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Shenako Land Use Plan

Hanns Kirchmeir, Michael Huber
(***E.C.O. Institute of Ecology, Klagenfurt, Austria***)

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Applying Landscape and Sustainable Land Management (L-SLM) for Mitigating Land Degradation and Contributing to Poverty Reduction in Rural Areas of Georgia

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Shenako land use plan 2018

for the GEF/UNEP financed Project "Applying Landscape and Sustainable Land Management (L-SLM) for mitigating land degradation and contributing to poverty reduction in rural areas"

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Prepared by REC Caucasus
13, B. Shoshitaishvili str.
0179 Tbilisi, Georgia

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TABLE OF CONTENTS

1 Introduction 6

1_1 Background 6

1_1_1 National LDN Targets of Georgia 8

1_2 Rationale 9

2 Shenako Land Use Plan 10

2_1 Methodology 10

2_1_1 Description of Planning Process 11

2_1_2 Mapping guideline for Shenako land use plan 11

2_1_3 Classifications of land use categories (LUC) 12

2_1_4 Classification of current use intensity 13

3 Documentation of current land use in Shenako 15

3_1_1 Recommendations on sustainable effective land use types 20

3_1_2 Draft of potential future land use scenarios 22

3_1_3 Summary on future scenarios 27

4 References and related studies 28

5 ANNEX: CLC Classification 29

5_1 Class 1.1 Urban fabric 29

5_1_1 112 Discontinuous urban fabric 29

List of Figures

Figure 1: Types, Degree and causes of global land degradation (Gruver 2013) 7
Figure 2: National LDN targets of Georgia. 8
Figure 3: Spatial planning procedures, documents and responsibilities on different planning levels in Georgia 10
Figure 4: Training on pasture management and fencing technologies in Shenako 2018. 11
Figure 5: Change in land use practice in Shenako from the 19th to 21st Century (own scheme). 15
Figure 6: Number of houses in Shenako with and without roofs. 16
Figure 7: Area per land use category based on the assessment 2018. 16
Figure 8: Agricultural land boarders of Shenako (source: Pasture Management Plan, GIZ/IBIS 2016) 17
Figure 9: Map of current land use categories in Shenako. 17
Figure 10: Land use map of Shenako (present use). 19
Figure 11: Area covered by current land use types in Shenako. 19
Figure 12: Land use intensity 19
Figure 13: Some parts of pastures show significant amounts of weeds (thistles) which are unsuitable as fodder for cows. 22
Figure 14:Change of size of arable fields, hay meadows and pastures within the current status and the 3 future scenarios. 24
Figure 15: Potential spatial distribution of land use categories in scenario 1. 25
Figure 16: Potential spatial distribution of land use categories in scenario 2. 26
Figure 17: Potential spatial distribution of land use categories in scenario 3. 27

Abbreviations

CLC – Corine Land Cover

COP – Conference of Parties

GEF – Global Environment Facility

LDN – Land Degradation Neutrality

L-SLM – Landscape – Sustainable Land Management

LUC – Land Use Classification

NAPCD – National Action Programme to Combat Desertification

NAPR – National Agency for Public Registry

NEAP – National Environmental Action Programme

SLM – Sustainable land management

ToT – Training of Trainers

TSP – Target Setting Process

UAV - Unmanned Aerial Vehicle

UNCCD – United Nations Convention on Combatting Desertification

WB – World Bank

1 INTRODUCTION

1_1 Background

The lack of efficient land management policies, a weak regulatory framework, limited access to appropriate information and technology, weak institutional capacities and a lack of cooperation between various stakeholders along with high rate of natural disasters are causing significant problems in land management sector and for overall ecosystem integrity.

Therefore, from the management point of view, one of the major problems Georgia is facing today is an absence of a comprehensive and integrated approach in the land management sector. In addition, an irrelevant legal framework sometimes is the source of additional "conflicts" with the evolved national strategy and policy packages.

Georgia has shown a clear drive to combat land degradation and to improve its land management systems by moving forward with the establishment of a strong baseline. This includes the accession to and implementation of most pertinent international agreements and the adoption of several related policies and laws (NEAP, NAPCD, etc.).

The above-mentioned factors underpin the importance of a review of the country's existing policy and regulatory framework related to the management of land resources. This will serve as upmost important component to overcome existing barriers to mainstream L-SLM activities. National plans and policies do not reflect holistic land management principles and practices.

There is a failure of national and rural decision-making frameworks to provide adequate legal parameters and tools to support L-SLM. Current policies result in disparate organizations responsible for various land management sectors making unilateral decisions leading to uncoordinated approaches. Consequently, "on the ground" management decisions made by responsible communities and resource users do not benefit from the guidance of coordinated, national strategies.

Capacity and information pathways do not exist to provide rural community members with examples of alternative, sustainable methods of resource use. Remote communities and resource users who are responsible for many land management issues, do not have satisfactory access to the information and tools necessary for informed decision-making. As a result, community land use plans and other decision-making tools intended to address land degradation fail to reflect L-SLM principles and practices.

The overall objective of the project is to support integration of good Landscape and Sustainable Land management (L-SLM) principles and practices into national policy and institutional framework to ensure adoption of economically viable practices by rural communities.

The land use plan for Shenako is on measure beside others to contribute to this objective.

Linkage to UNCCD and Land degradation neutrality

The globally ongoing degradation of land resources is threatening our food security and the functioning of ecosystem services. It is therefore, that a reduction and reversal of this trend has been defined as a Sustainable Development Goal (15.3) and become a strategic objective of the UNCCD. To achieve this global vision of Land Degradation Neutrality (LDN), action on national level is needed. To support the committed countries in defining national targets and an implementation strategy, the Global Mechanism (GM) of UNCCD launched the Target Setting Program (TSP). Georgia is one of the 113 countries (as of Sept. 2017) willing to take part in the TSP.

Unsustainable land use practices, such as deforestation, overgrazing and improper agricultural management systems are triggering the loss and degradation of valuable land resources in Georgia – a process that is being enhanced by the effects of climate change (e.g. droughts). These effects are visible across all countries of the South Caucasus and thus the report at hand can provide important impulses for other areas of the South Caucasus. The topic of land degradation is an issue which urgently needs to be tackled and integrated into national planning instruments.

With the 2nd UNCCD National Action Plan (2014-2022) adopted in 2014 and a transnational inception workshop on "National Target Setting to Achieve Land Degradation Neutrality" in June 2016, Georgia has taken

important first steps to combat land degradation. Next to this, several projects have already tackled the issue or are currently working on these challenges at the same time.

The main causes for land degradation and most affected regions in Georgia have already been identified. A TSP working group with participants from nine countries from Central and Eastern Europe, Southern Caucasus and Central Asia has been formed.

On behalf of the ONE WORLD – No Hunger initiative of the BMZ, the GIZ sector project BoDeN is supporting Georgia – as one of several selected countries – to proceed with the implementation of the LDN objective through pilot projects.

In line with priorities of main national partners, LDN at municipal level should be further specified particularly regarding target setting, baseline and monitoring and national and local capacities development to operationalize LDN.

Building upon to the UNCCD supported target setting, it is crucial to define pathways for LDN to enter formal/structural and policy processes at national and municipal level (e.g. land-use planning, regulations, incentives) to ensure a benefit on the ground. Monitoring change with regards to LDN would otherwise make little sense.

General and national understanding of degradation

For outlining LDN Monitoring and its purpose, it is indispensable to define a common understanding of land degradation in general and in a Georgian context. This definition is also crucial to define measures, to discuss with stakeholders and to measure success. Land degradation in general is a fuzzy concept, which is difficult to communicate and understand.

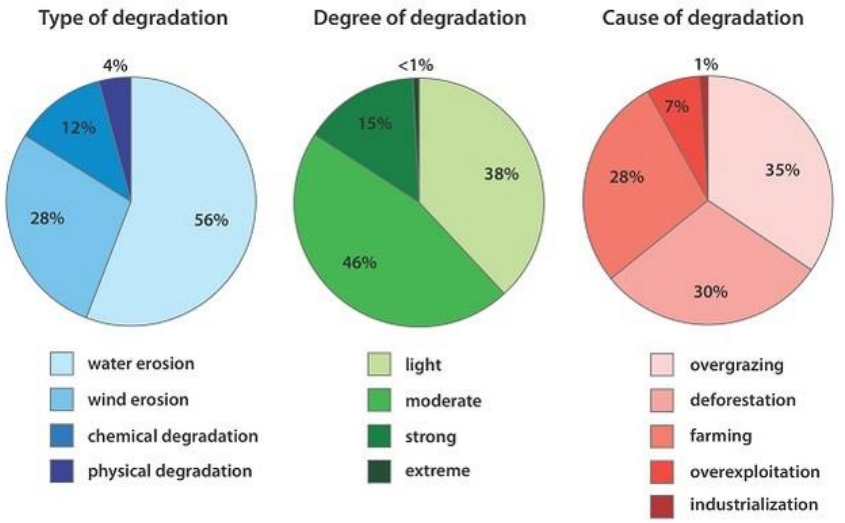

Figure 1: Types, Degree and causes of global land degradation (Gruver 2013)

The UNCCD "land degradation" means reduction or loss of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, includinALg processes arising from human activities and habitation patterns, such as:

- soil erosion caused by wind and/or water;
- deterioration of the physical, chemical and biological or economic properties of soil; and
- long-term loss of natural vegetation;

Land degradation implies a persistent reduction of land productivity such as land's biological products including forage, food or timber (Adeel et al. 2005). Consequently, Land degradation neutrality according to UNCCD refers to *"a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems*" (UNCCD, COP (12)/4 2015).

1_1_1 National LDN Targets of Georgia

To achieve the vision of zero net loss of healthy and productive land, measures and action on the ground are needed. Georgia is one of 114 countries that committed to define national LDN targets and an implementation strategy. In a first step, land degradation hot spots and main degradation causes had been identified. Land degradation in Georgia can be characterized by the following aspects:

- Loss of natural vegetation and soil quality caused by overgrazing;
- Loss of agricultural productivity and soil due to inappropriate farming techniques;
- Reduction of area and quality of forests due to illegal extraction and inappropriate forest management;
- Loss of productive land due to urbanization and conversion into non-agricultural areas.

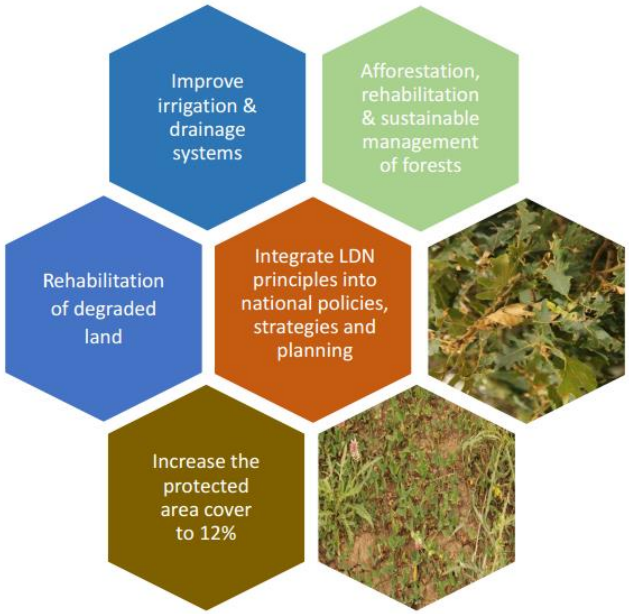

Figure 2: National LDN targets of Georgia.

The process of setting up national targets and an implementation strategy for LDN started in Georgia in 2016 in the frame of the ´Target Setting Program´ (TSP) facilitated by the Global Mechanism. Cross-sectoral meetings yielded in a set of national LDN targets, which were submitted to the UNCCD Secretary by the Ministry of Environment and Natural Resources Protection of Georgia in September 2017 (see Figure 3). Some pilot projects on sustainable land management within the municipalities most affected by land degradation – Akhmeta, Dedoplistskaro and Gardabani – are now being set up together with the local communities.

Shenako land use plan and LDN

The land use planning in the village of Shenako, Akhmeta Municipality is one of the pilot activities linked to LDN.

The land use plan documents the status quo of the current land use. It is a baseline which can be used to steer and to monitor future developments.

The mapping result is a detailed documentation of size and spatial distribution land cover categories. Beside the land category, the land use intensity or productivity of sites is mapped as well.

Both combined is an important indicator to monitor the loss and gains according to the LDN monitoring concept.

The plan and the development concept of a future land use scenario will help to anticipate the future gains and losses and to reflect the national LDN-target on the local level.

The land use plan on village level helps to break down these targets on the local level. Local stakeholders can identify areas of degradation risk and areas which can be rehabilitated. On village level, the applied land use practice is mainly controlled by the local stakeholder themselves. They are the main beneficiaries from the land management or, on the other hand, would suffer most from degradation. It can be assumed, that village population has a vital interest on a sustainable land management to ensure livelihood for them and future generations. This underlines the importance to include the local actors (farmers, tourism service

providers, land owners and other land users) into the development of future land use plans and concepts.

The terrestrial evaluation of the current land use can also serve to evaluate remote sensing technologies for semi-automatic classification of land cover categories.

1_2 Rationale

The project's pilot municipalities are characterized by socially vulnerable communities with low income, mostly dependent on agriculture. All are affected by climate change and land degradation.

Component 2 of the project aims to increase the understanding of L-SLM and its contribution to livelihood at local level via vulnerability profiles, local land use planning, and demonstration projects / proofs of concept of L-SLM interventions. Local community land use plans are not available at the moment. There is a need to develop such plans according to local needs and realities and in accordance with other policy frameworks.

There is a lack of capacity of local governments to develop land use plans which will support the optimal use of existing land resources and mitigate the land degradation process.

Effective planning and management of land use is hindered by the fact that there is no strong state institution responsible for all these fields.

Community engagement works best where it is an ongoing cumulative process enabling relationships and trust to build and strengthen over time. Individual engagement events should be planned and designed with this in mind and aim to contribute to the overall aims of the engagement process. Community or voluntary groups may want to participate at different levels – from providing advice to co-designing the process and from undertaking some aspects of the engagement to delivering projects to meet some of the outcomes.

Farming is the primary economic activity and therefore farmers play a central role in the development and designing the community land use plans.

Akhmeta municipality was selected for the development of land use plans involving the public. The municipality was chosen because the partner organization GIZ already has baseline GIS and RS Data for Akhmeta municipality and is currently supporting a spatial planning documentation for the whole municipality of Akhmeta implemented by the Ministry of Economy and Sustainable Development of Georgia. Therefore, Akhmeta would be a good showcase how erosion control measures, pasture improvements and land use planning on village level can be integrated in to the spatial planning process on higher level.

