An Assessment of Sustainable Land Management (SLM) in the Loess Hills of Central Tajikistan Using WOCAT Tools and DESIRE Guidelines

Masterarbeit der Philosophisch-naturwissenschaftlichen Fakultät
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vorgelegt von
Selina Studer
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Leitung der Arbeit:
Prof. Dr. Hans Hurni
Dr. Bettina Wolfgramm

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Master's thesis

Submitted to the Faculty of Science
University of Bern

Selina Studer, 2014

Supervisors:
Prof. Dr. Hans Hurni (AIG)
Dr. Bettina Wolfgramm (CDE)

Centre for Development and Environment (CDE)
University of Bern

Contact:
Selina Studer
Statthalterstrasse 18
3018 Bern

selina.studer@students.unibe.ch

Cover picture: View on different agricultural land use in the jamoat of Javonon. (Picture S. Studer, June 2012)

Preface and Acknowledgement

My great motivation to complete this thesis provided an opportunity for a more than one-year long research project where I had the opportunity to get to know one of the most remote parts of this world. This research allowed me to interact closely with the local population of Tajikistan and its culture and to learn some of the Tajik language. I had the opportunity to contribute to a base of knowledge that can help to improve the livelihoods of the people that I interacted with during the six-month field stay. With this research I had the chance to follow up a long-term research project and to draw conclusions from previous research and make a first step towards implementation, as I consider it to be crucial to make scientific knowledge available for realization.

During this research I met great people who supported me in different ways in the process. First of all, I want to thank Bettina Wolfgramm and Hans Hurni whose advice and support enabled this research under their supervision. I specially want to thank Kobiljon assisting and supporting me with his language skills, local expertise, emotional support and his cheerful personality. I also want to thank Jahonbek. Due to him all the contacts with farmers and workshop participants were possible. I am thankful to the residents of the jamoat of Javonon and especially to the workshop participants who contributed to this research. Thanks to all the people for helping me with translations in the field, supplying their competences in the workshops and helping me to understand cultural differences. To Megi I want to thank for all the times spent together and supporting each other during the fieldwork and also back in Switzerland. Thanks to my friends and family for the mental support during the process of writing this thesis. Christian I thank for valuable editing of the English writing.

Furthermore I want to thank the National Centre of Competence in Research (NCCR) North-South within this study was conducted and the SCOPES (Scientific co-operation between Eastern Europe and Switzerland) Institutional Partnership program, which financed the fieldwork.

Abstract

The agricultural land in the loess hills of central Tajikistan is exposed to land degradation processes. A high portion of the population has mixed livelihood strategies, in which agriculture plays and important role and depends on the productivity of the land. Over the last decade, a number of environmental and social research studies have been conducted in a sub-rayon, the jamoat of Javonon, within the framework of the National Centre of Competence in Research (NCCR) North-South. These studies focused on different aspects of soil degradation and conservation and its biophysical and socio-economic causes, whereas an overall integrative and transdisciplinary assessment of land degradation and conservation had not been done so far. In this thesis an assessment integrating a broad range of research approaches and materials is presented and followed with suggestions for SLM implementation in the study area.

First, a synthesis of previous research was carried out for an integrative assessment of the study area. It was done according to the hybrid SLM conceptual framework and with the help of indicators from WOCAT and LADA, which integrates *driving forces*, *pressures*, *state of the land*, *impacts* and *responses* concerning land use. The most important *driving forces* were identified and summarized with the headings: poverty, missing knowledge and support, labor migration, insecurities of the land tenure system and population growth. Those *driving forces* lead to *pressures* in the form of non-suitable land management (missing SLM, low technological input, low fertilizer input, deforestation, overgrazing, extensive land use, abandonment, trampling, insecure land use rights, lack of land, need for irrigation), which along with the unfavorable biophysical conditions (limited water points, topography, droughts, highly erodible soils, excessive runoff, heavy rainfalls) affect the *state of the land* as degradation processes increase. The *state of the land* has an *impact* on the *ecosystem services*, and leads particularly to low production. This results in several *responses*: on the one hand the implementation of SLM technologies; on the other hand land abandonment, labor migration and more extensive land use.

Second, the spatial occurrence of land degradation and conservation was defined together with experts and with the help of the WOCAT mapping questionnaire. This assessment is based on Land Use Systems LUS, namely annual cropland, perennial cropland, orchard, vineyard, grazing land, forest and abandoned land, as delineated in the previous study by Bühlmann (2006). For the degradation and conservation assessment the position of a LUS on slopes steeper or flatter than 16% was considered. The main degradation types in the study area are erosion by water in form of gully erosion, mass movements or loss of topsoil and biological degradation by the reduction of vegetation cover through grazing. A high extent of degradation (>40%) can be found on abandoned land, annual cropland and grazing land

whereas orchards on steep and on flat areas, perennial cropping on flat areas and vineyards showed degradation at a extent less than 20%. Perennial cropping on steep slopes and forest were specified as degraded at an area of 25% and 30%, respectively. Causes for degradation were specified as non-suitable management practices and unfavorable biophysical conditions.

Third, realistic SLM technologies were identified together with local farmers in order to find locally acceptable technologies and to create a base for their future adoption. With the participation of local farmers, a workshop was conducted according to the DESIRE guideline part III. Locally adapted SLM technologies were selected and evaluated for implementation purposes. This SLM planning workshop focused on the LUS "annual cropland" and "grazing land". For each of these, two LUS six technologies were selected. As pilot projects, three out of four villages established perennial grass plots and the fourth village implemented a "gully rehabilitation" project.

Lastly, three scenarios for future development of the jamoat of Javonon are discussed. They were developed in order to support future decision-making in the jamoat of Javonon. The first scenario, the "business as usual scenario" is basically the synthesis of previous research and results from the WOCAT mapping. It shows a downward spiral, where the degradation of land leads to more food insecurity. This works contrary to human wellbeing and poverty reduction. The second scenario contains the visions of the farmers. Namely, it takes up the SLM technologies the farmers selected in the workshop in order to achieve sustainable land use. The farmers considered these technologies as applicable on their land and are willing to implement them. Thus, it can be concluded that these technologies are socially accepted. Two technologies, "perennial grassland" and "orchards", were investigated more closely. With collected yield and input data, a cost and benefit analysis was conducted. The results support the conversion of hay making area or abandoned land to perennial grassland and the conversion of annual cropland to orchards. The main beneficial factors are higher yield, less work and monetary input and its conservation characteristics. The third scenario focuses on the need for effective institutions and approaches, with which the SLM planning and realization can be coordinated. Most of the selected SLM technologies were already known in the study area. Thus, it can be assumed, that the problem of land degradation and certain *responses* in form of SLM technologies are known, but for effective realization, approaches for implementation and an institution are needed. The scenarios show the benefit of SLM technologies but also the importance of SLM approaches for implementing these technologies at the village or rayon level. The maps of degradation and conservation from the WOCAT mapping questionnaire are a valuable basis for future SLM planning in the study area.

Table of Content

Abbreviations and Glossary

Agroforestry	"[…] is the combined cultivation of annual or perennial (permanent) crops, is thus combining cropland and trees" (Wolfgramm et al., 2011: iv).
CDE	Centre for Development and Environment (http://www.cde.unibe.ch)
Dekhan Farm	A farm established on the basis of land and property. Either managed by a collective where members from different families hold property shares and the farm is governed by a joint activity agreement. Or controlled by the members of one family, based on general agreement. The latter has less than 25 members (Wolfgramm et al., 2011).
DESIRE	Desertification Mitigation and Remediation of Land - a Global Approach for Local Solutions (http://www.desire-project.eu)
DPSIR	Driving forces-Direct Pressures-State-Impact-Responses (Smeets & Weterings, 1999)
ESS	Ecosystem services
Household plot	"A small plot of land assigned to a rural family for agricultural production that serves the family's subsistence needs and optimally allows sale of surplus products; the household plot usually consists of a parcel adjoining the family's house plus one or several parcels in fields surrounding the village" (Wolfgramm et al., 2011: iv).
Hukumat	Tajik name for the administration at district and regional level (Winning 2005).
Jamoat	"Third-level administrative division in the Republic of Tajikistan [RT], includes several villages (there are approximately 360 Jamoats in the RT)" (Wolfgramm et al., 2011).
Kolkhoz	Collective farm in the former Soviet Union. A cooperative agricultural enterprise on state-own land. The peasants who worked on that farm were from a number of households that belonged to the collective farm. They were paid as employees depending on the quality and quantity of the work they contributed. (EncyclopædiaBritannica, n.d.)
LADA	Land Degradation Assessment in Drylands (http://www.fao.org/nr/lada/)
Land degradation	„The reduction in the capacity of the land to provide ecosystem goods and services and assure its functions over a period of time for its beneficiaries" (LADA in: Bunning et al., 2011: 31).
LUS	Land Use System
NCCR	National Centre of Competence for Research (www.nccr.ch)
NGO	Non-governmental organization

Oblast	"Province, first-level administrative division in the Republic of Tajikistan [RT] (there are 4 oblasts in the RT)" (Wolfgramm et al., 2011: v).
Presidential land	"Land distributed to rural families for household farming by two presidential decrees (1995: Presidential Decree "On Assignment of 50'000 hectares of Land for Household Farming"; 1997 Presidential Decree "On Allocation of 25'000 hectares of Land for Household Farming")" (Wolfgramm et al., 2011: v).
Rayon	"District, second-level administrative division in the Republic of Tajikistan [RT] (there are 58 rayons in the RT)" (Wolfgramm et al., 2011: v).
SLM	"Sustainable Land Management (SLM) in the context of WOCAT is defined as the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions." (Liniger et al., 2008b)
Somoni	Tajik currency (at a rate of 1US$= 0.765 Somoni, August 1th 2012) (www.oanda.com)
Sovkhoz	"state-operated agricultural estate in the U.S.S.R. organized according to industrial principles for specialized large-scale production. Workers were paid wages but might also cultivate personal garden plots" (Encyclopædia Britannica, n.d.).
Technology	A WOCAT technology contains the "management, agronomic, vegetative and structural measures that control soil degradation and enhance productivity in the field" (Liniger et al., 2002).
TJS	Tajik Somoni
WOCAT	World Overview of Conservation Approaches and Technologies (https://www.wocat.net)

Part I Introduction

1 Context

1.1. Study Setup

This thesis was conducted within the frame of the Research Project RP11 of the National Center of Competence in Research (NCCR) North-South. This research project examined the land resource potentials whereby a comprehensive methodology for assessing the *impacts* of Sustainable Land Management (SLM) strategies is developed. The methodology is expected to lead to informed decision-making and win-win solutions for human needs and the environment in order to enhance food security and mitigate climate change in semi-arid to sub-humid agricultural environments (NCCR, 2010). The NCCR North-South lasted for 12 years and ended in June 2013. Within this research project, various studies analyzed the challenges as well as new opportunities connected to the last two decades of transition in the agricultural sector in Tajikistan.

As part of the the project on "Geoprocessing for Natural Resource Monitoring – Capacity Strengthening in Tajikistan and Kyrgyzstan" funded by the SCOPES (Scientific co-operation between Eastern Europe and Switzerland) Institutional Partnership program, which financed the fieldwork, this study contributes to the resource monitoring approach in the test area in the jamoat[1] of Javonon. The partnership supports scientific interoperability between Switzerland, Eastern Europe and states of the former Soviet Union for a common understanding and the achievement of integrative solutions (SCOPES: Proposal).

1.2. Problem Statement

One of the main agricultural problems in the hill zone of Tajikistan, is the soil erosion that affects large areas of agricultural land. Water and gully erosion are the main erosion processes. Erosion processes are especially active in the foothill regions. Human activity *impacts* the erosion process by intensive development of agriculture on slopes and associated non-suitable cultural practices (Bann et al., 2012). One of the case study areas within the NCCR North-South project is the jamoat of Javonon in the rayon of Faizabad, in a foothill loess region. Research on the socio-economic and natural *driving forces* and *pressures*, and their *impacts* on the *state of the land*, was conducted here in order to find solutions to help improve productivity and thus livelihoods for the people in the jamoat of Javonon. Previous research in the jamoat of Javonon raises the need for an integrative assessment of the available results with an integrative approach in order to improve land management planning. The overall goal of this study is to integrate the different datasets of previous research into a

[1] Lowest administrative division.

comprehensive assessment, based on which participatory SLM assessment exercises can be conducted in order to find SLM technologies which contribute to a sustainable development in the jamoat of Javonon. Bühlmann (2006) recognized that even though the severity of the problem of land degradation was recognized in general, only a few farmers started to implement SLM measures. In order to counteract that, scenarios with estimates of costs and benefits are provided in this thesis to support the farmers and local governments with the implementation of SLM technologies in their villages. This assessment is needed for an effective environmental decision-making process for the study area in the future.

1.3. State of the Art

1.1.1 Conceptual and Methodological Embedding

Breu et al. (2005) elaborated knowledge for sustainable development in the Tajik Pamir Mountains with a long-term baseline study and a stakeholder workshop. Knowledge for sustainable environmental development was also elaborated upon in a participatory assessment by Agyemang et al. (2007) in Ghana to organize complex environmental information and to facilitate decision-making. Agyemang et al. conducted the environmental assessment with the help of the *driving forces-pressures-state-impact-responses* (DPSIR) framework developed by Smeets and Weterings (1999). Smeets and Wetering introduced the importance of environmental indicators to provide information for environmental quality. Indicators simplify the complex reality, but at the same time they can focus on certain aspects, as for example "land use" which are regarded as relevant and on which data are available. Smeets and Weterings classified the environmental indicators as *drivers*, *pressures*, *state*, *impact* and *responses* from which the DPSIR conceptual framework arose (Smeets & Weterings, 1999). WOCAT (World Overview of Conservation Approaches and Technologies) and LADA (Land Degradation Assessment in Drylands) worked out specific indicators to assess land and its use with the DPSIR framework (Liniger et al., 2008b). Schwilch et al. (2011) developed the DPSIR framework further to the hybrid SLM conceptual framework where the DPSIR framework and the Millennium Ecosystem Assessment are brought together. The hybrid SLM conceptual framework uses the same classifications as Smeets and Wetering developed. Additionally, the framework became target oriented by aiming human wellbeing and poverty reduction (Schwilch et al., 2011).

Various tools were developed to assess the *driving forces*, *pressures*, *state, impact* and *responses*. LADA developed a manual for degradation and SLM assessment at the local level (Bunning et al., 2011). The WOCAT mapping questionnaire developed by WOCAT, LADA and DESIRE is a tool for the assessment of land degradation and SLM (Liniger et al., 2008b).

As the DPSIR framework developed by Smeets and Weterings, WOCAT has the same purpose, to improve the *state of the land* and livelihood. WOCAT aims at this goal through sharing and enhancing knowledge about sustainable land management with the documentation, evaluation and dissemination of local SLM knowledge (www.wocat.net). The EU DESIRE project developed participatory approaches where the local level WOCAT technologies are integrated. The DESIRE guidelines facilitate stakeholder learning and decision support workshops where SLM technologies are identified, assessed and finally selected for implementation (Schwilch et al. 2012b).

The entire process from applying assessment tools, identifying SLM technologies and decision-making was applied in the DESIRE study areas in Spain, Portugal, Greece, Turkey, Morocco, Tunisia, Russia, China, Botswana, Chile and Cape Verde (Schwilch et al., 2012b).

1.1.2 Previous Studies in the Jamoat of Javonon

Wolfgramm elaborated land use types from satellite data from the year 2002 and modeled hot spots of soil degradation and bright spots of soil conservation by comparing the soil organic carbon content and soil erosion. Connected to the PhD of Wolfgramm (2007), more research was conducted in the study area. Winnig (2005) made the first endeavor to collect local socio-economic data and captured the effects of socio-economic transition on land use. In her research she examined land use changes and focused on the *driving forces* that caused them. She followed up the identification of actors, which are involved in the decisions on land use changes, and of the most relevant socio-economic *driving forces* and their influences on land use changes. Bühlmann (2006) made an assessment of cropland and Wirz (2007) on grazing land. Whereas Bühlmann focused on onsite impacts of erosion, namely the net decrease of long-term productivity caused by loss of topsoil which has the highest organic matter content and which also has the most stable soil structure and offers the most optimal seedbed for germinating and emerging plants. He also modeled the effects of SLM technologies on soil loss for an evaluation of the potential for local soil conservation methods on cropland. An output of the thesis was a land use classification with 15 land use types for the year 2005. Wirz focused on the impact of different grassland management systems on land degradation. Guntli (2006) also made land use classifications of the year 2002. Eggenberger (2011) studied the effects on land use of rural out migration on rural livelihoods in Tajikistan with a focus on land use on the slopes, using qualitative household interviews in a broad variety of household characteristics. Roberts (2010) classified land use with CORONA imagery from 1970. Shokirov (2011) compared soil conservation practices in vineyards. Nazarmavloev (2011) modeled the amount of soil organic carbon in 2010 with an EO-1 Heperion image. Ruppen (2012) did a systemic biomass management analysis within the study area. In his research he collected, with interviews, precise data for the amount of crop yield cultivation, dried grass and perennial crops, dung and wood. He detected deficits of subsistence for large, medium and small farms concerning food security but also in the biomass cycle considering the soil organic matter. With various scenarios he proposed to increase the food security and the soil organic matter with alfalfa fields, mixed orchards and energy saving measures. Rohrbach (2012) made two land use classifications of the years 2005 and 2010.

Various researchers documented agricultural conservation technologies with the WOCAT technology questionnaire. They can be downloaded online on the WOCAT database.

1.4. Research Objectives

The overall goal of this study is to make a spatial assessment for SLM planning in the jamoat of Javonon. Therefore, datasets of previous research should be integrated into a comprehensive assessment. This assessment should be completed with an assessment of the present situation of the state of the land through consultations with local experts and using the WOCAT mapping methodology. With these two assessments based on previous and present knowledge, the basis is available on which a SLM planning exercise can be conducted in order to find SLM technologies which contribute to sustainable development in the jamoat of Javonon. In order to meet the overall goal of the study, for this thesis the following objectives were set:

- Firstly, the study seeks a comprehensive assessment of the study area by analysing the previous research, which helps to understand the *driving forces* that cause *pressures* on the *state of the land*.
- Secondly, it is the aim to locate the present spatial occurrence of land degradation and conservation in a participatory assessment with local experts.
- Thirdly, realistic SLM technologies should be worked out with a participatory approach in order to gain knowledge about locally acceptable SLM technologies and to create an acceptance base for future adoption of these technologies.
- Fourthly, scenarios of responses in land management shall be discussed whereas a cost-benefit analysis should support decision-making.
- Lastly, the aim of this study is to contribute a methodical approach for SLM planning may be applied in other regions.

Certainly the agricultural approach is not the only way to meet human wellbeing and poverty reduction goals. Nevertheless, within the NCCR project this thesis supports solutions with SLM technologies on the level of small-scale farming.

2 Background Information

2.1 Characteristics of Tajikistan

Tajikistan is an inland country in Central Asia that borders Afghanistan, China, Kyrgyzstan and Uzbekistan (see Figure 1). From 1929 till the independence in 1991, Tajikistan was a Soviet Socialist Republic (Allworth et al., 2013), whereby Soviet rule shaped the country. After independence a disastrous civil war broke out (1992-1997) and led to the death and dislocation of thousands of people, economic collapse and food and fuel shortages. This time slowed the formation of legal and institutional reforms during the time of transition onward (USAID, 2010).

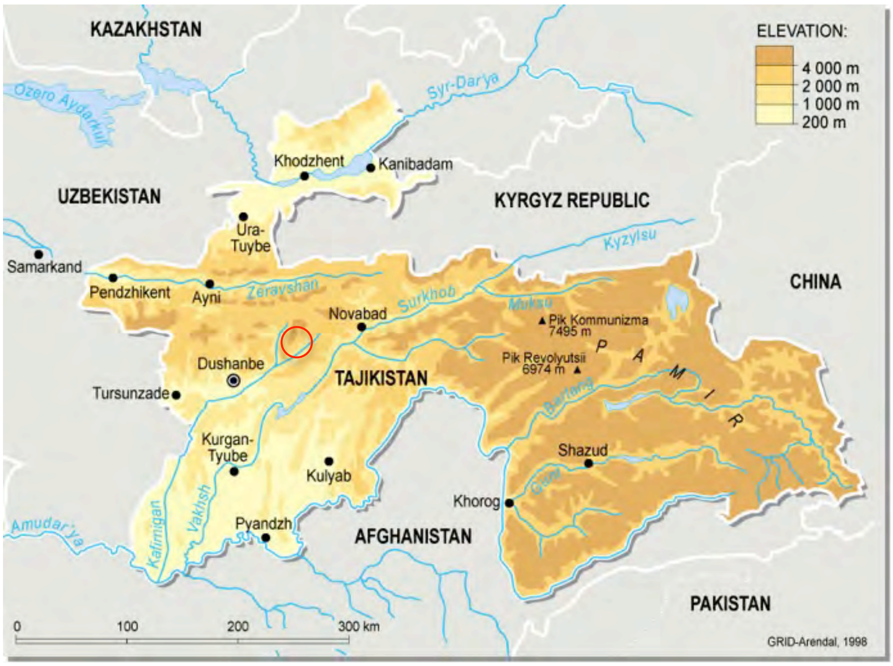

Figure 1 Topographic map of Tajikistan. The red circle marks the location of the study site. (Source: Rekacewicz, Bournay & UNEP/GRID-Arendal 1998)

Tajikistan has 7.8 million inhabitants with more than 70% living in rural areas (Allworth et al., 2013). The country, where more than 90% of its 143'100 km^2 area is mountainous, consists of two main geographical parts: the western part, which is shallow, hilly and mountainous and the eastern part, which consists of a high mountain region, the Pamirs, which is 2000-7500 m a.s.l. (see topographic map in Figure 1). The climate is hot and dry in summer and cold in winter (Allworth et al., 2013). The water storage capacity of the glaciers in the western high mountains enables, in some areas, irrigation in the summer when the ice melts. Irrigation is important for this highly agrarian country. Small-scale subsistence agriculture is predominant. In the year 2006, 60% of the population's employment was in the agricultural sector, which generates 30% of the total GDP (Lerman & Sedik, 2009).

Tajikistan is a country with ethnic variety with cross-border ethnic ties to neighboring countries. This has hindered the formations of national identity in the country (Allworth et al., 2013) and according to Foroughi (2002) it was ethnic nationalism which led to the civil war. Despite the ethnic variety of Tajik society, a Persian language became the single official language. Russian is often used, especially in the government and in business. The main religion in Tajikistan is Sunni Islam (Library of Congress, 2007).

2.2 Site Description

My study area is the jamoat of Javonon, selected by Bettina Wolfgramm as a representative site for the hillzone in Central Tajikistan. Wolfgramm selected it for first research within NCCR North-South. Based on her PhD, other research was conducted for this area, which is part of the following administrative entities listed from top to down: oblast RRS (Region of Republic Subordination), rayon Faizabad, jamoat of Javonon. The study area is situated in central Tajikistan (compare Figure 1), 50 km away from the capital Dushanbe, and a well-constructed road connects it to the capital. The jamoat of Javonon lies on a foothill of a mountain range and borders a river in the valley floor. In the flat valley floor, fertile and irrigated cropland can be found. Some irrigated cropland also exists on the slopes. Higher up in very steep areas grazing land can be found. The study area consists of loess soils with steep slopes, which is prone to erosion by water and wind. Due to 70 years of top-down planned economy, today the individual farmers have insufficient knowledge of conservation practices. Excessive tillage of land for grain cropping in the post Soviet era during the civil war, few conservation measures, heavy rainfalls in spring, limited water supply over the remaining months of the year and limited flat land are the factors which make a profitable and sustainable agriculture challenging.

Part II Framework

Beside natural processes, human activities such as indiscriminate grazing, quarrying of raw material, firewood harvesting, ineffective land use policy, poor education and poverty have played an increasingly important role in driving environments far beyond their carrying capacity. Such activities cause unprecedented degradation and depletion of natural resources (Agyemang et al., 2007). Agyemang et al. (2007) underline the importance of the assessment of environmental degradation and natural resource depletion as a tool for long-term management of natural resources and the sustenance of livelihoods that are dependent on them. Spatial and social determinants that cause human driven environmental problems have to be researched with an appropriate assessment tool (Agyemang et al., 2007), such as the hybrid SLM conceptual framework, introduced in the chapter 3. WOCAT tools were used as an assessment tool and with the DESIRE guideline a SLM planning was conducted. The methodological principles are described in the chapters 4 and 5.

3 Hybrid SLM Conceptual Framework

The hybrid SLM conceptual framework (see Figure 2), published by Schwilch et al. (2011) was used in this thesis. It is 'hybrid' because it combines two existing frameworks: the Drivers-Pressure-State-Impact-Response DPSIR framework and the ecosystem services perspective that is used by the Millennium Ecosystem Assessment (MEA). Both concepts help to carry out a system analysis. The five domains of the DPSIR (*driving forces*, *pressures*, *state of the land*, *impacts* and *responses)* framework, which was originally developed by Smeets & Weterings (1999), are still part of the SLM conceptual framework and can be found in the scheme in Figure 2. Social and economic developments (*driving forces*) exert *pressure* on the environment, and therefore the current *state of the land* changes. The resulting *impacts* on ecosystem services cause societal *responses*, which again influence this cycle. The Millennium Ecosystem Assessment conceptual framework contains the domains of *indirect drivers*, *direct drivers* and ecosystem services, which are similar to the DPSIR's *driving forces*, *pressures* and *impacts*. In addition, the MEA's goal is human wellbeing and poverty reduction. The combination of these conceptual frameworks outlines a dynamic, networked system. Within that system, SLM is a *response* to the *driving forces*, *pressures* and the *state of the land* with a *impact* on livelihood (Schwilch et al., 2011).

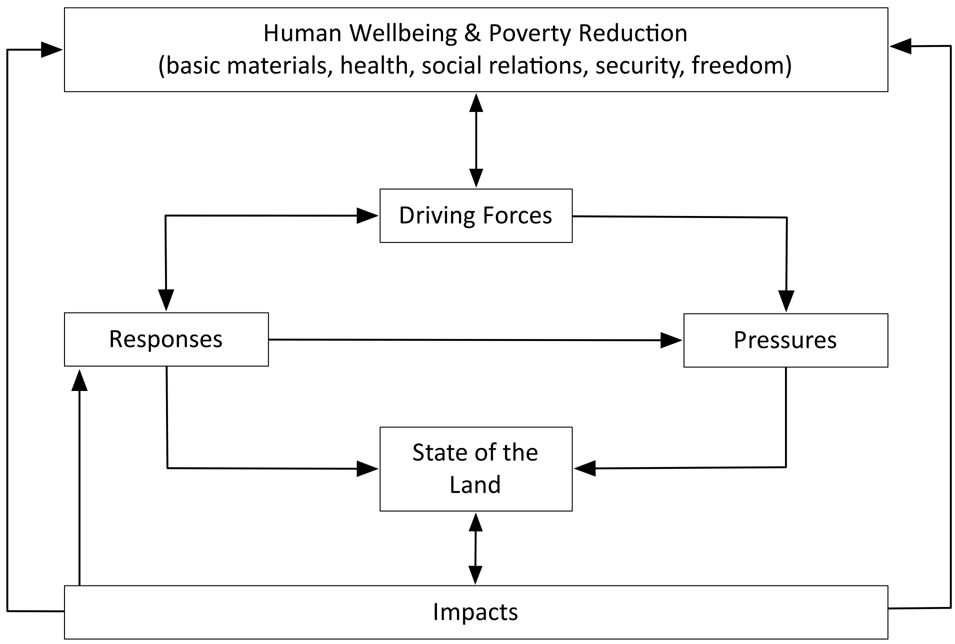

Figure 2: Hybrid SLM conceptual framework (according to Schwilch et al. 2011: 216 (modified)).

The overall goal of this dynamic system analysis is similar to the goal of the DPSIR framework as used by Agyemang et al. to understand the direct and indirect causes of land degradation and SLM, and to understand its *impacts* on the environment and on livelihood. The study of Agyemang et al. (2007) remarks that the DPSIR environmental assessment framework is an effective means of organizing complex environmental information to facilitate policy decision-making. It points out clear steps in the causal cycle where the chain can be broken by policy action, by finding appropriate *responses* in any or a combination of the domains (Agyemang et al., 2007). In this way the hybrid SLM conceptual framework is used in this research. The elaboration of the original DPSIR cycle can show the *driving forces* which cause land degradation, and with that knowledge possible countermeasures could be taken into consideration in order to obtain positive *impacts* on livelihoods.

4 The Aim of WOCAT

WOCAT stands for World Overview of Conservation Approaches and Technologies. The goal of the global network is to collect local knowledge on SLM practices all over the world (Liniger et al. 2008a). SLM is defined in the context of WOCAT *„as the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions"* (Liniger et al., 2008a). For the better use of local knowledge, Liniger et al. (2002) emphasize the requirement of common tools and a common language for the documentation of technologies and approaches. WOCAT technologies are management, agronomic, vegetative or structural measures that control soil degradation and enhance productivity in the field. WOCAT technologies address degradation and conservation by combining three basic sets of information: the land use where the technology is applied; the degradation type the technology addresses; and the conservation measures used. These three basic points of information are subdivided into more specific characteristics in order to describe the exact technology (Liniger et al., 2002). WOCAT considers knowledge on SLM as a local, individual source, valuable for others facing the same problems and interested in problem solving. WOCAT constitutes a database of know-how about SLM and disseminate it around the world (Liniger & Schwilch, 2002).

