Michael Succow Stiftung
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Ecosystem-based Adaptation in Central Asia

Vulnerability of High Mountain Ecosystems to Climate Change in Tajikistan's Bartang Valley

– Ecological, Social and Economic Aspects –

with references to the project region in Kyrgyzstan

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Jonathan Etzold

with contributions of
Qumriya Vafodorova
(Camp Tabiat) and
Dr. Anne Zemmrich

Michael Succow Foundation for the Protection of Nature
Ellernholzstraße 1/3, 17487 Greifswald, Germany
Tel.: +49 (0)3834 - 83542-18
Fax: +49 (0)3834 - 83542-22

E-mail: jonathan.etzold@succow-stiftung.de
www.succow-stiftung.de

Cover picture: Darjomj village in Tajikistan

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1. Glossary and abbreviations of terms and transcription used in the text

1.1 Glossary & abbreviations

GES – Hydroelectric power station (from Russian GidroElektroStanzija)

GIS – Geographic Information System

Jamoat – 3rd-level administrative divisions, similar to communes or municipalities (https://en.wikipedia.org/wiki/Jamoats_of_Tajikistan)

m asl. – meters above sea level

Milk-livestock – Sheep, goats and cows giving milk. For better using their milk, they are often kept in summer in the villages and not send to the more remote summer pastures. They are grazed on daily turns on the pastures in the nearer and wider surrounding of the village.

MSDSP Mountain Societies Development Support Programme by the Aga Khan Foundation (AKF)

VO – Village Organisation, set up with support of MSDSP

Vulnerability - The degree to which a livelihood system is susceptible to, or unable to cope with adverse effects of climate change including climate variability and weather extremes.

WUA – Water Use Association of Aiyl okmotu is responsible for irrigation water.

1.2 Transcription

Transcription of Russian, Kyrgyz and Tajik terms follows the Romanization table for Cyrillic letters according to the Encyclopaedia Brittanica (1997). The special Kyrgyz characters were transcribed as follows Ң/ң with NG/ng, Ө/ө with Jo/jo and Ү/ү with Y/y.

2. Introduction and scope of the report

Expected effects of climate change in Central Asia will exhibit an increase of the inter- and intra-annual variability of precipitation (Bolch 2007, IPCC 2007, Thomas 2008) and a continued rising glacier retreat with altered drain off regimes (Khromova et al. 2003, Solomina et al. 2004). Still major uncertainties exist about long-term trends in average annual temperature, rainfall amount and climate hazards including their economic and cultural consequences. For the high mountain area of the Kyrgyz Tien Shan a temperature increase of 2.4° C is predicted 2040-2070 by other sources (project background document without source). However, these changes will threaten the food security through water shortage, land abandonment and land degradation that is amplified by population growth in the region. Hence, there is an urgent need to adapt local land use to these changing climate conditions by any assistance including technical, institutional and policy support to strengthen the resilience of affected communities and their environment.

Fig. 1: The position of the project region in Kyrgyzstan (source: https://upload.wikimedia.org/wikipedia/commons/4/40/Kyrgyzstan_1996_CIA_map.jpg).

Fig. 2: The position of the project region in Tajikistan (source: https://www.lib.utexas.edu/maps/commonwealth/tajikistan_rel01.jpg)

The present report is part of the project "Ökosystembasierte Anpassung an den Klimawandel in Hochgebirgsregionen Zentralasiens" that aims to identify and establish adaptation measures to climate change in selected exemplary regions of Kyrgyzstan and Tajikistan.

The project region in Kyrgyzstan Bash-Kaiyndy is situated in the SSE of the country within the Naryn province (see Fig. 1) and includes the two villages Bash-Kaiyndy in the West and Bolshevik in the East

within the At-Bashy river floodplain. The project region in Tajikistan is situated in the West-Pamiri Bartang Valley (see Fig. 2) and encompasses the two villages Siponj and Darjomj, and their surroundings.

The detailed report on the project region in Kyrgyzstan by Dr. Anne Zemmrich with the title "Ecosystem based Adaptation to Climate Change in Mountainous Regions of Central Asia – Experiences in Kyrgyzstan" was handed in as a separate file. The present document refers in parts to Zemmrich's report.