The project will provide recommendations for the development of local land use and community management plans, identifying stakeholders and champions through demonstration activities.

Sustainable Land Management (SLM) is *"the adoption of land use systems that, through appropriate management practices, enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources"*. SLM is based on four common principles:

- Land-user-driven and participatory approaches;
- Integrated use of natural resources at ecosystem and farming systems levels;
- Multilevel and multi-stakeholder involvement; and
- Targeted policy and institutional support, including development of incentive mechanisms for SLM adoption and income generation at the local level.

Landscape and Sustainable Land Management (L-SLM) is the harmonization of these approaches, with an emphasis on combating land degradation and reducing rural poverty.

The Shenako land use plan contributes to a stainable land use by identifying the maximum grazing capacities, sites of erosion risks and unused fodder potentials, which can be used to increase overall productivity.

2 SHENAKO LAND USE PLAN

By the development of an innovative land use plan together with the local stakeholders and by the implementation of appropriate land management measures, eroded pasture land will be rehabilitated, and productivity will be increased. This is in line with the national land degradation neutrality targets and will lead to an increasing income of local farmers.

2_1 Methodology

According to the Chapter on Integrating the Land degradation Neutrality concept into spatial planning procedures (Georgian Spatial Planning Guideline) the procedure of defining a spatial development plan for a municipality goes along three stages:

- Stage 1: Gather background information & implement pre-design studies
- Stage 2: Task order preparation – synopsis of background information, consider international & national objectives and legal framework
- Stage 3: Develop a spatial development plan for the municipality, including territorial-functional zoning (priority areas for different uses and objectives)

On community level, the municipal spatial development plan is being concretized within a village development regulation plan

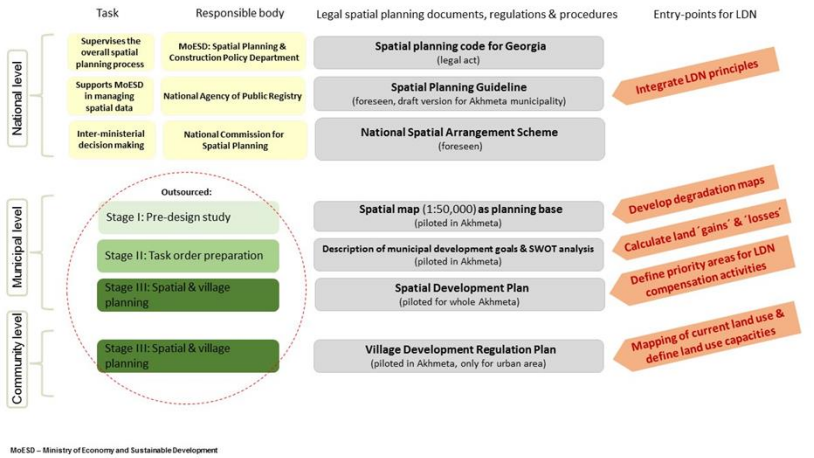

Figure 3: Spatial planning procedures, documents and responsibilities on different planning levels in Georgia

During the spatial planning process in Akhmenta Municipality, a development regulation plan was developed for Shenako (Studio 21 & Geographic 2018).

This planning document includes a detailed assessment of all buildings and the road infrastructure in Shenako and gives recommendation on the infrastructure development (e.g. enhancing parking areas). The development regulation plain is focusing on the settlement, while the agricultural resource use (arable lands, pastures, hay meadows) are not addressed in this document.

To add information to the overall spatial planning documented, the land use plan within this L-SLM activity is set up to deliver additional data and maps linked with the natural use potentials and to the monitoring of land degradation neutrality on village level.

The land use map will describe the current use of natural resources and will highlight spatial information areas under degradation (eg. eroded pasture land or unused arable fields). The mapping of the current size

and quality of pastures, hay meadows and arable fields will give a good impression of the current and potential productivity of the ecosystem. The mapping took into consideration the biodiversity hot spots of the village area.

The results should feed the ongoing participation process with the local village stakeholders to set up a plan showing the future land use of Shenako.

2_1_1 Description of Planning Process

The implementation process for 2018 was structured into the following work packages:

- Definition of the Shenako village boundary based on the pasture unit map
- Delineation of different land use units based on satellite and drone images
- Meeting with local stakeholders on the current land use practice
- Training of national experts in the field mapping of land use
- Evaluation of land use map in the field
- Integration of fodder biomass data from GIZ IBIS project
- Preparation of final GIS-Map of land use polygons
- Preparation of report

A follow up process with the local stakeholder involvement is needed in 2019 to discuss the results and develop a future land use plan that fits to the expectations and needs of the village population and is in line with L-SLM and Land degradation neutrality targets.

Figure 4: Training on pasture management and fencing technologies in Shenako 2018.

2_1_2 Mapping guideline for Shenako land use plan

For the mapping of the settlements, arable land and gardens, an ortho-image based on images from UAVs (unmanned aerial vehicles) prepared in 2016 by E.C.O. was used in Shenako. For other areas, maps from Bing-Maps were used. Google Earth and Bing Maps provide the same image information dated 26 August 2006.

For the field work maps of the area were printed in scale 1:2,500. The delineation of land use polygons is determined by the colors and structures visible in the images. The minimum size of a polygon for the Shenako Land use Plan was 25 m². For Shenako, houses were assessed separately, considering gardens and roads within the settlement in separate polygons. In the field maps each polygon has an assigned Map-ID number which is unique for each village. Polygons with the same land use category and land use intensity can have the same Map-ID.

Next to the drawing of the polygon on the map, a field form is used to describe each polygon by:

- Map-ID
- Current Land use category
- Current Land use intensity
- Remark (a specification of the polygon if needed)

In Shenako the historic land use (> 20 years) and the potential future land use was additionally indicated for each polygon.

2_1_3 Classifications of land use categories (LUC)

The land-use classification in this approach is based on the Corine Land Classification System. It was split into sub-categories where needed to meet the needs of local land use practices. For easy use, a 3-charakter code is used for each category (to be used in the forms). In brackets (after the land use type) the code from the Corine Land Classification system is added (three-number-code).

The pasture land was differentiated into different productivity classes. The 3 classes (low, medium and high productivity) where assessed in the field by vegetations cover and species composition. For the biomass estimation of each of the landcover types, mean values from the biomass map (IBIS/GIZ, Mikeladze &.Megvinetukhutsesi 2018) where used.

For the mapping in Shenako the following land use categories were selected.

Settlements and human infrastructure (Code, name)

- SET Settlement area
- SRP Roads and parking areas (CLC 112)
- SOI Other infrastructure (industry, shops …) (CLC 112)
- MES Mineral extraction sites (CLC 131)
- DUS Dump sites (CLC 132)

Only for Shenako:

- SHR Houses roofed (CLC 112)
- SRU Ruins (Houses without roof) (CLC 112)
- SCH Churches and scarified buildings (CLC 112)

Forests & shrubland

- FCC Closed Coniferous Forest (66-100% crown cover) (CLC 311)
- FCO Open Coniferous Forest (33-65% crown cover) (CLC 311)
- FDC Closed Deciduous Forest (66-100% crown cover) (CLC 312)
- FDO Open Deciduous Forest (33-65% crown cover) (CLC 312)
- FMC Closed Mixed Forest (66-100% crown cover) (CLC 313)
- FMO Open Mixed Forest (33-65% crown cover) (CLC 313)
- FSC Closed shrubland (66-100% crown cover) (CLC 324)
- FSO Open shrubland (33-65% crown cover) (CLC 324)
- FWB Windbreaks (CLC 211)

(Woodlands with crown cover < 33% will be classified as “open land” other than forests)

(Shrubland is built up by wooden species that will not exceed 5m in adult stage)

Agricultural managed land

- AP3 Pastures with high productivity (CLC 231)
- AP2 Pastures with medium productivity (CLC 231)
- AP1 Pastures with low productivity (CLC 231)
- AH3 Hay Meadows with high productivity (CLC 211)
- AH2 Hay Meadows with medium productivity (CLC 211)
- AH1 Hay Meadows with low productivity (CLC 211)

- AAF Arable field cultivated (CLC 211)
- AGL Garden land (CLC 112)
- AOR Orchards, fruit trees, berry-culture (CLC 222)
- AVY Vineyards (CLC 221)
- APD Paddock (to gather sheep/cattle overnight, mostly no vegetation) (CLC 231)

Natural and seminatural habitats

- NWL Wetlands (with grass and herb cover) (CLC 411)
- NRI Rivers (CLC 511)
- NLA Lakes (including man made dams and ponds) (CLC 512)
- NRO Rocks (CLC 332)
- NSF Natural scree-fields (CLC 332)
- NBS Naturally bare soil (CLC 324)
- NSG Snow and glaciers (CLC 335)
- NSV Sparsely vegetated areas (CLC 333)
- NGL Natural grassland (CLC 321)
- NMH Moors and Heathland (CLC 322)

2_1_4 Classification of current use intensity

0 Not used
1 low intensity
2 medium intensity
3 high intensity

Examples:

Pastures

1 low intensity: < 30% of plants are showing signs of browsing; signs of trampling hardly visible
2 medium intensity: 30%-80% of plants are showing signs of browsing; signs of trampling are visible but < 30%
3 high intensity: >80% of plants are showing signs of browsing; signs of trampling on > 30% of the area

Hay meadows

0 Not used for more than 2 years
1 low intensity: hay is cut once per year or once in two years
2 medium intensity: 2x hay cut /year
3 high intensity: more than 2 cuts a year, fertilizer/manure applied

Arable land

0 Not used for more than 2 years
1 low intensity: annual culture without user of pesticides, 1 culture a year
2 medium intensity: 1-2 cultivations a year, fertilizer and pesticides applied
3 high intensity: more than 2 cuts a year, fertilizer/manure applied

Roads

0 no gravel bed, not paved (usually with grass/herb cover in the middle)
1 gravel bed, not paved
2 paved, local road
3 paved, higher level road (main road, high way)

Settlements

0 Mainly ruins of old houses, only few houses are maintained
1 1-2 storage house, rural settlement with gardens between houses
2 Small city, 1-5 storage houses, administrative buildings, small commerce and industry buildings, shops
3 City with houses > 5 storages, large commerce and industry buildings, shopping malls.

Forest

The assessment should take into regard timber harvesting dating back to approximately 50 years.

0 no human management visible (no stumps, old trees, dead wood)
1 single tree selection cutting (gaps with size of 1-2 tree crown in the canopy)
2 group selection cuttings and small clear cuts/shelterwood cuttings < 0.5 ha
3 clear cuts and shelterwood cuttings > 0.5 ha (even aged stands)

Classification of historical and future land use (only Shenako)

- AL Arable fields
- BS Bare soil, rocks and scree-fields
- FL Forest and Shrubland
- GL Gardenland
- HM Hay medows
- NG Natural grassland
- SG Snow and glaciers
- NS Sparsely vegetated areas
- OV Orchards and Vinyards
- PL Pastures
- PLE Degraded pastures excluded from grazing
- SI Settlements
- WB Water bodies
- WL Wetlands

3 DOCUMENTATION OF CURRENT LAND USE IN SHENAKO

The village area which is used for the land use plan is defined by the pasture unit “98” (old soviet pasture system) and covers an area of 360 ha.

The area of arable lands, hay meadows and pasture around Shenako is about 260 ha and ranges from 1800 up to 2400m above sea level.

Main annual precipitation is 750-900mm and mean annual temperature is 2-4°C (CHELSA global climate data, Karger et al. 2016).

The land use practice has changed during the last centuries significantly. Until the begin of the 20th century the permanent settlement was in the villages up in Tusheti. In the Soviet period, the Tush population was resettle to newly created settlements in the lowlands (Alvani) and the complex traditional land use in Tusheti (pastures, hay meadows, arable fields) have been replaces by pure sheep breeding.

After the Soviet period, land use was changing again and mixture of sheep and cattle breeding as well as tourism developed. But grazing is not applied in a traditional or regulated form, which lead to overgrazing effects and erosion especially of steep pastures close to the villages.

Tourism gives new income opportunities for local stakeholders. But it is also important to keep agricultural use alive. The agricultural land use (livestock breeding, growing potatoes and vegetables) should be sustainable in ecological and economical dimension.

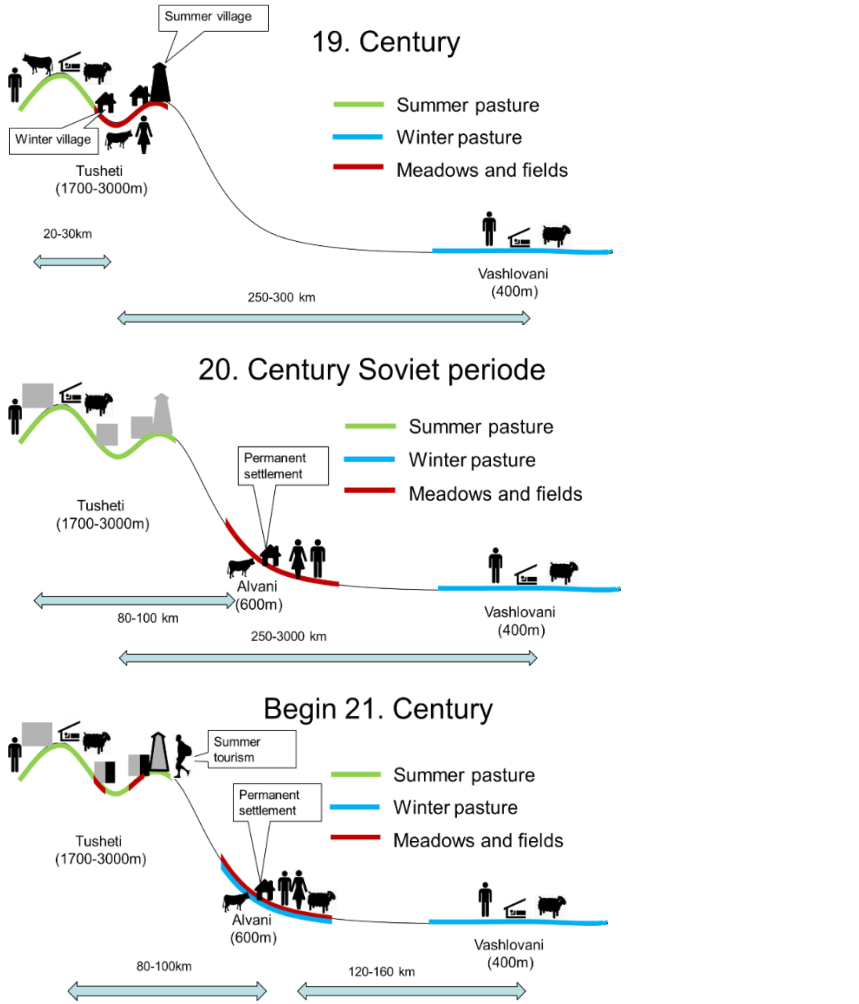

Figure 5: Change in land use practice in Shenako from the 19th to 21st Century (own scheme).