Complementary to the documentation of technologies and approaches, the WOCAT mapping questionnaire was developed which allows a general spatial assessment of land degradation and SLM and works out the causes and *impacts* of degradation and SLM on ecosystem services (Schwilch et al., 2012c). The resulting maps can be used for efficient and improved decision-making and optimized land management planning (Liniger & Schwilch, 2002).

5 SLM Planning with DESIRE Guidelines

The concept of SLM is a response to environmental problems such as land degradation, desertification, climate change, loss of biodiversity and food insecurity (Schwilch et al., 2012b). According to Schwilch et al. (2012b) SLM is "a multi-stakeholder issue, concerning individual and community land users, agricultural advisors, natural resource managers, government authorities, civil society, and researchers" (Schwilch et al., 2012b). The realization of SLM technologies is a crucial task, for which the DESIRE workshop guidelines were developed. Extern decisions on SLM technologies often failed due to lack of financial feasibility or socio-cultural acceptance (Schwilch et al., 2012b). That's why participatory approaches involving all stakeholders are meaningful for a successful SLM planning.

DESIRE is a project of the European Union, which develops integrated conservation approaches that can prevent and reduce widespread degradation in fragile arid and semi-arid ecosystems. The DESIRE project establishes promising alternative land use management conservation strategies (European Union, 2007). Within this research project, three guidelines were developed whose aims are to identify prevention and mitigation strategies, assess them and to select prevention and mitigation strategies to be implemented (see Figure 3). Part one is a guideline to identify land use problems and existing SLM technologies. Part two guidelines the evaluation and documentation of local solutions. The guideline part three includes a review of local innovations documented in the WOCAT database, the selection and adaption of potential SLM technologies and the negotiation process to identify technologies to be implemented in a given human and natural environment (Schwilch et al., 2012b).

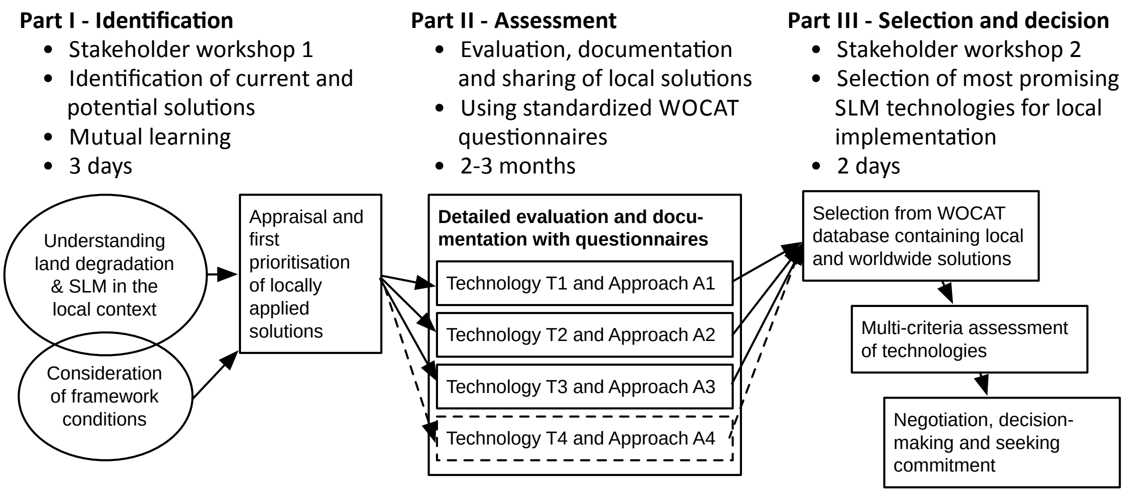

Figure 3 The three steps of the DESIRE methodology for identification, assessment and selection of SLM technologies. Part III was applied in this thesis. (According to Schwilch et al. 2012b: 88)

In a study about the acceptance of nature conservation measures in Switzerland, performed by Schenk et al. (2007) the integration of concerned persons in finding solutions for development and extensive communication about new implementations are important in order to create long-lasting acceptance (Schenk et al., 2007). The aim to create an acceptance base for SLM was followed up by applying the DESIRE guidelines in this study.

Part III Methods

In this part, the methods and the materials used are described. In chapter 6, the approach and methodical workflow are presented. Then the conceptual approach for the synthesis of previous research is described in chapter 7. For the baseline study degradation and conservation mapping with the WOCAT mapping questionnaire (chapter 8), the collection of statistical data from the jamoat (chapter 9) and the yield questionnaire (chapter 10) are presented. SLM planning with the DESIRE guideline is described in the chapter 11 and the scenario building in chapter 12.

6 General Approach and Workflow

In this thesis I follow a similar general methodological approach as Agyemang et al. (2007) developed for the assessment of environmental degradation in a study area in northern Ghana. Because human activities drive ecosystems beyond their carrying capacity, according to Agyemang et al. an "assessment of environmental degradation and natural resource depletion has […] become an essential tool for the long-term management of natural recourses and the sustenance of livelihoods that are dependent on them" (Agyemang et al., 2007). Agyemang et al. used the DPSIR framework as assessment tool, while in this study the hybrid SLM conceptual framework was employed.

The general research question was approached in four steps conducted within two phases of this thesis. The following described steps can be found in the schematic representation in Figure 4. Phase 1 deals with the past and present situation in the test area: An assessment of the environmental degradation using the hybrid SLM conceptual framework was conducted. The first step in this phase consists of the synthesis of the existing knowledge from literature. In a second step, knowledge about the *state of the land* degradation and conservation

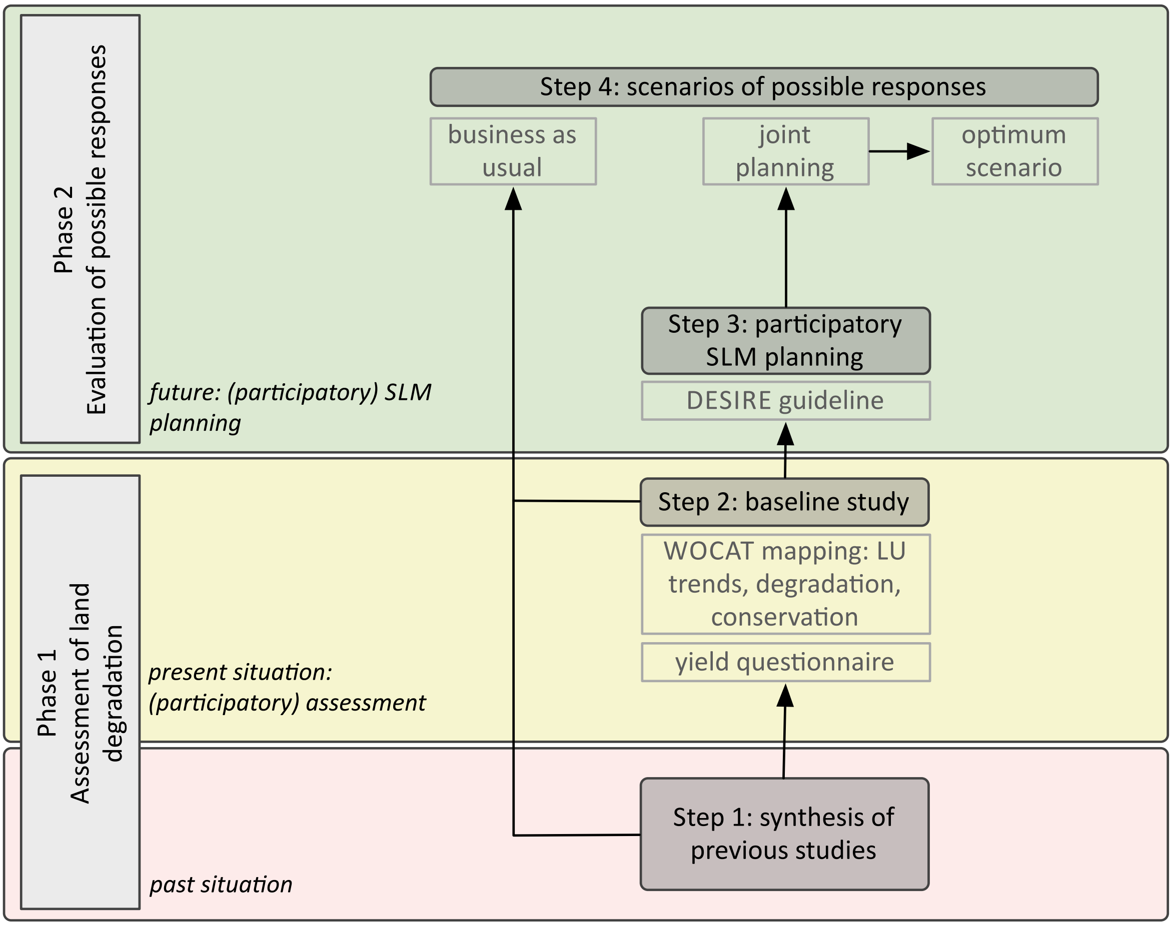

Figure 4 Schematic workflow of the study approach.

in the study area is collected using the WOCAT mapping questionnaire. Phase 2 is based on Phase 1, and deals with identifying technologies for implementing SLM, where possibilities to improve land management in a sustainable way should be determined. In a third step, local farmers selected possible SLM technologies in a workshop, which was conducted according to the DESIRE guideline part III. Finally, in the fourth step three different scenarios were analyzed in order to support future decision-making on land management planning.

The workflow in this study was in a similar way as the one by Agyemang et al. (2007) even though this research is building up on results of already existing theses, which were included in the assessment. In a first phase, Agyemang et al. (2007) used GIS and remote sensing techniques to evaluate and assess the *state of the land* of the study area, similar as Bühlmann (2006), Wirz (2009) and Wolfgramm (2007) did. In a second phase, Agyemang et al. used participatory approaches for community trothing. In this thesis, participatory approaches were also applied to assess the *state of the land* and to detect possible SLM technologies for intervention.

7 Synthesis of Previous Research

The long-term NCCR North-South project allowed for building up comprehensive scientific insights specifically from the jamoat of Javonon, which has contributed to knowledge on SLM in the study area. In order to present the state of knowledge in the study area and determine the *driving forces* for land degradation and *impacts* on human livelihood and well-being, the literature research and analysis in this thesis focused on the most important results of the previous research. This was achieved by applying the hybrid SLM conceptual framework as an assessment tool. Agyemang et al. (2007) emphasize the importance of spatial and social factors "in the assessment on human driven environmental problems" with an appropriate "environmental assessment tool". The PhD and master studies, conducted in the study area, were brought together for an overall assessment. The material is structured according to the domains of the framework used in this thesis. To facilitate the synthesis of the literature, the WOCAT/LADA indicators for *driving forces*, *pressures*, *state of the land*, *impacts* and *responses* were used to elaborate the domains of the framework.

Particularly, the *driving forces* are the "social, demographic and economic developments in societies and the corresponding changes in life styles, overall levels of consumption and production patter" (Smeets & Weterings, 1999: 8). The resulting changes in production and consumption exert *pressure* on the environment in the form of physical and biological agents, the use of resources, and the use of land and release of substances. *Pressures* change the quantity and quality of the *state of the land* in certain areas. For example the soil fertility declines due to intensive production without any input of fertilizers. These changes have *impacts* on the ecosystem services. *Responses* are guided by groups or individuals in the society or by the government in order to adapt, prevent, mitigate or rehabilitate to changes in the *state* of the environment (Smeets & Weterings, 1999). The *driving forces*, *pressures*, *state of the land*, *impacts* and *responses* can be determined easiest using the guiding WOCAT/LADA indicators in Figure 5, which strongly focus on agricultural land use. With these indicators the literature was reviewed in order to put the indicators in relation to each other and as an outcome system of knowledge for causes of land degradation in the study area results.

Peer-reviewed literature was used to confirm the credibility of the studies used for the synthesis of previous research. Additional data for population growth is included which was collected at the jamoat.

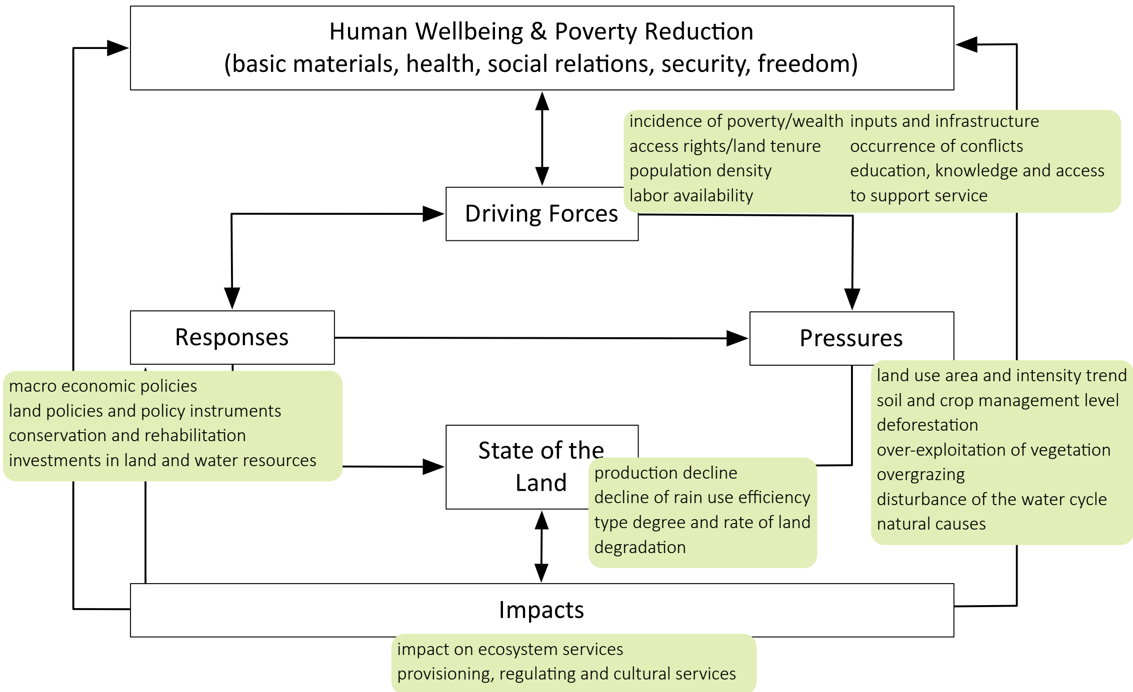

Figure 5 Hybrid SLM conceptual framework (according to Schwilch et al. 2011: 216) with selected indicators according to WOCAT/LADA (Liniger et al. 2008b).

8 Mapping Degradation and Conservation with the WOCAT Mapping Questionnaire

The WOCAT mapping questionnaire was filled out within a workshop. In this chapter the different methodological steps, the preparations and the steps in the workshop are presented. The creation of the base map is described in the chapter 8.1. In the chapter 8.2 the experts are introduced. The chapter 8.3 explains the procedure of the workshop and in the chapter 8.4 the limitations and critics of the proceeding are recorded.

8.1 Creation of the Base Map

The ‘Questionnaire for Mapping Land Degradation and Sustainable Land Management’ elaborated by Liniger et al. (2008b) is a tool to collect qualitative local knowledge on land degradation and conservation for different Land Use Systems (LUS), based on expert opinion and consultation of land users (Schwilch et al., 2012c). This questionnaire uses the DPSIR framework, the predecessor framework of the hybrid SLM conceptual framework, to collect indicators of *driving forces*, *pressures*, *state of the land*, *impacts* and *responses*. To apply this questionnaire, a base map with LUS is needed for the study area. A LUS is determined by uniform characteristics within one LUS. In this case, the land cover and land use type were considered as significant indicators to assess degradation and conservation of a LUS. As a subdivision the slope at 16% was differentiated due to different exposition of slopes to erosion. The slope of 16% was chosen due to the break WOCAT recommends at 16% from rolling to hilly (Liniger et al., 2008b). Bühlmann and Wolfgramm also differentiated at a inclination of 15% where contour ploughing solely has an effect on soil erosion (Bühlmann, 2006) and the risk of erosion occurring significantly was reduced at a steepness below 15% (Wolfgramm, 2007).

The land use map of the jamoat of Javonon made by Bühlmann (Bühlmann, 2006) was used as an initial position. The map was made in 2005. Generally, the feedback of researchers in Faizabad was that not that much has changed in terms of land use. A field visit of Ruppen in 2011 showed unpublished sketches which demonstrated that not much changed in terms of land use. The 14 land use classes made by Bühlmann (2006) were narrowed down to 7 classes in order to simplify the process of degradation mapping. The reduction of land use classes included an assessment of balance between a simple and still precise degradation assessment. The aim is to create LUS’s where each describes an area that has the same exposure to degradation. Since erosion is supported by the steepness of slopes, each land use class was divided into two at a slope of 16 percent[2]. Abandoned land, forest, extensive grazing land and vineyards do not exist in areas below 16% thus 10 LUS in Table 1 resulted from this process. The base map was created in ArcGIS before it was uploaded on the WOCAT database. The results of the workshop also were inserted in the database.

[2] Instead of 16% in the field 9° was used. Local people are more familiar with the unit degree.

Table 1 Land Use Systems (LUS) derived from the land use classes created by Bühlmann (2006).

ID	LUS	classes Bühlmann
1	abandoned land steep	abandoned land
2	annual cropping flat	wheat, chickpeas, flax, safflower, vegetables
3	annual cropping steep	
4	forest steep	natural forest
5	extensive grazing land steep	extensive grazing land
6	perennial cropping flat	alfa-alfa, esparzet, intensive grazing land (hay making)
7	perennial cropping steep	
8	orchard flat	orchard, orchard with intercropping, moulberry
9	orchard steep	
10	vineyards steep	vineyards

After Bühlmann made the land use map, Wirz (2009) assessed six different grassland systems which were not considered in detail in this assessment by the WOCAT mapping questionnaire. As part of the grazing land, he assessed also haymaking areas and orchards. Upon consultation with, the supervisor of both theses, the map conducted by Wirz is more precise and therefore the map of Bühlmann was complemented with the orchards and haymaking areas from Wirz. The classes of haymaking and orchard from Wirz were added to Bühlmanns map after geo-referencing both maps. Rohrbach (2012) geo-rectified the two Quickbird satellite images from the years 2005 and 2010 according to a most precise geo-rectified World View image. The maps of Bühlmann and Wirz were geo-referenced in ArcGIS to this newest spatial orientation in the coordinate system WGS (World Geodetic System 1984) 42N before the LUS were created. Bühlmann made the digital elevation model (DEM), used to separate the LUS at the specific slope, from Soviet military topographic map of the year 1983 (Bühlmann, 2006). (All GIS data can be found in the electronic annex.)

8.2 Experts at the WOCAT Mapping Workshop

A team of experts was assembled for the mapping workshop. Three participants were from the local government, the forestry department and from the horticulture institute at the field station, three Tajik researchers whom are familiar with the study area, a local researcher from Faizabad, a local farmer and a researcher from Switzerland who was familiar with the study area were present.

8.3 Procedure of the WOCAT Mapping Workshop

The data collection with the WOCAT mapping questionnaire consists of 4 steps. In the first step the experts work out knowledge on land use by determining the land use area trends and intensity trends of the LUS in the past ten years as indicators for *direct drivers*. In the second step the degradation for each LUS is specified with the use of the *state* indicators: major degradation type, extent, degree and rate of degradation. In the same step the direct and indirect causes (*driving forces* and *pressures*) of land degradation and the *impacts* on ecosystem services were compiled. In the third step SLM practices for the LUS were documented. Those were put into conservation groups, categorized according to conservation measures and ordered according to its purpose: prevention, mitigation and/or rehabilitation. Then it was defined to which degradation type the measures address, estimations of the effectiveness and the trend of this conservation type were made, *impacts* on ecosystem services were indicated and some other basic information was collected. The fourth step included expert recommendations for each LUS, how to address degradation, by adaption, prevention, mitigation or rehabilitation (Liniger et al., 2008b). An overview of the steps for degradation and conservation assessment can be found in Table 2.

Table 2 Overview of the WOCAT mapping questionnaire for assessing land degradation and SLM. (Source: Schwilch et al. 2012c: 25)

Degradation assessed for each LUS	**SLM technologies assessed for each LUS (*responses*)**
Type	Name/Group/Measure
Extent (area)	Extent (area)
Degree	Effectiveness
Impact on ecosystem services (type and level)	Impact on ecosystem services (type and level)
Direct causes (*pressures*)	
Indirect causes (*driving forces*)	Degradation type addressed
Recommendations	

For each mentioned step and its sub steps, a broad range of codes with indicators was provided in the WOCAT mapping questionnaire. With those indicators the workshop participants described the LUS, the degradation and the conservation. To simplify the workshop procedure, needless codes were dropped in the preparation and translated Russian and Tajik codes were also provided (see electronic annex). The workshop was carried out in the following order: The group of experts worked out the answers for each step and for each LUS, with negotiations as part of the process. For each step, remarks by the experts could be added. The answers (codes) were filled in to a table and were inserted in the online WOCAT mapping database after the workshop. In the online WOCAT mapping website (www.wocat.net) the results can be looked up in the database and can also be found in the electronic annex. The data can be downloaded as a *shapefile*, which includes the base map and the codes defined by the experts in the workshop. This *shapefile* was processed in

ArcGIS to visualize and analyze degradation and conservation, which can be found in the result chapter.

8.4 Limitations and Critics in the Proceeding of the WOCAT Mapping Workshop

Irrigated and non-irrigated agricultural land was not differentiated, because no information for irrigated area was available. Risks for erosion were only considered according to the type of land use and the slope, but not according to if the land is irrigated or not. However, this is also an important factor which influences soil erosion. The differentiation of irrigated and not irrigated probably would have brought more classes, which would have extended the procedure of the workshop.

For a next time, in the class of perennial cropping, the haymaking area should not be included. Because perennial crops like alfa-alfa are sometimes irrigated, this class was not understood as an uniform class by the experts. The idea behind making this class was that perennial crops and haymaking cover the soil all year, and due to that the protection of the soil would be similar.

The participants were local experts. Nevertheless, data cannot be completely trusted due to the highly qualitative assessment. The mapping questionnaire is intended to be clear and simple but there are assessment steps such as extent or degree of degradation, whose evaluation is rather subjective. Already Ruppen (2012) stated, that uncertainties of his field data are high, because the collected data is based on rough estimates of interviewees. The previous research of Wolfgramm (2007), Bühlmann (2006) and Wirz (2009) helped to confirm the output of the WOCAT mapping questionnaire where descriptions for the *state of the land* were available.

The workshop was conducted in the hot summer season during Ramadan. This holiday, as well as the remaining work in the fields made it difficult to get the experts interested for the workshop. In addition, the workshop does not contribute to the personal development of the experts. It collects local knowledge and does not immediately give anything back to them. The time to conduct a workshop was better chosen in the second workshop, the SLM planning in October.

9 Collection of Statistical Data

Statistical data was collected together with a translator at the jamoat office. The data was only available from 2005 to 2012. The data at the jamoat included population, household, livestock and yield data. The raw data can be found in the electronic annex. The change of the population and livestock number and yield data are important indicators for *driving* *forces*, *pressures, state of the land* or *responses* and should be included in an overall assessment. Wirz (2009) stated, that stocking rates are an indicator for degradation respectively overgrazing. Population growth and thus increasing population density are key determinants of environmental degradation. Yield data is an important indicator for productivity. Together with data of expenses and labor input the profitability of a crop can be determined.

Here I want to add that statistic data collected at the jamoat has to be treated with caution. As Wirz stated, people are afraid to give true numbers because it could reach the tax administration office.

10 Yield Questionnaire

With a yield questionnaire another approach to collect data about yields was developed in order to collect additional data alongside the jamoat statistics. (The yield questionnaire can be found in annex 6). 500 questionnaires were distributed among all the households of the four villages of Obi Sangbur, Hojomard, Karsang and Chanoro.

To collect yield data, each household had to fill in the data for one field of choice that could be orchard with or without intercropping, vineyard, wheat, flax, chickpeas, vegetables, safflower, hay making (irrigated or not irrigated), alfa-alfa, esparzet, alfa-alfa and esparzet or other crops. Other than the type of land use, the steepness (0%-16%, 16%-30%, >30%), the size of the field, amount of work, expenses for machinery, fertilizers and seeds, and finally the output of this field were asked. The high number of questionnaires was used to finally get a good amount of data for each land use types. However, this expectation did not occur. The returned questionnaires were limited on few land use types.

According to Ruppen (2012) information given by the interviewees are usually based on rough estimates. Along with a low sampling number uncertainties are high. The yield questionnaire was distributed to a bigger number of participants but still the information is expected to be based on rough estimates.

The questionnaire was distributed in October after the main harvest when farmers were expected to remember yields best. The questionnaires were distributed and collected by representatives of the director of the local research station in Karsang.

10.1 Critique of the Methodology of the Yield Questionnaire

A high number of questionnaires returned but the data is very different to the official government data as available from the local jamoat office. In Table 3, the differences between statistic data from the jamoat and data collected for this study with the yield questionnaire can be found as an example from the village Obi Sangbur. The number of persons per household is 8.8 according the data from the jamoat and 5.1 according the data from the questionnaire. Also the number of cows per household varies immensely, which is 0.6 per household according to the data from the jamoat and 3.4 according to the questionnaire. Wirz (2009) stated, that people would not declare proper animal numbers to the jamoat due to taxes they have to pay. Thus the differences in number of animals per household could be explained like this.

Fieldwork in the jamoat of Javonon has to be strongly controlled in order to get reliable data. Data collections with questionnaires, which heavily rely on statements of "unknown" people, have to be treated with caution.

Table 3 Example of differences of statistic data from the jamoat and data collected with a quantitative questionnaire for the village Obi Sangbur.

	jamoat statistics 2012	**yield questionnaire 2012**
Household (HH)	119	53
Persons (P)	1053	268
P/HH	8.8	5.1
Cows/HH	0.6	3.4

11 SLM Planning with the DESIRE Guideline

As explained earlier in the chapter 5, DESIRE provides guidelines for SLM planning in three parts. Whereas in part I current and potential solutions to land degradation are identified, in part II such technologies are assessed and in part III most promising technologies are selected for local implementation. Within the NCCR North-South project, research investigated the problems related to land use in the jamoat of Javonon. Existing solutions were identified and documented in the WOCAT technology database. The ten-year long partnership and the close collaboration with local people involved local stakeholders for the identification of SLM technologies. That is why in this thesis the DESIRE workshop guideline part III for selection of most promising SLM technologies for local implementation was applied directly. The core participants of this workshop were local farmers.

11.1 The Proceeding of the SLM Planning Workshop

The two-day workshop for identifying appropriate SLM technologies with participants from the villages Karsang, Obi Sangbur, Hojomard and Chanoro was conducted in October 2012. In the phase of the workshop preparation, appropriate technologies from the WOCAT database were selected, the workshop program and material was prepared, the team familiarized with the topic and the participants invited. The Tajik speaking team consisted of the moderator, two PhD students and a research assistant, all operating as facilitators. The responsible person for WOCAT and the head of NCCR North-South Dushanbe and a translator also attended the workshop. 20 small- and large scale-farmers from the four designated villages were selected to participate in the workshop. Some of the participants are also represented in the local government or are themselves researchers. Effectively, 15 to 20 participants were present and one third of the participants were women. The participants were chosen by the local longtime NCCR North-South partner Jahonbek Boev, the director of the research station in Karsang. He chose people who were interested to work with SLM methods. That was the most reasonable way to find motivated participants, as people did not get paid for their participation. The workshop was hold in Tajik, the local language. The occasion of this workshop was also a finalizing project of the NCCR North-South research project in Faizabad, to show the farmers some outputs of the researches and give them something back for what they contributed to the research. For the thesis the goals were defined as follows:

Table 4 Goals of the SLM planning workshop

- Introduction and selection of prevention and mitigation technologies to be implemented
- Strengthen trust and collaboration among concerned stakeholders within and between the villages
- Collect the shared visions for future land use amongst the participants
- Provide suitable tools and background material which can be used in the future
- Follow the third objective of the thesis: "Realistic SLM technologies should be worked out with a participatory approach in order to gain knowledge about locally acceptable SLM technologies and to create an acceptance base for future adoption of these technologies."

An overview of the workshop program is shown in Table 5. The details of the workshop program can be found in annex 2. Times and parts of the content were adapted during the two days of workshop. First, a common basic knowledge had to be established with theoretical inputs about soil erosion and soil productivity. Then the objective of the workshop, the "reduction of soil erosion and increase of soil productivity on cropland and grazing land" was introduced. The definition of this objective would have been part of a workshop with the DESIRE guideline part I. However, long and careful research in the study area for problem assessment enabled me to define these goals without applying the stakeholder workshop with the guideline part I, but rather based on previous research.