The basic data of the project region in Kyrgyzstan are given here in Tab. 1.

Tab. 1 Basic data of the project region in Kyrgyzstan.

Data	**Project region**
Administrative position	Naryn oblast, At-Bashy rayon
Geographic position	426 km SSE of Bishkek, 6 hour's drive
Settlements	Villages Bash-Kaiyndy & Bolshevik
Altitudinal range	2100 – 4300 m asl from At-Bashy river floodplain to mountain peak
Mean annual rainfall	280 mm in the lowland
Climate	Arid climate in lowland & village

3. The project region in Tajikistan

3.1 Introduction to project region

Darjomj and Siponj villages are both situated in the deep cut valley of the lower reaches of Bartang River, which flows here between the Yaszgulem Range (with its highest peak Vudor, 6132 m asl.) to the north and the Rushan Range (with its highest peak Patkhor, 6083 m asl.) to the south. Darjomj (2230 m asl.) is located on the river's left banks, Siponj (2180 m asl.) around 9 km downstream on the right river banks (see Fig. 2 and Fig. 3). They both belong to the administrative unit Siponj (Bartang) Jamoat (with the administrative centre in Siponj) together with 6 other villages: Razuj approximately 2.5 km upstream of Darjomj on the opposite side of the river; Ravivd directly opposite of Siponj; Dasht and Visav opposite of each other approximately 2 km downstream of Siponj; Khijez another 5 km downstream from Dasht and Visav and remote Ravmed 17 km upstream a tributary valley southeast from Khijez. These neighbouring villages are worth mentioning, as their populations' activities all are more or less of importance for the daily life of Darjomj and Siponj people.

Tab. 2: Basic data of the project region in Tajikistan.

Data	Project region
Administrative position	Gorno-Badakhshan Autonomous Region, Rushon District, Siponj (Bartang) Jamoat (8 villages, among them the two pilot villages Darjomj and Siponj
Geographic position	Direct distance 270 km ESE of Dushanbe, on the road approximately 600 km, + 14 hours drive
Settlements	Villages Darjomj and Siponj
Altitudinal range within small watersheds	2170 – 5000 m asl. from Bartang River floodplain to highest mountain peak
Mean annual rainfall	Not known, for Khorog 235 mm
Climate	Arid climate in valley bottom, might be significantly more humid in the higher belts (Walter & Breckle 1994), needs checking by GFZ

Darjomj and Siponj villages are both situated in the deep cut valley of the lower reaches of Bartang River, which flows here between the Yaszgulem Range (with its highest peak Vudor, 6132 m asl.) to the north and the Rushan Range (with its highest peak Patkhor, 6083 m asl.) to the south. Darjomj (2230 m asl.) is located on the river's left banks, Siponj (2180 m asl.) around 9 km downstream on the right river banks

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The only road that connects those villages with the district centre Rushon and though the closest and only relevant access to the Pamir Highway runs as mostly gravel road along Bartang River. In winter it is often not passable for longer time due to avalanches; in summer from time to time mudflows and landslides block or even destroy the road. Upstream this road continues to the very distant higher Pamir Highway close to Kara Kul Lake.