In the northern and eastern part, there are step slopes with inclination

more than 30° with signs of heavy erosion. The area of this erode pastureland is about 50-60 ha.

Within the GIZ-IBiS project (former GIZ-Project on Erosion Control in the Southern Caucasus) an area of 23 ha of heavily eroded pasture have been excluded from grazing by electric fencing in the north part and a test site of 6 ha for rotational pasture system west of the village have been installed in 2016. In 2018 another 6 ha have been fenced with electric fence in the east part of the area (3 ha eroded area, 3 ha medium productive pasture) within the RECC-L-SLM project (GEF funded).

This area is an old clearance of the natural forest cover. The current settlement is located in the center of the area on the top of a hill. The currently used settlement is the former summer village. The former winter village is in the valley north of the summer village. While in the summer village more than 90% of the buildings are still equipped with a roof, most of the (former) houses (58%) does not have a roof any more.

Status	Winter village	Summer village
Houses with roof	27	98
Ruins without roof	37	7
Total	64	105

Figure 6: Number of houses in Shenako with and without roofs.

Within the Integrated Erosion Control (IEC) component of the SMBP/IBIS program of GIZ, a first participatory pasture management plan for Shenako community was implemented (IEC/GIZ 2016). In 2017 a training on rotational pasture management was provided (Zollner 2017). Some key findings from both reports have been included in this documents.

In the pasture management plan (IEC/GIZ 2016) it is mentioned, that there are 5 main cattle breeders, one sheep breeder and about 15 families having horses in Shenako. The sheep breeder (approximately 350 sheep) is mainly using a pasture outside of Shenako, crossing the village are in the morning and evening.

Most of the cattle breeder are using the pasture land in Shenako only for summer pasture (3-4 month). In the last years, only one farmer stayed in Shenako over winter time with about 20-25 cows. In 2018 a second farmer decided to stay over the winter with his cattle as well. For feeding the cattle in winter, hay is produced at the hay meadows near to the winter village.

The historic land area managed by the village people of Shenako can be seen in Figure 8. South of the Alazani River Gorge large pasture areas and former arable lands are situated, which are not under use any more.

In the interviews in 2017 and 2018 an approximate number of 60-80 milking cows and 40 calves have been reported by the village people. The number of horses varies a lot (40-100), as not all of them are in Shenako for the whole summer and/or every year and they are moving around in the larger surrounding of Shenako.

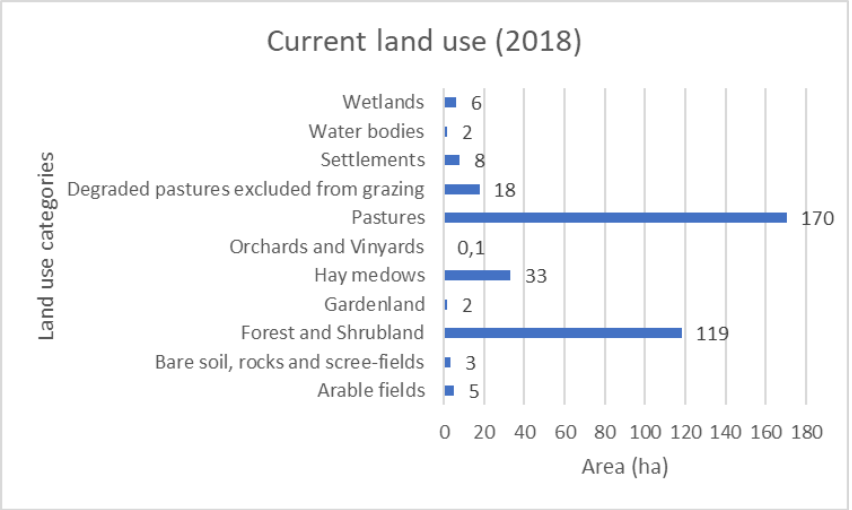

Figure 7: Area per land use category based on the assessment 2018.

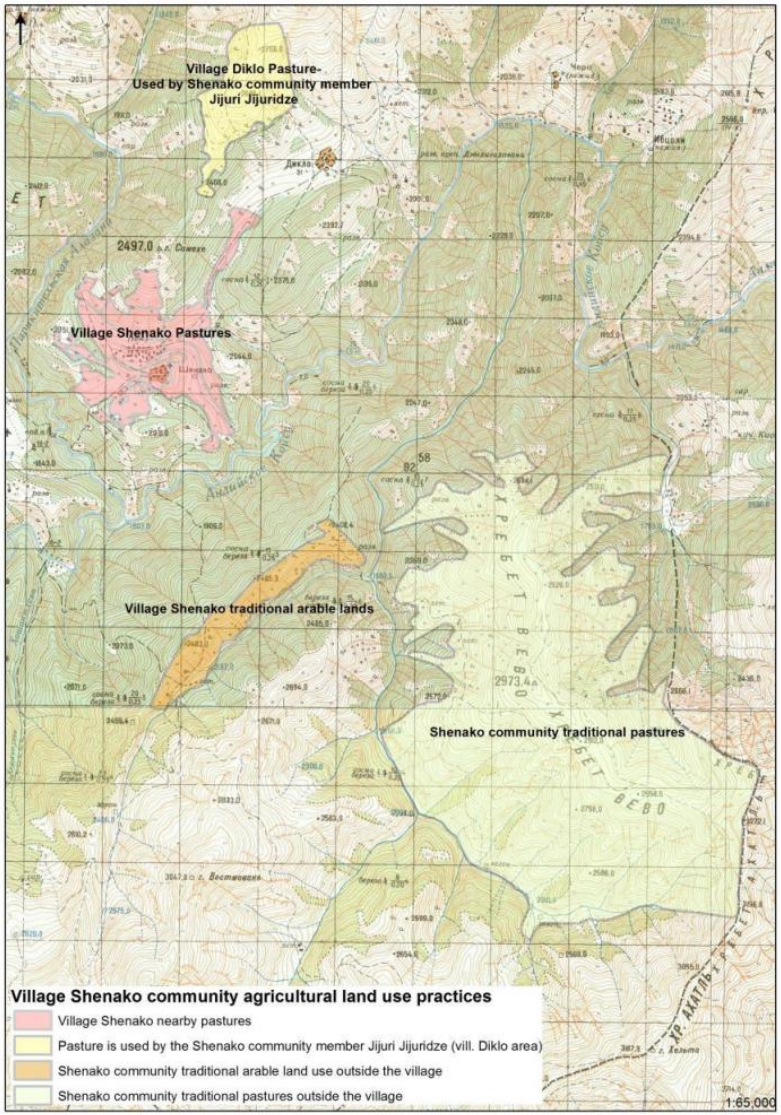

Figure 8: Agricultural land boarders of Shenako (source: Pasture Management Plan, GIZ/IBIS 2016)

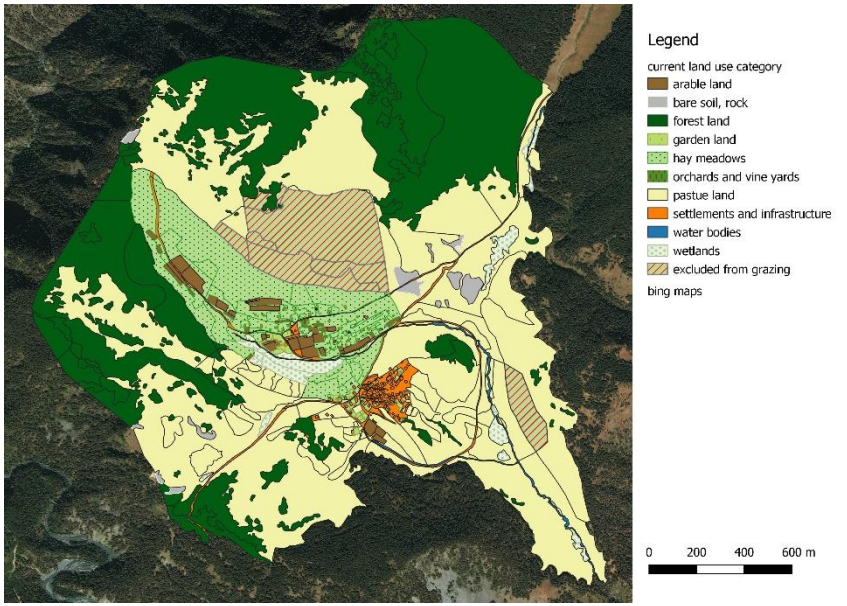

Figure 9: Map of current land use categories in Shenako.

The largest land use category are pastures (170h + 18 ha) followed by forest and shrublands (119 ha). Hay meadows cover 33 ha and wetlands, which are not used, grazed or used as hay meadows as well, cover 6 ha. Arable fields (5 ha) and gardens (including orchards, 1,7 ha) cover a minor part, while the settlement area covers 9 ha. Water bodies (1,6 ha) and bare soil (with sparse vegetation, 3,3 ha) are land use categories of minor size.

A detailed map provides a spatial overview (Figure 10). The absolute area sizes are provided in Figure 11.

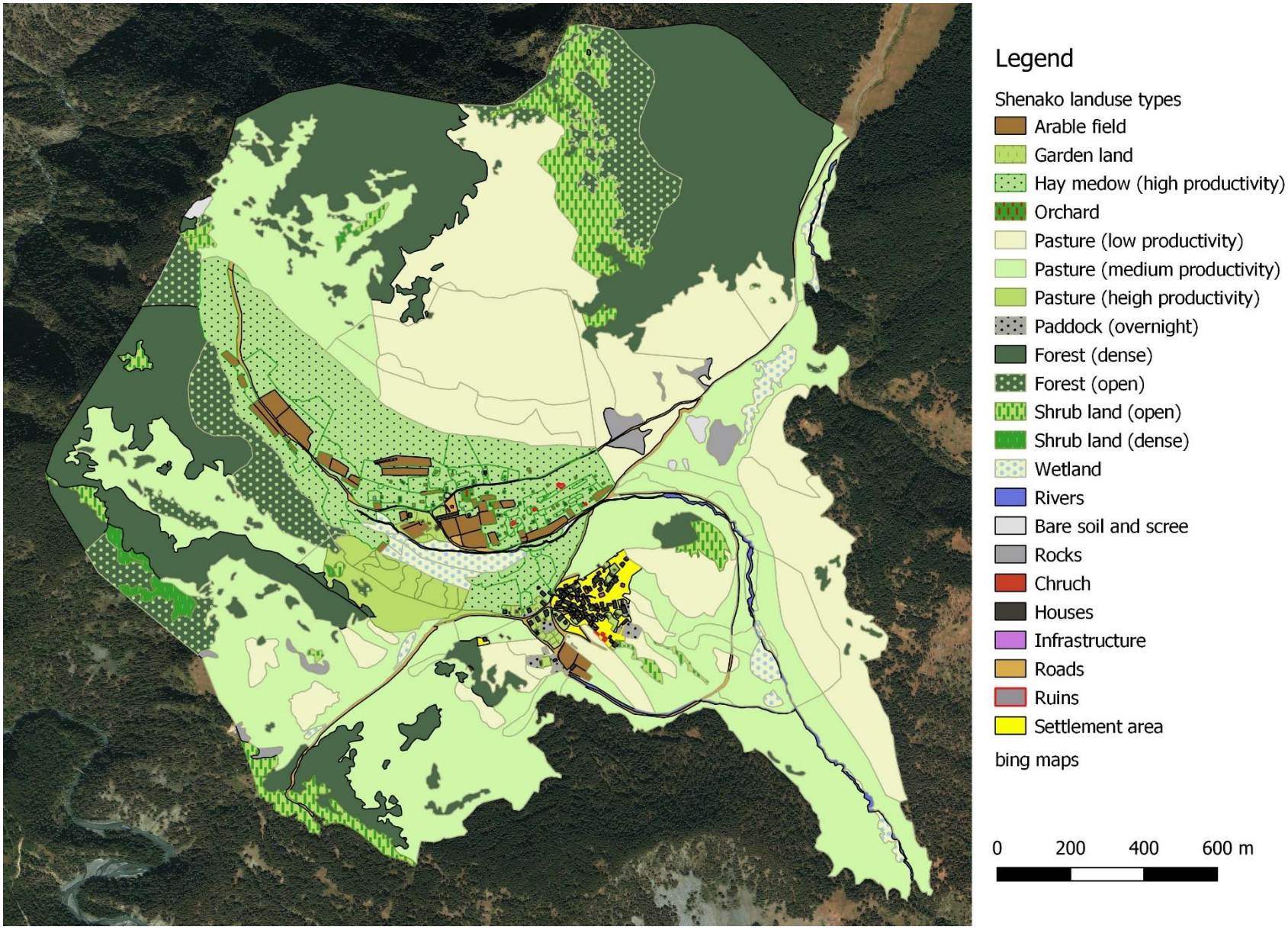
Legend
Shenako landuse types
Arable field
Garden land
Hay medow (high productivity)
Orchard
Pasture (low productivity)
Pasture (medium productivity)
Pasture (heigh productivity)
Paddock (overnight)
Forest (dense)
Forest (open)
Shrub land (open)
Shrub land (dense)
Wetland
Rivers
Bare soil and scree
Rocks
Chruch
Houses
Infrastructure
Roads
Ruins
Settlement area
bing maps
0
200
400
600 m

Figure 10: Land use map of Shenako (present use).

