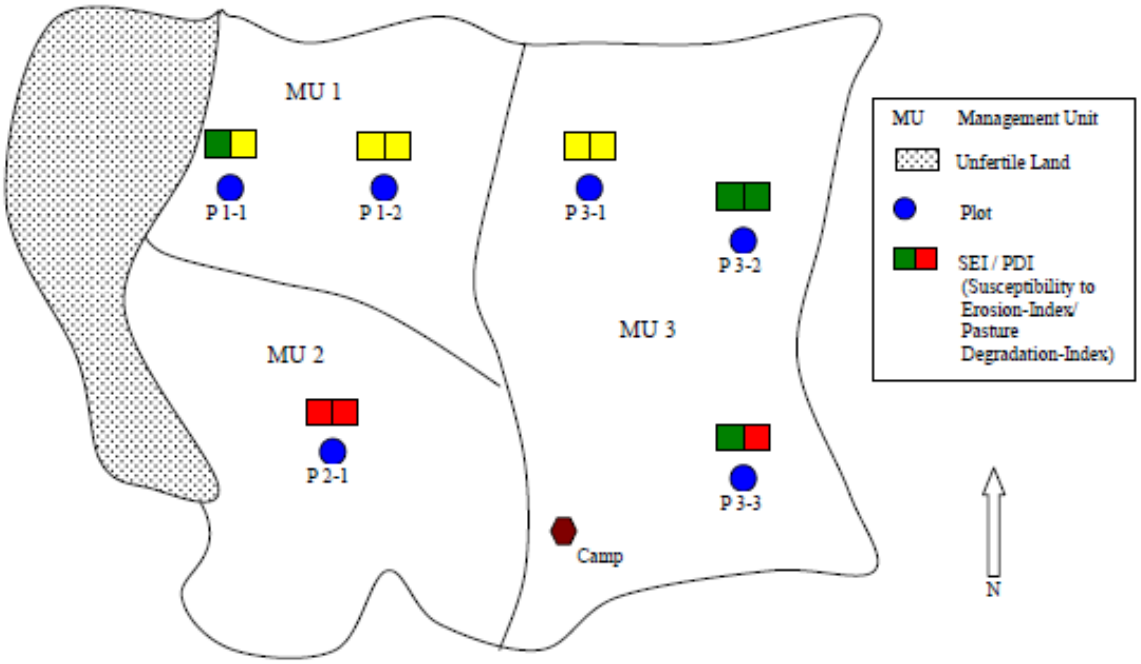
(file name should later have the site's GPS name)

Picture Nr:

5.3.5 Example calculation of SEI and PDI (see 3.4).

Sample 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) = $\frac{\text{Sum of scores obtained}}{\text{Sum of maximum scores}} \times 100$					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	Stoniness/ rubble	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	Cattle 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	6	4	2	6	9	2
Var. 13	Tussock land	0,2,4,6,8,9,10,	0	10	6	6	0	8	8	2
Var. 14	Grazing tracks	0,2,5,8,10	0	10	0	0	2	2	0	0
Var. 15	Turf-cladding	0,2.5, 5	0	5	2.5	5	0	5	0	2.5
Var. 16	Cover grazing indicator spec. groups	1,2,4,6,8,9,10	0	10	4	9	4	9	9	6
Var. 17	Flowering plants	0,2.5,5	0	5	0	0	2.5	2.5	0	0
Var. 18	Number of plant species	0,2,5,8,10	0	10	5	5	2	8	8	0
Var. 19	Economic elements	0,2,5,8,10	0	10	10	8	0	5	10	2
				105						
Sum of maximum scores				105						
Sum of scores obtained					61.5	52	25.5	70.5	75	33,5
PDI (normalized) = $\frac{\text{Sum of scores obtained}}{\text{Sum of max scores}} \times 100$					58,5	49.5	24,2	67.1	71.4	31,9
Degradation of Pasture					Medium	Medium	High	Medium	Low	High
Expressed as traffic light					Yellow	Yellow	Red	Yellow	Green	Red



5.3.6 SAMPLE EXTRAPOLATION OF RESULTS FROM PLOTS TO MANAGEMENT UNITS (SEE 4.1)

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

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

$$\text{SEI-MU 2} = 31.1$$

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

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)

$$\text{PDI-MU 1} = \frac{\text{PDI P 1-1} + \text{PDI P 1-2}}{2} = \frac{67.5 + 41.3}{2} = 54.0$$

$$\text{PDI-MU 2} = 24.2$$

$$\text{PDI-MU 3} = \frac{\text{PDI P 3-1} + \text{PDI P 3-2} + \text{PDI P 3-2}}{2} = \frac{67.1 + 71.4 + 31.9}{2} = 56.8$$

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	54.0	34-67	Medium	Yellow	2.5
PDI -MU 2	24.2	0-33	Strong	Red	0
PDI -MU 3	56.8	34-67	Medium	Yellow	2.5

5.3.7 Sample 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 (cattle units per ha (SU/ha)) are recommended.

	SPI-MU	Management recommendation
SPI-MU 1	5	0.6 SU/ha
SPI-MU 2	0	No grazing
SPI-MU 3	7.5	0.8 SU/ha

5.3.8. Example of preparing management recommendations (See 4.3)

Calculation of the recommended livestock number for a pasture

Name of MU	Size (ha)		Stocking rate (SU/ha)		Recommended sheep units
MU 1	50	x	0.6	=	30
MU 2	50		0		0
MU 3	100		0.8		80
Sum (Recommended cattle units for the pasture)					110

110 cattle units are recommended to be kept on this pasture.

Calculating the required change in livestock numbers

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

Change in cattle units = 110-269 = -159

Case 3 has occurred: the pasture conditions allow you only to keep fewer animals on the pasture than the farm or community actually has. The herder has to destock 159 cattle units to improve the pasture condition. This can be arranged by renting other pastures or by looking for alternative solutions to this problem.

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

Share of grazing time (MU 1) (%) = 30 x 100/110= 27 %

Share of grazing time (MU 2) (%) =0 x 100 /110= 0 %

Share of grazing time (MU 3) (%) = 80 x 100/110= 73 %

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

5.4 CATTLE UNITS' CONVERSION COEFFICIENTS

Bull	1.10	Calves (older than 1 year)	0.60
Cow	1.0	Horses of different age average	0.80
Average of all the cattle of different age	0.75	Sheep and goats of different age average	0.14

Cattle units' conversion coefficients of different species, age and gender of the domestic animals

5.5 SCHEDULE AND ORDER OF ROTATIONAL USE OF PASTURES (MANAGEMENT UNITS)

Pasture/ management unit			Number of herds, flocks	Grazing timing (rotations)			Grazing duration
Number	Area, ha	Name		I Cycle	II cycle	III cycle	

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