Table 5 Broad program of the workshop.

Day 1: Problem statement, introduction and selection of technologies

a) Theoretical Inputs: Introduction in soil erosion and soil productivity. Introduction of the degradation maps from the WOCAT mapping
b) Introduction of the two objectives: Reduction of soil erosion and increase of soil productivity on 1) annual cropland 2) grazing land
c) Explain what the WOCAT database is and how it was used
d) Introduce SLM technologies from the WOCAT database
e) Identification of SLM technologies for grazing land and annual cropland

Day 2: SLM implementation

a) Introduce the criteria
b) Score the SLM technologies and rank the criteria
c) Introduction of SLM approaches
d) First ideas of possible projects for implementation in the villages
e) Personal motivation for SLM
f) Specific planning (fill in the application form)

The next step was based on the WOCAT technology database. 33 technologies (see annex 3), which were selected in advance, were presented to the participants. Technologies for annual cropland and grazing land, with potential for reducing soil erosion and increasing the productivity under the semi-arid conditions had been selected. The technologies address problems like erosion by water or wind, lack of water, loss of nutrients, overgrazing and energy efficiency. Posters for each WOCAT technology in combinations with WOCAT technology movies were used to introduce the technologies[3]. The technologies were assigned in 4 categories according to the land use type they could be applied to: grazing land, annual cropland, orchards and other SLM technologies which do not necessary take place on the land but still help the conservation of land, as for example, better insulation. Tajik speaking facilitators introduced at four stations each one category of technologies to small groups of participants. The participants recorded the advantages and disadvantages of the technologies and already decided if it is applicable to the study area or not. The participants rotated, till everyone learned about all the technologies.

In a next step, the participants from each village had to decide if they want to focus on SLM technologies for annual cropland or grazing land. The participants of each village negotiated for six technologies to choose for the following procedure by select the best technologies.

To ensure the sustainability of the SLM technologies for the study area, ecological, sociocultural and economic criteria were defined in advance, as shown in Table 6. These criteria were introduced to the participants and ranked according to the importance for them.

[3] The movies can be looked up on the WOCAT database. (https://www.wocat.net/en/knowledge-base/documentation-analysis/videos.html, last access: 12.12.2013)

Table 6 Criteria for a sustainable SLM technology.

ecological	socio-cultural	economic
▪ decreased soil loss ▪ increased water availability	▪ strengthen the community ▪ benefit for the small and large scale farms	▪ increasing yield ▪ fewer expenses ▪ low work input

In the next step the technologies were scored. The six selected technologies were taken and scored for each criteria between 6 to 1 according how they meet the criterion.

The DESIRE workshop guideline guides until this part of the workshop. For organizing the procedure, the facilitator "Multi-Objective Decision Support System" (MODSS) open source software, which was adapted for the DESIRE projects, was used. This software supports certain steps of the evaluation and decision-making process (Schwilch et al., 2012b).

11.2 WOCAT Technology Database

The WOCAT technology database (www.wocat.net) contains documentation of SLM technologies, which were documented with the help of standardized questionnaires. It contains various SLM technologies on different places in the world and especially a high number from Tajikistan. Bühlmann (2006) started to document the first SLM technologies in the jamoat of Javonon. Meanwhile more than 60 technologies have been documented in Tajikistan and 380 from over 40 countries (WOCAT, n.d.).

11.3 Approaches for the Implementation of SLM Technologies

After selecting possible SLM technologies for the study area, approaches are needed for efficiently implementing SLM. In the workshop five different approaches were introduced. In Table 7 an overview of these approaches can be found: A) In order to achieve a large-scale implementation of a technology, it might be subsidized. For example fences could be sold with a discount if they are used for a specific technology. With a financial incentive a widespread implementation of a technology could be promoted. B) The distribution of leaflets with instructions for technologies and advice in the villages would be a good approach to draw the attention of the villagers to the problem and motivate them to implement SLM. C) Learn from experts by inviting a consultant to the village or making a field trip could allow many people to learn about possible technologies. D) The inclusion of schools for the establishment of a technology would involve the whole village and already sensitize the youth on land degradation problems. This approach was introduced with a movie corresponding to the approach A_TAJ022 on the WOCAT database. E) The convocation of self-help groups could help to exchange experiences and motivate each other to work on behalf of SLM (WOCAT approach A_KEN13). (Details about these approaches can be found in annex 4).

The idea behind these approaches was first, to give an idea how to implement the projects at the end of the workshop, and second, to have a long-term impact with this workshop, by having the whole village participating in the project, and not just one family to whom the plot belongs.

Table 7 Five approaches for the implementation of SLM technologies.

A) Financial support for a large-scale implementation of a technology
B) Distribute leaflets with instructions for technologies and advices, e.g. through the jamoat
C) Learn from experts, e.g. invite a consultant or make a field trip
D) Include schools for the establishment of agricultural projects to sensitize the youth
E) Organize regular meetings for self-help groups

After the workshop, each village received a set of material to bring home. That material, included the WOCAT degradation and conservation maps, WOCAT movies about SLM technologies, booklets with the topics such as self-help groups or desertification, the WOCAT technology posters, and the leaflets about the approaches. The idea behind this was that the material and knowledge presented in this workshop could be used again and distributed further in the villages or discussed in, for example, self-help groups.

11.4 Farmers Project

To complete the SLM planning workshop, each village received a fund of 500 US dollars to invest in SLM. Because the fund was rather small, I expected that it would be spent for one of the approaches in order to share the fund among the villagers. It was required that the implementations have to be in favor of SLM and the ideas had to be written in an application form. Each village needed a responsible person for the implementation and the participants from each village got a short application form where a problem statement, the description of the proposed project, the working steps and a short budget planning had to be presented. At the end of the workshop the first ideas were collected and exchanged. Then the participants were given another two weeks time to finalize their ideas. One check of the implementations was promised to the participants to make sure the projects were carried out.

11.5 Review of the SLM Planning Workshop

The selection of the date of the workshop is an important factor for a successful proceeding. Two workshops had been conducted in this thesis, the WOCAT mapping workshop in the labor-intensive season in July and the SLM planning workshop in October. October was a good time to conduct the workshop, then most of the yield had already been collected and people could participate without the constant need to go home. Another good decision was to organize the transport for the participants to come to the workshop. As a result, people did not leave earlier than the car which brought them back to their villages.

The participants were selected by the director of the research station in Karsang. Because a high authority decided who is going to participate at the workshop, people felt obligated to go. That probably lowers the motivation, because the participation of these people was not voluntarily.

12 Scenarios

As a final part, three different types of *responses* were discussed in order to support the local government and local experts in decision-making concerning the implementation of SLM. First, a business as usual is discussed, which was derived from the synthesis of literature and the assessment with the WOCAT mapping questionnaire. Second, the outcomes of the SLM planning workshop were applicable and accepted SLM technologies. These were used for a cost-benefit analysis in comparison to a business-as-usual land management. Thirdly, an ideal land use planning according to the author's consideration based on the workshop and on the previous literature is presented. These three different scenarios of *responses* can give a wider view about what could happen in the future concerning land degradation and conservation in the study area. This discussion of different *responses* can support the local communities, the local government and NGOs for future actions in the jamoat of Javonon.

Part IV Results

The previous research conducted in the jamoat of Javonon examined socio-economic and biophysical *driving forces* and *pressures* in relation to land use. This research is synthesized in the following chapter 13 according to the hybrid SLM conceptual framework. In order to work out a good basis of system knowledge for the study area, the focus of the synthesis of previous studies is on the *driving forces* and *pressures*, whereas *state of the land* and *impacts* are documented with the WOCAT mapping questionnaire in chapter 14 and the *responses* are discussed within the results of the SLM planning workshop and the scenarios in the chapters 16 and 18.

13 Synthesis of Previous Studies - *Driving Forces* and *Pressures*

According to the hybrid SLM conceptual framework, the *driving forces* cause *pressures* on the *state of the land* and are influenced by the *responses*. The WOCAT/LADA indicators describe the *driving forces* with incidences of poverty and wealth, access rights to land tenure, population density, labor availability, (chemical and technological) inputs and infrastructure, occurrence of conflicts, education, knowledge and access to support services and protected areas (Liniger et al., 2008b). Existing local and international literature (Egorov, 2002), (Winnig, 2005), (Wolfgramm, 2007), (Lerman & Sedik, 2008), (Muminjanov, 2008), (Wirz, 2009), (Eggenberger, 2011), (Betti & Lundgren, 2012), (Kurbanova, 2012), (Ruppen, 2012), and (Shatovna, 2013) with relevance to the local *driving forces* have been analyzed and synthesized in this chapter. The results of such extensive research review and the main identified *driving forces* and the resulting *pressures* are presented in the following chapters, summarized under the headings: population growth, poverty, labor migration, institutional support, missing knowledge and support and insecurities of the land tenure system. How the *driving forces* are part of the the whole hybrid SLM conceptual framework can be found in the graphic in Figure 19. The biophysical *pressures* do not result from the *driving forces* but are also described in a paragraph.

13.1 Population Growth

Population growth is a *driving force* for changes in land use. The population of Tajikistan is about 7.2 million. More than 60% of existing population is at the age of 16 or below. The population growth rate is considered to be very high in Tajikistan, and continues to be 1.5% annually within the next 5 years. About 26% of the population resides in cities and 74% in rural areas (Muminjanov, 2008). In the jamoat of Javonon in 2012 the population density was between 117 and 160 people per km^2.[4] Since 2006 the population has grown by 16% to a total population of 11'723. For the period 2006 to 2012 an annual population growth of 2.3 % is calculated (Source: Jamoat, compare Figure 6). In Tajikistan especially in the rural areas the population is expected to grow faster, which increases the demand for food and requires measures to strengthen the food security and puts pressure on the agricultural production and the land resources (Muminjanov, 2008).

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[4] Uncertain number according to 3 numbers of the size of the area (1) area of the extract of the satellite imagery, 2) information from the jamoat, 3) a existing GIS layer with the jamoats from Tajikistan).

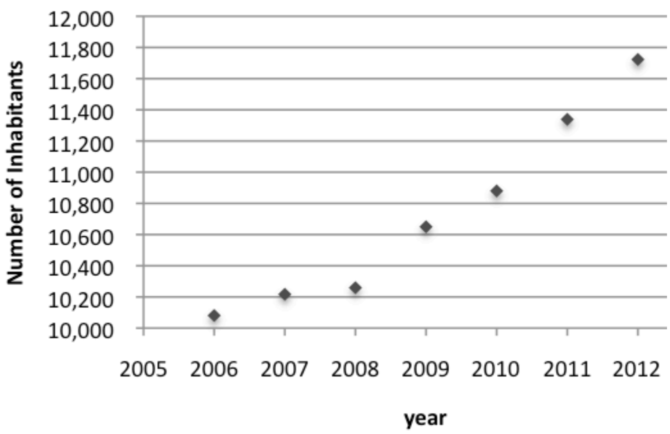

Figure 6 Number of inhabitants in the jamoat of Javonon in the years 2006-2013. (Source: jamoat 2012 and Eggenberger 2007 (for the years 2006 and 2010))

13.2 Poverty

The households in the jamoat of Javonon are predominately subsistence, mixed, small-scale farms. People grow crops and keep animals. Surplus is sold on the market. Livestock is held for food production and working force. The farms cultivate land between 0.03 ha and 27.1 ha (Ruppen, 2012). The main income sources are remittances of labor migration and agricultural production (Eggenberger, 2011). In the period of economic transition, the agricultural sector suffered a decline but since the end of the civil war in 1997 Tajikistan's agricultural production has been recovering (Lerman & Sedik, 2008). As people in the jamoat of Javonon are predominantly subsistence farmers, they rely on the provisioning function of soils to produce food, fuel and feed. This means a healthy and fertile soil is required (Ruppen, 2012). Even though loess soil is considered as a fertile soil, fertility decline of the soils and at the same time insufficient input of manure and fertilizers were observed (Wolfgramm, 2007). Due to its high costs and limited availability inorganic fertilizers are applied little and irregularly. Animal dung or plant residues are organic fertilizers but dung is also a common energy source for cooking, baking and heating and plant residues are often given to the animals as feed (Ruppen, 2012). Illegal forest cutting for fuel wood, cooking, baking and heating due to lack of alternative energy was observed.

Food, feed and fuel scarcity and unreliability and temporary food insecurity is widespread in the study area. The main coping strategies are to rely on less preferred and expensive food, borrow food from friends and relatives, purchase food on credit, limit portion sizes of meals, seek alternative employment or increase labor migration as is described in the following chapter (Ruppen, 2012).

13.3 Labor Migration

Besides agriculture, pensions, off-farm occupations like teacher and doctor salaries, and especially remittances, are other income sources (Winnig, 2005). According to World Bank data, the remittances to Tajikistan have continuously increased since 2002, with a drop in 2008 as a consequence of the world's economic crisis (Betti & Lundgren, 2012). In the jamoat of Javonon in most of the households, at least one person works abroad (Eggenberger, 2011; Winnig, 2005). The jamoat data shows different numbers: 0.17 person per household in the year 2012 and 0.31 in the year 2007. Betti & Lundgren (2012) calculated an average of 1.3 migrants per household in rural areas in the nearby oblast of Kathlon. Remittances of labor migration are often the main income source and are therefore economically more important than farming (Eggenberger, 2011). Especially for households without access to land or leased land, labor migration is an important survival strategy in the jamoat of Javonon. The migrants are usually male in working age (18-55 years) (Winnig, 2005). Eggenberger (2011) counted in two villages in the study area 10-20% of the population as labor migrants in 2010, which was 50-70% of men at working age. Few households do not have any migrants, due to the lack of male labor force (Eggenberger, 2011).

Labor migration happens predominantly seasonally, usually between the months of March and November (Eggenberger, 2011). This period coincides with the period of the highest labor intensity in agriculture (Winnig, 2005). The main destination of labor migration is Russia. The non-visa requirement, Russian language proficiency and the existing network of relatives and friends are the pull factors (Eggenberger, 2011). At home, labor migration has positive and negative impacts. Living conditions have improved visible. The number of cars increased, which allows better mobility and also the number of residential houses increased. Due to brain drain, education quality hasn't improved substantially (Eggenberger, 2011). The study of Betti & Lundgren (2012) in Khatlon noted that labor migration increases employment. Migrants get more jobs, and by leaving they also give more job opportunities to those who choose to stay (Eggenberger, 2011). The investment of remittances in land use is very little (Eggenberger, 2011; Mukhammadieva et al., 2010). Often they are used to pay land taxes but mostly the expenses are spent on food and clothes. Eggenberger mentions a lack of land trade and that demanded irrigated land in the valley floor is not available, which is probably why remittances are very rarely invested in enlarged land access (Eggenberger, 2011). Some remittances are invested in livestock which is used as income saving and can be sold at some point (Winnig, 2005). Due to remittances, the number of livestock increased rapidly in the post war period (Wirz, 2009). Labor migration has also impact on the human capital through reduced labor force and diseases and injuries migrants often bring from their stay abroad (Eggenberger, 2011). Absence of men due to labor migration has shifted agricultural workload towards women and children. As a consequence, agricultural land is often not cultivated or it is used extensively (Eggenberger, 2011; Winnig, 2005).

13.4 Institutional Support

Various governmental institutions such as the Hukumat, the Jamoat, the rayon Land Committee and the Rayon office of the Ministry of Forestry are responsible for land use planning, the inventory book, the implementation of laws and decrees on land legislation, the control of legal and proper use of the land, the preparation of certificates for land leasing and maintenance of the forest and afforestation (United Nations, 2011; Winnig, 2005). A non-governmental institution in the jamoat of Javonon is the farmers association. This association helps farmers with juridical, financial, technical support and other information (Winnig, 2005). Other nongovernmental organizations are the international NGOs which work in the development field, for instance agricultural development programs which are meant to support farm privatization or improve the knowledge for land use (Winnig, 2005). However, the family can be seen as the most important institution. Winnig recognized that the social network is concentrated mainly on the (extended) family. A reason that cooperation was not extended intensively further than the family is to avoid conflict. Nevertheless, there is also cooperation among villagers, particularly among neighbors. Concerning land use, the collaboration extends to exchanging fertilizers, cost sharing through common leasing of machinery, such as tractors or harvest combiners, and mutual help during the harvest. The tenure of communal grazing land and the leading of animals to grazing land in turn is an important institution in the village. People like neighbors or relatives also can provide financial support in forms of credits (Winnig, 2005). An observation during the workshop, which was conducted for this thesis, showed that the participants from one out of four villages were not willing to work together for a common project. The reason was that the people could not find a consensus to work together, and instead each villager worked independently. The other three projects were finally also implemented mainly each by one family.

13.5 Knowledge and Support

The agricultural knowledge of today's farmers is mainly a mix of fragments from the Soviet agricultural and educational system and knowledge brought by western development agencies. In Soviet times kolkhozes and sovkhozes were equipped with specialists such as engineers, agronomists and accountants and the government also generated knowledge in its state universities. The breakdown of the Soviet Union changed this system and impacted the quality of knowledge initiation negatively (Shtaltovna, 2013). According to studies by Egorov (2002), most of the research institutes that were built during Soviet times are aging and the quality of research does not meet today's needs (Egorov, 2002). Nowadays, the poor quality of knowledge generated by the national agricultural research institutes cannot be transferred to the agricultural producers due to a lack of money. After the breakdown of the Soviet Union there are no longer kolkhozes but rather a great number of stand-alone farmers who mostly lack farming experience and knowledge on how to run agriculture and enter in to the market or to process agricultural goods (Shtaltovna, 2013). In the WOCAT mapping workshop the experts mentioned that specialist such as agronomists or veterinarians left and are missing now. The farmers are not educated and technologies are not applied anymore. Shtaltovna (2013) mentions international donor organizations as new actors which provide agricultural knowledge (Shtaltovna, 2013). Some put much effort to restore the traditional knowledge or sustainable land use management strategies. For example, the book "Traditional Land Management Knowledge in Central Asia" published by the United Nations Development Program, which outlines some of the most profound traditional techniques of land management in Tajikistan (Bekturova & Romanova, 2007).

Kurbanova mentions the legacy of "Soviet-style thinking", for example, the restoration of grazing land is understood by people to be necessary, but according to the same group of people it can only happen through large-scale irrigation, planting projects or the use of chemical fertilizers. The concept of small-scale self-help groups are not accepted (Kurbanova, 2012). It seems that the attitude of people towards improvements in land management is rather passive. In the workshop conducted within this thesis, at the end each village got a small fund for a SLM project to be implemented. The first reaction was that with this little money nothing could be done. The proposal to spend the money in approaches was not followed up by the participants.

13.6 Insecurities of the Land Tenure System

According to the Tajik constitution, land and its resources are the property of the state and the state guarantees its effective use in the interest of the people (TJ, 1994). Because land is the property of the state, it never can be private, but its rights can become individual or private. In order to improve efficiency, farms have been reorganized in line with law after the breakdown of the Soviet Union (Lerman & Sedik, 2008). Primarily, two laws were introduced in 1992, one to improve the productivity of the farms and another that introduced a better management strategy for individual farms. First, the law "On Land Reform" was established in order to give a platform for competition to achieve higher production and efficient land use. The second law "On Dekhan Farms" was introduced to allow the establishment of individual dekhan farms.

Fundamentally, there are two types of land users: primary land users and secondary. The primary land users can get land title for lifetime-inheritable, perpetual or fixed-term use rights, whereas the secondary land users lease the land. The land plots may be leased with agreements for up to 20 years (Halimova, 2012; United Nations, 2011). Households and smaller-scale dekhan farms lease additional grazing land from the large collective farms, state reserve, and forestland. Halimova notes that the leasing practices for grazing land are not specified, are usually just for one year, which makes tenure rights of lessees weak, promotes exploitative practices and is sensitive for corruption (Halimova, 2012). The primary land users pay taxes to the state and receive a higher amount from the lessees. Overgrazing due to high livestock numbers is the consequence (Kurbanova, 2012). Leased land is particularly common in the jamoat of Javonon. It is rented from a large farm by households or from the village as a juridical person (Winnig, 2005).

The long process of reforms and amendments gradually improved land use rights and its handling. This includes the introduction of Land Use Certificates and Land Passports, to confirm the right of land use for individuals and the simplified procedures for registration of land use rights (Lerman & Sedik, 2008; United Nations, 2011). Dekhan farmland is managed independently by the owner of the farm, either by a collective or by an individual. The rights of land tenure are inheritable (Winnig, 2005). According to Eggenberger the number of individual farms are increasing in the jamoat of Javonon. Because the household had to be part of the local sovkhoz or kolkhoz during Soviet times, not all tenants have the chance to transform their rented land into an individual dekhan farms (Eggenberger, 2011). Individual dekhan farmers have secured better land use rights than tenants. Land is not taken away and farmers can decide on their own how they would use their land, which is not always the case for land tenants (Eggenberger, 2011).

Ultimately, access to the land property is confusing but according to Eggenberger (2011) at least every household has access to a household plot in the jamoat of Javonon. According to the interviews of Eggenberger 50% (80% according to the jamoat representative) of the households in the two villages do not have any further access beside the household garden (Eggenberger, 2011). This is because of a lack of money or the absence of the head of the household while the land was being distributed (Winnig, 2005).

Financial aspects do not play the key role in terms of improved land use rights. Land on the valley floor is in high demand and is already tenanted, and land on the slopes is not in demand. Families without land access have never had land since the break-up of the Soviet times. Leading figures of Soviet Union systematized the land distribution to their own advantages (Eggenberger, 2011). Grazing land usually is communally rented from a collective dekhan farm from the village (Winnig, 2005). The run of long-term land rental causes the critic that inaccessible areas under private use increase at the expense of the public grazing land (Wirz, 2009). By contrast Eggenberger (2011) stresses that land on the slopes, which is usually common land, is not in demand compared to flatter areas. Villagers criticized the enforcement of land regulations due to the corruption of functionaries, particularly in that they do not assist in questions of land use, but rather they are more so interested in raising taxes and bribes (Wirz, 2009). According to Halimova (2012) the "privatization" of land affects the originally collective grazing land. She brings up the negative effects of the trend towards privatization of land, which threatens the secure access to common grazing land on which villagers have long relied upon while strengthening the privileges of primary users (Halimova, 2012; Kurbanova, 2012).

The process of land reform had been running for 20 years in the interest of the farmers but lack of awareness of land use rights and long and bureaucratic processes prevent farmers from making proper land registrations (Kurbanova, 2012). Eggenberger (2011) identified that some households are not aware of their exact land property rights, and that they do not always know about the legal status of their land access. Kurbanova (2012) expects increased conflict potential concerning land access within the next ten years.

13.7 Biophysical Conditions

An important biophysical factor is the annual distribution of the rainfall in the region. According to the Tajik Meteorological Service in (Wolfgramm, 2007) the mean annual rainfall in Faizabad is close to 900 mm per year, concentrated in the period from November to May. 50 percent of the rainfalls are observed in March, April and May with highest intensities in May from which the highest rainfall erosivity can be deduced. The period from June to October is dry combined with an increasing air temperature. The average temperature over the summer half year is 20°C (Tajik Meteorological Service, Ministry of Environment in: Wolfgramm, 2007).

Farmers assess the water availability as insufficient. The irrigated arable land is limited. Some areas cannot be irrigated the whole year long or are used as rain fed (Eggenberger, 2011; Winnig, 2005). Due to this, less water-needy plants, for instance wheat, are cultivated (Winnig, 2005). Limited drinking water for livestock on grazing land leads to frequent trampling at the water points. Droughts, more wind storms and dried out of springs were observed (Kurbanova, 2012).

The jamoat of Javonon is on 1200-2400 m asl. The difference in altitude entails that higher grazing land is used later in the spring and thus for a shorter period due to snow which remains longer in higher altitudes (Wirz, 2009). It also indicates moderate to steep slopes with a flat to gently sloping valley floor. The subsoil are loessial deposits on which the two main soil classes calcareous montane brown soil and typical montane soil formed (Bühlmann, 2006). Loess is an unconsolidated and mainly wind deposited, mineral sediment. Loess typically forms thick deposits, of several meters to several 100 m. The deposit shows little or no stratification and has a high porosity (Canarache et al., 2006). Soil organic matter is crucial for aggregate stability and soil nutrient cycling (Wolfgramm, 2007). Bühlmann (2006) modeled high and very high soil erosion by water whereas erosion by wind, soil compaction and soil fertility decline are other degradation forms of the soil. Topsoil erosion by water removes the part of the soil with the highest organic matter. This influences the soil characteristics and its functions: soil fertility, aggregate stability, water infiltration characteristics, moisture storage capacity and nutrient balance (Wolfgramm, 2007). The heavy rainfalls in spring and irrigation of slopes cause soil erosion by water. Strong winds, especially in winter, cause erosion by wind.

14 Mapping Land Degradation

In the following chapter the results of the WOCAT mapping workshop are presented. First, the used base map with the LUS is described in chapter 14.1. Then the trends in extent and intensity of the LUS according to the experts are presented in chapter 14.2. In the chapters 0-0 the degradation types, *state* indicators of degradation and the *indirect* and *direct drivers* for degradations are presented as well as the *impacts* on ecosystem services.

14.1 Land Use Systems

The base map with the LUS had to be created in order to map land degradation and conservation with the WOCAT mapping questionnaire. In the methodology chapter 8.1 it is described how it was created. The first criteria for building the LUS was the type of land use. There the land use types of perennial cropping, annual cropping, orchard, vineyard, grazing land, forest and abandoned land were considered. The land use classes can be found in the map in Figure 7. The second criteria, was the slope, differentiated at 16% whereas a simplified line in Figure 7 marks the break steeper or flatter than 16%. Ten LUS resulted according to the two criteria. The shares of the different LUS of the whole agricultural area are shown in Figure 8 whereas the total agricultural area is 55.6 km^2. Thereof 8.4 km^2, around 15.2% of the agricultural land are slopes <16% and the other 84.8% (47.2 km^2) of agricultural land is on slopes >16%. The 15.2% areas with a slope <16% mainly are used for annual cropland (58%), perennial cropping (26%) and orchards (15%). 50.4 km^2 (46.8%) of the area is grazing land. The remaining land all on slopes >16% is used to following shares by these LUS: perennial cropping (16.9%=9.4 km^2), annual cropping (4.5%=2.5 km^2), orchard

(8.3%= 4.6 km²), vineyard (0.9%=0.5 km²), forest (0.4%=0.2 km²) and abandoned land (7.2%= 4 km²).

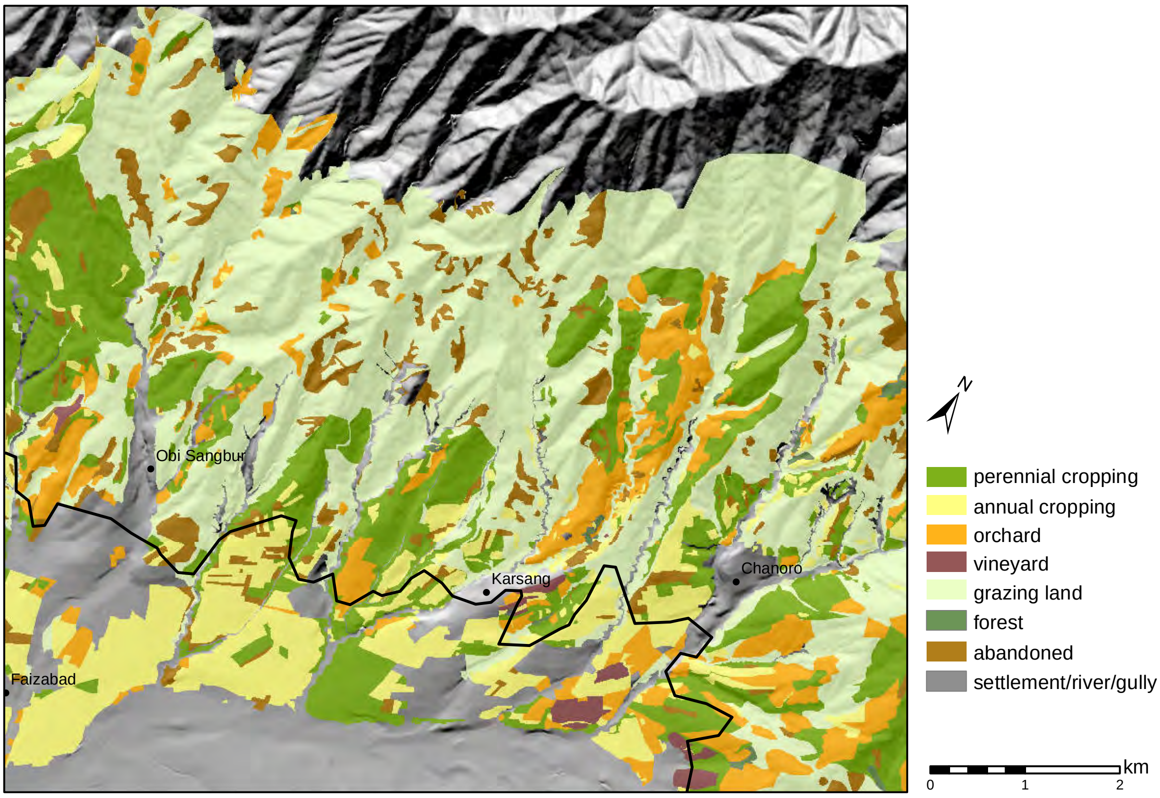

Figure 7 Land use in the jamoat of Javonon used as the first criteria to build the LUS. The black line marks the second criteria, northern areas are steeper than 16%, southern areas flatter. (based on Bühlmann 2006 and Wirz 2009. Background: Digital Globe 2010)

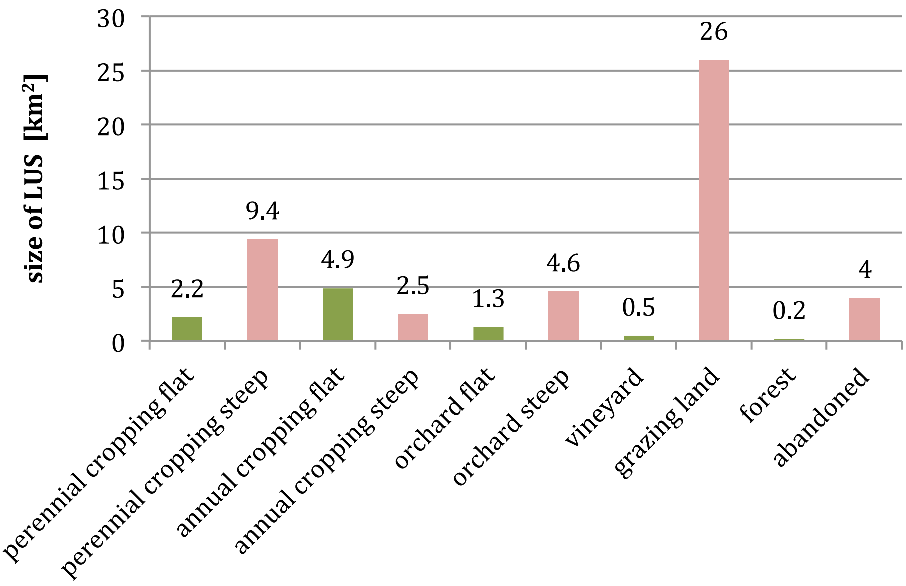

Figure 8 Area sizes of the LUS. Flat areas (slope <16%), shown in green colors, steep areas (slope >16%) in red.