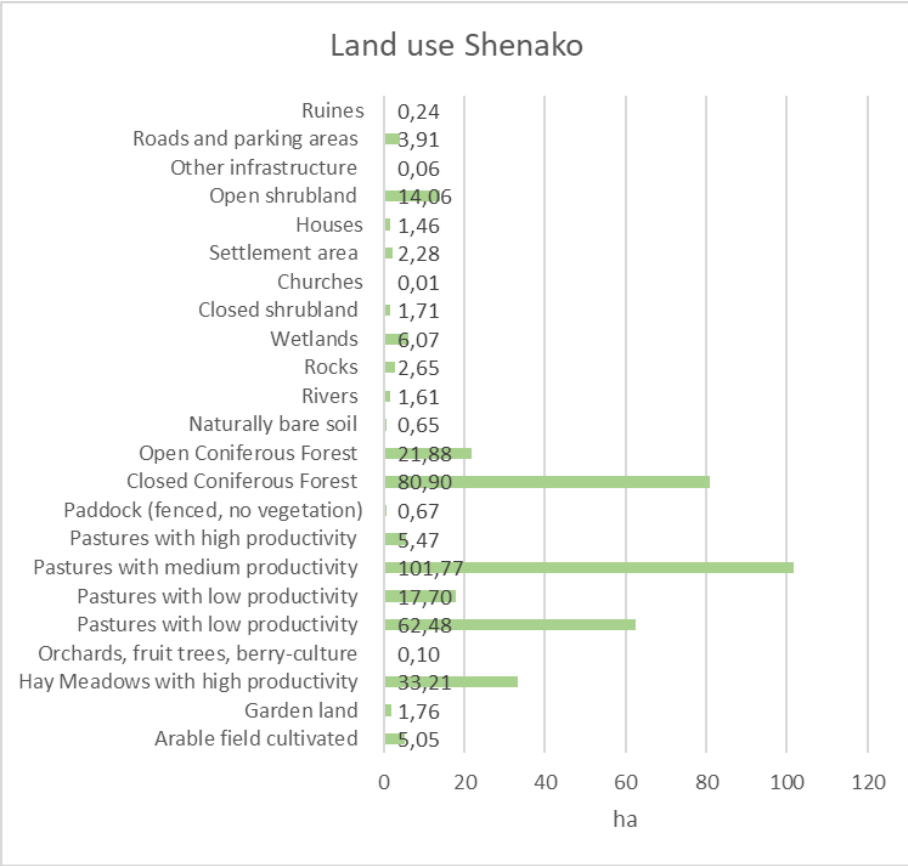

Figure 11: Area covered by current land use types in Shenako.

Not all of the area is used in the same intensity. The map in Figure 12 is showing the spatial distribution of the land use intensity. Some parts of the pastures are excluded from use by electric fence. Close forest and rocky areas are also classified as “not used”. It is visible, that only 30-40% of the existing hay meadows are currently used.

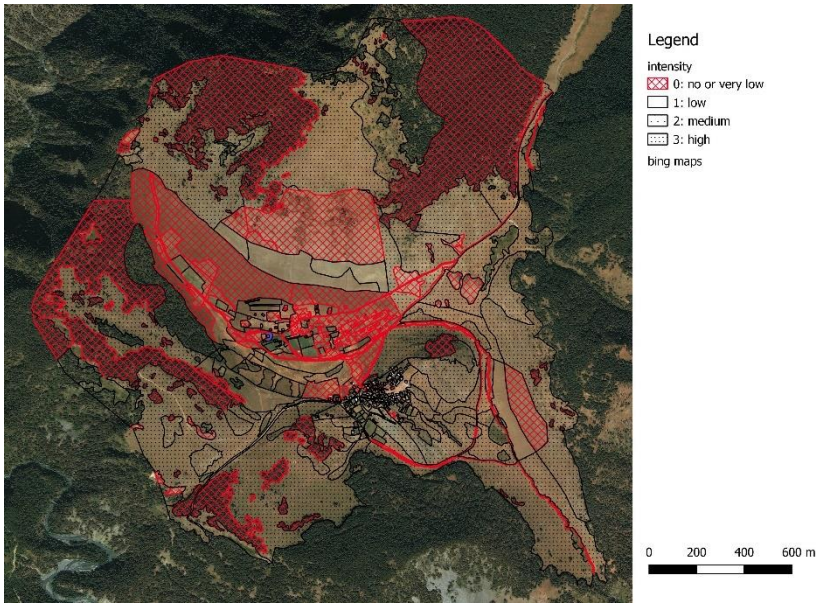

Figure 12: Land use intensity

The pastures and hay meadows are the most important categories for livestock breeding. Table 1 shows the mean and total fodder biomass in dry weight tons of hay meadows, the pasture land as well as the open forest and shrub land categories. There is additional grassland biomass available in other categories (settlement area, closed forest/shrubland, arable fields after harvest) which is not included in this analysis.

Table 1: Available biomass of relevant land use categories in Shenako.

Land use type	ha	t/ha	t total
Hay Meadows with high productivity	32,95	3,5	116,2
Pastures with low productivity	78,58	1,2	94,4
Pastures with medium productivity	102,8	1,5	153,7

Pastures with high productivity	5,44	2,7	15,0
Wetlands	6,09	2,3	14,1
Open Coniferous Forest	21,93	0,6	14,2
Open shrubland	13,93	1,2	17,3
		Total:	424,9

The biomass values are based on a remote sensing study carried out within the GIZ IBIS project. It is based on Sentinel 2 satellite images (2016, 2017) and a calibration dataset of approximately 90 biomass samples from the Tusheti area. The remote sensing data indicates the current state of biomass at the time of the satellite image (for Shenako July 2017). At this time, the pastures had been already grazed for more than one month leading to an underestimation of the total biomass production over the year. As authors observed that the pastures also contain unfavorable weeds and unpalatable species, which are not grazed by cattle, the authors expect that these factors (underestimation of biomass by remote sensing data, content of unfavorable weeds) balance out.

The data indicate a total amount of 424 tons of available fodder biomass (dry weight). 116 tons grow on hay meadows and 308 tons on grazable lands. The average biomass per ha is highest in hay meadows (3.5t/ha) whilst pastures with low productivity only add 1.2 t/ha in average.

The average living weight of cattle is 300kg (based on reports from farmers and local stakeholders). The daily consumption/ fodder need of cattle is 4% of its living weight (i.e. 12 kg).

Given the total amount of biomass available in Shenako, a maximum of 214 cows can be fed over a summer period of 120 days.

If the cattle should be fed the whole year (pasture in summer, hay in winter) a total number of 97 cows can sustained with the available biomass given.

Currently, only 5,5 ha of the hay meadows and wetlands potentially used for hay cutting (inside fence) are in fact used. The total potential area is 35 ha. Thus, only 16% of the potential amount of hay is used at the moment.

This is related to the fact that only a very low number of cattle stays in Shenako during winter time (ca. 20-40 cows).

3_1_1 Recommendations on sustainable effective land use types

Based on the interviews and discussions with local stakeholders and observations in the field during the last 5 years, recommendations on the following topics are formulated:

- Preserve biodiversity hot spots: wetlands and semi-dry grasslands
- Establish a cooperative dairy infrastructure for chees production
- Improve yield of hay meadows by proper hay management
- Introduce crop rotation on potato fields with fodder crops
- Expand rotational pasture system
- Improve productivity of pasture land by weed control

Preserve biodiversity hot spots: wetlands and semi-dry grasslands

There are two biodiversity hot spots around Shenako. The most sensitive are the wetlands along the small river in the norther and eastern part of the village area. Large parts of the wetlands near to the winter village are excluded from grazing. Some parts have been under hay production management. The wetlands in the eastern part are under intensive grazing and trampling has a significant disturbance impact.

Grazed, mowed and unmanaged wetlands provide different habitat qualities to plant and animal species.

Trampling effects like water filled holes with are important micro habitats for some insects and amphibs. The wet hay meadows (dominated by Molinea sp.) give a perfect habitat for the corncrake (Crex crex) as long mowing is done late in autumn. The wettest parts, which cannot be mown are dominated by sedge species (Carx sp.) and are examples of a rare wetland phyto-coenosis.

To save this diverse habitat structure, the management should be kept similar as it is: some part mown, some part grazed, some part unmanaged. In the future scenarios (see below) this mixture is tried to be preserved. A special focus should be set to the mown and unmanaged

wetlands, as these types rarely can be found anywhere else in Tusheti. Most of the other wetlands in Tusheti are grazed and hay meadows on wet lands can rarely be found.

The second biodiversity hotspot are semi-dry grasslands under mowing management. As mentioned above, grazed areas are widely distributed in Tusheti while still managed hay meadows are restricted to small areas. The hay meadows in Tusheti are showing very high plant species diversity. It can be assumed that diversity of invertebrates (insects, spiders etc.) is closely linked to the plant diversity. This high diversity depends on the continuation of the mowing regime in low intensity (1-2x per year) without artificial fertilizers.

Establish a cooperative dairy infrastructure for chees production

The number of cows per family has increased during the last decades to make a living from (but the number of cattle breeding families has decreased in parallel). Currently, each farmer does his own milk processing and chees production. To run a cooperative dairy in Shenako, a total volume of 400-500 liters of milk would be needed (estimation from local stakeholders), while at the moment 250-300 liters are produced by the 60-65 dairy cows. An increase of productivity can be reached by increasing the number of cows, and/or increasing quality of fodder (e.g. by adding concentrated fodder harvested on arable land).

Improve yield of hay meadows by proper hay management

No suitable machinery and less man power are available to do the hay cutting on the 33 ha of available hay meadows. The hay mowing starts in July and last till the end of September. Because livestock management and maintenance and harvest of potato fields and work in the green house takes also a lot of time, only limited work power is available to do the hay cutting. This leads to the effect, that even very productive hay meadows are only cut once a year and a significant portion (>50%) of the hay is cut in an unsuitable late stage of development with lower nutrition value.

By improving the machinery, the time needed for harvesting the hay will be significantly reduced. This enables the two farmers staying in Shenako during winter to cut enough hay in July, when it has the best nutrition factor. It will even enable the farmer to make use of hay fields, which are unused by now and to give additional fodder to the livestock in the morning and or evening after milking.

Introduce crop rotation on potato fields with fodder crops

There is around 5ha of fields, that were used for crop growing on former times. Currently, the largest part of this is used for growing potato. But no crop rotation is applied to the potato field by now. By introducing sainfoin/peas/beans (leguminous) and barley and/or triticale for crop rotation, productivity of the fields can be increased and additional fodder with high nutrition factor (concentrated fodder) can be produced. This additional fodder will help to increase milk production even with having less pasture land available due the erosion control measures on the steep and degraded pastures.

Expand rotational pasture system

In 2016 an area of 6 ha was divided into 3 paddock units for rotational pasture system. It turned out, that this area was too small to be used for the milking cows and therefor was used for the calves instead.

Rotation pastures systems are working with several pasture units divided by fences. While one pasture unit (paddock) is used, the grass and herbs on the other paddocks can regrow. While a high number of livestock is grazing a relatively small pasture unit, the grazing pressure is at the end of the grazing time very high and even not preferred pants like thistles are browsed by the cattle. After this intensive grazing, the paddock is left for regeneration without grazing for a couple of weeks (4-6) before being grazed again.

The rotational pasture system has two advantages:

1. During the rehabilitation phase of 4-6 weeks, much more biomass can re-grow than on permanently grazed pastures.
2. High grazing intensity during a short period leads to cleaning up of unfavourable herbs and grasses so less human maintenance work is needed.

But rotational pastures need also additional investments and workload:

1. Fences have to be bought and built up as well as to be managed

2. Drinking water has to be supplied to each paddock
3. A farmer/shepherd is needed to bring and fetch the cattle from the fenced paddock each morning and evening

There is potential to extent the rotational pasture system to the lower sections of the fenced areas in the north (7ha) and the lower part of the eastern fenced area (3ha). At the eastern fenced area, an section of 400m additional fence is needed to separate the lower, productive from the higher eroded part.

Improve productivity of pasture land by weed control

As large areas of the former pasture land need to be excluded from grazing for rehabilitation, it is important to improve the quality of the remaining pasture land to feed the livestock without being overgrazed. One activity to increase the available fodder biomass on pastures is to remove thistles, which cover 10-25% of the pasture land especially on sites with good soil conditions.

Figure 13: Some parts of pastures show significant amounts of weeds (thistles) which are unsuitable as fodder for cows.

Thistles should be cut with a motor-cutter (string trimmer, brush cutter) in mid-summer before seeds are ripe. At this stage of development, most energy is put into the flower and seeds and less energy is stored in the root system. Thus, cutting the above ground part of the thistle will affect regeneration power significantly. After cutting the thistles, intensive grazing can help to reduce re-sprouting of thistles. The cutting of thistles must be repeated over several years to show long term effects.

The pasture land that needs thistle cutting is about 10 ha. A motor-cutter is available in the village from the former GIZ-Project. On an area of 2ha the thistles have been cut by motor cutter in summer 2018. This management needs to be repeated on a yearly basis to successfully suppress thistles on the long term.

3_1_2 Draft of potential future land use scenarios

While the pasture land is already under strong grazing pressure, there is still a big potential for fodder production on the hay fields and unused arable land.

We developed 3 future scenarios for the future development. It is important to mention that these scenarios are only proposals, which have to be discussed and further developed with local stakeholder.

In all scenarios the areas it is assumed that the area of settlements, water bodies, wetlands, bare soil, rocks and scree-fields, forest and shrubland as well as garden land will stay the same size. Changes only have been applied for arable land, hay meadows and pastures.

The change for arable land was for all three future scenarios the same: the total area of arable land is increased from 5 to 10 ha. This assumption is based on the need to introduce crop rotation for the potato production. In the current use, almost all fields are used for potato growing. In 2018 the arable land area was increased by 1 ha (sainfoin and barley). To enable similar amount of potato production, the area of arable land has to be at least increased up to 10 ha to enable a 4-year rotation system. Beside potato harvest, high quality fodder can be harvested as concentrated fodder with high energy value for the cows. We assume that this fodder production can be applied on 5 ha of the arable land and will give a fodder crop of 10t per year. Having 100 dairy cows, 100kg can

of concentrated fodder can be additionally added to the hay and green fodder from grassland. This can increase milk productivity of 100-150 kg per cow and year. The straw of barley and triticale can be used for litter supply in the stables in winter.

It is also assumed, that 17 ha of the most eroded pasture land stays fenced all year and is excluded from grazing in all 3 future scenarios. The lower parts of the fenced areas in the North (7 ha) and at the East (3 ha) can be integrated into a rotational pasture system.

In the scenarios Future 1-3 the amount of cattle staying in Shenako through winter time has been varied.

For the establishment of common professional dairy infrastructure, the amount of 500 kg milk per day is needed (estimation from local stakeholders). With the current milking result of 5 kg milk per cow per day, 100 dairy cows are needed to reach that amount of milk. So, for the following scenarios a fixed number of 100 cows was taken as a basis.

The cows can either only be grazed in Shenako for 4 months in summer or stay in Shenako for the whole year. Given a weight of 300 kg a cow would need 1,44 t dry fodder biomass during these 4 months. When the cows stay the whole year, the grazing time can be extended by another 2 months (0,72 t) and 6 months the cow has to be fed with hay when it is in the stable in winter (2,16 t). During the whole year, one cow needs 4,38 ton of dry fodder biomass.