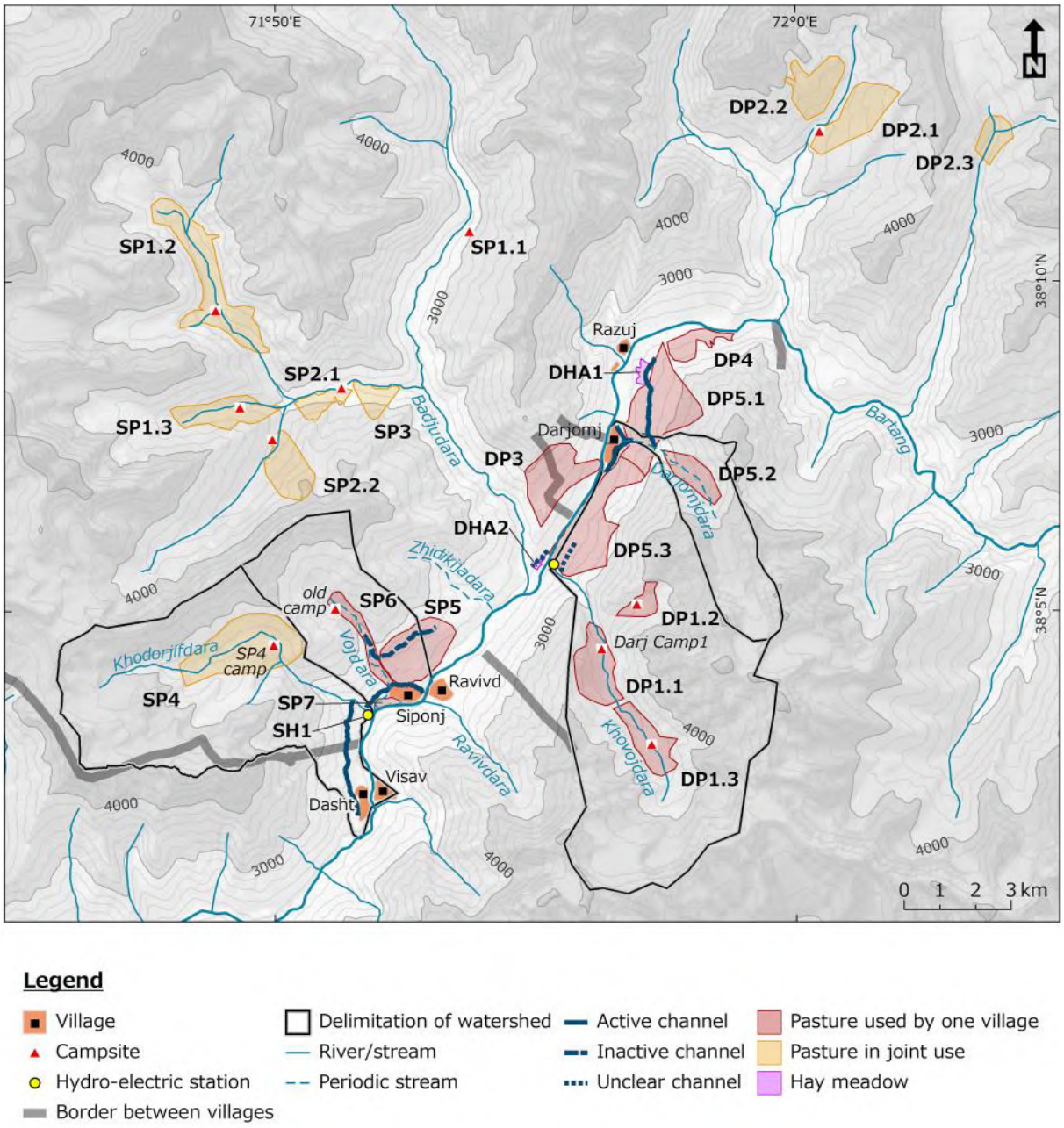

Fig. 3 Map of the project region in Tajikistan with main geographic features and information on land use

Tab. 3: Statistical Data of Siponj, Darjomj (in parts incomplete) and partly of its neighbouring villages; * Dasht, Visav and Siponj belong to one farmer association (based on interviews by Qumriya Vafodorova).

	Village	Households	Population	Cattle	Goats	Sheep	Chicken	Honey bees	Gardens	Arable land	Hay meadow	Forest land	Homestead land	Pasture
		n	persons	heads	heads	heads	heads	bee hives	ha	ha	ha	ha	ha	ha
1	Dasht	43	232	91	194	404	80	9	11 (only Siponj 3.87ha) *					
2	Visav	32	166	80	251	552	96	0						
3	**Siponj**	**97**	**328**	**136**	**281**	**680**	**20**	**20**		**13**	**0.7**		**16**	**1250**
4	Ravivd	41	201	80	149	351	50	0	0					
5	**Darjomj**	**52**	**233**	**132**	**131**	**507**	**70**	**10**	**2**	**10**	**8**	**6**	**8**	**383 (only nearby pastures)**
6	Razuj	53	246	140	214	356	60	20	2					

Siponj is the larger of two villages with approximately 328 inhabitants divided into 97 households. Darjomj hosts 233 inhabitants in 52 households (latest source, in September was mentioned 128/58). This and other statistical data, also partly for the neighbouring villages, are given in Tab. 3.