14.2 Trend in Extent and Intensity of the Land Use Systems

The first step collects the historic trend of extent and intensity of the LUS in the last ten years. This can help for the prediction of future land degradation and may enable the implementation of SLM strategies (Schwilch et al., 2012c). In annex 5 a map with trends of the area extend (*pressure*) within the past ten years is presented and in Figure 10 the trends for each LUS are shown. According to the experts, extensive land use, abandoned land and grazing land has been rapidly increasing in size in the last ten years. Slowly increasing in size have been the LUS flat annual cropping, orchards on steep and flat slopes and vineyards. According to jamoat data in Wirz (2007) the surface of orchards increased annually more than three times in the period from 2004 to 2008 to an area of 3.4 km². The LUS map based on data from 2005 and 2006 shows an area of 5.8 km². An assumption for the difference could be that people do not specify their land as orchard due to higher taxes which have to be paid for this LUS. The area of perennial cropping on steep slopes remained stable, annual cropping on steep slopes, forest and flat perennial cropping are the decreasing LUS. The experts mentioned that no trees are planted and at the same time trees have been cut. Because limited availability of electricity, especially in winter there is only 2 to 3 hours electricity a day, firewood is used. People also cut nut-, almond- and other trees illegally and sell them. None of the LUS decreased rapidly.

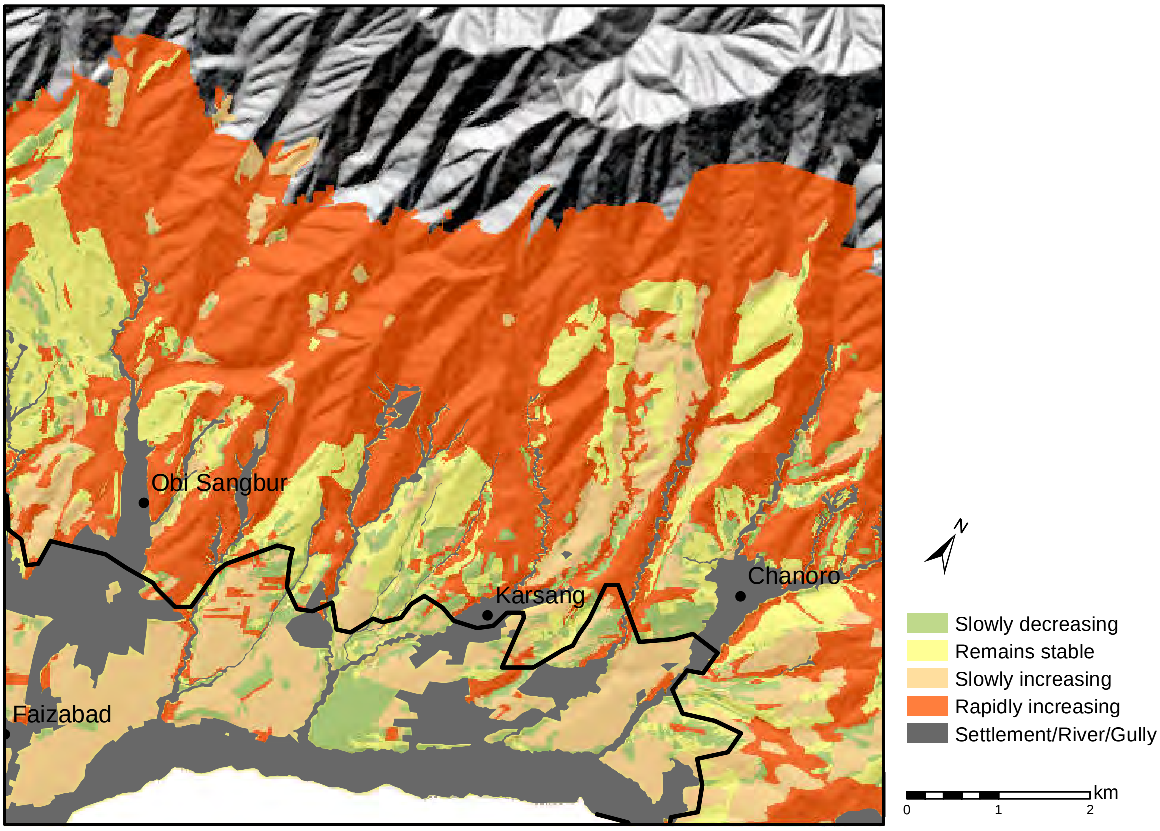

Figure 9 Area Trend in land use in the jamoat of Javonon. (based on Bühlmann 2006, Wirz 2009, background: Digital Globe 2010)

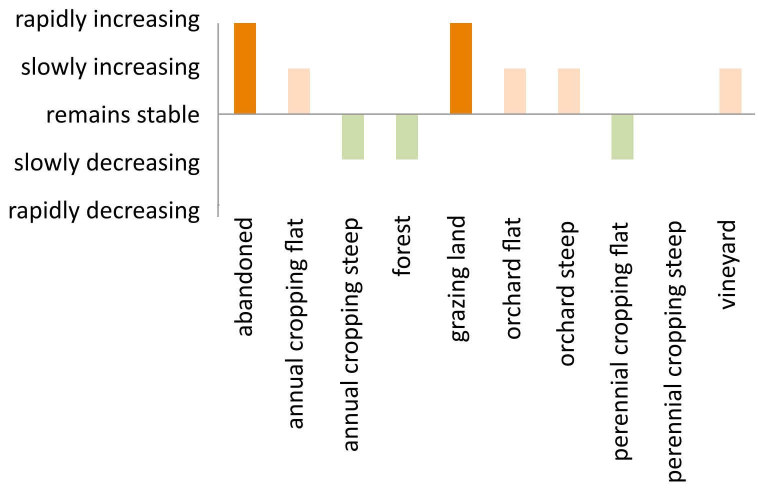

Figure 10 Area trend of each LUS.

The land use intensity trend (*pressure*) in the last ten years is presented in the map in Figure 11 and the intensity trend for each LUS is described in Figure 12. On abandoned land a major decrease of intensity was stated. For annual and perennial cropping on steep slopes a moderate decrease of intensity was stated, whereas a moderate to major increase of intensity was observed for the LUS orchard steep, vineyard and grazing land.

Characteristic for the extent and intensity of annual cropping are the reports of Winnig (2005) who describes wheat cultivation on slopes whereas Eggenberger (2011) observed some years later that cultivation on steep slopes ceased. Remittances made people not too dependent on wheat anymore, as it is cheaper at the market than the input in these fields. Also, the labor force is missing and the yield on these fields decreased. At the same time annual cropland on steep slopes decreased whereas grazing land expanded. Because the number of livestock increased grazing land is used more intensive.

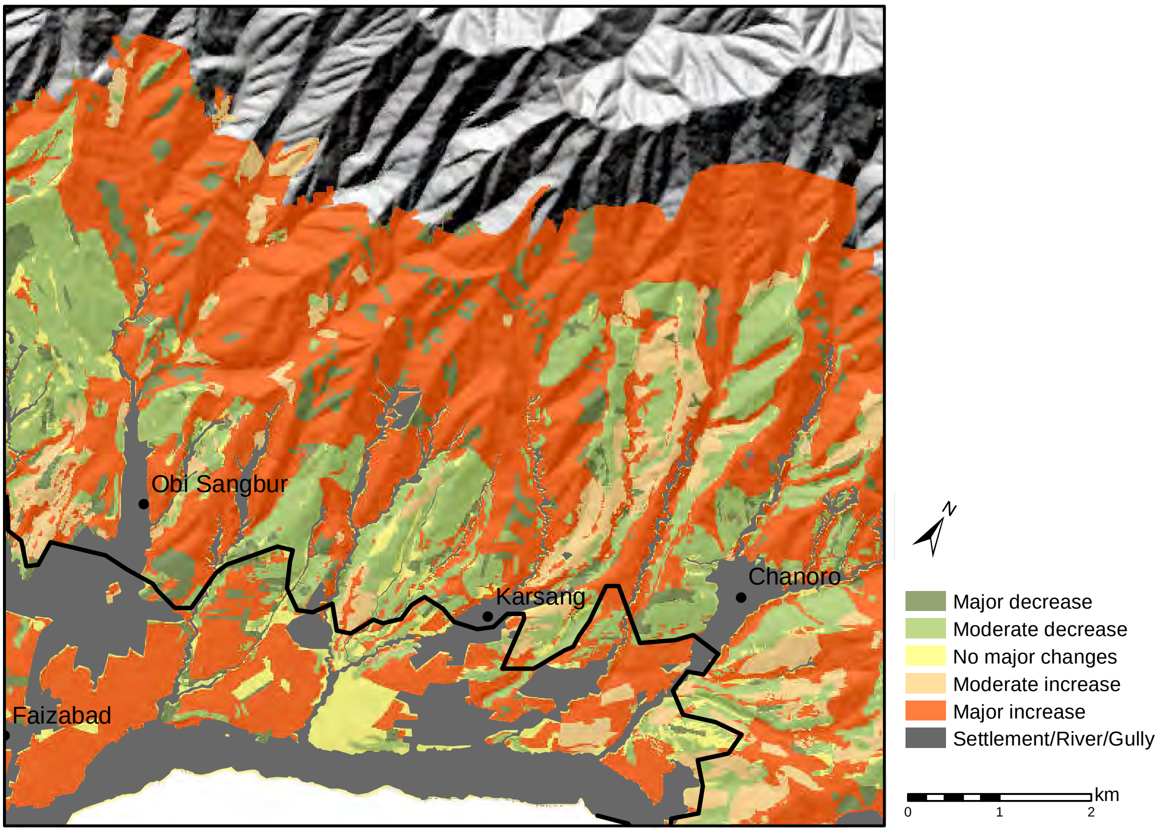

Figure 11 Land use intensity trend in the jamoat of Javonon. (based on Bühlmann 2006, Wirz 2009, background: Digital Globe 2010)

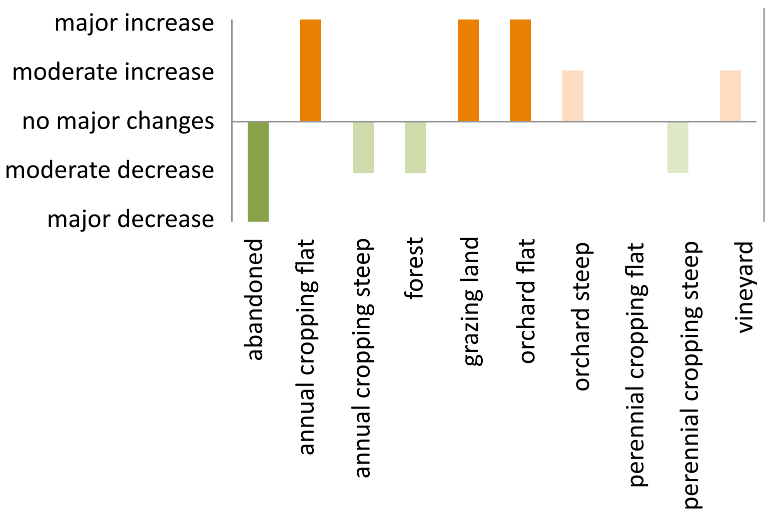

Figure 12 Land use intensity trend for each LUS.

14.3 Degradation Types

The major types of land degradation, secondary types of land degradation, degree of land degradation and extend of land degradation, all *state* indicators, were indicated by the experts in the WOCAT mapping workshop. The major degradation types in the jamoat of Javonon are caused by biological degradation or by soil erosion by water eather by gully processes, mass movements or loss of topsoil on large areas. The distribution of these degradation types can be found in the map in Figure 13. The main degradation type on grazing land is mainly the reduction of vegetation cover by grazing whereas mass movements/landslides and loss of topsoil by wind were indicated as secondary degradations types. The second largest main degradation type, loss of topsoil through soil erosion by water, happens on the LUS annual and perennial cropping and on orchards, all on both steepness classes, whereas the secondary degradation types are compaction, fertility decline, loss of topsoil by wind erosion, loss of soil life, sealing and crusting and reduction of vegetation cover. Abandoned land is affected by gully erosion, loss of topsoil through erosion by wind and aridification. On the 0.2 km^2 of forest area mass movements/landslides are mentioned as major degradation types (which probably happens due to deforestation), aridification and loss of habitat are the secondary degradation types. An Overview can be found in Table 8.

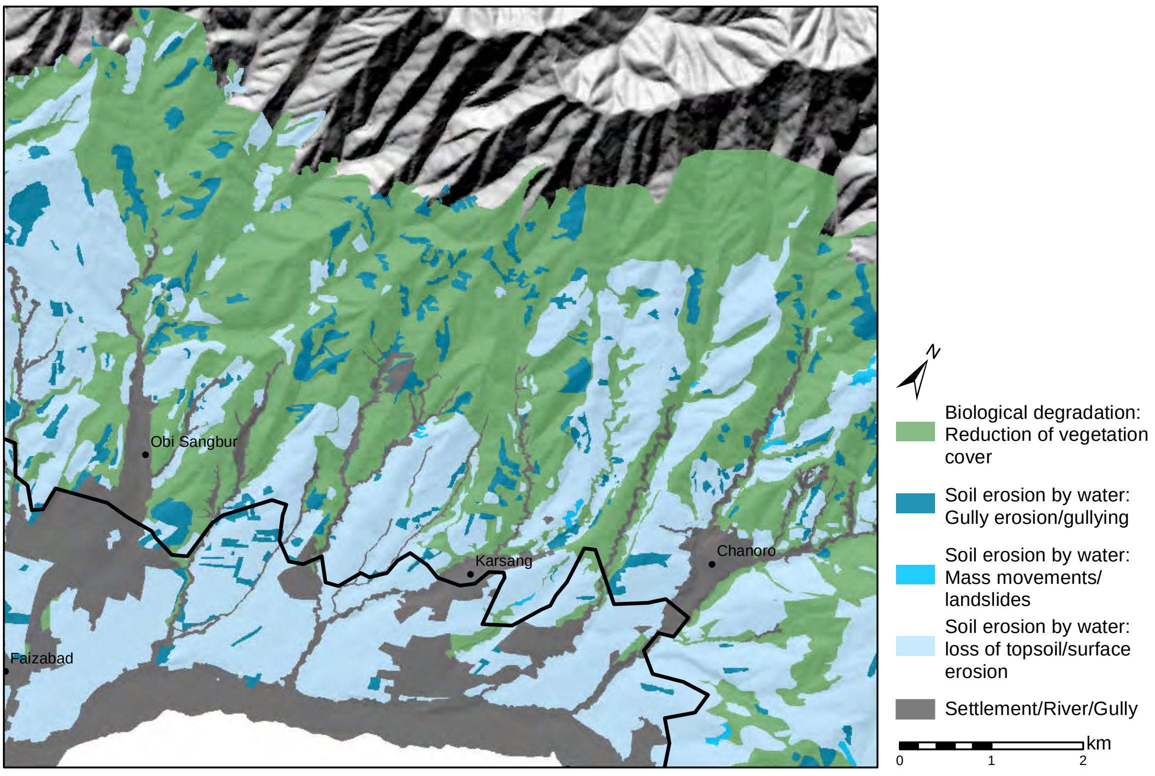

Figure 13 Major degradation type. (Based on Bühlmann 2006 and Wirz 2009. Background: Digital Globe 2010)

Table 8 LUS and its major and secondary degradation types

LUS	major degradation type	secondary degradation type	
abandoned	gully erosion	loss of topsoil by wind	aridification
annual cropping flat	loss of topsoil by water	compaction	fertility decline & reduced soil organic matter content
annual cropping steep	loss of topsoil by water	loss of topsoil by wind	fertility decline & reduced soil organic matter content
forest	mass movements	aridification	loss of habitats
grazing land	reduction of vegetation cover	mass movements	loss of topsoil by wind
orchard flat	loss of topsoil by water	fertility decline & reduced soil organic matter content	loss of soil life
orchard steep	loss of topsoil by water	fertility decline & reduced soil organic matter content	loss of soil life
perennial cropping flat	loss of topsoil by water	sealing & crusting	reduction of vegetation cover
perennial cropping steep	loss of topsoil by water	sealing & crusting	reduction of vegetation cover
vineyard	loss of topsoil by water	fertility decline & reduced soil organic matter content	loss of soil life

Bühlmann (2006) modeled soil loss rates of 89t/ha*year for cropland and 27.3 t/ha*year for tree and shrub cropping. He assessed 35% of the cropland and 82% of the total study area with high to very high erosion risk. High erosion risk occurs mainly on steep slopes. Low erosion rates are predicted for terraced land. As the experts in the workshop stated, Bühlmann also calculated that grassland used for haymaking has lower soil loss rates than grazing land. He explains the higher soil erosion as a consequence of poor canopy cover and breaking of the soil surface by animal trampling. He modeled higher erosion rates for annual cropland than for perennial cropland with well managed grass cover in comparable physical conditions (Bühlmann, 2006). The modeling of Bühlmann shows a correlation between slope steepness and soil erosion. Depending on the crop and land use types, slope has different impacts on erosion rates. Soil loss is generally higher on annual cropland than on grazing land or perennial cropland. He could especially differentiate the erosion risk at a slope of 12%, where soil loss increases rapidly for annual and mixed cropping and much less for perennial cropping and grazing land. Another finding of Bühlmann was that abandoned land with a permanent but rather low canopy cover protects the soil better than for example wheat with a much higher but temporally cover (Bühlmann, 2006). In conclusion it can be said, slope and canopy cover and thereby the land use type have a high impact on the process of soil erosion. Wirz assessed different LUS within grassland. Degradation within grassland is much more diverse than it is shown on the maps in this thesis. Vegetation cover and slopes can be differed within the LUS of grassland. Rather low degradation is seen in haymaking and marginal areas. The latter are remote and can be found high up in the mountains. Daily grazing land, former cropland and trampling paths are closer to the villages and are more degraded areas of grazing land. The same apply for seminomadic grazing land and resting places (Wirz, 2009). Additional to the statements in the workshop, Wirz mentions a fertility decline on all grassland systems especially on daily grazing land. He argues, this is due to lack of fertilizers that used to be transported to the grazing land by trucks for free and because animal dung is collected nowadays as energy source whereas it was used as a fertilizer. Kurbanova (2012) mentions additionally increasing weed and rodents and decreasing medicinal herbs and useful grasses and shrubs on grazing land. Droughts and increasing number of windstorms and drying water springs also affect the grazing land.

14.4 *State* Indicators of Degradation

The experts also described the *state* indicators extent, degree and rate of degradation. The extent of degradation is a rather uncertain indicator. By 'uncertain,' I mean in terms of definition. What does it mean if the extent of degradation is 20 percent or 60 percent? The experts did not really know how much of the area is affected by a degradation type. A map of the extent of degradation can be found in annex 5. The degree of degradation describes the "intensity of the land degradation process" (Liniger et al., 2008b) which was between light (initial phase of degradation process) to strong (difficult to restore within reasonable time limits). As it is shown in Table 9 strongly degraded areas are the LUS abandoned land, annual cropping on steep slopes, forest and grazing land. Moderate degradation can be found on flat annual cropland, steep orchards, steep perennial cropland and vineyards. Orchards and flat perennial cropping are just slightly degraded whereas there is no LUS without degradation. The rate of degradation indicates "the trend of degradation over a recent period of time" (Liniger et al., 2008b). On each LUS only increasing degradation can be found and none is declared as stable or decreasing degradation. In Table 9 the rating for each LUS for extent, degree and rate can be found.

Table 9 Extent, degree and rate of land degradation.
Legend: Degree: 1-light, 2-moderate, 3-strong, 4-extreme.
Rate: 3-rapidly increasing, 2-moderately increasing, 1-slowly increasing.

	extent %	degree	rate
abandoned	100	3	3
annual cropping flat	40	2	2
annual cropping steep	60	3	2
forest	30	3	3
grazing Land	60	3	3
orchard flat	8	1	1
orchard steep	15	2	1
perennial cropping flat	15	1	1
perennial cropping steep	25	2	1
vineyard	20	2	1

14.5 Indirect and Direct Causes (*Driving Forces* and *Pressures*) of Land Degradation

The experts specified the indirect and direct causes of land degradation for each LUS. Indirect causes are the *driving forces* of the direct causes (*pressures*) of land degradation. As indirect causes, the factors of population pressure, land tenure, poverty, labor availability, education, governance, institutions and politics and inputs and infrastructure were mentioned. These factors were specified in the previous chapter 13. Direct degradation causes are human activities and natural causes that lead to land degradation. In Table 10 it can be looked up, which *pressure* leads to degradation in a LUS.

Table 10 Direct causes (*pressures*) for land degradation for the LUS.

	abandoned	annual cropping flat	annual cropping steep	forest	grazing land	orchard flat	orchard steep	perennial cropping flat	perennial cropping steep	vineyard
cultivation of highly unsuitable/vulnerable soils			x			x	x	x	x	x
missing or insufficient soil conservation / runoff and erosion control measures		x				x	x	x	x	x
heavy machinery (including timing of heavy machinery use)		x				x	x			x
tillage practices (ploughing, harrowing, etc.)	x		x			x	x	x		x
reduction of plant cover and residues (including burning, use for fodder, etc.)	x		x	x				x	x	
inappropriate application of manure, fertilizer, herbicides, pesticides and other agrochemicals or waste (leading to contamination and washing out (non-point pollution)		x	x			x	x			x
inappropriate irrigation (full and supplementary): inefficient irrigation method, over irrigation, insufficient drainage, irrigation with salty water		x	x			x	x	x	x	x
bush encroachment and bush thickening			x							
conversion to agriculture	x			x						
excessive gathering of fuel wood, (local) timber, fencing materials	x			x						
removal of fodder				x	x			x	x	
excessive numbers of livestock	x				x					
trampling along animal paths	x				x					
too long or extensive grazing periods in a specific area or camp leading to overutilization of palatable species	x				x					
change in livestock composition: from large to small stock; from grazers to browsers; from livestock to game and vice versa					x					
excessive runoff	x									
lower infiltration rates/ increased surface runoff	x	x			x	x	x	x	x	x
irrigation						x	x	x	x	x
change in temperature	x									
change of seasonal rainfall	x					x	x	x	x	x
heavy / extreme rainfall (intensity and amounts)	x	x	x	x	x	x	x	x	x	x
droughts		x	x	x	x			x	x	
topography	x	x	x				x	x	x	x

Pressure indicators are bad management of soils: cultivation of highly unsuitable soils, missing SLM technologies, use of heavy machinery and application of tillage practices. Other factors are bad management of crop and grazing land: reduction of plant cover and residues and inappropriate application of inputs such as fertilizers and pesticides, inappropriate irrigation, bush encroachment and bush thickening. Forest and abandoned land is converted to agricultural land. The vegetation is overexploited for domestic use by fuel collection and removal of fodder. Overgrazing puts *pressure* on the grazing and abandoned land with excessive numbers of livestock, trampling along animal paths, too long grazing periods and changing of livestock composition. Excessive runoff leads to excessive runon in neighboring areas. Lower infiltration rates and increased surface runoff disturbs the water cycle. Water is over-abstracted due to irrigation. Natural causes for degradation are change in temperature, change of seasonal rainfall, droughts, topography and especially the heavy rainfalls. Remarkable is that latter, the intense rainfalls in spring are considered to be a cause for land degradation in each LUS.

14.6 *Impacts* on Ecosystem Services

The main *impacts* on ecosystem services through land degradation are assessed here with the WOCAT mapping questionnaire. The ecosystem services were derived from the Millennium Ecosystem Assessment (Liniger et al., 2008b). Ecosystem services are provisioning, regulating and cultural services provided from the ecosystem for the people. Changes in factors directly affect ecosystems and thereby affect human well-being (Millennium Ecosystem Assessment, 2005). In the jamoat of Javonon land degradation has almost solely negative *impacts* on ecosystem services. Land degradation has negative *impacts* on provisioning services, namely production and land availability. Ecological services are affected in regulating excessive water, a lower organic matter status, soil cover, soil formation and structure. The nutrient and carbon cycle are negatively affected and also the biodiversity. The socio-cultural services result in conflict transformation, food, livelihood security and poverty, the net income, protection, damage of private and public infrastructure and marketing opportunities. The *impacts* on the ecosystem services can be found in Table 11.

Table 11 *Impacts* on Ecosystem Services.

Productive services
- Production (of animal/plant quantity and quality including biomass for energy) and risk
- Land availability (area of land for production per person)

Ecological services (regulating/supporting)
- Regulating of excessive water such as excessive rains, storms, floods eg. Affecting infiltration, drainage, runoff, evaporation, etc.
- Organic matter status
- Soil cover (vegetation, mulch, etc.)
- Soil structure: surface (eg. Sealing and crusting) and subsoil affecting infiltration, water and nutrient holding capacity, salinity etc..
- Nutrient cycle (N, P, K) and the carbon cycle (C)
- Soil formation (including wind-deposited soils)
- Biodiversity

Socio-cultural services / human well-being and indicators
- Conflict transformation
- Food & livelihood security and poverty
- Net income
- Protection / damage of private and public infrastructure (buildings, roads, dams, etc.)
- Marketing opportunities (access to markets, etc.)

15 Yield Data

Here the data of different crops, collected with the yield questionnaire, is presented. Data for yield, expenses for fertilizer, machinery and seeds and the labor input was asked. 157 questionnaires could be used in this analysis. In some questionnaires the information about labor input was not specified and those could not be used. Labor input is important as the data was used in a cost-benefit analysis. The data of the plot size was also important because all data was calculated for one hectare in order to make it comparable. Some consecutive questionnaires declared the size of a plot smaller than one ar. The labor inputs on these plots definitively exceeded the amount of yield and workload per hectare. I assumed, these questionnaires were not filled in properly. Due to the high number of these questionnaires they strongly impacted the median. Thus, documented plots smaller than one ar were not considered. Due to the high variety of the data, the results are expressed with the median which has a lower influence of outliers. This data can be found in Table 12. The quartiles can be found in annex 6. The steepness was rarely filled in in the questionnaire. Due to that, no interpretation concerning steepness and no comparison of yield between steepness classes was done. The sample size is not equal for each land use type because the farmers were free to choose to document anyone of their plots. I observed that some consecutive questionnaires declared for example the yield of esparzet in bundle others in kg. This leads to the assumption, the questionnaires were filled in in groups or by one person. Bundles were transferred to kg by multiplying wiht 7.5 according a number Conder (2014) used in her research. One bundle was declared to be 6 TJS, which is 0.8 TJS per kg. For further calculations the salary of 20 TJS per day was used, according to the median of the answers in the questionnaire. For market prices on mixed vegetable plots and orchards a mean market price was calculated: the median prices of a sort were weighted according to the proportion of harvest of a sort on the total area of vegetable cropping or orchard cropping.