If there is only grazing in summer in Shenako, the fodder for the rest of the year has to be provided in the lowland. If the farmer does not have adequate pastures and hay meadows in the lowland, the fodder must be bought, which decreases the economic income significantly.

The advantage of having the cattle the whole year in Shenako is, that no money has to be spend for buying fodder, as long the number of cows is adequate to the grazing and hay areas in Shenako.

Live weight of one cow	300 kg
daily consumption (4%)	12 kg
yearly consumption (t) (12 months)	4,38 t
Summer consumption (4 months)	1,44 t
Intermediate grazing (2 months)	0,72 t
Hay consumption in winter (6 months)	2,16 t

Depending on the number of cattle staying in winter in Shenako, the amount of hay and therefore the area of hay meadows needed varies. As all other land use categories are assumed to stay the same, only the pasture land has been adopted corresponded to the change of the size of hay meadows (see Figure 14).

Table 2: Number of cows (summer/all year) in different scenarios and needed amount of fodder in tons dry weight/ha (m = month).

Scenario	Cows staying all year	Cows summer only	grazing fodder summer (4 m)	grazing fodder additional 2 m	Hay (6 m)
Futur 1	20	80	144 t	14 t	43 t
Futur 2	50	50	144 t	36 t	108 t
Futur 3	80	20	144 t	578 t	173 t

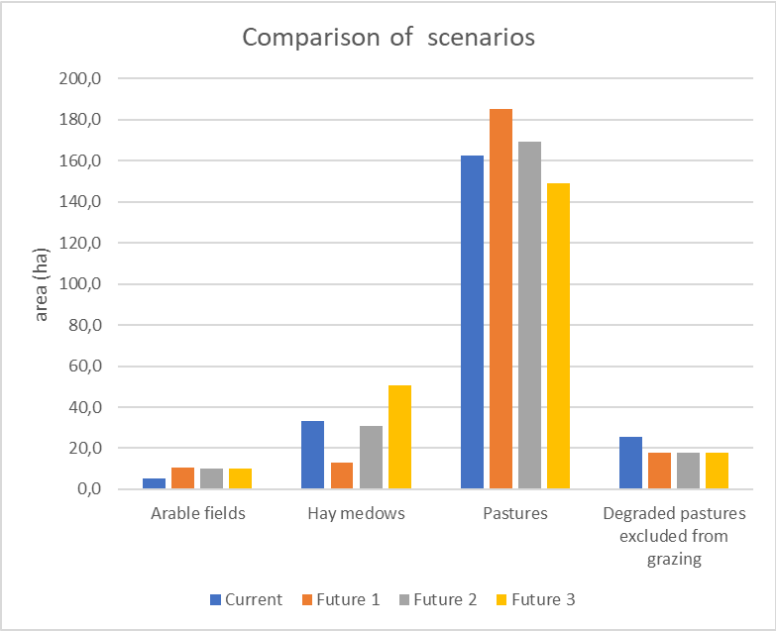

Figure 14:Change of size of arable fields, hay meadows and pastures within the current status and the 3 future scenarios.

Future 1: 20% cows staying during winter in Shenako

Livestock breeding is in future is mainly applied during the summer period (similar to the current use). Only 20% of the cattle stays in Shenako during winter. In this case hay is only needed for 20 cows. In this scenario it is possible to decrease the hay fields and use about 20 ha of the former hay meadows as good quality pastures. This would compensate from the exclusion of the eroded pasturelands which are fenced by now.

In this scenario only about 54% of the overall fodder potential in Shenako is used. For those 80 cows not staying in Shenako additional 236 tons of fodder are needed for feeding in autumn, winter and spring. This is equivalent to 7800 bales of hay. Given a price of 3-5 GEL per bale this would be a value of 23,000 to 39,000 GEL.

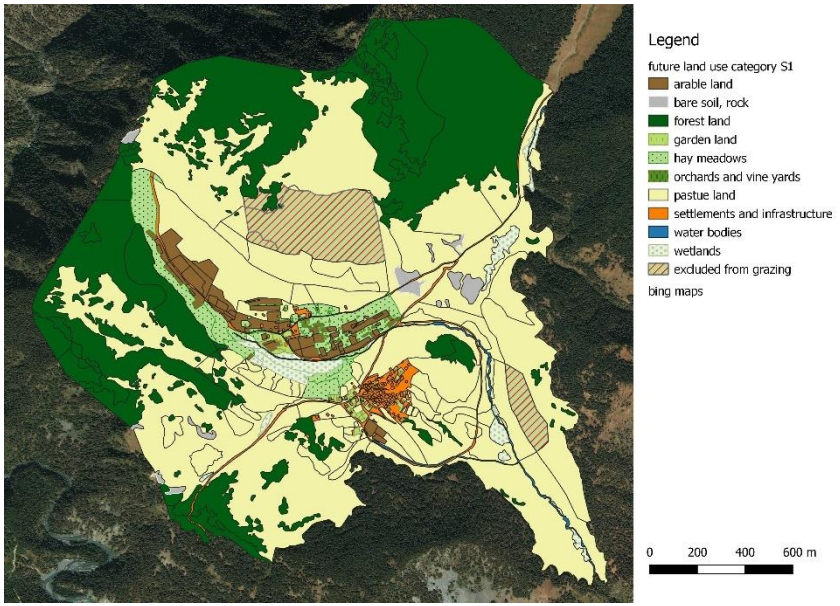

Figure 15: Potential spatial distribution of land use categories in scenario 1.

Future 2: 50% cows staying during winter in Shenako

50% of the cattle stays in Shenako during winter. In this case hay is needed for 50 cows. In this scenario 108 tons of hay are needed for feeding in winter. To produce such an amount of hay, 31 ha of hay meadows on good soils are needed. As we assume, that the arable fields are increased from 5 to 10 ha, the current area of hay fields would be shrunk from currently 33 ha to 28ha. For this scenario it would be necessary to increase the hay meadows by 3 ha. This would be most suitable at the northern exposed slops near to the village, as productivity of the soil is very high there. Some parts of the proposed area are currently uses as fenced calve pasture.

In this scenario only about 62% of the overall fodder potential in Shenako is used. For those 50 cows not staying in Shenako additional 150 tons of fodder are needed for feeding in autumn, winter and spring. This is equivalent to 5000 bales of hay. Given a price of 3-5 GEL per bale this would be a value of 15,000 to 25,000 GEL. In comparison to scenario 1 approximately 8-14,000 GEL can be saved for buying additional fodder per year.

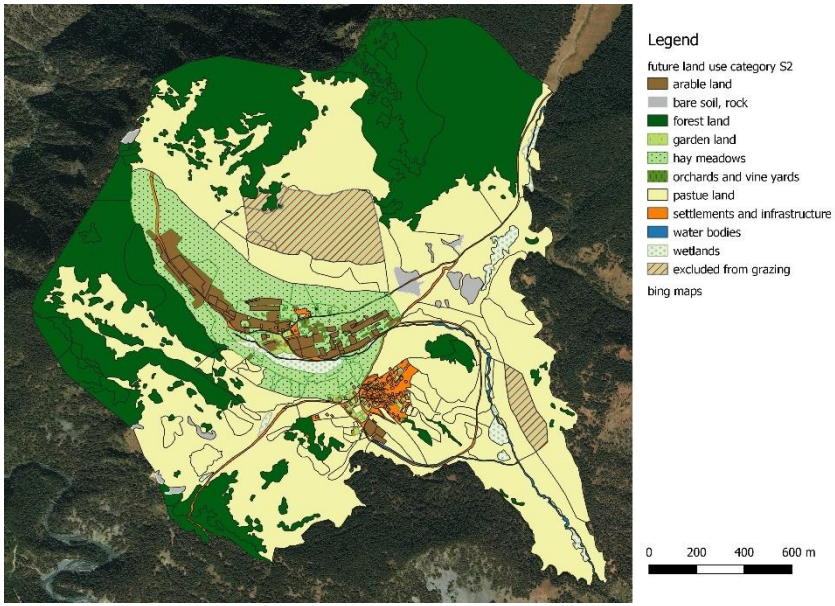

Figure 16: Potential spatial distribution of land use categories in scenario 2.

Future 3: 80% cows staying during winter in Shenako

80% of the cattle stays in Shenako during winter. In this case hay is needed for 80 cows. In this scenario 173 tons of hay are needed for feeding in winter. To produce such an amount of hay, 50 ha of hay meadows on good soils are needed. As we assume again, that the arable fields are increased from 5 to 10 ha, the current area of hay fields would be shrunk from currently 33 ha to 28ha. For this scenario it would be necessary to increase the hay meadows by 22 ha. This would be most suitable at the northern exposed slops near to the village and on the flat ground near the river east of the village as productivity of the soil is very high there. Most parts of the proposed area are currently used as pasture.

In this scenario only about 87% of the overall fodder potential in Shenako is used. For those 20 cows not staying in Shenako additional 64 tons of fodder are needed for feeding in autumn, winter and spring. This is equivalent to 2100 bales of hay. Given a price of 3-5 GEL per bale this would be a value of 6,000 to 10,000 GEL. In comparison to scenario 1 approximately 17-29,000 GEL can be saved for buying additional fodder per year.

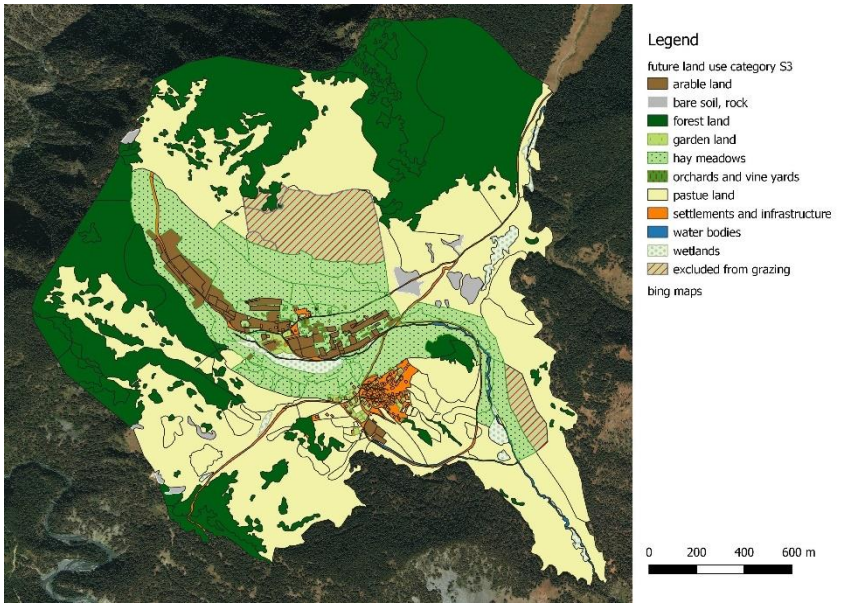

Figure 17: Potential spatial distribution of land use categories in scenario 3.

3_1_3 Summary on future scenarios

The three scenarios reveal, that the most efficient land use is described in scenario 3. Most of the biomass available in Shenako is used for milk (and meat) production. The more of the fodder biomass available in Shenako is used by cows, the less is available for sheep and horses. In the scenario three, sheep needs to be grazed outside the village area and a maximum number of 30-40 horses can be grazed during a summer period of 4 month.

While scenario 3 would deliver the highest economic revenue to the farmers, it strongly is limited by the willingness of farmers to stay in Shenako all winter. There is no road connection to Shenako in winter and the area is very isolated.

4 REFERENCES AND RELATED STUDIES

Huber, M., Joseph, A., Kirchmeir, H., Ghambashidze, G. 2017: Pilot project on land degradation neutrality in Georgia: Final Report. Study contracted by GIZ-IBIS Program; E.C.O. Institut für Ökologie, Klagenfurt, 50 p

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Mikeladze, G. & Megvinetukhutsesi, N. 2018: Estimation of grassland aboveground biomass using multispectral remote sensing data in Tusheti Protected Area. Study contracted by GIZ-IBIS Program, Georgia. 10p.

Studio 21 & Geographic 2018: Development regulation plan for Shenako. Project report.

Zollner, D. 2017: Improving management of pastures: Rotational Pasture Management Tusheti National Park in Shenako, Georgia. Study contracted by GIZ-IBIS Program. E.C.O. Institute of Ecology, Klagenfurt 25 p

5 ANNEX: CLC CLASSIFICATION

5_1 Class 1.1 Urban fabric

5_1_1 112 Discontinuous urban fabric

The discontinuous urban fabric class is assigned when urban structures and transport networks associated with vegetated areas and bare surfaces are present and occupy significant surfaces in a discontinuous spatial pattern. The impermeable features like buildings, roads and artificially surfaced areas range from 30 to 80 % land coverage.

Clarification:
The discrimination between continuous and discontinuous urban fabric is set from the presence of vegetation visible in the satellite image illustrating either single houses with gardens or scattered apartment blocks with green areas between them.

The density of houses is the main criterion to attribute a land cover class to the builtup areas or to any other class. For example, in case of patchwork of small agricultural parcels and scattered houses (with distance between them less than 300 m), the threshold to be applied for separation between class 112 (discontinuous urban fabric) and class 242 (complex cultivation patterns) is 30 % of urban fabric within the patchwork area. Above that threshold the area should be assigned to class 112, below the threshold to class 242.

This class is applicable for:

- permanent residential built-up areas of sparse to significant soil sealing degree.
- residential suburbs made of individual houses with private gardens and/or small squares, private housing estates;
- villages and hamlets with scattered blocks of residential buildings where numerous non-sealed spaces (gardens, lawns) can be distinguished between the houses;
- areas of multi-flat or multi-storey houses forming built-up areas, representing a typical physiognomic uniformity, particularly at the outskirts of urban settlements;
- mixed fabric of residential and industrial / commercial activities (the latter not dominating);
- complex cultivation pattern areas with scattered houses occupying > 30 % of the patchwork area;
- holiday cottage houses with well-developed infrastructure and road network connected residential built-up areas, and visually not separable on the satellite image;
- street-along ('ribbon development') villages if houses and kitchen gardens reach 100 m width;
- troglodyte villages along streets and subterranean housings visible from the satellite image.