People highly depend on mainly subsistence agriculture based on the production of livestock and dairy products and the cultivation of vegetables, fruits, nuts and partly also cereals (irrigation dependent). However, a part of this production is sold to markets as well. Remittances from relatives living and working in urban areas or abroad (in case of Siponj 161 persons) are of high importance too.

Drinking and irrigation water mainly stems from the tributaries which are partly fed by small glaciers in their watersheds (in case of Siponj, in Darjomj in cold and dry months also Bartang River is a source of water, for details on water supply see chapter 3.3.1). In Siponj a sometimes dysfunctional Soviet time hydroelectric power station (80kw) is fed by the main tributary Khodorjifdara River, which has a constant water provision (see Annex 3.8.2 Fig. 4). The same applies to the tributary Khovojdara River in Darjomj which feeds a newer hydroelectric power station (120kw, see Annex 3.8.2 Fig. 10).

The present report is based on a field survey in Bartang valley between September 25th and October 4th 2015. The tasks were similar as described in chapter 2 in Zemmrich 2015 (p. 5./6). Amendments from these tasks are described in this report in chapter 3.2.

3.2 Methods

The author visited the two project villages with representatives of Camp Tabiat between September 25th and October 4th. In contrast to the Kyrgyz project start, initial meetings to introduce the project to inhabitants of the two villages did not take place prior to the arrival of the author. Instead, they were held under participation of and very beneficial for the author at the beginning of the field work on September 25th in Siponj and on 26th in Darjomj, and led by the director of Camp Tabiat Umed Bulbulshoev and field manager Qumriya Vafodorova. "The purpose of the meetings was: Introduction to the project, identification stakeholders, informing about the project scale, an initial discussion on local steering body for the implementation of the ecosystem based approach to climate change" (for detailed results see Annex 3.8.1).

As agreed on between representatives of Michael Succow Foundation and GIZ on a workshop in September 2015, in contrast to the field work in Kyrgyzstan the emphasis of the field stay in Bartang Valley was laid on the assessment of the natural resources in the watersheds from a landscape ecological point of view, without going into deep socio-economic detail. Therefore due to time constraints, a longer workshop in each village with the aim of participatory identification of natural resources, land use products or ecosystem goods and services including their spatial and temporal distribution was not intended anymore. It was rather decided that these steps and a more detailed household survey will take place at a later stage of the project, with a set of "Open Standard" methods.

With the help of the mentioned representatives of Camp Tabiat the author intended to gain a first overview on these items through own field observations and free interviews with only a few key informants. For answering open questions on e.g. land use practice, Qumriya Vafodorova visited the villages another time by the end of November 2015 (see Tab. 3, 6, 7). The informants of both stays are given in Tab. 4. Interviews on natural hazards and general questions of livelihood are attached as file (see Annex (3.8.8).

Field surveys were carried out as direct observations during walks in the nearer and wider surrounding of the villages. In those ecosystems that were mentioned by villagers to be of importance for their livelihoods a representative preferential sampling on plot level of ecological data of ecosystem components was conducted and documented in field protocols (see Datasheet in Annex 3.8.3, based on Etzold & Neudert

2013, and the field data in Excel as Annex 3.8.4, both attached as file), photo images, GPS data, and GIS data base etc. (Annexes 3.8.5 to 6, both attached as file).

After data entry the plots were aggregated to ecologically meaningful groups with the help of the assessed dominant species. With the help of existing literature (e.g. Walter & Breckle 1994, Breckle & Wucherer 2006) these groups were named as coarse vegetation units (see Tab. 5 and Annex 3.8.4).