Ruppen (2012) stated, that perennial grasses could be cut two to four times a year, depending if it is irrigated or not. Conder (2014) had varying information of a farmer who collected 50% of the first yield in the second harvest. Another informant stated 70% of the first yield for the second harvest, 50% for the third harvest and 20% for the fourth. According to this information, assumptions were made, in order to calculate the yield for one season. The yield in the questionnaire was assumed to be the 3^{rd} harvest of three harvests, which is 50% of the 1^{st} harvest. The yield of the three harvests were calculated and summed up to a total yield in a year. In Table 12 the data of the yield, expenses and labor input for the land use types perennial grasses, hay, vineyard, flax, vegetables, wheat and orchard can be found. Reference data of other research can be found in Table 13 whereas the comparison is rather confusing due to a high variety of data between the studies.

Table 12 Overview medians of yield, expenses on agricultural inputs, labor input, market price, profit and net profit per land use type.

	sample size	yield [kg/ha]	expenses agricultural inputs [TJS/ha]				expenses labor		market price [TJS/kg]	profit [TJS/ha]	net profit [TJS/ha]
			machinery	seeds	fertilizers	total	[day/ha]	[TJS/ha]			
perennial grasses	20	6257	693	362	262	1375	120	2400	0.8	3631	1231
hay	9	4500	417	400	500	1500	50	1000	0.8	2100	1100
vineyard	7	1500	500	0	400	900	100	2000	4	5100	3100
flax	15	2000	1000	500	500	1680	75	1500	5	8320	3100
vegetables	66	3000	480	1000	710	2060	103	2060	1.8	3340	1280
wheat	25	2000	800	500	500	1850	63	1260	2	2150	890
orchard	15	3057	600	667	867	1933	45	897	0.8-2	3281	2383

Table 13 Reference data for yield from various authors [kg/ha].

	perennial grasses	hay	flax	vegetables	wheat
Ruppen (2012)		1320	450	Ø9610	1340
Muminjanov (2008)	14’400		460	19’020	2300
FAO (in Ruppen 2012)	2600				
Jamoat (2012)		19		190’000	7500

The harvest of perennial grasses is 6257 kg/ha a year. That for costs of 693 TJS for machinery, 362 for seeds and 262 TJS for fertilizers per ha occurred. The labor input is 120 working days per ha. For hay the yield was with 4500 kg/ha less than half comparing to the perennial grasses. The inputs were 1500 TJS and the labor input was 50 day per ha whereas the net income is much lower for hay than for perennial grasses. The harvest of a vineyard is 1500 kg per ha with a relatively high labor input of 100 days per ha but still a high net profit of 3100 TJS due to a rather high market price of 4 TJS per kg. Flax is according to this data a very profitable crop. The yield is 2000 kg per ha and the labor input is with 75 days per ha rather low. The market price is with 5 TJS per kg high. The profit of flax is absolutely the highest per ha. Here the question arises, if the information for the yield of flax is the raw product and the market price probably already for the processed flax oil. Expenses for the processing of the product were not asked and that may falsify the data. Vegetable plots give a high yield (3000 kg/ha) and request a high labor input of 103 days/ha. The net profit is 1280 TJS/ha. Wheat has a high workload with little return, but farmers rely on wheat production, as bread is the staple food. Orchards are beneficiary as they have a rather high yield and a small workload.

16 SLM *Responses*

16.1 Actual *Responses* from the WOCAT Mapping Workshop (Mapping Conservation)

In the WOCAT mapping workshop, SLM technologies applied in the study area were collected. Five SLM technologies were discussed in the workshop: “buffer strips on steep sloping cropland”, “ploughing on contour lines”, “gully rehabilitation”, “pasture management” and “orchard-based agroforestry”. Except for “ploughing on contour lines”, all SLM technologies are documented in the WOCAT technology database. The purposes of these SLM technologies are prevention or rehabilitation and can be applied on the LUS “annual cropland”, “grazing land” and “orchards”. The extent of the technologies on the LUS was estimated by the experts, whereby the range was from 8 to 20 % per LUS. These low numbers of estimations of local experts show that there would still be a potential to increase SLM technologies in the study area. An overview of the discussed conservation measures, their purpose, the LUS they are applied on, and the extent of application can be found in Table 14.

The technologies prevent loss of topsoil through water erosion or gully erosion, prevent decline in fertility and prevent the reduction of organic matter content and the reduction of vegetation cover. The effectiveness of the technologies in reducing the degree of degradation or preventing degradation are all considered to be high to very high. The effectiveness of “buffer strips”, “pasture management” and “orchard-based agroforestry” is considered to be high. They control the land degradation appropriately by controlling the soil loss, sustaining the water infiltration rate and the soil fertility. The measures stop further deterioration but improvements are slow. The effectiveness of “ploughing on contour” lines and “gully rehabilitation” are considered to be very high which means that they control land degradation and improve the situation before degradation occurred. Although I doubt that "ploughing on contour lines" on steep slopes truly stops further degradation, rather than merely just slowing the process down. "Gully rehabilitation" accumulates soil and produces wood, whereby it can be said it probably improves the initial situation. According to the experts the technologies increase in effectiveness. As shown later in the overview in Figure 19, *driving forces* and *pressures* have negative impacts on the *state of the land* and this is why the technologies have a growing positive impact on the reduction of degradation. "Orchard-based agroforestry" additionally has the impact of increasing the production.

Table 14 SLM technologies, their purpose, the LUS where it is applied to and the extent on the LUS.

SLM technology	**purpose**	**LUS**	**extent %**
buffer strip on steep sloping cropland	prevention	annual cropping steep	10
ploughing on contour lines	prevention	annual cropping steep	20
gully rehabilitation	rehabilitation	grazing land	15
pasture management	rehabilitation	grazing land	20
orchard-based agroforestry	prevention	orchard flat	8
orchard-based agroforestry	prevention	orchard steep	8

In the final step in the WOCAT mapping workshop the experts gave recommendations on how to address land degradation. It was recommended to fertilize abandoned land and cultivate them with perennial crops. On flat annual cropland, ongoing degradation should be mitigated by irrigation and with the input of fertilizer, which should become standard. On steep annual cropland mitigation and rehabilitation is needed. Plants should be cultivated correctly and contour ploughing should be applied. On deforested areas afforestation is needed, where there is still some forest the degradation process should be mitigated. Grazing land should be addressed with mitigation such as "pasture management" and "pasture rotation". On perennial cropland fertilizers should be used and crops should be rotated. According to this expert recommendation inputs of fertilizers are very crucial. But financial limitations are an important factor chemical fertilizer cannot be used and dung is still used for cooking.

16.2 Joint Planning: *Responses* Elaborated in the SLM Planning Workshop

In the SLM planning workshop, possible *responses* to the degraded *state of the land* on "annual cropland" and "grazing land" in terms of SLM technologies were defined. Out of 33 SLM technologies the participants chose technologies that are applicable in their villages according to their assessment.

16.2.1 Ranking Criteria

The participants had to rank criteria the SLM technologies should urgently or less urgently meet. Seven criteria were given: “decreased soil loss”, “increased water availability”, “strengthen the community”, “benefit for the small and big scale farms”, “increasing yield”, “fewer expenses” and “low work input”. The participants of the four villages ranked these criteria according to their importance as it is shown in Figure 14. The highest importance is ranked with 1, the lowest with 7. Chanoro, with high ranking for the socio-cultural criterion, clearly demonstrated that they are not interested in working together with each other. The participants of this village gave the same impression during the workshop and especially when the participants did not manage to implement a pilot implementation together. In all four villages the economic criterion “increasing yield” was ranked with the highest importance. This shows that an SLM technology is only accepted if it also increases the yield. The natural criteria “decreased soil loss” and “increased water availability” have medium importance for all the four villages. This is surprising, after the workshop was introduced, that surface runoff causes soil loss, whereas water infiltration reduces soil loss but increases the water availability for plants. Water scarcity for irrigation was mentioned by the participants. For a higher yield, which is, according to the ranking of the criteria, important for the participants, soil conservation and also soil moisture is important. The importance of the other criteria differ between the villages whereas “less expenses” seem to be an important criterion except in the village Karsang. That the benefit of the technology is for small and big scale farms is only considered as important in the villages Hojomard and Obi Sangbur, Karsang and Chanoro ranked that criteria with 6, as not important.

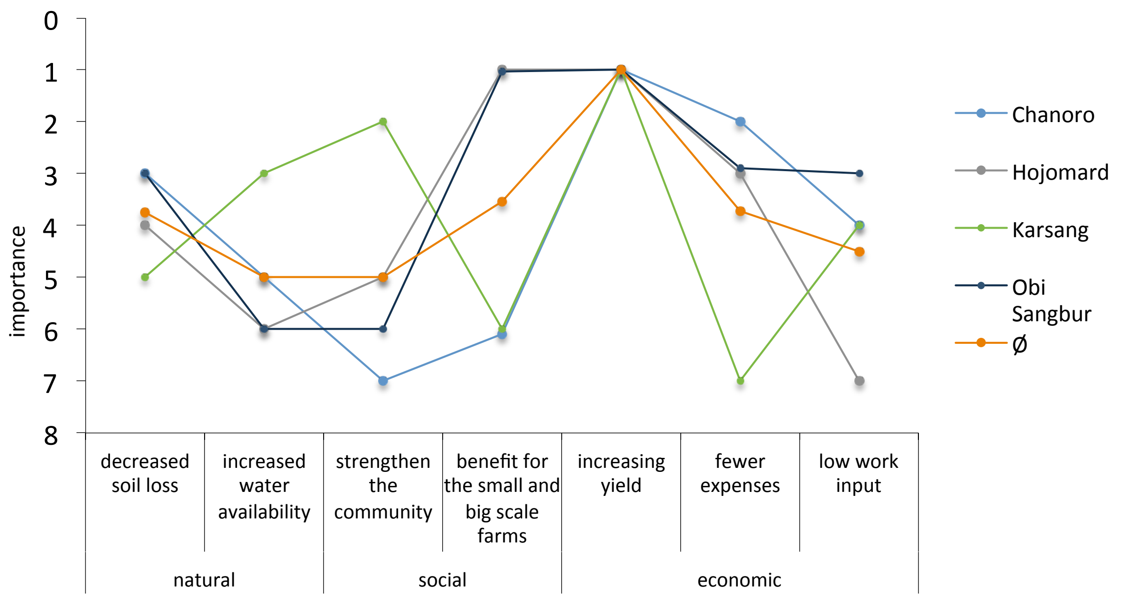

Figure 14 Ranking the criteria for an ideal SLM technology by the participants of the four villages Chanoro, Hojomard, Karsang and Obi Sangbur.

To sum up, the demand is for an effective technology for production with rather less input in expenses whereas the work input is not as that important. Social criteria are rather less important and the natural criteria are ranked medium, probably because the focus is to increase the yield and the natural criteria are just a means to reach that.

16.2.2 Selection of SLM Technologies

In a next step the participants selected six technologies for each, "annual cropland" and "grazing land". An overview of the selected technologies can be found in Table 15 and they are introduced shortly in the following section, including the notes the participants made and the establishment and maintenance costs. In annex 3 pros and cons elaborated by the participants during the introduction and discussion of all the SLM technologies can be found.

Table 15 Selected SLM technologies for cropland and grazing land.

annual cropland		**grazing land**	
TAJ354	energy efficient stove	UZB002	rotational grazing
TAJ10	drainage ditches	TAJ354	energy efficient stove
TAJ107	drip irrigation	TAJ08	establishment of an orchard
TAJ009	perennial fodder plants	TAJ115	gully rehabilitation
TAJ006	grass strips	TAJ366	living fence
TAJ115	gully rehabilitation	TAJ100	rotational grazing with additional water points

Energy efficient stove (TAJ354): The technology was introduced with a convincing WOCAT movie where a woman introduces her efficient stove and calculates how much dung she can save because of its efficiency. The saved dung was added on a plot, which became fertile. The use of cow dung and wood, used as low cost fuel source for cooking, baking and heating leads to decreased soil fertility. With simple modifications of the traditional cooking stoves with an annual dung consumption of 15.1 tons, 2.3 tons of fuel material can be saved which increases the application of organic fertilizers on the fields. The modification involves the improvement of the aeration process during the burning of the fuel with a metallic cover with one inflow whole and six small smoke outflow holes, surrounding the cooking pot. Additional savings using straw, mud and wood to improve the thermal insulation of the houses can be made. And also by using a pressure cooker that reduces the cooking time and a heat exchanger. (Compiled by Tuychiboy Safarov, Worldbank Tajikistan) **Participants notes: Advantages:** Gives more income and saves dung. **Disadvantages:** Expensive technology.

Modified cooking stove and pressure cooker. (Photo: T. Hafizova)

profit	establishment cost		maintenance costs per year
saves dung which can be used as organic fertilizer	labor	43.3 US$	3.3 US$
	equipment and material	343.4 US$	
	total	386.7 US$	3.3 US$

Drainage ditches (TAJ10): Drainage ditches are dug in steep sloping cropland to reduce soil erosion by diverting excessive rainwater. 15 cm deep and 30 cm wide ditches with an interval of 5-10 m are dug across slopes. The ditches are dug each year after tillage and sowing. At the top of the field a 50 cm deep and 50 cm wide ditch is built to prevent run-on onto the field. This ditch has to be cleared regularly from soil washed into it. The maintenance of this technology is important. (Compiled by Erik Bühlmann, CDE) **Participants notes: Advantages:** few expenses, good yield, good conservation, attractive.

profit	establishment cost		maintenance costs per year
less soil loss	labor	3 US$	21 US$
	equipment and material	5 US$	
	total	8 US$	21 US$


drainage ditch in a wheat field (Photo: E. Bühlmann)


Polyethylene tube with screw (Photo: A. Abduqodirov)

Drip irrigation (TAJ107): The low cost drip irrigation technique for orchards consists of a reservoir, polyethylene irrigation tubes and screws. In spring water is collected in the reservoir with which the orchard can be irrigated in the dry summer months. By means of the natural water pressure due to height difference the water runs through the tubes and via the screw emitters, installed in the tubes directly to the roots of the trees. Loss of water and soil erosion is avoided. Fertilizers can be added directly to the water reservoir. (Compiled by Aslam Qadamov, Pamir Biological Institute) **Participants notes: Advantages:** efficient water use, good for dry years, applicable. **Disadvantages:** medium to high.

profit	establishment cost		maintenance costs per year
less soil loss, water use efficiency	labor	148 US$	30 US$
	equipment and material	1267 US$	74 US$
	total	1415 US$	104 US$

Perennial fodder plants (TAJ009): Perennial fodder plants as esparzet or alfalfa is grown for haymaking. Esparzet improves the soil structure and accumulates nitrogen in the soil. Annual crops can be grown again. The intact ground cover reduces soil erosion. (Compiled by Erik Bühlmann, CDE) **(KYR004):**Perennial fodder plants are a high nectar-producing crop from which honey can be made. As a result of insect pollution seed production of 100-200 kg/ha was observed. Seeds can be distributed among other farmers, which are able to expand their areas with perennial fodder plants. Plowing along and planting across (on contour line) the slope increases the vegetation cover and after the harvest stubble remain. (Compiled by Abdybek Asanaliev, Kyrgyz Agrarian University Bishkek) **Participants notes: Advantages:** Can be cut 1-2 times a year, fodder production, keeps the soil moisture, few erosion, very applicable. **Disadvantages:** -

profit	establishment cost		maintenance costs per year
enriches the soil, honey seed and fodder production, reduces soil erosion	labor	13.10 US$	25 US$
	equipment and material	133.80 US$	13.30 US$
	total	146.90 US$	38.30 US$


Grass strip on steep sloping cropland. (Photo: E. Bühlmann)

Grass strips (TAJ006): Approximately 10 m wide grass strips on steep sloping cropland are used as buffer. The strip is simply left uncultivated. A adjacent drainage ditch reduces run-on onto the field downwards the slope. The technology reduces rill development and fertility decline. (Compiled by Erik Bühlmann, CDE) **Participants notes: Advantages:** few expenses, hay production, conservation, attractive. **Disadvantages:** -

profit	establishment cost		maintenance costs per year
less soil loss, water use efficiency, hay	labor		4 US$
	equipment and material	10 US$	
	total	10 US$	4 US$

Gully rehabilitation (TAJ115): This technology prevents a gully from expansion and supports the rehabilitation of the gully. The technology consists of three measures. Willow trees with deep roots are planted on the bottom of the gully to prevent the soil from being eroded and slow down the runoff and to accumulate the sediments. On top of the side slopes a bush line with native trees is planted to stop the horizontal erosion and at the lower end of the gully a stonewall collects the sediments. (Compiled by Selina Studer, University of Bern) **Participants notes: Advantages:** Protects the environment, very applicable. **Disadvantages:** trees, stones, labor needed.

Willow trees at the bottom of the gully. (Photo: G. Nekushoeva)

profit	establishment cost		maintenance costs per year
wood, more usable land	labor	79 US$	5.6 US$
	Equipment and Material	78 US$	
	total	157 US$	5.6 US$

Rotational grazing (UZB002): An assessment of the grazing land is done in order to determine the carrying capacity of it. According to it the livestock number is corrected each season. The whole area is split into two sectors and each into 3 rotation areas, which are grazed sequentially. Based on the productivity, in that case each area can be grazed for 30 days. Planned rotational grazing gives the plants an opportunity to restore their vitality. (Compiled by Irna Bekmirzaeva) **Participants notes: Advantages:** Conservation. Improves the fodder. **Disadvantages:** Needs a herder in every village (duty of the jamoat).

profit	establishment cost		maintenance costs per year
improved quality of grazing land	labor	437.5 US$	6625.77 US$
	equipment and material	1612.5 US$	2590.43 US$
	total	3450.0 US$	2916.20 US$

Establishment of an orchard (TAJ08): A fruit orchard was established on degraded cropland. The trees were planted in rows with an interval of 8-10 m. The orchard is intercropped with annual and perennial crops. On top of the field is a irrigation channel, stabilized with aligned poplar trees. This channel serves as cut-off drain in the rainy season. 2.5 m wide grass strips around the tree lines protect from splash erosion. The gross farm production could be increased considerably, also due to its mixed use. Simultaneously soil and water resources are conserved and the technology prevents the development of gullies. (Compiled by Erik Bühlmann, CDE) **Participants notes: Advantages:** Solid soil, conservation, fruits and wood, dung improve ecology, applicable.

Orchard surrounded by degraded grazing land. (Photo: E. Bühlmann)

profit	establishment cost		maintenance costs per year
increased yield, less soil loss, water use efficiency	labor	195 US$	80 US$
	equipment and Material	275 US$	130 US$
	total	470 US$	210 US$

Living fence (TAJ366): In the described technology a living seabuckthorn fence protects an afforested area from livestock grazing. The fence consists of two layers. The outer layer is an instant fence made of thorny seabuckthorn branches. The inner layer are planted seabuckthorn seedlings, which establish itself over a number of seasons to a fence. (Compiled by Michael Angermann, GIZ) Although seabuckthorn does not grow in the study area, the species could be replaced. **Participants notes:** -

profit	establishment cost		maintenance costs per year
protected area	labor	1352 US$	47 US$
	equipment and material	1700 US$	20.9 US$
	total	3052 US$	67.9US$

Rotational grazing with additional water points (TAJ100): Additional water points, resting places and a rotational system were established to improve the quality of grazing land. The water is brought with pipes from sources where the water supply is throughout the whole year. There a cement catchment is built. Additional shady resting places for the livestock are found and a rotational grazing scheme was introduced, where the grazing land is divided into 10 parts. Each part is grazed for 5 to 8 days. This allows longer growing times for grass on specific pastures. (Compiled by Sady Odinashoev, CARITAS) **Participants notes: Advantages:** milk production, fertilizer, conservation, less sicknesses. **Disadvantages:** requires pipes, channels, transport, labor and seeds.

Profit	Establishment cost		Maintenance costs per year
Conservation of the grazing land. Less loss of weight of the animals.	Labor	2356 US$	748 US$
	Equipment and Material	5525 US$	
	Total	7881 US$	748 US$

When the SLM technologies were chosen, the participants were split up into groups of the villages. The villages Chanoro, Hojomard and Obi Sangbur decided to continue to work with SLM technologies on "annual cropland", Karsang decided to continue to work with SLM technologies on "grazing land". In the next step the SLM technologies either for "annual cropland" or "grazing land" were scored from 1 to 6, according to how well a technology fits each criterion. According to the ranking of the criteria and the scoring of the technologies, the MODSS software mapped the most appropriate technologies for each village, which can be seen under *"general"* in the Figures 15-18 below. The closer the technology is to 1, the better the technology fits according to all the criteria. Under *"ecological"*, *"economic"* and *"socio-cultural"* it is shown how the technologies fit to the criteria of a dimension of sustainability. With that more detailed analysis, SLM technologies which would not fulfill the criteria of a dimension can be detected. The red short bar shows that the score for all criteria was the same, the span of the green bars shows the variability a technology was scored between the criteria. Because only suitable technologies were selected before and assessed with the help of the criteria, not much discrepancy can be detected between the technologies. In all the four villages the technologies came off well and none of the chosen technology is completely inapplicable. The results for the village Chanoro are shown in Figure 15. The technology *perennial fodder plants* was scored in all three dimensions with the highest value which means the technology is ecological, natural and socio-cultural sustainable. All the technologies meet the criteria in the highest quartile.

In Hojomard (Figure 16) perennial fodder plants and drip irrigation are generally the best scored technologies. Both fulfill the two ecological criteria with the highest ranking. But the drip irrigation does not fully meets the economic and especially the socio-cultural criteria. Surprisingly the "gully rehabilitation" technology is considered not to be economic sustainable although it is not a cost intensive technology

For the village Obis Sangbur (Figure 17) perennial fodder plants is a very suitable technology as well as the "gully rehabilitation" technology. The drip irrigation is distributed with a wide range among the criteria with being suitable to meet the socio-cultural criteria but rather not being eclogical. The technology also does not meet all the economic criteria. It increases the yield but it is a rather expensive technology.

Karsang (Figure 18) assessed SLM technologies for "grazing land". For Karsang a more diverse assessment is illustrated compared to the figures of the villages before. Suitable technologies are the "additional water points in the grazing land", "gully rehabilitation" and "establishment of an orchard". All three technologies meet the ecological, economic and socio-cultural criteria. The "energy efficient stove" does not meet the socio-cultural criteria. It was mentioned to be a women's technology

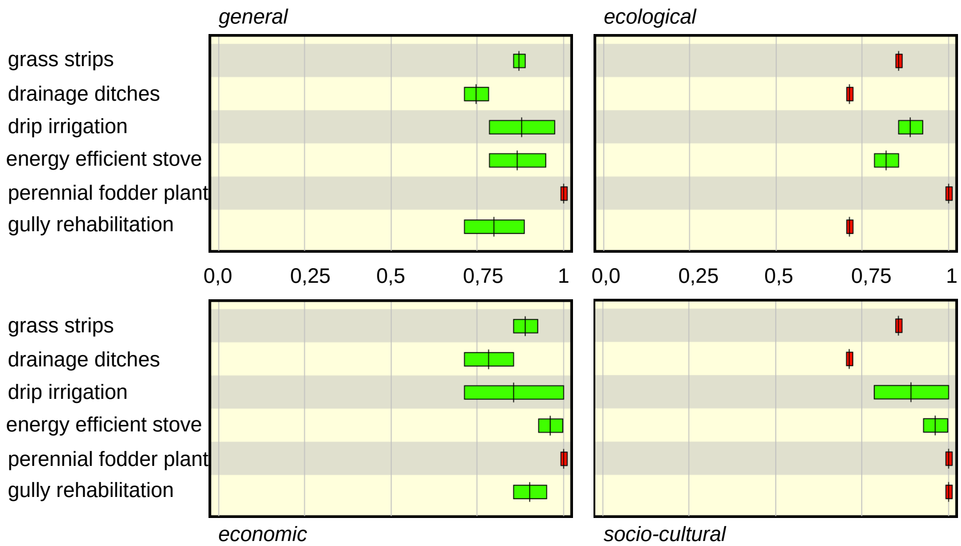

Figure 15 Results of the MODSS software for Chanoro.

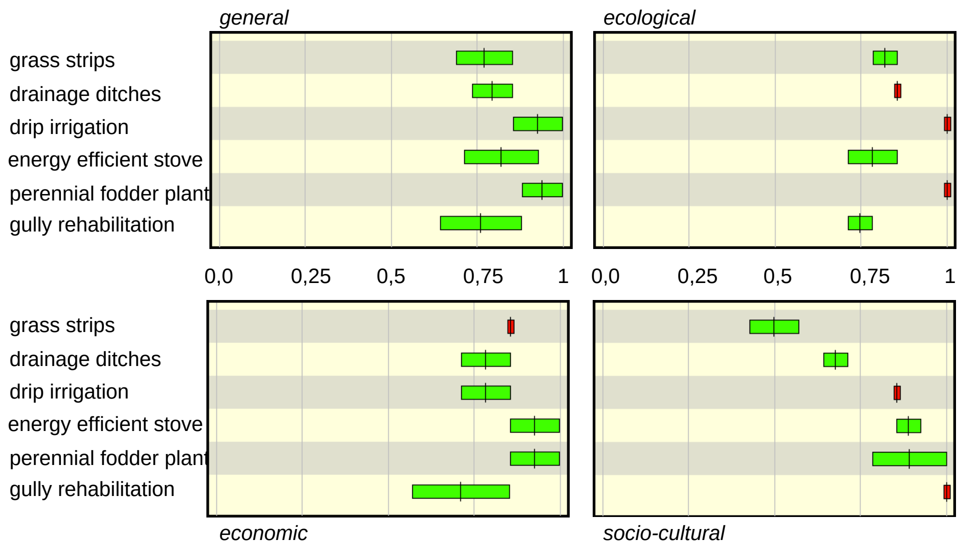

Figure 16 Result of the MODSS software for Hojomard.

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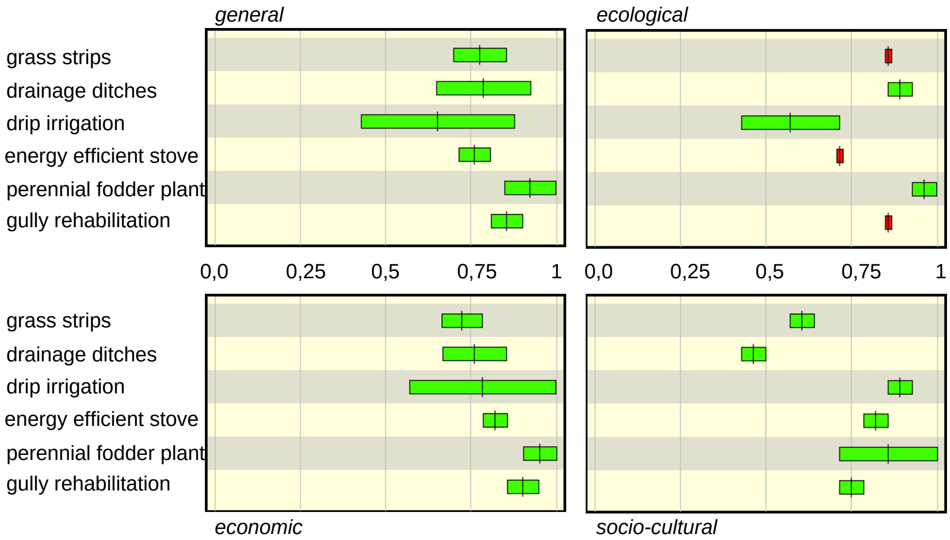

Figure 17 Results of the MODSS software for Obi Sangbur.

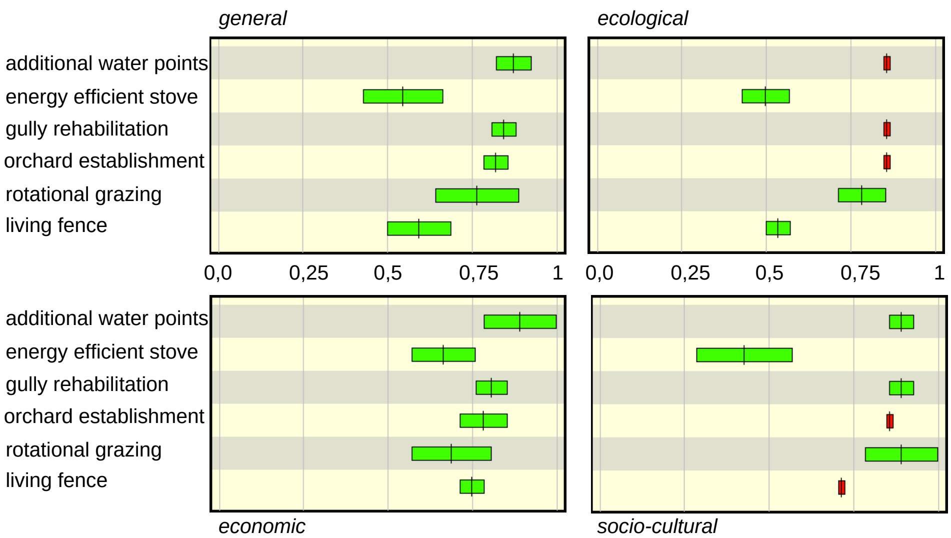

Figure 18 Result of the MODSS software for Karsang.