This class includes:

- individual houses,
- small and large blocks of flats,
- vegetation and green spaces between buildings (gardens, lawns, flower beds, shrub and tree formations),
- parking areas/lots,
- playgrounds;
- transport network features, squares, streets;
- sports areas < 25 ha;
- buildings with educational, health care and production functions and market
- places < 25 ha;
- cemeteries (vegetated or non-vegetated) < 25 ha;
- public utilities or community service facilities < 25 ha;

This class is not applicable for:

- holiday cottage areas, holiday parks, permanent/static caravan sites, lodges etc., which are only used for recreational purposes and recognizable as a separate unit in the satellite image (class 142);

This class excludes:

- greenhouses for crop production purposes (classes 211, 212). In this case they are not considered as buildings in the sense of being counted for soil sealing degree

Class 1.3 Mine, dump and construction sites

Artificial areas mainly occupied by extractive activities, construction sites, man-made waste dump sites and their associated lands.

131 Mineral extraction sites

Open-pit extraction sites of construction materials (sandpits, quarries) or other minerals (open-cast mines). Includes flooded mining pits, except river-bed material extraction.

This class is applicable for:

- open-pit extraction sites of construction material (stone, gravel, sand or clay) or
- ore / non-ore mineral material (iron, manganese ores, magnesite, lignite, brown
- coal, kaolin, etc.);
- rock salt pits;
- sand extraction sites inside coastal dune areas;
- extraction sites of petroleum (crude oil), natural gas and shale gas (fracking sites).

This class includes:

- consolidated or non-consolidated surfaces of mineral materials under active
- open-pit extraction;
- heaps of extracted material piled up on storage areas ;
- infrastructure of buildings and installations serving for extraction, or primary processing of the quoted material and minerals (extractive industry);
- transport networks associated with areas of open-pit extraction;
- lay-by areas belonging to the mine area;
- water bodies (smaller than 25 ha), usually associated with open pit extraction of
- gravel, sand, etc.

This class is not applicable for:

- exploited peat bogs (class 412);
- associated land of mines where barren materials are dumped (coal tips, slag
- dumps) (class 132);
- coastal and inland salinas (class 422);
- natural outcrops of rocks or minerals, scree-covered areas (class 332);
- extraction sites reconverted to leisure areas (class 142);
- disused mineral extraction pits filled with water (512);
- abandoned or reclaimed extraction sites, which are to be mapped according to their actual land cover (e.g. 231, 324, 333).

132 Dump sites

Public, industrial or mine dump sites.

This class is applicable for:

- dump sites of public, communal waste (landfills);
- dump sites of industrial waste - waste rock after processing of various raw materials;
- dump sites of waste material from wastewater treatment plants (sewage sludge);
- pools of waste water/liquid waste, products of various chemical processes;
- associated land of mines where barren materials are dumped (coal

tips, slag dumps).

This class includes:

- surface of dumped material (solid or liquid)
- protecting dikes;
- line vegetation belts, part of buffering/protective zones around the dump sites;
- buildings, transport networks including parking lots, associated with dump site;
- non-vegetated slag heaps.

This class is not applicable for:

- decanting basins of biological water treatment plants by means of lagoonage processing; recycling centres(class 121);
- dump sites abandoned and reconverted to leisure areas (class 142);
- abandoned or reclaimed dump sites, which are to be mapped according to their
- actual land cover (231, 324, 333)

This class excludes:

- completed buildings, other structures already in use (classes 11x, 12x, 14x);
- completed parts of transport networks when they are larger than 25 ha (class 122)

Class 2.1 Arable land

211 Non-irrigated arable land

Cultivated land parcels under rainfed agricultural use for annually harvested non-permanent crops, normally under a crop rotation system, including fallow lands within such crop rotation. Fields with sporadic sprinkler-irrigation with non-permanent devices to support dominant rainfed cultivation are included.

This class is applicable for:

- cultivated land under crop rotation with crops like:
- temporary (1-3 years) fallow land under rotation system, where the below quoted agricultural crops were cultivated;
- weeded crops;
- fragmented agricultural land use resulting in juxtaposition of different annual crops;
- drained arable land;
- abandoned irrigated arable land when the irrigation channel network is still visible in the satellite image;
    - flooded crops as water cross beds;
    - nurseries of fruit trees and fruit shrubs.

This class includes:

- cultivated herbaceous plants and low growing shrubs like:
    - regular annual crops, such as cereals, root crops, leguminous crops, oil crops;
    - fodder crops, annual or multiannual grown as part of the crop rotation (alfalfa, sown grass for silage or hay production);
    - vegetables;
    - multi–year plants as asparagus and chicory;
    - semi-permanent crops as strawberries;
    - non-permanent industrial crops as textile plants, oleaginous plants (e.g. cotton, flax);
    - tobacco;
    - condiment plants (e.g. mustard);
    - sugar cane;
    - flowers under a rotation system;
    - industrial flower crops as lavender species;
- aromatic and medicinal plants;

- bare soil of cultivated land;
- weeds;
- stubble of harvested arable crops;
- ligneous crops (fruits and berries) or permanent grass occupying altogether <
- 25% of area;
- dispersed, mostly linear semi-natural or ruderal vegetation between parcels;
- dirt roads between parcels;
- hedgerows or stone walls separating parcels;
- greenhouses ((plastic or glass) out of the Mediterranean climate zone;
- temporary deposits of harvested crops or crop residues (e.g. straw);
- patches < 25 ha of other cultivation types (e.g. pastures, plantations), given that
- > 75 % of the total area is under a rotation system.

This class is not applicable for:

- city gardens (class 242);
- allotment gardens within or around settlements (142);
- lands that lay fallow for at least three years (classes 231 or 32x);
- hop plantations (class 222);
- rice field (class 213);
- fruit trees and berry plantation under glass greenhouses (class 222);
- willow trees for wicker production (class 222);
- greenhouses (plastic or glass) in the Mediterranean climate zone (class 212);
- permanent plantations of roses (class 222);
- wine-growing nurseries (class 221);
- pastures and meadows / permanent grassland under agricultural use (class 231);39
- arable land abandoned for > 3 years, being in the process of succession by herbaceous vegetation (class 231) or shrubs (class 323 or 324);
- areas where intermixed other cultivation types (permanent crops or pastures) occupy > 25% of area, but none of them predominates (class 242);
- areas where a mosaic of parcels <25ha of agricultural land (arable crops, pasture,
- permanent crops) are intermixed with natural vegetation and natural areas
- (<25ha) that occupy >25% and <75% of the area (class 243);
- arable crops with dispersed forestry trees in an agro-forestry system (class 244).

212 Permanently irrigated arable land

Cultivated land parcels under agricultural use for arable crops that are permanently or periodically irrigated, using a permanent infrastructure (irrigation channels, drainage network and additional irrigation facilities). Most of these crops cannot be cultivated without artificial water supply. Does not include sporadically irrigated land.

This class is applicable for:

- arable land or sown grassland (as part of crop rotation) under permanent irrigation with
  - spray sprinkler line;
  - rotary sprinkler;
  - irrigation channels.

This class includes:

- arable crops;
- non-permanent grass;
- irrigation infrastructure (channels, technical structures, ponds);
- greenhouses in Mediterranean climate areas.

This class is not applicable for:

- arable crops irrigated only sporadically (classes 211, 242);
- permanent crops under permanent irrigation (classes 22x);
  - vineyards (class 221);
  - orchards (class 222);
  - olive groves (class 223);
- agricultural land with drainage network intended to dry up wet soils (classes 211,
- 22x, 231 or 242);
- arable land, pastures or mixed agriculture under irrigation from superficial water
- supplies with pumping infrastructure (classes 211, 231 or 242);
- areas irrigated by underground irrigation pipes and above ground pipes and furrows (classes 211, 22x, 231 or 242);
- spray sprinkler line used only sporadically (classes 211, 22x, 231 or 242);
- land under irrigation with drop by drop system (classes 211, 22x, 242);42
- arable land with abandoned irrigation system even the irrigation channel network
- is still visible in the satellite image (class 211);
- permanent grasslands, pastures, meadows under permanent irrigation (class 231).

This class excludes:

- crops under greenhouses outside Mediterranean climate zones (classes 211 or 222);
- rice fields (class 213).

Class 2.2 Permanent crops

221 Vineyards

Areas planted with vines, vineyard parcels covering >50% and determining the land use of the area.

This class is applicable for:

- vineyards for wine production;
- vineyards for consumer grapes and raisins;
- complex cultivation pattern mosaics where vineyard parcels cover at least 50 % of the area;
- permanently irrigated vineyards;
- vine-growing nurseries inside vineyard areas.44

This class includes:

- vine plants;
- bare soil or grass cover among vine plants;
- patches of orchards or annual crops, occupying < 50% of territory;
- scattered patches or rows of (semi-) natural vegetation
- constructions supporting crops (espaliers, climbers, canes);
- access roads inside plantations;
- stone walls separating parcels or terraces.

This class is not applicable for:

- vineyards mixed with arable land and/or meadows within a single parcel (class 241);
- single vineyard parcels < 25 ha in mosaic with arable land and/or

meadows interspersed with significant natural vegetation where the vineyards themselves cover < 50 % of the area (class 243)

- complex cultivation pattern where vines occupy < 50% of area, intermixed with other cultivation types in a mosaic (class 242).

222 Fruit tree and berry plantations

Cultivated parcels planted with fruit trees and shrubs, intended for fruit production, including nuts. The planting pattern can be by single or mixed fruit species, both in association with permanently grassy surfaces.

This class is applicable for:

- plantations of berry shrubs;
- plantations of orchards;
- plantation of citrus fruit trees;
- groves of nut crops;
- plantations of tropical fruit trees;46
- permanent industrial plants;
- hop plantations;
- willow plantation for wicker production;
- permanent florist plantations of roses;
- complex cultivation pattern mosaics where fruit parcels cover at least 50 % of the
- area;
- plantation of vines associated to fruit trees within the same parcel where vines
- cover < 50 % of the surface;
- recently abandoned orchards which still preserve characteristic alignment or installations (espaliers and climbers);
- permanently irrigated orchards and hop plantations.

This class includes:

- woody permanent crops such as
  - berry shrubs: black and/or red currants, raspberries, gooseberries, blackberry;
  - orchards: apples, pears, plums, apricots, peaches, cherries, quinces, other *Rosaceae* and figs;
  - citrus species: oranges, lemons, mandarins, tangerines, grape fruits, pomelos;
  - nut crops: chestnut, walnut, almond, hazelnut, pistacia;
  - tropical fruit species: avocados, bananas, guavas, mango, kiwis, passion fruits, papayas, pineapples, pomegranates, brazil nuts, cashew nuts, coconuts, nutmegs;
  - industrial plants: coffee, cacao, mulberry, tea
- bare soil or grass among woody crops;
- fruit trees under greenhouses;
- scattered greenery, and natural vegetation <25% among plantations;
- constructions supporting crops (espaliers, climbers, canes);
- access roads inside plantations;
- irrigation ponds and pools < 25 ha;
- buildings, sealed or non-sealed storage areas associated to fruit production < 25ha.

This class is not applicable for:

- strawberry plantations (class 211);
- cotton plantations (class 211)
- multi–year plants as asparagus (class 211);
- olive groves (class 223);
- vineyard and areas dominated by vine plantations, >50% share (class 221);

- fruit tree nurseries (class 211);
- carob tree plantations (class 311);
- chestnut and walnut groves intended for wood production (class 311);
- short (8-20 years) rotation forestry and coppice areas grown for pulpwood or as energy crop (classes 31x);
- abandoned orchards where plantation structures have disappeared (class 324);
- non-permanent crops (arable land) associated with permanent crops on the same parcel, with occupation rate of non-permanent crops > 50 % (class 241);
- complex cultivation patterns where fruit parcels cover < 50 % of the area in mosaic with other crops;
- complex cultivation pattern mosaics where patches of natural vegetation cover >25% and < 75% (class 243).

Class 2.3 Pastures

231 Pastures, meadows and other permanent grasslands under agricultural use

Permanent grassland characterized by agricultural use or strong human disturbance. Floral composition dominated by *Graminacea* and influenced by human activity. Typically used for grazing - pastures, or mechanical harvesting of grass – meadows.

Clarification:

Pastures can be described as extensively or intensively grazed permanent grasslands with presence of farm infrastructure such as: fences, shelters, enclosures, watering places, drinking trough, and/or regular agricultural measures and works: mowing, drainage, hay making, seeding, manuring, shrub clearance. Typical visible signs of use are regular parcel structure and/or animal paths

This class is applicable for:

- permanent grasslands under grazing by domestic animals;
- permanent grasslands (not part of the crop rotation) used for harvesting the grass (in form of hay or silage) by mowing;
- abandoned arable land (after 3 years), arable land abandoned for more than 3 years, being in the process of succession by herbaceous vegetation;
- permanent grasslands under strong human disturbance, degraded grasslands, ruderal areas dominated by grass cover;
- humid meadows with dominating grass cover. Hygrophyle species, such as sedges, rushes, thistles, nettles cover < 25 % of the parcel surface;
- pastures with scattered trees and shrubs, woody vegetation covering <30% of the ground
- herbaceous vegetation cover of abandoned or reclaimed mineral extraction sites and dump sites;
- grass-covered ski-pistes used as pasture most of the year;
  - grassland areas with hedges (bocage);
- drained wetlands, in particular peatlands, converted to pasture;
- heavily grazed semi-natural grasslands such as machair plains at the rear of sand dunes.

This class includes:

- herbaceous vegetation;
  - grasses (*Graminacea*) that dominate the botanical composition,
  - herbs (*Taraxacum officinale, Ranunculus spp., Chrisanthemum leucantemum, Knautia arvensis, Achillea millefolium, Salvia* spp., etc.);
- scattered woody vegetation, trees covering not more than 30% of area;
- hedgerows;
- stone walls separating parcels;

- installations of farming infrastructure (fences, shelters, enclosures, watering places, drinking trough).

This class is not applicable for:

- grass covered surfaces of airports (class 124);
- lawns inside city parks (class 141) or sport and leisure facility areas (class 142);
- sown grass grown as annual crop under the crop rotation system (for silage or hay production) (class 211);
- arable fodder crops other than grass (e.g. alfalfa) (class 211);
- military exercising grass fields (without grazing) (class 321);
- high-productive natural alpine meadows far from houses and/or crops (class 321);
- derelict (poorly or not maintained) grassland where semi-ligneous/ligneous vegetation cover at least 25 % of the parcel (class 322, 323, 324);
- humid meadows where hygrophyle plant species cover at least 25 % of the parcel (class 411);
- salt meadows (class 421).

This class excludes:

- herbaceous grass cover composed of non-palatable and undesirable species for cattle such as *Molinia spp*. and *Brachypodium spp.* (class 321).

Particularity of class 231: Grassland on abandoned arable land

Uncultivated parcels that turned into grassland by not using arable land for more than three years. Identification of the quoted grassland requires application of multi-temporal (multiannual) satellite imagery.