16.2.3 SLM Projects

In the last step of the workshop the participants of each village could organize a project, which should contribute to SLM in their villages. According to the participants the fund of 500 US dollars was too small to realize a SLM project. Approaches as explained earlier were introduced in the workshop that the money could be invested for an approach for SLM as knowledge exchange. But the proposition to invest in an approach was also difficult to explain. The idea, to spend money for nothing "substantial" seemed not to be a possibility. In a first round project ideas the participants developed in the workshop were presented. The villagers from Karsang were interested in the technology for the water points. They wanted to look for natural springs. The cost of the infrastructure the participants from Karsang wanted to cover with additional donors as for example the Small Grants Programme[5]. The approach for implementation was community and volunteer work and the application for funding. The participants from Chanoro wanted to plant esparzet on poor soils, on sloping and not irrigated plots. They mentioned that it would be a lot of work in the beginning but in 6 years, the workload will decrease. The implementation would be private and needed inputs are labor, the rent of machinery and seeds. In Obi Sangbur they wanted to establish a rain fed orchard with drip irrigation. This orchard should be combined with esparzet. The drip irrigation would allow to have more water due to the efficient use. The approach would be community based volunteer work and money is needed for the irrigation system. The participants from Hojomard presented two ideas. The first idea was to implement a gully rehabilitation project on voluntarily basis and work together with schools. The approach and the technology is similar to the WOCAT movie, showed in the workshop. The second idea was to invite a stove builder who teaches people from the village to make "energy efficient stoves" in their homes. The participants got two more weeks to finalize their applications. The final applications were much different to the first ideas. In three villages the participants decided to implement an esparzet plot on degraded land. The plot in Hojomard sometimes can be irrigated. In Chanoro a farmer implemented a "gully rehabilitation" on his own, because the participants from this village did not find a way to work together. A description of the SLM projects with budget data and a first monitoring, done in September 2013 are recorded in the annex 7. Noticeable are the completely different implementations comparing to the ideas the participants had during the workshop. During the workshop the moderators had a remarkable influence on the ideas for projects. Left alone, the participants applied for the common technologies of "esparzet planting" and "gully rehabilitation". The workshop gave the participants some new ideas for SLM planning as the drip irrigation. The motivation for such new SLM technologies vanished latest when the participants were left alone with the sheet for the application. Difficulties were probably that it is difficult to work together within a village, probably because the experience for that is missing. The implementation was done in all projects by one family. Why other people should help to plant esparzet on a private leased plot? Only in Chanoro the neighbors came and helped to establish the esparzet field help. The "gully rehabilitation" was the only project implemented on common land in Chanoro although the participants stated from the beginning, they will not work together and though an implementation on a private leased field would be apparent.

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[5] Further information: https://sgp.undp.org (last access: 30.01.2014)

17 General Overview: System Knowledge as a Basis for SLM Planning

This overview section elaborates on a whole system of knowledge with its *driving forces*, *pressures*, *state of the land*, the *impacts* on ecosystem services and its *responses*. This general overview of the study area shows how the various indicators elaborated in this study influence each other and thus *driving forces*, *pressures*, *state of the land* and *impacts* on ecosystem services could be changed with appropriate *responses*. A schematic overview can be found in Figure 19.

Driving Forces

The main *driving forces*, with both positive and negative effects on the *state of the land*, are poverty, missing knowledge and support, labor migration, insecurities of the land tenure system and population growth – as described in the chapters of the same name in the synthesis of previous literature in chapter 13. From these *driving forces*, various *pressures* on the land can be derived. Poverty does not allow investment in SLM technologies nor in SLM planning. Furthermore, the financial resources to treat land appropriately with machineries or fertilizers are not available. Insufficient support to acquire knowledge is a further reason not to apply SLM technologies and SLM planning. After the breakdown of the Soviet Union, the state Academies of Science still conduct research but are also severely limited due to inappropriate availability of resources. The main problem is that this knowledge is not brought to the local level to support farmers in their activities. Information on the land tenure system, which was reformed several times over the last two decades in order to improve the farming conditions, is not well spread among the farmers. There are many secondary land users, which lease the land under uncertain conditions. The consequences are no investment in the leased land. At the same time the "privatization" of land user rights reduces the communal land whereby the pressure on the remaining common lands increases. Namely, higher livestock numbers graze on limited grazing land which leads to overgrazing and trampling. The increased number of livestock is also due to the remittances labor migrants bring from Russia. The labor migration on the one hand leads to a more intensive use of grazing land due to the increase of less labor intensive animal husbandry but on the other hand it also leads to more extensive land use and abandonment of annual crop land due to the lack of male labor force during the most labor intensive season. Population growth is a general driver, which increases the demand for food production in the study area.

Pressures

The *pressures* as a consequence of the *driving forces* are summarized in the system overview in Figure 19 with the headings 'non-suitable land management' and 'biophysical conditions'. The non-suitable land management practices describe the insufficient use of SLM technologies, improper technological or fertilizer input, extensive land use in the form of grazing land or abandonment. Intensive land use in form of overgrazing and trampling exert *pressure* on grazing land. Deforestation reduces the vegetation cover and irrigation also exerts *pressure* on the *state of the land*, latter especially by promoting soil erosion on slopes. The biophysical conditions are not necessarily a *pressure*, but along with non-suitable management the biophysical conditions can exert *pressure* on the *state of the land*. Biophysical conditions that result in *pressures* on the land are mainly the heavy rainfalls, steep slopes, droughts, highly erodible soils, strong winds and water scarcity.

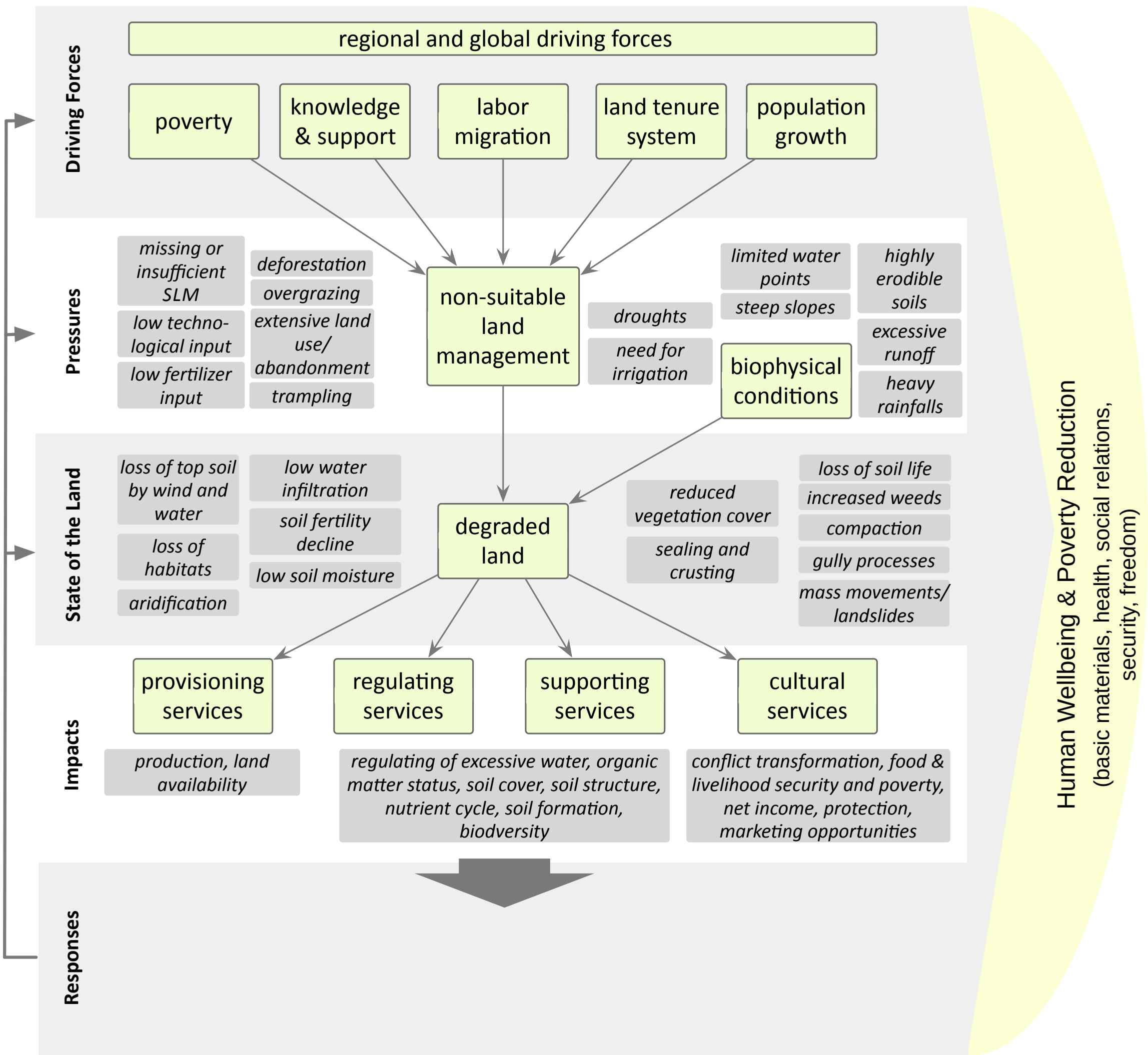

Figure 19 Overview of the *driving forces*, *pressures*, *state of the land* and *impacts* of the agricultural land in the study area.

State of the Land

The described *pressures*, caused by non-suitable land management, affect the *state of the land*. Generally, a more extensive land use on the slopes and a more intensive land use on flat areas was observed – which is a logical consequence if we note that the land is degraded more severe on steep slopes. Land degradation observed in the study area is soil erosion by water and wind, loss of top soil and soil fertility decline, reduced water infiltration, low soil moisture storage capacity, reduced vegetation cover, loss of soil life, compaction, sealing, crusting, and increased amount of weeds. Looking at the extent, degree and rate of degradation, it is abandoned land, annual cropping on steep slopes, and grazing land that are the hot spots of land degradation. Bright spots of land conservation are perennial croplands and orchards, especially on flat areas but also on steeper areas, where the risk of erosion is high due to topographic conditions. Additionally, the canopy cover also determines erosion processes.

Impacts

The *impacts* of degraded land on the ecosystem services are lower soil productivity and thus, a decrease of yield. A loss of biodiversity, including medicinal plants was also observed. Another *impact* that was observed is the disturbance of the water cycle: the degraded land shows a reduced water infiltration and storage capacity.

The non-suitable land management practices, namely the non-existence of SLM technologies and SLM planning have negative *impacts* on the *state of the land*. Land degradation in turn *impacts* the ecosystem services, which provoke *responses*. Thus in the chapter 18 I concentrate on SLM planning with SLM technologies as a *response*. Such an approach has good potential to improve various processes in the agricultural system.

18 Scenarios of Possible *Responses*

Up to this point, the *responses* of the local population were not yet discussed. This chapter is dedicated to the analysis of *responses* already applied in the study area (chapter 18.1), *responses* selected in the SLM planning workshop (chapter 18.2), and also *responses* in form of a recommendation that I developed in the frame of this study (chapter18.3). With this thesis I want to support decision-making in the study area with estimates of costs and benefits of implementation of SLM technologies. Local farmers selected, in groups, possible technologies which they consider to be reasonable to implement in the study area. The main goal, which was defined for the SLM planning workshop was the "reduction of soil erosion and the increase of soil productivity on cropland and grazing land". In this chapter, I want to follow up with three scenarios, which help to understand the basic conditions and with three different kinds of *responses* what can be reached. The first scenario is business as usual, a continuation of that what was already shown in the results of the literature review and the WOCAT mapping questionnaire. The second scenario is the vision of the farmers, where costs and benefits of a few technologies the farmers selected in the SLM planning workshop are compared to other common land uses. The third scenario is a maximum scenario where recommendations are worked out, based on the past research and on my own experiences from the field work.

18.1 Business as Usual: A Downward Spiral

The business as usual is the continuation of the observed development in the study area. It is expected that the *driving forces*, namely poverty, missing knowledge and support, labor migration, insecurities of the land tenure system and population growth continue developing as over the past 10 years, and thus the expected *impacts* on the *state of the land* and the ecosystem services continue as it was described in the synthesis of literature in chapter 13. Also, the degradation of the land would continue as it was documented with the WOCAT mapping questionnaire. The scenario is discussed under the assumption that current processes as described in the previous chapters are continuing similarly. It is supposed that no big changes will take place, for example in the socio-political context, such as a sudden visa requirement by Russia for Tajiks. Such visa requirements are expected to have significant effects on the number of Tajik going abroad for seasonal labor. Population growth is considered one of the main *driving forces* with regard to increasing the *pressure* on land resources, due to the linked increase in food demand. As Muminjanov (2008) states, the food consumption per capita has sharply reduced in recent years all over the country. Increased food demand leads to higher requirements in food production. This likely increases the labor migration, which brings more money to the study area, but as determined by Eggenberger (2011), remittances are generally not invested in the conservation of the land. Instead it is invested in livestock that increase the *pressure* on the grazing land. Awareness of the importance of sustainable land use does not arise and SLM planning is not going to be developed without knowledge input or support by suitable institutions. Thus, it must be expected that land degradation will continue: soil erosion, reduced vegetation cover, increased weed infestation, soil fertility decline, and lower soil moisture storage capacity. Bühlmann (2006) estimated that with the business as usual scenario the average annual soil loss in the study area amounts to 79 t/ha. The maximum rate of soil loss that can occur and still permits crop productivity to be sustained economically over a longer-term should be approximately 11 t/ha. Ruppen (2012) determined a negative biomass flow into the soil resources and thus a reduction in soil organic matter. This causes negative *impacts* on the ecosystem services.

Currently practiced *responses* to land degradation were detected in the literature reviewed and *responses* in form of SLM technologies were described during the WOCAT mapping workshop (see chapter 16.1). The current *responses* are presented as an extension of the overview in Figure 20. As a response the land use rights were transformed and support the "privatization" of the land by transferring user rights to individual dekhan farms. Here the problem is that not all land users have the same access to land and not all can profit from the better secured land use rights. Labor migration is an important *response* to generate additional income which cannot be generated from agriculture. More extensive land use or abandonment is a result if the labor force is utilized mostly for labor migration. A *response* in the study area is to increase the livestock numbers as an income saving strategy requiring less labor input compared to cultivation. Other *responses* to land degradation are the NGOs operating in the study area and are providing knowledge assistance to farmer associations. Some families chose livelihood strategies providing an income outside agriculture in order to improve their livelihood. SLM technologies are applied in the study area as well, but not enough so degradation can be widely observed and affects the productivity of the land.

18.2 Medium scenario: Joint Planning

With the SLM technologies selected in the SLM planning workshop, the downward spiral in a business as usual scenario is expected to be halted. The participants from the workshop chose the following SLM technologies: "energy efficient stoves", drainage ditches, "drip irrigation", "perennial fodder plants", "grass strips" and "gully rehabilitation" for addressing land degradation on cropland. "Rotational grazing", "energy efficient stoves", "establishment of an orchard", "gully rehabilitation", "living fence" and "rotational grazing with additional water points" for grazing land were assessed to be effective and applicable technologies for grazing land. In this scenario, I want to focus on two technologies, perennial grasses and orchards, for which cost and benefit data is available as it was collected for this study with the yield questionnaire. The data can be used to support decision-making and to show that technologies such as perennial fodder crops and orchards produce more yields and require less labor input. Already Bühlmann (2006) and Ruppen (2012) supported the cultivation of perennial fodder crops and orchards. The SLM planning workshop showed that the participants are willing to implement SLM technologies up to a certain level as long as it is economically beneficial. According to the ranked criteria discussed during the SLM planning workshop, it is important that the technology improves the economic situation, in the form of higher production and by creating only small expenses for the establishment and the maintenance of the technology. Bühlmann (2006) defines the criteria for SLM technologies and the desired impacts as follows: *„While soil loss has to be reduced, overall farm production* *should at least remain at the same level or increase in comparison to the situation before [...] implementation [of the SLM technology]. Establishment and maintenance costs should not exceed these gains in a long term perspective. Generally, it can be expected that the lower the costs are to implement and maintain a [SLM technology] [...], the more likely will be its adoption by fellow farmers. Furthermore, the [SLM] [...] technology should not hinder traditional farm operations and should allow changes in land use practices such as mechanization"* (Bühlmann 2006: 43). Perennial fodder crops were chosen for the implementation project in three of four villages. It is a low cost and less labor-intensive technology. Already Ruppen (2012) proposed a conversion of uncultivated field plots to perennial forage crops in order to reach higher land productivity. He states that the shift from hay to alfalfa. Or the establishment of an additional alfalfa plot, improves the feed self-supply of small households although it does not close the open biomass cycle.

The results from the yield questionnaire show that on average the yield for hay was 4500 kg per ha a year. The inputs for machinery, seed and fertilizers were 1500 TJS per ha and the labor input 50 days per ha (compare Table 16). The profit converted to monetary values with a market price for hay of 0.8 TJS/kg is 2100 TJS/ha. In comparison, one ha of perennial grasses, which is harvested three times a year corresponds to an overall yield of 6257 kg/ha. The material expenses are 1375 TJS/ha and the labor input amount to 120 days per hectar and year if harvested three times. Thus, the profit for perennial grasses is 3631 TJS/ha. This shows that cultivating perennial grasses needs fewer expenses for purchasing agricultural inputs than haymaking, but a higher labor input is needed, as there are three harvests. But the yield and thus profit of perennial grasses are also higher than for haymaking. The gross profit is 1531 TJS/ha more for perennial grasses than for haymaking. The net profit is due to the higher labor input for the three harvests only 131 TJS/ha. But in this calculation the labor for each workday is considered, however, if provided by the farmer family these expenses (2400 TJS/ha) remain in the family if no extern labor force is hired.

Table 16 Comparison of cost and benefit of perennial grasses and hay making cultivation.

	sample size	**yield [kg/ha]**	**expenses agricultural inputs [TJS/ha]**				**expenses labor**		**market price [TJS/kg]**	**profit [TJS/ha]**	**net profit [TJS/ha]**
			machinery	**seeds**	**fertilizers**	**total**	**[day /ha]**	**[TJS/ha]**			
perennial grasses	20	6257	693	362	262	1375	120	2400	0.8	3631	1231
hay	9	4500	417	400	500	1500	50	1000	0.8	2100	1100
difference								1400		1531	131

The conversion of annual cropland to orchards was also discussed earlier in the literature. Bühlmann especially emphasizes the conversion of annual cropland on steep slopes to orchards with intercropping. In the Table 17 the costs and benefits of vegetables and orchards are presented. The conversion into monetary returns shows a slightly higher benefit from vegetable cropping. Due to the much higher labor input (more than double) on vegetable plots, the net profit from orchards is 1103 TJS higher than from vegetable fields.

Table 17 Comparison of cost and benefit of vegetables and orchards with intercropping.

	sample size	yield [kg/ha]	expenses agricultural inputs [TJS/ha]				expenses labor		market price [TJS/kg]	profit [TJS/ha]	net profit [TJS/ha]
			machinery	seeds	fertilizers	total	[day/ha]	[TJS/ha]			
vegetable	66	3000	480	1000	710	2060	103	2060	1.8	3340	1280
orchard	15	3057	600	667	867	1933	45	897	0.8-2	3281	2383
difference							58			59	1103

The costs and benefits for the other land use types vineyard, flax and wheat cropping are presented in Table 18. All three crops seem to be attractive in terms of cost and benefit. Although, as compared earlier, the result for flax (6820 TJS/ha) as determined by the questionnaire applied in this study, shows a much higher average flax yield than it did in other studies. Wheat generates the lowest profit (890 TJS/ha), but is the staple food in Tajikistan and usually the most important crop. Vineyards also generate a high profit with 3100 TJS/ha.

Table 18 Cost and benefit for vineyard, flax and wheat.

	sample size	yield [kg/ha]	expenses agricultural inputs [TJS/ha]				expenses labor		market price [TJS/kg]	profit [TJS/ha]	net profit [TJS/ha]
			machinery	seeds	fertilizers	total	[day/ha]	[TJS/ha]			
vineyard	7	1500	500	0	400	900	100	2000	4	5100	3100
flax	15	2000	1000	500	500	1680	75	1500	5	8320	6820
wheat	25	2000	800	500	500	1850	63	1260	2	2150	890

The conversion of hay making areas and vegetable plots into perennial grasses and orchards are promising SLM technologies. For the land use types orchards and perennial grasses Bühlmann (2006) modeled lower soil erosion rates and Ruppen (2012) detected a higher soil organic matter content than for other land use types. Although Bühlmann recorded high establishment costs for orchards, long term they would pay out in terms of sustainable soil conservation and profit (for more information about establishment costs of an orchard consult the thesis of Conder, 2014). In addition to the higher yield and soil conservation property, perennial grasses accumulate nitrogen and cover the nitrogen requirements of crops cultivated in subsequent crop rotations (Ruppen, 2012).

Additional to technologies applicable to certain LUS, other technologies were selected in the SLM planning workshop. For those technologies no data is available with which supporting calculations of its application can be done. The “energy efficient stove” was one of these selected technologies. Also Ruppen (2012) suggested additionally energy saving technologies such as cook stoves, pressure cookers, joint bread baking and insulation of the house in order to reduce the fuel and dung consumption, which helps to conserve grooves and save dung, which can then be spread on the field as fertilizer. Ruppen stated a reduction of up to 60% of fuel consumption with such measures. For this technology and also for technologies on grazing land as “rotational grazing”, no cost-benefit analysis could be conducted in the frame of this study. But the implementation of such additional technologies would be advisable if we take into account that biomass is taken away, also from areas with perennial grasses or from orchards. Bühlman (2006) modeled the impacts of SLM technologies on soil erosion. “Contouring”, “perennial crops”, “drainage ditches”, “orchards” and “terracing” all show positive impact on soil loss reduction.

These *responses* of SLM technologies, the conversion to perennial grasses and orchards, show higher benefits than in the business as usual mode and have the ability to conserve the land while securing a sustainable production. The knowledge that perennial grasses and orchards protect the land and result in a higher yield is not new to the study area. Both these land use types are applied already in the study area. What is missing is the implementation of these technologies over large areas, which requires reaching also farmers whom were so far not interested in conservation technologies. For an effective implementation, more than just the selection of technologies is needed. The optimum scenario discussed in the following section, is representing an ideal suggestion in the sense of an effective approach facilitating changes towards sustainable land use in the jamoat of Javonon.

18.3 Optimum Scenario

Many of the SLM technologies selected by the participants in the workshop are technologies that were documented in the jamoat of Javonon. Namely, the technologies “grass strips”, “establishment of an orchard”, “gully rehabilitation”, “drainage ditches”, and “perennial fodder plants” were documented in the study area itself. This allows for concluding that people knew these technologies before, and that the workshop did not introduce completely new knowledge. Nevertheless, the participants were motivated to participate in the workshop and probably this event generated motivation to do more about SLM on their land. Even though many examples exist where the technologies have already been implemented in the study area, the technologies are still not frequently applied. This leads to the assumption that even availability of knowledge and awareness is not enough to implement SLM technologies. Evidence for how SLM technologies increase production, or a coordinated land management planning by an NGO or a governmental institution along with financial support could help scaling up SLM technologies, would probably result in the scenario presented in this chapter.

Based on the WOCAT mapping which was done in this study, an SLM planning can be conducted. With consistent planning in combination with good approaches and a strong institution such a plan could be realized. Currently, the people in the jamoat of Javonon do not come up with the implementation of SLM technologies on their own, at least not in large areas. However, the experience from this study indicates that education on cost and benefits of SLM technologies and maybe with some financial support, the local population would be willing to do more about SLM. Wirz (2007) describes that the forest administration and the rayon level land use committee both plead for top down measures such as, for example, enforcing the conversion of parts of the former cropland into fodder production areas or to prohibit cutting down trees. And Bühlmann (2006) realized that land users usually do not implement SLM technologies due to lack of awareness, which influences the priorities when investing. A farmer mentioned that if he talks about SLM technologies people are not impressed, but if an authoritative person, for example from the government, introduces technologies, he is sure people would apply them. Furthermore, Bühlmann (2006) mentioned that the farmers' acceptance and adoption of SLM technologies may be enhanced if the technologies suggested by conservationists or proposed by the land committee are adaptations and outgrowths of indigenous practices from the study area.

As a tool for SLM planning, the LUS map developed for this research could be used. Such a planning could involve focusing on specific degraded LUS (hot spots) such as annual cropping on steep slopes, grazing land and abandoned land. Bright spots such as perennial cropland and orchards should be created on larger areas. A planning where the aim is to convert hot spots into bright spot areas could improve the sustainable use of land resources. Where the conversion of LUS is not reasonable, specific other SLM technologies should be promoted on these LUS such as, for example, the other mentioned technologies "energy efficient stoves" or "grass strips". Such a planning requires SLM approaches with which the implementation of SLM technologies can be realized. In the SLM planning workshop a number of SLM approaches were introduced providing options for how people could be motivated to implement SLM in their fields. As the workshop participants did not take up the proposed ideas, an institution such as a planning body for planning and implementing is proposed. Following the three steps also listed in Figure 20, a full planning and implementation process can be performed. With a consistent planning a maximum output could be generated resulting in a minimum of erosion and a maximum of production.

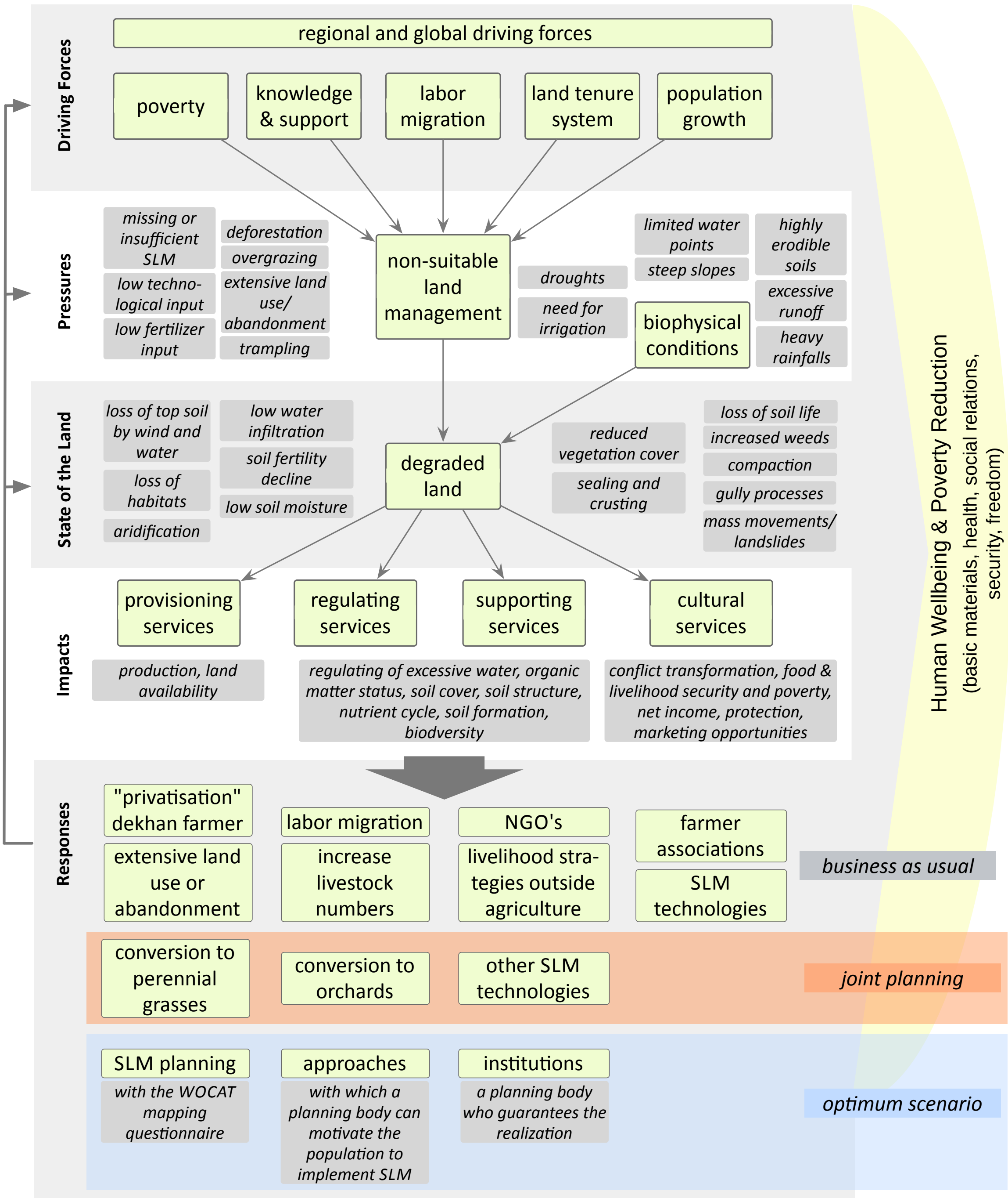

Figure 20 Overview of the *driving forces*, *pressures*, *state of the land* and *impacts* of the agricultural land in the study area with the *responses*: 1) business as usual, 2) joint planning, 3) optimum scenario

Part V Evaluation and Conclusion

19 Evaluation of the Proceeding and Methodical Challenges

19.1 Hybrid SLM Conceptual Framework

The hybrid SLM conceptual framework is a useful tool to assess the environment of an area. Indicators such as the one from WOCAT/LADA help to structure the procedure. The strength of the framework is that with it a variety of *driving forces* for the study area which cause environmental degradation can be considered. Within the framework conditions of this study that focus on sustainable land management it was clear from the beginning that *responses* in form of SLM technologies would be suggested as a solution. Other solutions probably would contribute to a sustainable development in the study area, such as, for example, a *response* in the form of better market integrations. Such kinds of *responses* were not included in this study, although the hybrid SLM conceptual framework would be a good tool which involves an overall view on the study area and thus a broad variety of responses could be suggested. A more integrative assessment, rather than only focusing on SLM technologies, would involve more possibilities for *responses*, which would contribute to a sustainable development in an area.

19.2 WOCAT Mapping Questionnaire

The WOCAT mapping questionnaire is a good methodology to get an overview of the degradation and conservation of the land. But it was not entirely satisfactory. The assessment is made with the consultation of experts. This process requires good experts whom have a good knowledge for the whole area. It is important that they know spatial occurrences of land degradation and conservation, also on a map. Furthermore, they have to be familiar dealing with such a detailed code system with which degradation and conservation are described. The willingness to spend an amount of time for the careful assignment of the codes is a further requirement that experts have to fulfill. In my case the experts were indeed representatives of the local government, but the content of the workshop seemed to be rather 'boring' for the experts so they were not too interested in the outcome of the assessment. I now doubt that maps will be used as a planning instrument in the future. Low salaries paid to the employees of the government result in them still having to be primary farmers and not full time government workers. Thus, for the WOCAT mapping workshop good experts who were motivated to work out an assessment for the jamoat were not available. Rather, it gave me the impression that the workshop was considered to be boring and useless. Hence I assume that the seriousness of the data information can be in doubt.

I think the questionnaire can be applied better in another country where government representatives or experts from other institutions are paid well for their job and are seriously interested in the outcome of the assessment and make use of the end product: the maps. In the jamoat of Javonon such experts were not available. For another time, a creation of an expert team that is involved in the assessment but also in later planning with the WOCAT mapping questionnaire probably would be reasonable. Furthermore, payment for experts should be taken into consideration.

With a good continuation the outcomes of the WOCAT mapping workshop certainly can be used as a helpful planning tool. Whereas a good planning body, as requested in the maximum scenario would be crucial.

19.3 SLM Planning Workshop

After a long stay in the field and interaction with local people it was still difficult to estimate or to adapt the workshop program for a smooth and effective operation. I expected the people to be much more inventive, to have ideas for approaches for which the funding could be used. The creativity could not really be activated during the workshop, so the program had to be adapted spontaneously. Instead focusing on approaches, the participants were not that happy about the small size of the fund. The argument was that only a few technologies can be implemented with this amount of money and that a project within all the villages is difficult for them to organize. That is why nearly all the projects resulted in esparzet planting, which is a relatively cheap technology whereby the seeds can be distributed in the community. I my opinion a discussion on approaches, how to sensitize or motivate people to do more for SLM on their own fields would be an important step towards SLM. In such a discussion people can come up with their own ideas, how SLM could be implemented in the study area. Although, I think a "culture for discussion" has to be trained as it did not really work according to my expectations. Probably, combining research and implementation workshops is not the ideal way to improve SLM and introduce SLM planning. The contact between research and farmer should be closer, the relationship should be constant and long term and some monetary input would be necessary. Probably it would be better if an NGO works in the area, or even, if after the research phases, an NGO comes in and would be responsible for the implementation phase by bringing extra money for implementation of projects. Good approaches should be led, well structured, by an NGO or another institution, which first has to be established in the case of the study area. It does not seem that the local government is able to implement such projects. The maximum science can provide is a planning that recommends where which technologies should be implemented while giving reasons to support their implementation. With the application of the DESIRE guideline part III, the NCCR North-South project in the jamoat Javonon has now reached a stage where science should be replaced by implementation, where the scientific knowledge about SLM can finally benefit the local population.

20 Conclusion

Land degradation and especially soil erosion was observed in the jamoat of Javonon, affecting large areas of agricultural land. Valuable base knowledge of socio-economic processes and related impact on the *state of the land* had been generated in a long-term research project in the study area (NCCR North-South). This broad variety of knowledge raised the need for an integrative assessment of the *state of the land* as a basis to find solutions to improve land use planning.

In an analysis of previous research the *driving forces* and *pressures* that cause land degradation were worked out. The *driving forces* can be summarized under the headings: poverty, missing knowledge and support to improve land management, labor migration, the insecurities of the land tenure system and population growth. Those *driving forces* exert *pressures* on the *state of the land.* These *pressures* are either in form of non-suitable land management or due to unfavorable biophysical conditions. Non-suitable land management puts *pressure* on the *state of the land* in the form of missing or insufficient SLM, low technological input, low fertilizer input, deforestation, overgrazing, extensive land use, abandonment, trampling and need for irrigation. The unfavorable biophysical conditions that put *pressure* on the *state of the land* are limited availability of water points, topography, droughts, highly erodible soils, excessive runoff, and heavy rainfalls. The hybrid SLM conceptual framework used in combination with the WOCAT/LADA indicators is a good methodical framework for synthesizing the literature and to define the causes for land degradation. The framework and the indicators help to structure the literature and to focus an overall analysis on the *state of the land*.

The present spatial occurrence of land degradation and conservation was elaborated in a participatory approach, with the WOCAT mapping questionnaire and the consultation of local experts. The results are degradation and conservation maps that give a good overview of the type, degree, extent and causes of land degradation for each of the LUS which are "perennial cropland", "annual cropland", "orchard", "vineyard", "grazing land", "forest" and "abandoned land". The LUS on slopes >16%, which is 84.8% of the study areas is more affected by land degradation than the 15.2% flat area on slopes <16%. The LUS on steep slopes: "abandoned land", "annual cropping" and "grazing land" are most affected by land degradation and are thus the hot-spots of the agricultural land of the jamoat of Javonon. "Perennial cropland" and "orchards" are the bright-spots of the agricultural land. The assessment also showed a tendency of a more extensive use of vulnerable sloping land whereas flat areas experience a more intensive use.

The WOCAT mapping questionnaire turned out to be a good tool to assess the *state of the land*, the causes for land degradation (*driving forces*) and the *impacts* on the ecosystem services qualitatively. The tool gives, with a relatively low work input (1-day workshop), a good overview of the study area whereas the consultation of good experts is crucial for this qualitative assessment. For the jamoat of Javonon, most of the knowledge collected in the questionnaire was already available from the previous studies. The WOCAT mapping questionnaire is especially recommended for areas where less intensive research had been conducted before and where an overall assessment for land degradation and conservation is needed.

Tying up to the spatial assessment, SLM planning was conducted with the DESIRE guideline part III for the LUS: “annual cropland” and “grazing land” which are the hot-spots of the agricultural land. The DESIRE guideline is a tool facilitating the selection of SLM technologies to be implemented. In a 2-day workshop with 20 participants from four villages out of 33 SLM technologies 6 were assessed to be most applicable for the LUS “annual cropland” (“energy efficient stove”, “drainage ditches”, “drip irrigation”, “perennial fodder plants”, “grass strips” and “gully rehabilitation”) and “grazing land” (“rotational grazing”, “energy efficient stove”, “establishment of an orchard”, “gully rehabilitation”, “living fence”, “rotational grazing with additional water points”). This planning resulted in pilot projects in 4 villages in the jamoat of Javonon. A ranking of criteria by the participants showed that SLM technologies with the property to increase the yield are demanded. Whereas the selection of reasonable technologies went well, the expected implementation of approaches was not incorporated in the pilot projects. It was not interesting for the participants to invest in the distribution of knowledge.

In order to support local farmers in decision-making for SLM technologies, three scenarios were discussed: the “business as usual” - a downward spiral which worsens land degradation, a “joint planning” where a cost-benefit analysis supports the implementation of specific SLM technologies and a “maximum scenario” where desirable support for SLM planning is emphasized. The cost-benefit analysis of SLM technologies supports decision-making for its implementation if the yield can be increased with the technology. In this study, a cost-benefit analysis comparing “orchards” with “annual cropland “and “perennial grasses” with “haymaking” was conducted using yield data, collected with a questionnaire. Esparzet planting and “establishment of orchards” results in higher profit (131 TJS/ha more for perennial grasses and 1103 TSJ/ha more for orchards) and at the same time have protective properties as Bühlmann (2006) stated earlier. The higher soil organic carbon content of these LUS makes those technologies more suitable for the conservation of the soil, as Ruppen (2012) suggested. Other SLM technologies could not be included in the cost-benefit analysis but are recommended for implementation additionally due to their preserving properties.

The strength of this study was the workflow with the combination of the different methodologies and the participatory approaches. The spatial assessment with the WOCAT mapping questionnaire and the SLM planning with the DESIRE guideline involved the local population. Thus an acceptance base for future adoption of the selected SLM technologies could be created. The four pilot implementation projects of SLM technologies showed that people are willing to do SLM planning and implement SLM technologies on their own land. The workflow with the WOCAT mapping and the following application of the DESIRE guidelines was developed by WOCAT and DESIRE and applied in other study sites. The support of the selected SLM technologies with a cost-benefit analysis was an additional step made in this study. SLM technologies should fulfill criteria as increasing yield or reduce soil loss. If SLM technologies can be supported with cost-benefit data, the decision for implementation of such technologies is easier.

A crucial point of the proceeding in this study was discussed in the "maximum scenario". People participated in all stages of the planning whereas the organizational part came from outside. The selected SLM technologies were not new for the study area, the preserving properties of the technologies were known before. But still large areas are affected by land degradation. Thus an effective institution has to be found which can follow up a large-scale SLM planning with the use of the maps resulted from the WOCAT mapping workshop. Those LUS based maps are a good tool for SLM planning which I strongly recommend to use further in a planning concept.

The workflow applied in this study is recommended to apply in other areas. With the WOCAT mapping questionnaire a quick overall assessment of the *state of the land*, based on the knowledge of local experts can be conducted. Thus previous research, as it was available for the study area is not necessary. A base map could be created based on freely available Google Earth images.

Bibliography

Agyemang, I., McDonald, A., & Carver, S. (2007). Application of the DPSIR framework to environmental degradation assessment in northern Ghana. *Natural Resources Forum*, *31*(3), 212–225.

Allworth, E., Hambly, G. R. G., Imshenetsky, A. I., Sinor, D., & Smith, D. R. (2013). Tajikistan. In *Encyclopædia Britannica*. Encyclopædia Britannica Online Academic Edition. Access: 03.02.2014.

Bann, C., Shukurov, R., Boziev, L., & Rakhmatova, D. (2012). The Economics of Land Degradation for the Agriculture Sector in Tajikistan. UNDP. Retrieved from www.unpei.org/sites/default/files/dmdocuments/TJ_Economy%20of%20land%20degradation_ENG.pdf. Access: 03.02.2014.

Bekturova, G., & Romanova, O. (2007). *Traditiona Land Management Knowledge in Central Asia*. Almaty: UNDP United Nations Development Programme.

Betti, G., & Lundgren, L. (2012). The impact of remittances and equivalence scales on poverty in Tajikistan. *Central Asian Survey*, 395–408.

Breu, T., Maselli, D., & Hurni, H. (2005). Knowledge for Sustainable Development in the Tajik Pamir Mountains, *25*(2), 139–146.

Bühlmann, E. (2006). *Assessing Soil Erosion and Conservation in the Loess Area of Faizabad Western Tajikistan. Integrating WOCAT Methods with a GIS-based RUSLE Model*. Master Thesis. University of Bern.

Bunning, S., McDonagh, J., & Rioux, J. (2011). Manual for local level assessment of land degradation and sustainable land management. FAO. Retrieved from www.fao.org/nr/lada/index.php?option=com_content&view=article&id=152&Itemid=168&lang=en. Access: 02.03.2014.

Canarache, A., Vintila, I., & Munteanu, I. (2006). loess. *Elsevier's Dictionary of Soil Science: Definitions in English with French, German, and Spanish Word Translations.* Burlington: Elseviert.

Conder, M. (2014). *Sustainable Land Management by Disaster Risk Reduction in Muminabad district, Tajikistan, using WOCAT methods.* Master Thesis. University of Bern.

Eggenberger, S. (2011). *Effects of Labour Migration on Rural Livelihoods in Tajikistan. With a special regard on the interlinkages to agricultural land use*. Master Thesis. University of Bern.

Egorov, I. (2002). Perspectives on the Scientific Systems of the Post-Soviet States: A Pessimistic View. *Prometheus*, *20*(1), 59–73.

Encyclopædia Britannica. (n.d.). sovkhoz (Soviet agriculture) Encyclopædia Britannica. Retrieved from http://www.britannica.com/EBchecked/topic/557139/sovkhoz. Access: 02.03.2014.

EncyclopædiaBritannica. (n.d.). kolkhoz. Encyclopædia Britannica. Retrieved from http://www.britannica.com/EBchecked/topic/321400/kolkhoz. Access: 08.03.2013.

European Union. (2007). DESIRE. Retrieved from http://www.desire-project.eu/index.php?option=com_frontpage&Itemid=1. Access: 03.02.2014.

Foroughi, P. (2002). Tajikistan: Nationalism, Ethnicity, Conflict, and Socio-economic Disparities-Sources and Solutions. *Journal of Muslim Minority Affairs*, *22*(1), 39–61.

Guntli, D. (2006). *Classification of landcover and land use. An object-oriented approach in western Tajikistan*. Master Thesis. University of Zürich.

Halimova, N. (2012). Land Tenure Reform in Tajikistan: Implications for Land Stewardship and Social Sustainability: A Case Study. In V. Squires (Ed.), *Rangeland Stewardship in Central Asia* (pp. 305–329). Dordrecht: Springer Netherlands. Retrieved from http://www.springerlink.com/index/10.1007/978-94-007-5367-9_13. Acess: 03.02.2014.

Kurbanova, B. (2012). Constraints and Barriers to Better Land Stewardship: Analysis of PRAs in Tajikistan. In V. Squires (Ed.), *Rangeland Stewardship in Central Asia* (pp. 129–161). Dordrecht: Springer Netherlands. Retrieved from http://www.springerlink.com/index/10.1007/978-94-007-5367-9_7. Access: 03.02.2014.

Lerman, Z., & Sedik, D. (2008). *The Economic Effects of Land Reform in Tajikistan*. Policy Studies on Rural Transition 1. FAO Regional Office for Europe and Central Asia.

Lerman, Z., & Sedik, D. (2009). Agricultural Development and Household Incomes in Central Asia: A Survey of Tajikistan, 2003-2008. *Eurasian Geography and Economics*, *50*(3), 301–326.

Library of Congress (2007). *Country Profile: Tajikistan*. Retrieved from http://memory.loc.gov/frd/cs/profiles/Tajikistan.pdf. Access: 02.03.2014.

Liniger, H. P., Cahill, D., Thomas, D. B., van Lynden, G. W. J., & Schwilch, G. (2002). Categorization of SWC technologies and approaches–a global need. In *Proceedings of ISCO Conference 2002* (Vol. 3, pp. 6–12).

Liniger, H. P., Schwilch, G., M., G., Mekdaschi Studer, R., Hauert, C., van Lynden, G., & Critchley, W. (2008a). *Technologies: A Framework for Documentation and Evaluation of Sustainable Land Management*. Bern, Rome, Wageningen: WOCAT. Retrieved from https://www.wocat.net/fileadmin/user_upload/documents/QT_and_QA/TechQuestE.pdf. Access: 03.02.2014.

Liniger, H., & Schwilch, G. (2002). Enhanced decision-making based on local knowledge: the WOCAT method of sustainable soil and water management. *Mountain Research and Development*, *22*(1), 14–18.

Liniger, H., van Lynden, G., Nachtergaele, F., & Schwilch, G. (2008b). *Mapping Land Degradation and Sustainable Land Management. (QM)*. Bern, Rome, Wageningen: CDE/WOCAT, FAO/LADA, ISRIC.

Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being: A framework for assessment. Retrieved from http://www.unep.org/maweb/en/Framework.aspx. Access: 03.02.2014.

Mukhammadieva, B. Z., Asoev, A. A., Norov, Q. D., & Gukasova, T. P. (2010). *The impact of migration and remittances on welfare in Tajikistan. Results from a sample survey in August 2010*. Agency on Statistics under the President of the Republic of Tajikistan.

Muminjanov, H. (2008). State of plant genetic resources for food and agriculture (PGRFA) in the Republic of Tajikistan. *Country Report*. Retrieved from http://www.fao.org/docrep/013/i1500e/tajikistan.pdf. Access: 03.02.2014.

Nazarmavloev, F. (2011). Evaluation of the EO-1 Heperion Image for Assessment of Soil Organic Carbon in Faizabad Watershed, Tajikistan. School of Engineering and Technology. Thailand.

NCCR. (2010). RP11 - Land resource potentials. *NCCR North-South*. Retrieved from http://www.north-south.unibe.ch/content.php/page/id/287. Access: 12.03.2014.

Osepsahvili, I. (2006). *Thematic paper Land use dynamics and institutional changes in Central Asia*. Rome: Food and Agriculture Organization.

Roberts, G. (2010). *Landnutzungsveränderungen in der Region Faizabad, Tadschikistan. Analyse unter Verwendung von CORONA- und Quickbird-Satellitenbildern, sowie Sowjetischer Landnutzungskarten*. Bachelor Thesis. University of Bern.

Rohrbach, N. (2012). *Landbedeckungsveränderungen in der Region Fayzabad, Tadschikistan*. Bachelor Thesis. University of Bern.

Ruppen, S. (2012). *A Systemic Biomass Management Analysis of Small-Scale Farmers in the Hill-Zone of Western Tajikistan*. Master Thesis. University of Bern, Bern.

Schäfer, M. C. (2007). *Russlands Aussenpolitik gegenüber Zentralasien. Eine Analyse der Interessen, Mittel und Strategien unter Präsident Putin.* Berlin: LIT Verlag.

Schenk, A., Hunziker, M., & Kienast, F. (2007). Factors influencing the acceptance of nature conservation measures—A qualitative study in Switzerland. *Journal of Environmental Management*, *83*(1), 66–79.

Schwilch, G., Bachmann, F., Valente, S., Coelho, C., Moreira, J., Laouina, A., Chaker, M., Aderghal, M., Santos, P., Reed, M.S. (2012a). A structured multi-stakeholder learning process for Sustainable Land Management. Journal of Environmental Management, 107, 52-63.

Schwilch, G., Bachmann, F., & Graaff, J. de. (2012b). Decision support for selecting SLM technologies with stakeholders. *Applied Geography*, *34*, 86–98.

Schwilch, G., Bestelmeyer, B., Bunning, S., Critchley, W., Herrick, J., Kellner, K., … Winslow, M. (2011). Experiences in monitoring and assessment of sustainable land management. *Land Degradation & Development*, *22*(2), 214–225.

Schwilch, Gudrun, Bachmann, F., & Liniger, H. (2008). *Guidelines for WB3 Part III: Stakeholder workshop 2. Selection and decision on prevention and mitigation strategies to be implemented.* Bern.

Schwilch, G., Hessel, R., & Verzandvoort, S. (Eds.). (2012c). *Desire for Greener Land. Options for Sustainable Land Management in Drylands.* (1st ed.). Bern, Switzerland and Wageningen, the Nehterlands: University of Bern - CDE, Alterra - Wageningen UR, ISRIC - World Soil Information and CTA - Technical Centre for Agricultural and Rural Cooperation.

SCOPES. (n.d.). Proposal: SCOPES 2009-2012 Institutional Partnership: Geoprocessing for Natural Resource Monitoring – Capacity Strengthening in Tajikistan and Kyrgyzstan.

Shokirov, Q. (2011). *Comparative study of two different soil conservation practices from the vineyard mulching treatment in Faizabad region of Comparative study of two different soil conservation practices from the vineyard mulching treatment in Faizabad region of*. Master Thesis. Antioch University New England.

Shtaltovna, A. (2013). *Knowledge gaps and rural development in Tajikistan: Agricultural advisory services as a panacea?* Bonn: Zentrum für Entwicklungsforschung ZEF University of Bonn.

Smeets, E., & Weterings, R. (1999). *Environmental indicators : Typology and overview Prepared by : Project Managers :* (No. 25). Copenhagen.

TJ. (1994). Constitution of the Republic of Tajikistan. Retrieved from http://legislationline.org/documents/section/constitutions. Access: 03.02.2014.

United Nations. (2011). *Country Profiles on the Housing Sector*. Geneva.

USAID. (2010). *USAID Country Profile Property Rights and Resource Governance* (pp. 1–22). Retrieved from http://usaidlandtenure.net/tajikistan. Acess: 03.02.2014.

Winnig, A. (2005). *Socio-Economic Factors for Land Use Changes in the Hill Zone of Western Tajikistan*. Master Thesis. Universität Bonn.

Wirz, C. (2009). *Assessing impacts of different grassland systems on land degradation and conservation in Faizabad (Tajikistan)*. Master Thesis University of Bern.

WOCAT (n.d.). WOCAT Strategy (2008-2012, extended to 2013). Retrieved from https://www.wocat.net/fileadmin/user_upload/documents/General_WOCAT_documents/Wocat_Strategy_2008-2013.pdf. Acess: 03.02.2014.

Wolfgramm, B. (2007). *Land Use , Soil Degradation and Soil Conservation in the Loess Hills of Central Tajikistan*. Inauguraldissertation. University of Bern.

Wolfgramm, B., Stevenson, S., Lerman, Z., Liniger, H., & Zähringer, J. (2011). Tajikistan Pilot Programme for Climate Resilience. Component A5 : Phase 1. Agriculture & Sustainable Land Management Final report.

Annex

1. Yield Questionnaire

Aufwand und Ertrag auf verschiedenen Landnutzungstypen

Lieber Mitwirkender, liebe Mitwirkende, herzlichen Dank für Ihre Partizipation an dieser Umfrage. Ihre Ernte wurde inzwischen hoffentlich erfolgreich eingeholt. Mit diesem Fragebogen möchte die Universität Bern Informationen über den Aufwand und den Ertrag auf ihren Feldern aufnehmen. Damit soll die Effizienz der verschiedenen Landnutzungstypen in der Jamoat of Javonon erfasst werden.

Persoaldaten

Familienname:________________________ Hausherr:____________________________

Anzahl Erwachsene im Haushalt:________ Anzahl Kinder im Haushalt:_____________

Wohnort: □ Karsang □Hojomard

□Obi Sangbur □Chinoro

Haustiere

Anzahl Tiere pro Familie:	Kühe:______________
Geißen:_____________	Pferde:______________
Schafe: ______________	Esel:________________

Feldinformationen

Im folgenden Abschnitt sollten die Fragen nur für eines von Ihnen bewirtschafteten Felder ihrer Wahl ausgefüllt werden. Bitte kreuzen Sie den Nutzungstyp an für den Sie die Fragen beantworten:

□ Obstgarten ohne Zwischenfruchtbau	□ Heuen bewässert
□ Obstgarten mit Zwischenfruchtbau	□ Heuen nicht bewässert
□ Weinbau	□ Alfa-Alfa
□ Weizen	□ Esparzet
□ Flachs	□ Alfa-Alfa und Esparzet
□ Kichererbsen	□ Sonstiges: ______________
□ Gemüse	

Wie stark ist das Gefälle dieses Feldes? □0°-9° □9°-17° □>17°

Grösse des Feldes: _____________aren

_____________hektaren

Input

Wie viele Personen arbeiteten in dieser Saison (2012) auf dem Feld?

a) Anzahl Familienmitglieder: ___________ b) Anzahl Angestellte:__________________

Wie viele Arbeitstage wurde pro Person in diesem Jahr durchschnittlich in das Feld investiert? (Angestellte und Familienmitglieder)____________________Tage pro Person

Wie viel Gehalt erhielt die angestellte Person pro Tag? ________________TS

Wie viele Ausgaben hatten Sie in dieser Saison für das Feld für ...

a) ...Maschinen? ________________TS

b) ...Saatgut? __________________TS

c) ...Düngemittel? _____________TS

Output

Auf Obstgärten und bei Baumreihen wurden allenfalls verschiedene Früchte geerntet. Bitte verwenden Sie für jede Sorte eine Zeile.

Was wurde auf dem Feld geerntet?	Wie viel Kilogramm wurde geerntet?	Was ist der Marktpreis für das Produkt pro kg?	Wie viel kg wurde davon auf dem Markt verkauft?
____________________	____________________	____________________	____________________
____________________	____________________	____________________	____________________

Besten Dank für Ihre Teilnahme!