This class is applicable for:

- areas of grassland representing succession of natural overgrowth of arable land by prevailingly herbaceous vegetation;

This class includes:

- herbaceous vegetation dominated by grasses
- sporadically occurring shrubs

Particularity of class 231: Wooded meadows

Meadows where dispersed woody vegetation occupy up to 50% of surface. These meadows are characterised by rich floristic composition.

This class is applicable for:

- areas of grassland used primarily for hay production (mowing) with scattered trees and shrubs occupying 30% - 50%.

This class includes:

- herbaceous vegetation partially covered by tree crowns;
- scattered shrubs
- scattered forestry trees not occupying > 30% of total area.

This class is not applicable for:

- areas of grassland with >30% tree cover (class 311, 312, 313);
- fruit trees mixed with meadows within a single parcel (class 241);
- pastures (grazing land) with dispersed forestry trees in an agro-forestry system (class 244).

This class excludes:

- fruit trees

Particularity of class 231: non-used parcels between buildings and around settlements

This class is applicable for:

- grass covered parcels (possibly with scattered shrubs) inside or at the edge of settlements that are likely to be used for construction

of houses but have not yet been converted to dwelling ground

- grass covered areas of abandoned or temporarily stopped construction sites, without any particular use.

This class includes:

- grass and ruderal vegetation;
- scattered shrubs.

Class 3.1 Forests

311 Broad-leaved forest

Vegetation formation composed principally of trees, including shrub and bush understorey, where broad-leaved species predominate.

Clarification:

The predominant classifying parameter for this class is a crown cover density of > 30 % or a minimum 500 subjects/ha density, with broad-leaved trees representing > 75 % of the formation. The minimum tree height is 5 m.

This class is applicable for:

- mature forests of natural or anthropogenic origin like the following:
  - pure or mixed stands of beech (*Fagus*), oak (*Quercus*), hornbeam (*Carpinus*), lime (*Tilia*), maple (*Acer*), ash (*Fraxinus*), poplar (*Populus*), birch (*Betula*) species among others;
  - riparian and gallery woodlands, with dominant *Alnus, Betula, Populus* or *Salix*
  - thermophyllous deciduous broad-leaved woodland (dominated by *Quercus pubescens*)
  - evergreen broad-leaved woodlands composed of sclerophyllous trees (mainly *Quercus Ilex, Quercus Suber, Quercus Rotondifolia*);
  - olive-carob forests dominated by *Olea europaea spp. sylvestris*, *Ceratonia siliqua*;
  - palm groves woodlands;
  - holly woods dominated by *Ilex aquifolium*;
  - *Tamarix* woodlands;
  - arborescent matorral with sclerophyllous broad-leaved species;
  - walnut trees and chestnut trees used for wood production included into forest area context;
  - plantations of eucalyptus;
  - carob plantations;
  - short (8-20 years) rotation forestry and coppice areas grown for pulpwood or as energy crop;
- young plantations of broad-leaved trees reaching the 5 m height;
- broad-leaved wooded dunes.

This class includes:

- deciduous and evergreen broad-leaved tree species listed under the “applicable for” section with >75% cover
- palm trees;
- optionally sporadically occurring patches of coniferous trees not exceeding 25 % share of the tree covered area;
- sporadically occurring <25 ha patches of:
  - shrubs and dwarf shrubs;
  - herbaceous vegetation (grasses and herbs);
  - mosses and lichens;
  - denuded spots.

This class is not applicable for:

- mixed broad-leaved / coniferous stands where broad-leaved trees cover < 75%, but > 25% of the area (class 313);
- recent or older burnt areas inside forest areas (classes 334 or 32x);
- woodland areas composed of broad-leaved trees smaller than 5 m height (class 322, 323);
- vegetated areas where the crown cover of the broad-leaved trees

is < 30 % (class 324, 231, 321), except boreal forest where crown cover threshold is 15%;

- forest nurseries specialised in reproduction situated inside broad-leaved wooded areas (class324);
- young plantations not yet reaching the 5 m height (class 324);
- clear-cuts (class 324);
- forest nurseries outside forests for commercial purpose (class 211);
- wooded parks (in urban setting class 141, outside urban setting class 142).

This class excludes:

- deciduous coniferous trees, dominantly larch (*Larix*) species (class 312).

312 Coniferous forest

Vegetation formation composed principally of trees, including shrub and bush understorey, where coniferous species predominate.

Clarification:

The predominant classifying parameter for this class is a crown cover density of > 30 % or a minimum 500 subjects/ha density, with coniferous trees representing > 75 % of the formation. The minimum tree height is 5 m (with the exception of Christmas tree plantations).

This class is applicable for:

- mature coniferous (needle-leaved) forests of natural or anthropogenic origin like the following:
  - pure or mixed stands of fir (*Abies*), pine (*Pinus*), spruce (*Picea*), cedar (*Cedrus*), cypress (*Cupressus*), juniper (*Juniperus*), yew (*Taxus*), Douglas fir (*Pseudotsuga*) species among others;
  - deciduous coniferous woodland composed of larch trees (*Larix spp*.);
  - arborescent matorral with dominating *Juniperus oxycedrus/phoenica*;
  - short (8-20 years) rotation forestry and coppice areas grown for pulpwood or as energy crop;
- young plantations of coniferous trees reaching the 5 m height;
- coniferous wooded dunes;
- Christmas tree plantations (also < 5 m height).

This class includes:

- evergreen and deciduous coniferous trees species listed under the “applicable for” section with > 75% share;
  - optionally sporadically occurring patches of broad-leaved trees with < 25 % share of the tree covered area;
- sporadically occurring <25 ha patches of
  - shrubs and dwarf shrubs;
  - herbaceous vegetation (grasses and herbs);
  - mosses and lichens;
  - denuded spots.

This class is not applicable for:

- mixed broad-leaved – coniferous stands where coniferous trees cover between 25 and 75% of the area (class 313);
- vegetated areas where the crown cover of trees is < 30 % (class 324, 231, 321);
- woodland areas composed of grown-up coniferous trees smaller than 5 m height (class 322, 323);
- young plantations not yet reaching the 5 m height (class 324);
- clear-cuts (class 324);
- recent or older burnt areas inside forest areas (classes 334 or 32x);
- forest nurseries specialised in reproduction, situated inside coniferous wooded areas (class 324);
- forest nurseries outside forests for commercial purpose (class

211);

- wooded parks (in urban setting class 141, outside urban setting class 142).

This class excludes:

- dwarf coniferous trees as Pinus mugo spp. mughus (class 322);
- sclerophyllous trees (class 311);
- evergreen broad-leaved trees (class 311).

313 Mixed forest

Vegetation formation composed principally of trees, including shrub and bush understorey, where neither broad-leaved nor coniferous species predominate.

Extension:

Mixed forests with a crown cover of > 30 % or a 500 subjects/ha density for plantation structure. The share of both coniferous and broad-leaved species exceeds 25 % within the canopy closure. The minimum tree height is 5 m.

This class is applicable for:

- mature forests with at least 30 % crown cover density, where both broad-leaved and coniferous trees occupy at least 25 %, but maximum 75 % of tree-covered area, of natural or anthropogenic origin;
- forests where broad-leaved and coniferous trees are mixed individually or in small groups within the stand (parcel);
- forests consisting of < 25 ha patches of homogeneous broad-leaved and coniferous stands (parcels) none of the types dominating with > 75 %;
- mixed-forest wooded dunes.

This class includes:

- deciduous or evergreen broad-leaved trees with 25-75 % share;
- evergreen or deciduous coniferous (needle-leaved) trees with 25-75 % share;
- sporadically occurring <25 ha patches of:
  - shrubs and dwarf shrubs;
  - herbaceous vegetation (grasses and herbs);
  - mosses and lichens;
  - denuded spots.

This class is not applicable for:

- forests where either broad-leaved or coniferous trees cover > 75% of the area (classes 311 and 312, respectively);
- vegetated areas where the crown cover of mixed species trees is < 30 % (classes 324, 231, 321).
- woodlands with mixed species grown-up trees smaller than 5 m high (classes 322, 323);
- young plantations not yet reaching the height of 5 m (class 324);
- clear-cuts (class 324);
- recent or older burnt areas inside mixed-forest areas (class 334 or 32x);
- forest nurseries specialised in reproduction situated inside mixed-forest areas (class 324);73
- forest nurseries outside forests for commercial purpose (class 211);
- wooded parks (in urban setting class 141, outside urban setting class 142).

This class excludes:

- dwarf coniferous trees as *Pinus mugo spp. mughus* (class 322).

Class 3.2 Shrubs and/or herbaceous vegetation associations

321 Natural grassland

Grasslands under no or moderate human influence. Low productivity grasslands. Often situated in areas of rough, uneven ground, steep slopes; frequently including rocky areas or patches of other (semi-)natural vegetation.

Clarification:

Natural grasslands are areas with herbaceous vegetation (maximum height is 150 cm and gramineous species are prevailing) covering at least 50 % of the surface. Besides herbaceous vegetation, areas of shrub formations, of scattered trees and of mineral outcrops also occur. Often under nature conservation.

In this context the term "natural" indicates that vegetation is developed under a minimum human interference,(not mowed, drained, irrigated, sown, fertilized or stimulated by chemicals, which might influence production of biomass). Even though the human interference cannot be completely discarded in quoted areas, it does not suppress the natural development or species composition of the meadows. Maintenance mowing and shrub clearance for prevention of woody overgrowth due to natural succession is tolerated. Sporadic extensive grazing with low livestock unit/ha is possible. Typical visible characteristics: large extent, irregular shape, usually in distant location from larger settlements.

This class is applicable for:

- permanent grasslands of natural origin, under minimum human influence, with close to natural or semi-natural botanical composition, such as:
  - natural grasslands, meadows, steppes on any type of soil (calcareous / acid / neutral, rock /gravel / sand / loess), humid or dry growing conditions, on lowland , riverine, montane, subalpine, alpine, boreal habitats,
  - natural grasslands with sporadically occurring ligneous vegetation (trees and shrubs) if it does not cover > 30 % of the considered surface;
  - saline grasslands grown on temporary wet areas of saline soils;
  - humid meadows where sedges, rushes, thistles, nettles cover > 25 % of the parcel;
  - herbaceous grass covered composed of not palatable gramineous species such as *Molinia spp*.and *Brachypodium spp*.;
  - o grasslands found on calcareous soils with a high proportion of calcicole species of limestone, chalk machair or karst;
- grasslands that can be extensively grazed, but never sown nor otherwise managed by application of fertilizers, pesticides, drainage or reseeding except by burning;
- high-productive Alpine grasslands far from houses, crops and farming activities;
- herbaceous military training areas;
- grasslands with a yearly productivity less than 1.500 units of fodder/ha;
- grasslands under nature conservation with only maintenance cultivation;
- derelict natural grassland where ligneous vegetation covers < 50 % of the area, trees occupying <30%;
- natural grasslands formed by process of natural succession / colonization on agricultural land
- abandoned for time long enough for development of a near natural species composition.

This class includes:

- herbaceous vegetation with > 50% cover, dominated by grasses;
- scattered woody vegetation with < 50% cover, trees occupying <30% of area;
- bare rocks or bare natural surfaces covering < 50 % of the area.

This class is not applicable for:

- permanent grasslands under intensive agricultural use (class 231);
- degraded grass-dominated vegetation of abandoned or ruderal areas, leftover areas around human settlements, under no agricultural use, but with strong human disturbance (class 231);
- derelict grassland where semi-ligneous/ligneous vegetation covers at least 50% of the parcel (class 322, 323, 324);

- grey dunes (class 331);
- natural grasslands where natural bare surfaces (rock, pebble, sand, salt plane) cover 50-90% of area (class 333);
- swampy grassland (class 411);
- humid meadows where hygrophyle plant species cover at least 25 % of the parcel (class 411);
- salt meadows under occasional tidal influence (class 421)
- fallow land (class 211).

Particularity of class 321: Alpine meadows

Grass formations which occur in high mountains above the timberline as natural climax-state herbaceous plant communities, where growing conditions do not allow development and survival of woody vegetation.

This heading is applicable for:

- Alpine grasslands which are either completely unused or only in very extensive use under grazing with low livestock units/ha.

This class includes:

- herbaceous plants (grasses and herbs) covering >50%;
- rocky formations <50%;
- dwarf pines <50%.

Particularity of class 321: Grass formations of alluvial and coastal plains with high soil humidity and seasonal inundation, with low human influence.

This class includes:

- natural grassland;
- water bodies;
- shrub formations and scattered trees.

322 Moors and heathland

Vegetation with low and closed cover, dominated by bushes, shrubs, dwarf shrubs (heather, briars, broom, gorse, laburnum etc.) and herbaceous plants, forming a climax stage of development.

Extension:

Moors and heathlands are often formed in habitats where natural formation of forests is hindered by or made impossible by growing conditions. However, in some of these habitats afforestation is possible with human intervention.

This class is applicable for:

- Climax stage vegetation dominated by shrubs and dwarf shrubs on temperate, Atlantic, maritime, alpine and arctic habitat, such as:
  - wet heath distributed on humid or semi-peaty soils (peat depth < 30 cm) with Erica tetralix/ciliaris, Sphagnum spp. and Molinia spp.;
  - dwarf pine (*Pinus mugo*) coverage above the upper tree limit in the Alpine zone or in the bottom of large depressions with temperature inversion;
  - maritime, prostrate, wind-swept and cushiony heaths with maritime ecotypes;
  - heath and scrub formation in Atlantic, sub-Atlantic and sub-continental areas with gorse (*Ulex spp*.), vaccinium heaths (*Calluna vulgaris, Vaccinium spp*.), heather (*Erica spp*.), bracken or gorse (*Genista spp*.), bilberry heaths (*Vaccinium myrtillus*), briar patch (*Rubus spp*.);
  - moors in supra-Mediterranean area with box trees and gorse, hedgehog-heaths (*Buxus spp., Astragalus spp., Bupleurum spp*., etc.);
  - sub Alpine tall herbs with dominating bushy facies (*Calluna spp., Vaccinium spp., Rubus spp., Juniperus nana*, etc.);
  - arctic moors areas with moss, lichen, gramineous coverage and small dwarf or prostrate shrub formations (*Betula nana, Salix lapponum, Salix glauca, Juniperus alpina, Dryas spp., Vaccinium myrtillus, Empetrum nigrum*);

- alpine heaths with dwarf shrubs (*Empetrum, Betula nana, Vaccinium myrtillus, Phyllodoce caerulea, Cassiope tetragona, Dryas*), mosses and lichens
- thickets and brush woods in temperate climate areas (box, bramble thickets, broom fields, gorse thickets, bracken fields, common juniper-scrubs);
- brush woods and bush-like forest in Alpine area with dwarf mountain pine scrub or green alder scrub (*Pinus mugo ssp. mughus* and *Alnus spp*.) Alpine willow brush, etc., accompanied by *Rhododendron spp.;*
- thickets and bush-like forest in arctic area with Betula nana and *Salix lapponum/glauca spp*.;
- dwarf-shrub covered areas with <30 cm peat and without visible sign of morphological features typical of bogs (e.g. pools, peat hags, peatland gullying);

- agricultural crops abandoned for > 3 years, where the above listed ligneous/semi-ligneous vegetation covers > 50 % of the surface;
- coastal dunes (so-called brown dunes) covered and fixed with shrubs *(Hippophae spp., Empetrum spp., Salix spp*.);
- areas covered by the above-listed vegetation types used as ski-pistes during skiing season.

This class includes:

- shrubs and dwarf shrubs, dominating the vegetation;
- trees of dwarf growth form, not higher than 3 m;
- herbaceous vegetation (grasses and herbs);
- mosses and lichens;
- outcrops of natural bare surfaces not reaching 50% cover of the area.

This class is not applicable for:

- Mediterranean drought-tolerant climax stage vegetation (maquis, garrigue, matorral) (class 323);
- heathland in transition, under afforestation process with presence of young forest trees (class 324);
- heathland under natural recolonization process where tree-like species cover > 30 % of the surface (class 31x)
- dwarf-shrub covered areas with >30 cm peat, with visible sign of morphological features typicalof bogs (e.g. pools, peat hags, peatland gullying) (class 142).

This class excludes:

- sclerophyllous shrubs (class 323);
- trees of > 5 m height with >30% cover (classes 31x);
- young forest trees (class 324).

Particularity of class class 322: Dwarf mountain pine scrub

Climax stage dwarf pine stands formations of 2-2.5 m height with a compact canopy occurring in high altitudes, where growing conditions do not allow development higher woody vegetation.

Clarification:

Dwarf pine is usually found from 1,000–2,200 m a.s.l. in Europe, occasionally as low as 200 m in the north of the range in Germany and Poland, and as high as 2,700 m in the south of the range in Bulgaria and the Pyrenees. It is also often artificially planted, for instance in coastal dunes as protection against deflation (e.g.in Lithuania and Denmark), where it can become invasive.

This class is applicable for:

- natural stands of dwarf mountain pine;
- dwarf pine plantations;

This class includes:

- dwarf mountain pine (Pinus mugo spp. mughus);
- rocky formations;
- sporadic areas of grassland;
- sporadic tree enclaves.

324 Transitional woodland/shrub

Transitional bushy and herbaceous vegetation with occasional scattered

trees. Can represent woodland degradation, forest regeneration / recolonization or natural succession.

Clarification:

Areas representing natural development of forest formations, consisting of young plants of broad–leaved and coniferous species, with herbaceous vegetation and dispersed solitary adult trees. Transitional process can be for instance natural succession on abandoned agricultural land, regeneration of forest after damages of various origin (e.g. storm, avalanche), stages of forest degeneration caused by natural or anthropogenic stress factors (e.g. drought, pollution), reforestation after clearcutting, afforestation on formerly non-forested natural or semi-natural areas etc.

This class is applicable for:

- clear cuts in forest areas;
- selective cut, patch or strip clearcut areas within forest where leftover trees cover <30% of the mapped patch
- open clear-felled or regeneration areas in the transitional stage of regrowth, which lasts for usually 5-8 years (more than that in boreal forests) or until trees reach the 5 m height;
- young forest plantations;
- forest nurseries inside forests area;
- natural grassland areas with small patches of forest < 25 ha and/or with trees intermixed which cover < 30 % of the surface;
- burnt forest or burnt natural shrubland areas that do not show black tones any more in the satellite imagery, but damage is still visible;
- forests heavily damaged by wind, snow-brake, avalanche, insects, acid rain or other pollution with > 50 % of trees severely affected;
- areas of re-cultivation of mineral extraction sites and dump sites by means of afforestation or natural / semi-natural succession with shrubs;
- agricultural lands (classes 2xx) under recolonization process with occurrence of young forest trees, which cover > 30 % of the surface (scattered trees or small plots of young trees);
- abandoned fruit tree plantations and orchards;
- afforestation on former natural grasslands or natural shrubs (322, 323), even when original vegetation still dominates;
- arborescent matorrals that are pre- or post-formation of broad-leaved evergreen forest with a usually thick evergreen shrub stratum composed of evergreen oaks (*Quercus suber/ilex/ rotundifolia*), olive trees, carob trees or pines, with crown cover density < 30 %;
- marginal zones of bogs with vegetation composed of shrubs and pines, which cover > 50 % of the surface.

This class includes:

- young broad-leaved and/or coniferous trees;
- damaged or dead trees and shrubs;
- fully grown trees, covering < 30% of area;
- shrubs;
- herbaceous vegetation (grasses and herbs);
- bare soil or natural bare surfaces.

This class is not applicable for:

- young forests where trees reach 5 m height (class 31x);
- abandoned olive groves (class 323);
- agricultural lands (classes 2xx) with patches of forest vegetation with an overgrowth occupation
- rate < 75 % (class 243);
- stable/climax forest formations with a tree height < 4 m, and Pinus mugo spp. mughus forests
- (class 322);
- coastal dunes (so-called brown dunes) covered and fixed with

shrubs (*Hippophae spp., Empetrum spp., Salix spp*.) (class 322);

- moors and heathland in the process of natural regeneration after fire damage (class 322);
- sclerophyllous shrubs in the process of natural regeneration after fire damage (class 323).

This class excludes:

- dwarf mountain pine (*Pinus mugo*).

Particularity of class 324: Wooded fen, bog and transitional bog

Shrubby-herbaceous vegetation with scattered trees forming marginal zones of peat bogs.

This class is applicable for:

- shrubs and herbaceous vegetation with scattered trees (*Betula pubescens, Alnus glutinosa, Picea abies, Pinus silvestris, Salix spp.*), woody vegetation covering > 50% of area.

Class 3.3 Open spaces with little or no vegetation

332 Bare rock

Scree, cliffs, rock outcrops, including areas of active erosion, rocks and reef flats situated above the high-water mark, inland salt planes.

This class is applicable for:

- naturally sparsely vegetated or non-vegetated areas where 90 % of the land surface is covered
    - by rocks;
- stable rocks with limestone pavements, block litter and mountain-top-debris;
- non-vegetated limestone pavement;
- sites and products of recent volcanic activities, volcanic ash and lapilli fields, barren lava fields;
- non-vegetated supra-littoral rocky zones,
- inland hard salt planes;
- areas with loss of vegetation due to erosion;
- non-vegetated abandoned mineral extraction sites.

This class includes:

- bare rock, large mineral fragments (boulders, scree, lapilli) occupying at least 90% of the area;
- scattered vegetation occupying < 10% of area.95

This class is not applicable for:

- mineral extractions sites (class 131);
- mine dumps, deposits of artificial solid waste materials (class 132);
- white dunes (class 331);
- mediolittoral rocky sea beds (class 423);
- bare rocks with 10-30% cover of scattered trees (class 324);
- sparse shrubland on rocky terrain with dominating shrub cover (class 322, 323);
- moraines and gravel beds (class 331);
- sparsely vegetated rocky areas with 10-50% vegetation cover (class 333).

This class excludes:

- sand and gravel (class 331)
- artificial and waste material (class 132).

333 Sparsely vegetated areas

Areas with sparse vegetation, covering 10-50% of surface. Includes steppes, tundra, lichen heath, badlands, karstic areas and scattered high-altitude vegetation.

Clarification:

Scattered vegetation is composed of herbaceous and/or ligneous and semi-ligneous species, the rest of area is naturally bare ground. In Mediterranean and extreme dry areas the identification of the class often requires early-in-vegetation-season (spring) imagery, following the phenological cycle of (therophyte) herbs and grasses, which dry out completely during the unfavourable, dry summer period.

This class is applicable for:

- sparsely vegetated and unstable areas of stones, boulders, or rubble on steep slopes where the vegetation layer covers between 10 % and 50 % of the surface;
- sub-desertic steppes with gramineous species (*Artemisia spp*.) mixed with alfa (*Stipa spp*.) covering between 10 % and 50 % of the surface;
- lichen heath;
- sparse vegetation of 'lapie' areas or limestone paving;
- bare soils inside military training areas;
- karstic areas with scattered gramineous, ligneous and semi-ligneous vegetation;
- sparsely vegetated badlands;
- sparse vegetation of abandoned or reclaimed mineral extraction sites or dump sites;
- sparsely vegetated areas used as ski-pistes during skiing season.

This class includes:

- bare surfaces (rock, boulders, mineral fragments, bare soil)
- herbaceous and/or woody vegetation altogether covering <50% of surface.

This class is not applicable for:

- windblown part of dune areas (class 331);
- areas where non-vegetated surface covers at least 90 % of the area (class 332);
- areas where the vegetation covers > 50 % of the surface (classes 31x, 32x);
- sparse forests with >30% tree cover (class 31x);
- dense alfa (*Stipa ssp*.) coverage (class 321);
- clear cuts and afforestation areas where most the surface is non-vegetated (class 324)
- mineral extraction sites or dump sites reclaimed by means of afforestation, even if most of the surface is still without vegetation cover (class 324).

335 Glaciers and perpetual snow

Land covered by glaciers or permanent snowfields.

Clarification:

Permanent snow and ice can be captured by finding the patches' smallest extent during the year. This can be captured when they shrink to minimum due to summer warmth, but before the first snowfall after summer occurs. Such ideal date is between end July (August in Northern countries) and late September.

This class is applicable for:

- glaciers and perpetual snow;
- rock glaciers and debris-covered glaciers clearly identifiable by shape.

This class includes:

- permanent ice and snow surfaces;
- bare rocks occupying < 50% of area;

- rock debris covering ice.

This class is not applicable for:

- snow patches pertaining over a part of summer period, but not throughout the whole year (class 3xx).

Class 4.1 Inland wetlands

411 Inland marshes

Low-lying land usually flooded in winter, and with ground more or less saturated by water all year round.

This class is applicable for:

- non-forested areas with dominantly herbaceous vegetation that is liable to flooding by fresh running or stagnant water;
- fens and transitional bogs without peat deposition or on peaty ground with less than 30 cm thick peat layer ;
- marsh vegetation located in margin zones of raised bogs;
- water-fringe vegetation of reed beds;
- sedge communities, fen-sedge beds, tall rush swamps;
- riparian cane formations;
- inland saline (alkali) marshes (prevailing archeic) with halophile and gypsophile plant communities;
- humid meadows where hygrophyle plant species cover at least 25 % of the parcel;
- humid meadows around the landward edge of brackish lagoons

This class includes:

- specific low ligneous, semi-ligneous or herbaceous vegetation;
- reeds, bulrushes, rushes, willows, sedges and tall herbs, sphagnum hummocks and other water plants;
- alder, willows or other tree species (covering < 30%);
- high floating vegetation;
- water surfaces <25 ha within inland marshes.

This class is not applicable for:

- humid meadows (water logging of between 10 and 30 cm depth) (class 231 or 321);
- rice fields (class 213);
- salt marshes (class 421);
- salt meadows under tidal influence (class 421);
- polders with reticulated channels bordered by hydrophilic vegetation (class 2xx);
- humid forests with a crown cover > 30 % (class 31x);

This class excludes:

- free water space in wetlands > 25 ha (class 512);
- low floating aquatic vegetation under water (class 512).

Particularity of class 411: Treeless fens and transitional bogs sometimes with > a 30 cm–thick peat layer

Areas located in inland through-flow basins, in river flood valleys, areas of springs, and margin zones of raised bogs. Surface of peatlands is plain or concave with small microforms - hummocks and tussocks.

This class is applicable for:

- areas of hydrophilous herb vegetation (Cares spp., Comarum palustres, Menyanthes trifoliata, Phragmites australis, Trychophorum alpinum, Oxycoccus spp.)

Class 5.1 Inland waters

511 Water courses

Natural or artificial water-courses serving as water drainage channels. Includes canals. Minimum width for inclusion: 100 m.

Clarification:

In case of rivers with oscillating water level (when the width of the stream is less than 100 m in certain seasons of the year), the whole river bed must be added to the narrow water surface and then classified as 511. However, if there is no water in the river during a substantial part of the year (> 6 months), then the gravel and sand parts of the river bed (along with the narrow river bed, if appropriate) must be classified under class 331.

This class is applicable for:

- natural water streams;
- rivers that are canalised;
- artificial canals;
- branching glacial rivers with dynamically changing courses and interspersed gravel islands, where water surface in yearly average occupies >50% of the area.

This class includes:

- flowing water;
- sand or gravel accumulations along / among streams < 25 ha;.

This class is not applicable for:

- water bodies connected to watercourses (class 512);
- hydroelectric plant located on watercourses > 25 ha (class 121);
- sections of river mouth affected by tide (class 522);
- branching glacial rivers with dynamically changing courses and interspersed gravel islands where water surface occupies <50% of area most of the year (class 331).

512 Water bodies

Natural or artificial water bodies with presence of standing water surface during most of the year.

This class is applicable for:

- natural freshwater and inland salt water lakes;
- water reservoirs, areas of water retention;
- archipelago of lakes inland;
- fish ponds, water surfaces used for freshwater fish-breeding activities;
- disused mineral extraction pits filled with water;
- fish ponds and water reservoirs temporarily without water (seasonal lack of water, maintenance, etc.), given that the area is most of the year covered by water.

This class includes:

- water surface;
- low floating aquatic vegetation with species such as *Nuphar spp., Nymphaea spp., Potamageton spp.* and *Lemna spp.;*
- embankments separating pools of fishponds;
- temporarily dry sand, gravel or rock surfaces around lakes with changing water level;
- floating aquaculture installations (cages, buoy lines).

This class is not applicable for:

- agricultural land temporarily inundated for flood prevention purpose or as result of natural flood event (classes 2xx);
- temporal lakes, most of the year used as agricultural land, such as polje of the Dinaric Alps (classes 2xx);
- open water surfaces of rice fields (class 213) ;
- salt or brackish water surfaces separated from the sea by narrow stretches of land and having connection to sea water (class 521).

This class excludes:

- surface plant species characteristic for standing water (e.g. Typha latifolia, Carex riparia, Glyceria maxima, Sparganium erectum and Phragmites communis (class 411);

- liquid waste (class 132);
- flowing water (class 511)