2. Program SLM Planning Workshop

Program for the SLM planning workshop in the jamoat of Javonon:
Reduction of soil erosion and increase of soil productivity (09.-10. October)

Time	Objective	Realisation	Output	Material
Day 1				
09.30-10.10	Opening and introduction to the workshop	Opening (20)	The participants are clear about objectives, the procedure and programme of the workshop. The participants know each other.	Certificate (waited long for jamoat)
		Introduction round of the participants (15)		
		Objectives and programme of the workshop (5)		Objectives on a poster
10.10-11.00	Step 1: Land degradation and introduce, define objective	a) Theoretical Input: Soil Erosion and Soil Productivity (20) b) Input: Gully measurement (10) c) Introduce the erosion maps from the mapping WS (10) d) (10) Introduce Objective: 1) **Reduction of soil erosion and increase of soil productivity on cropland** 2) **Reduction of soil erosion and increase of soil productivity on grazing land**	The PP get basic knowledge about the problem statement.	Pinwall and arrows of the “water cycle” Mapping maps 50 min theory made people already bored.
			The PP learn about the problem statement in this WS.	
11.00-11.20 break				
11.20	Step 2: Identification of SLM technologies according to the objective	a) (5) Introduction: explain the preparatory work (where technologies are from), explain what the WOCAT database is and how it was used.	The participant learn about the WOCAT technology database.	– WOCAT Technology folder
		b) 4 stations where at each some technologies are discussed: rotate every 40 minutes Discuss for each technology advantages, disadvantages and adaptions has to be done for suitability in local context and collect them on a poster. 11.30-12.20 1.Part (50) 12.20-13.00 2.Part (40)	The PP learn to know different technologies from the WOCAT database.	– Moderators – posters with three columns (advantages, disadvantages, adaptions) for each technology – WOCAT movies
Lunchbreak: 13.00-14.00				
		14.00-14.40 3. Part 14.40-15.20 4. Part		
15.20-15.50		c) Split group into two groups (Cropland and Grazing Land), let the groups select the technologies which fit best to the goal Presentation in the plenum and select if more than seven technologies.	Choose 4-7 SLM technologies which are feasible and interesting enough for the context of the study area.	– Technology cards
15.50-16.00	Step 3: Identification of relevant criteria for evaluation	a) Give 15 Criteria already identified through studies in the area. (increased water availability, less soil loss, increased yield, low cost, low labor, strengthen the community, useful for small & large scale farmers		Criteria

2nd day				
09.00	"	Short review of the last day		
09.15-09.45	Explanation of the criteria			
09.45-11.00	Step 4: Scoring the SLM technologies Step 5: Creating a hierarchy and ranking criteria	a) 4 Village groups choose grazing land or cropland b) score for one of the goals Karsang (patureland), Hojomard, Chinoro, Obi Sangbur c) score the importance of all criteria 1-7	All SLM technologies are assessed for the different criteria	scoring tool poster for the results 4 moderators
11.00-11.30 break				
11.30-12.00		Analysis of the tables		
12.00-12.30	Step 8: Implementation & Approaches	Movie and introductions of the 4 approaches (methods from Switzerland)		Movie confused people, because they did not understand, why on school land and the school got only little
12.30-13.30 lunchbreak				
13.30-14.30		What is needed in the villages? Choose a technology and an approach (30) Presentations (30)		Table with technology and approaches 3 new approaches by the PP (Chamar, apply for money, privat)
14.30-15.00	Step 7: Influence and motivation to implement SLM (Visions)	Stand in a line: 1) SLM is for them important – not important 2) Influence high-low 3) Takes initiative: high participation – low participation in the project		– Outside
15.00-15.30	Step 9: Specific Planning	Introduce the application form: Develop a specific project for each village which contributes to SLM for (here the credit of 500$ should be used) Ask for the name of a responsible person to whom the money can be given to.		Material per village: LUS map, degradation map, technology posters, application form
15.00-15.45	Conclusion and feedback			

3. Technologies from the WOCAT Database

Orchard	Disadvantages	Advantages	
Establishment of an orchard TAJ008	Medium	Solid soil, apple, fruits, grass, conservation, wood, dung improves ecology	applicable
Planting of fruit trees to increase slope stabilization TAJ111			
Low cost drip irrigation or orchard TAJ107	Medium-high	Economical water use, yield from the garden, good for dry years, reasonable use of water	applicable
Cascading Rock irrigation channel TAJ371			
Drip irrigation using polyethylene sheeting & intermittent cloth strips TAJ372			
Woolen water retention under the roots of a tree irrigated by a pipe TAJ398	Few	In dry years	applicable
Conversion of grazing land to fruit and fodder plots TAJ004 + Film	Medium-high	Few precipitation →few yield, good grass and trees, conservation,	applicable
Gully and Perennial crops			
Gully rehabilitation with willow trees TAJ115			
Infilling of Gullies with vegetative structures TAJ356 + Film	Various trees, stone, cement, pipes, labor	Protection of the environment	Very applicable
Stem cuttings NIC04			
Perennial herbaceous fodder plants TAJ009	No disadvantages	More fodder production, cutting 1-2 times a year, keep moisture, conservation	Very applicable in Faizabad
Perennial grass seed area KAZ007	No disadvantages	Few erosion, fodder production	applicable
Grazing land			
Rotational grazing with additional water points TAJ100 + Film	Animals, Pipes, channel, Transport, Work, Seedling	Milk production, Fertilizer, Conservation, Number of animals, less sicknesses	
Pasture Rotation every 30d UZB002	Herder in every village necessary (duty of the jamoat)	Conservation, fodder improvement	
Stabilization of sand dunes TUM001			
Living sea buckthorn fence TAJ366			
Tree plantation on abandoned land UZB004	Seedlings, labor, tools, money	Less gullies, firewood, ecology	applicable
Rehabilitation with Izen (perennial shrub) TAJ368			
Sainfoin KYR004	Prepare land, processing the field, seeds (1kg=18TS), yield	Enrich soil, beekeeping, fodder production	Very applicable
Various			
Vertical growing potatoes TAJ375	Often few yield, potato needs more water, humidity not enough		To grow potatoes is favorable in Faizabad
Off season irrigation KAZ008	-	-	Applicable
Shelterbelt for irrigated fields TAJ110	Too much expenses		It is necessary, due to in Faizabad is strong wind
Buffer strips TAJ006	Less expenses	Hay, conservation	attractive
Drainage ditches TAJ010	Less expenses	Good yield, conservation	attractive
Gradual development of bench terraces from contour ditches TAJ362	A lot manual labor, clean channel, drip irrigation with bottles	Grass, fruit trees, wood, conservation	applicable

Thermal insulation TAJ102	Medium expenses	Few wood and dung, heat house once a day	applicable
Energy efficiency measures to increase the application of organic fertilizers. TAJ354	For ten pieces it is expensive	More income, use 4 instead of ten dung pieces to cook tea.	Save dung and more income
Roof top rainwater harvesting stored in a polythene lined earth retention tank. TAJ104			
Roof Top Rain Water Harvesting – Concrete Tank TAJ348	Less expenses, technology can be learned from each other.	Water for animals, trees	People know that technology in Faizabad
Mulching in rainfed vineyards on terraces in the loess hill zone TAJ105	No expenses, enough hay	High income and everyone thinks about his/her living conditions	Applicable, would be cheaper with cellophane
Small scale conservation tillage KEN30			
The ridge sowing technology KYR002			
Growing cereals by using minimum tillage KYR003	Technical standard as a problem, money missing, few fire wood		Applicable, Faizabad good for the growth of cereals

4. Approaches

Finanzielle Unterstützung für grossräumige Umsetzung einer Technologie

Eine mögliche Projektumsetzung ist die finanzielle Unterstützung von einer bestimmten Technologie. Zuerst muss das Ziel welches mit dem Projekt erreicht werden möchte, klar definiert werden. Dies könnte beispielsweise „Wasser bei der Bewässerung zu sparen“ sein. Mit welche Technologie soll gefördert werden, um das Ziel zu erreichen? Beispielsweise kann die Tröpfchenbewässerung (vgl. Technologieposter) im Dorf fördern gefördert werden. Es wird überlegt, welcher Bestandteil der Technologie finanziell unterstütz werden könnte. Je nach dem, wie viel Geld zur Verfügung steht, kann ein Bestanteil des Materials mit einem gewissen Prozentanteil finanziell unterstütz werden. Für die Tröpfchen Bewässerung könnte das beispielsweise ein Beitrag an den Bewässerungsschlauch sein.
Mit dieser Methode, einem finanziellen Anreiz, können Farmer motiviert werden eine Technologie bei sich selber umzusetzen.

- Überlegt euch, ähnlich wie das Beispiel die Tröpfchen Bewässerung finanziell zu unterstützen, welche Technologien in euren Dörfern idealerweise vermehrt umgesetzt werden sollten und mit finanzieller Unterstützung gefördert werden könnte.

Ist ein bisschen Geld vorhanden, kann ein bestimmtes Projekt durch Beteiligung an den Kosten, die ein einzelner Landwirt hat unterstützt werden. Mit der finanziellen Unterstützung für gewisse Materialien, die für eine bestimmte Technologie eingesetzt werden, kann eine Anreiz geschaffen werde, so dass viele Leute dieses Angebot in Anspruch nehmen.
Es sollte gut überlegt werden, wofür man finanzielle Unterstützung leisten möchte, denn mit der Auswahl der Technologie, kann gesteuert werden, welche Technologie vermehrt angewendet wird.

Beispielsweise
- kann jeder Meter Zaun, der für die Umzäunung eines neuen Obstgartens verwendet wird, mit einem bestimmten Prozentanteil unterstützt werden.
- Setzlinge für einen neuen Obstgarten werden mitfinanziert.
- Während eines Sommers werden die Kosten eines Traktors z.B. für die Erstellung von Terassen unterstützt.

Informationsblätter

In vielen Regionen der Welt gibt es ähnliche Probleme mit Bodenerosion und Bodenkonservierung. Technologien werden entwickeln, die diesen Problemen entgegenwirken. Grundsätzlich ist viel Wissen vorhanden, das aber nicht weit verbreitet ist.

Auf Merkblätter, die Beispielsweise von der Jamoat erstellt und verteilt werden, können ausgewählte Technologien beschrieben werden. Skizzen oder kurze Anleitungen von Technologien könnten auf solchen Merkblätter abgedruckt werden und am besten an alle Haushalte halbjährlich oder jährlich verteilt werden.

Der Vorteil von Merkblättern ist, dass für ein gewisses Thema viele Haushalte angesprochen werden können. Möchte man beispielsweise konkret Gullies in der Gemeinde bekämpfen, kann ein Merkblatt mit verschiedenen Möglichkeiten wie man Gullies verhindern, bzw. stoppen kann, herausgegeben werden. Dieses wird dann an alle Haushalte verteilt. Die Leute in der Gemeinde werden über diese Merkblätter sprechen, die Technologien auf den Merkblätter diskutieren und so auch weiterentwickeln. Die Merkblätter motivieren auch Neues auszuprobieren und in Angriff zu nehmen.

- Was könnten mögliche wichtige Themen sein, die auf den Informationsblättern an die Haushalte verteilt werden?
- Durch wen könnten solche Informationsblätter herausgegeben werden?
- Denkt Ihr Merkblätter würden von den Bauern genutzt oder schätzt Ihr diese eher als überflüssig ein?
- Wie müssten Merkblätter gestaltet sein, dass sie mit Interesse gelesen und verwendet werden?

Die Technologieposter und die Technologiehefter sind Beispiele dazu, wie der Inhalt solcher Merkblätter aussehen könnten. Jedes Dorf wird am Ende des Workshops die Technologieposter und auch die Technologiehefte erhalten. Die Inhalte können zur Gestaltung von eigenen Merkblättern verwendet werden.

Neues Wissen durch Beizug von externen Fachpersonen

Fachpersonen, die sich auf gewisse Bereiche spezialisiert haben, kennen verschiedene Möglichkeiten, wie ein Problem angegangen werden könnte. Diese können mit ihrem Wissen bei konkreten Problemen Inputs leisten, die einem weiterhelfen. Solche Inputs durch Fachpersonen können in verschiedenen Formen, wie Exkursionen, landwirtschaftliche Beratung oder einer Schulung stattfinden.

Eine Exkursion ist ein Ausflug an einen Ort, eine spezielle Technologie angeschaut wird und lernt, wie Landkonservierung an anderen Orten gehandhabt wird. Daraus können Ideen entstehen, die dann zuhause umgesetzt werden können.

Eine Fachperson kann auch beratend tätig sein. Wird der Person ein Problembereich erklärt, kann die Fachperson versuchen, Lösungsansätze gemeinsam mit den Landwirten zu erarbeiten.

In einer Schulung oder in einem Seminar wird eine Fachperson eingeladen, die über ein bestimmten Themenbereich referiert oder einen Tag im Feld organisiert und dabei ein Problem und dessen möglichen Lösungsansätze behandelt.

- Überlegt euch, in welchen Themenbereichen euch eine Weiterbildung interessieren würde und haltet diese schriftlich auf einem Plakat fest.
- In welcher Form könnte solch eine Weiterbildung stattfinden? Exkursion, Schulung, Beratung?
- Wohin könnte eine Exkursion gemacht werden und zu welchem Themenbereich?
- Kennt Ihr mögliche Fachpersonen, die für eine Schulung oder Beratung angefragt werden könnten? Zu welchem Themenbereich?

Das Handbuch hilft einem Experten, eine Weiterbildung für Farmer zu planen. Dieses Handbuch erhält jedes Dorf und kann an mögliche Experten aus dem eigenen Dorf oder extern weitergegeben werden.

Eine mögliche Exkursion könnte beispielsweise nach Mumminabad unternommen werden. Dort gibt es einen Experten zu Weidelandmanagement. ______________________kann unter der Nummer ________________ erreicht werden.

Links: Auf Exkursionen können Methoden, die anderorts verwendet werden, angeschaut werden.
Rechts: Im Gespräch mit einem Experten, kann ein Problem konkret angeschaut und Lösungen erarbeitet werden.

Einbindung von Schulen in Landwirtschaftsprojekte

Werden Projekte in Zusammenarbeit mit den Schulen umgesetzt, können Kinder für Bodendegradation und Bodenkonservierung sensibilisiert werden. Ein sinnvolles Projekt, kann dabei auf einem geeigneten gemeinschaftlichen Land umgesetzt werden. Ein Projekt, welches zusammen mit den Schulen in angriff genommen wird, involviert alle Leute der Gemeinde, die Regierung, die Lehrerinnen und Lehrer, die Kinder und somit auch die Eltern. In der Gemeinde wird über das Projekt gesprochen. Werden Schulkinder in ein Projekt involviert, werden sie bereits im Kindesalter auf mögliche Probleme der Bodendegradation sensibilisiert. Indem sie beim Aufbau der Technologie praktisch tätig werden, sehen sie auch, was beispielsweise gegen Bodendegradation unternommen werden kann.
Wenn alle Leute involviert sind, wird über das Projekt gesprochen und ausgetauscht. Dies motiviert Leute, auch auf ihrem eigenen Land die Technologie umzusetzen.
Die umgesetzte Technologie kann zu einem Vorzeigeprojekt werden, das auch Auswärtige anschauen können oder für Ausbildungstrainings verwendet kann. Wird die umgesetzte Technologie allenfalls noch mit Informationstafeln an wichtigen Punkten ausgestattet, kann das Projekt zu einem wirkungsvollen Ausbildungsobjekt werden.

Im Film gestern, war ein Lehrer aus Kovaling zu sehen, der mit der Schule ein Projekt zur nachhaltigen Landnutzung umgesetzt hat. Der Film kann nochmals angeschaut werden.

- Wie findet Ihr die Idee, Schulen bei der Umsetzung von Projekten einzubeziehen? Was sind die Vorteile dabei, was spricht dagegen?
- Welche Technologie könnte konkret in euren Dörfern mit der Schule umgesetzt werden?

Abbildung 1: Die Kinder helfen mit, den Gully zu befestigen.

Selbsthilfegruppen

Leute mit einem gemeinsamen Interesse, in einem gewissen Bereich etwas Neues zu erreichen, schließen sich zusammen und treffen sich regelmäßig. In diesen Treffen werden anfallende Probleme und mögliche Lösungen diskutiert. Die Anzahl Treffen werden durch die Gruppe bestimmt. Je nach Bedürfnis können wöchentliche, 2-wöchentliche, monatliche oder 4-teljährliche Treffen organisiert werden. In jedem Treffen soll ein spezifisches Problem behandelt werden, über das Diskutiert werden kann.

Verschiedenste Themen, die die Gruppenmitglieder beschäftigen, können in der Gruppe diskutiert werden, sei das ein Gully, der im Weideland der Gemeinde entsteht, Trockenheit, die die Ernte schmälert, knappes Brennholz für den Winter etc. Oftmals entwickeln Leute eigene Technologien wie Brennholz gespart werden kann, ein Gully verbaut werden kann oder die Erde fruchtbarer wird. Manchmal fehlt der Raum, wo solche innovativen Ideen ausgetauscht und weiterentwickelt werden können. Selbsthilfegruppen bieten sich für den Informations- und Erfahrungsaustausch an, aber auch dazu, Beziehungen zu stärken und sich gegenseitig zu motivieren.

Diskutiert in der Gruppe folgende Punkte und haltet diese auf einem Plakat fest. Im Plenum wird dies dann vorgestellt.

- Welche dringenden Themen könnten in einer Selbsthilfegruppe behandelt werden?
- Wo könnte sich die Gruppe treffen? Wie oft würde sich so eine Gruppe idealerweise treffen? Wie könnte ein solcher Nachmittag/Abend gestaltet werden?
- Was spricht dafür, solche Gruppen in eurem Dorf einzuführen? Was spricht dagegen?

WOCAT hat Filme wie wir die gestern gesehen haben, zu den folgenden Themen gedreht:

- Weideland mit Zusätzlichen Wasserstellen (Mumminabad)
- Bodenerosion, Gullyrehabilitation (Kovaling)
- Energiesparsame Kochstellen für vermehrten Dünger (Thermomalik) (2 Filme)
- Gullyrehabilitation und Diversität von Obstgärten (Faizabad)
- Errichtung eines Obstgartens auf vermeintlich unfruchtbarem Land (Varzob)
- Rotation des Weidelands (Mumminabad)
- Regenwasser auf Hausdächern sammeln

Diese Filme und die WOCAT Technologieposter könnten beispielsweise für Sitzungen in der Gruppe verwendet werden. Jedes Dorf wird eine CD mit diesen Filmen und die Technologieposter erhalten.

Erfahrungsaustausch und Ideensammlung (links), gegenseitige Schulung von Technologien, wie zum Beispiel den Bau eines Ofens (rechts).

5. Extent of Land Degradation

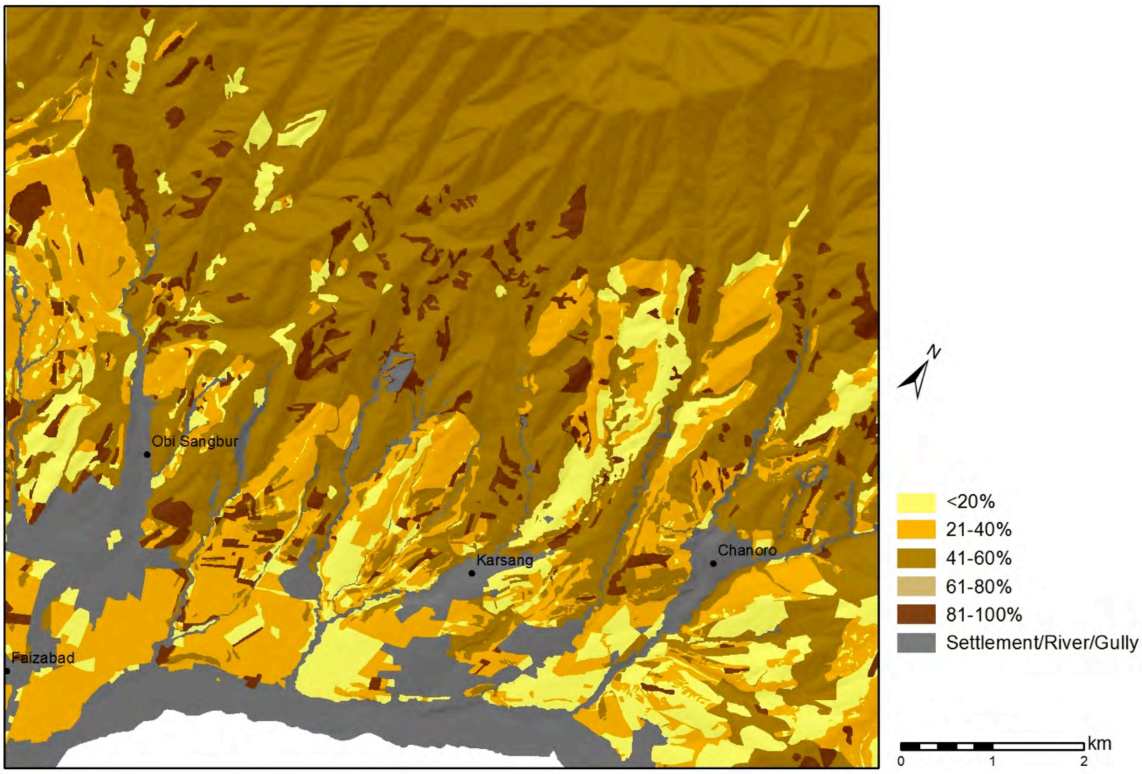

Figure 1 Extent of land degradation. (Based on Bühlmann 2006 and Wirz 2009. Background: Digital Globe 2010)

6. Yield Data Quartiles

Table 1 Yield data per land use type collected with the yield questionnaire. Including the minimum, 25%-quantile, median, 75%-quantile and the maximum.

	sample size	yield [kg/ha]	expenses agricultural inputs [TJS/ha]				labor [day/ha]	market price [TJS/kg]
			machinery	seeds	fertilizers	total		
perennial grasses								
minimum		2640	0	0	0	0	30	
25%-quantile		4400	450	0	0	600	69	
median	20	6257	693	362	262	1375	120	0.8
75%-quantile		19052	1000	817	669	2377	213	
maximum		29643	8978	1029	2000	10764	480	
hay								
minimum		625	125	0	100	225	10	
25%-quantile		1667	380	200	333	900	18	
median	9	4500	417	400	500	1500	50	0.8
75%-quantile		5250	500	600	900	1730	64	
maximum		6094	875	750	938	2563	80	
vineyard								
minimum		1000	400	0	200	600	30	
25%-quantile		1000	500	0	375	875	58	
median	7	1500	500	0	400	900	100	4
75%-quantile		1500	650	125	700	1700	123	
maximum		2500	1250	500	1000	2300	140	
flax								
minimum		1000	500	250	0	1100	5	
25%-quantile		1500	750	350	325	1485	46	
median	15	2000	1000	500	500	1680	75	5
75%-quantile		2200	1550	1000	900	3950	155	
maximum		20000	20000	8000	6000	34000	2400	
vegetables								
minimum		458	0	200	0	600	7	
25%-quantile		2000	0	667	467	1333	61	
median	66	3000	480	1000	710	2060	103	1.8
75%-quantile		7150	1000	1475	1050	3445	166	
maximum		19200	3000	2667	4000	9500	500	
wheat								
minimum		500	333	100	0	700	14	
25%-quantile		1500	500	350	250	1150	33	
median	25	2000	800	500	500	1850	63	2
75%-quantile		2500	1000	800	720	2320	100	
maximum		4000	2750	2000	1600	6000	280	

	sample size	yield [kg/ha]			expenses [TJS/ha]	agricultural inputs			labor [day/ha]	market Price [TJS/kg]		
		vegetables	fruits	grass	machinery	seeds	fertilizers	total		vegetables	fruits	grass
orchard												
minimum		0	0	0	0	30	0	90	15			
25%-Q		151	0	0	20	450	483	1230	37			
median	15	671	136	2250	600	667	867	1933	45	1.8	2	0.8
75%-Q		2952	1498	3938	849	800	900	2300	73			
maximum		6850	4000	7500	1000	1500	1200	3500	233			

7. SLM Projects

Obi Sangbur: Increase yield on a rainfed area

Application: The participants from the village Obi Sangbur wants to increase the yield on a rainfed area, on grazing land, leased by a person. Today's situation is threatening due to the variability of rainy and dry years and also due to climate change. With the plantation of perennial crops, degradation can be avoided. That's why the applicants propose to plant esparzet or similar plants because it grows well in Faizabad. With the use of a tractor the land should be processed and irrigated. The best type of seed should be found. Four to five neighboring families showed interest in the project and want to help to establish the field. They could profit in the next years as they can harvest seeds to create their own esparzet fields. That fore in the next years the esparzet can only be cut two instead of three times in order to let the seeds develop. The project leader expects 100 kg of seeds, which can supply five to six households depending on their land area. Esparzet is going to be sown in the period from March to April in 2013.

Figure 2 Introduction of the project in Obi Sangbur. (Photo: Sebastian Ruppen, October 2012)

Budget:

Item	Amount	Costs TJS
Esparzet seeds	80 kg (18TJS/kg)	1440
Tractor	1 ha (plowing)	500
Workers	2 days, 5-6 person	350
Food for the workers	2 days, 5-6 person	200
Total		2490

Field visit: Esparzet was planted in November 2012. It was implemented by the farmer and his family.

Figure 3 Newly planted esparzet field in the pasture area of Obi Sangbur. (Foto: Kobiljon Shokirov, 2013)

Karsang: Reduction of soil erosion by precipitation

Application: More frequent precipitation causes more soil degradation, which reduces the benefit of the soil. To avoid rill erosion native trees as sea buckthorn should be planted. The idea is to expand the tree plantation every year that rills cannot expand and deepen. The responsible person owns a 2 ha rain fed field that is grazing land nowadays. He would like to make a garden out of it. He has been leasing the land for one year and before it was communal land. First the field has to be ploughed manually. The community, namely the workshop participants from Karsang will help. As a return they get seeds and fodder. The neighbors already showed interest. Fertilizer is too expensive that's why esparzet is used as fertilizer. The field will not be irrigated. The trees are going to be grown up by bottle irrigation. That fore the farmer takes his own expenses. As water conservation measure he will make terraces around the trees. (land lease 142 TJS a year).

Budget:

Item	Amount	Costs TJS
Tractor	1 ha	350
Fuel	40 l	280
Esparzet seeds	70 kg	1400
Labor harvest	5 p/day, 3-4 times a year	384
Total		2414

Field visit: Esparzet was planted in November 2012. Implemented by the farmer and his family.

Hojomard: Avoid soil erosion with esparzet

Application: Due to climate change, expenses increase. Due to wind the soil fertility decreases. Perennial crops like esparzet can avoid degradation and preserve the land. With a tractor the land has to be processed, then the esparzet can be sown and the yield collected. The farmer family has 1.2 ha bad land where irrigation is available. They want to improve the soil quality with esparzet. As in Obi Sangbur the seeds will be for free for the community. The farmer family plants everything in March.

Budget:

Item	Amount	Costs TJS
Tractor	1 ha	400
Diesel	Unknown	700
Esparzet seeds	80 kg	1600
Transport		300
Total		3000

Field visit: Esparzet was planted in November 2012, by the farmer and her family. They also invited neighbors as volunteers to help sowing esparzet and plant trees among the esparzet. Due to irrigation, the plot in Figure 24 is still green in September 2013.

Figure 4 Partly irrigated esparzet field in the village Hojomard. (Foto: Kobiljon Shokirov, September 2013)

Chanoro: Gully/slope stabilization on communal land to avoid the development of gullies

Application: To avoid expansion and deepening of a gully, native trees, shrubs and esparzet should be planted. A tractor is needed to process the land. The farmer from Chanoro wants to expand his technology (TAJ115) upwards the gully as a first part of the project and as a second part he wants to improve 20 acre where is a gully. The neighboring land does not belong to anybody. The farmer expects that when this land is stabilized and slowly filled up it is really good land. The initiative is taken by the farmer and his son. A bulldozer to stabilize the land is needed and also seedlings (almods, cherries from the market, willow and poplar trees he has) . The project is not a community project but on common degraded land. Because the plot it's not fertile the farmer is not afraid that anyone else wants to use it.

The farmer got the condition to try to integrate other farmers in the project. He is willing to show how he builds up the technology. He wants to inform people that trees can be grown for example in gullies and they do not have to cut firewood in the mountains. But actually he thinks people from his village would not show any interest.

Budget:

Item	Amount	Costs TJS
Pine tree	30 pieces	300
Spanish Drok	1000 pieces	1000
Bulldozer	Ca. 2 days	1000
Fruit trees	Unknown	300
Total		2600

Field visit: Trees mostly were planted in December 2012. Implemented by the farmer and his family. The result is a stable slope, stabilized with willow and cherry trees in Figure 22. The farmer from Chanoro believes that the community does not learn if a person shows how to implement a technology but that people like to repeat what one person does successfully. He started an earlier gully rehabilitation project where people were not engaged in the process but the technology became popular, because they can see the benefit out of it. The farmer believes that with the new project it will be the same, once he starts getting fruits and fodder from his new plot, people realize and will start implementing similar technologies

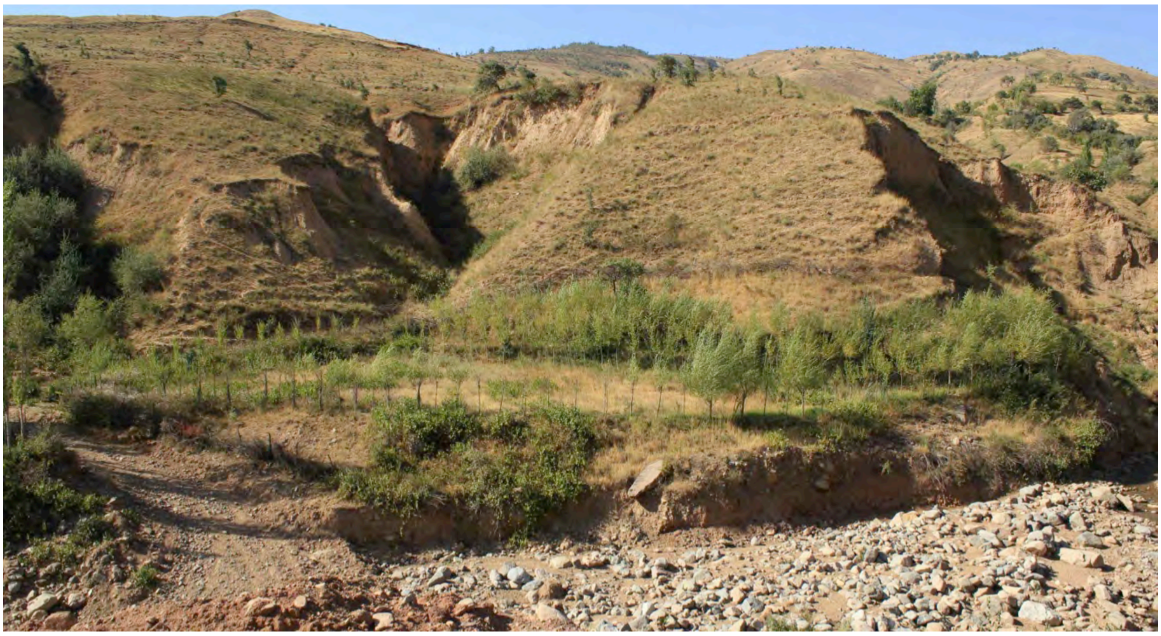

Figure 5 Slope stabilization close to the river bed in front of the picture. (Foto: Kobiljon Shokirov, September 2013)

Esparzet grows well in spring months and is usually cut in May. After that livestock grazing starts in the hills and since the esparzet fields are not protected, livestock can go on the plots. According to farmers this is not a problem, because anyway after May esparzet does not grow and livestock does not disturb the roots of esparzet and it can grow well next spring. According to the farmers, during the first year esparzet grows slowly and establishes roots. From the second year they will start getting hay.

In all three implementations of esparzet fields, fruit trees were planted. In September 2013 the trees were small but growing well. The only thread is that maybe at some point livestock can damage the newly planted trees, but it has been taken care by the farmers. In August 2013 the esparzet fields grew well and the farmers confirmed that the community saw what these farmers did. The newly established esparzet fields are prone to damage by the livestock but the farmers believe that once other people start planting esparzet and the fields get bigger there will be more attention and livestock problem can be solved. For now, there is an interest from the community members for the projects and one of the farmers said “let’s see how many more people will apply similar project this year”. Farmers all have said that they are open to give advice for the people whom are going to implement similar technologies.

Erklärung

Gemäss Art. 28 Abs. 2 RSL 05

Name/Vorname: ……………………………………………………………………………………………

Matrikelnummer: ……………………………………………………………………………………………

Studiengang: ……………………………………………………………………………………………

Bachelor ☐ Master ☐ Dissertation ☐

Titel der Arbeit: ……………………………………………………………………………………………

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LeiterIn der Arbeit: ……………………………………………………………………………………………

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……………………………………………………………

Ort/Datum

……………………………………………………………

Unterschrift