Information on land use practice and results of ecosystem analyses were processed with a GIS under usage of different satellite images, freely available Digital Elevation Models (DEM) and topographic maps (e.g. http://maps.vlasenko.net/smtm100/j-42-072.jpg), resulting in maps of the project region (see Fig. 3 and 4). The intention to conduct a supervised classification of satellite images by using the plot data as ground truth was given up for several reasons:

- the orographically highly dissected pilot area with its deep-cut valleys and very steep slopes would demand time-consuming efforts for correcting shadows which are necessary as preparation for a subsequent classification.
- the mostly low vegetation cover combined with a very diverse geology expressed by various colourful bedrocks would demand further efforts; the assessed plots (in total 37) might have been not sufficient to gain satisfying result in a classification.

The aim was to draw first conclusions on the health of these ecosystems, their possible vulnerability to climate change with consequences to their provision of ecosystem services and thus consequences on the vulnerability of the village population to climate change.

Tab. 4: Informants from the villages Siponj and Darjomj on questions of land use practice, by Qumriya Vafodorova

	Siponj village	
1	Davlatmamadov Sarkori	Biologist. Collects all information about weather changes
2	Maskaev Maskaev	Deputy chairman of village
3	Pasorov Navrusmamad	Land committee director of Siponj Jamoat
4	Gulomnabiev Haidarsho	Representative of village elders
5	Rahmonbekov Nazardod	Village chairman
6	Mulkaliev Nazarkhudo	Shepherd
7	Yasakiev Jumakhon	Accountant
8	Shakhbozov N	Farmer association member
9	Shakhbozov Atomamad	Ecology

10	Pallaeva Oina	The person who is staying in summer camp with the cattle
11	Bodurov Navrus	Contact person of CAMP Tabiat
	Darjomj village	
1	Oshurov Ulfatsho	Leader of VO, contact person of CAMP Tabiat
2	Shoibekov Davlat	Farmer association member
3	Pallaev Palla	Farmer association member
4	Nematuloev Sanavbar	GES worker
5	Khudoberdiev Islom	Farmer association leader
6	Pallaev Olimbek	The person who is staying in summer camp with the cattle
7	Odinaev Elchibek	Road maintenance management (Дорожное эксплуатационное/DEU)
8	Qurbonbekov Ruzador	Former head of the land committee GBAO
9	Pasorov Navruz	Director of the land committee, Siponj Jamoat

3.3 Results

3.3.1 Ecosystems, their goods, services, their spatial distribution and usage

The combined findings as well from interviews as from representative preferential sampling on plot level of ecological data are presented in this chapter. The raw data of the latter research are found in Annex 3.8.4; the plots are sorted according to the assignment to ecosystems/ coarse vegetation units in their respective altitudinal belts. This information in combination with some findings on land use practice is summarized in Tab. 5.

Details to the main ecosystem goods are given in the following subchapters. Ecosystem goods of minor importance like berries, mushrooms, medicinal plants are mentioned only in Tab. 5.

All abbreviations/ short names given below refer to Fig. 3 and are listed in Tab. 6 and 7. Those assigned to Darjomj start with "D", those to Siponj with "S".

Water

Water access for Darjomj village

Darjomj village receives water from three sources; in Fig. 3 the village's two watersheds taken into focus by this project are shown:

- Darjomjdara River which runs through the village from May on (snow melt) before drying up in the summer months, usually in August/beginning of September. Due to the unusual high snow cover in winter 2014/2015, water was still available at the end of September. Besides irrigation channels (see Fig 3) at least six plastic pipes starting at the exit of the river from its gorge are distributing drinking water (outside the frost months) to the houses.

  For the irrigation season in spring and summer Darjomjdara River seems to provide just enough water for irrigation purposes (hay meadows, fields, gardens, fruit tree groves).

- Bartang River, from where water is brought mainly in winter by buckets (only in former times by pumps?, 15 to 200 m to houses).

- The permanently running Khovojdara River around 3 km SW of the village, which has glaciers in its watershed. Currently a small channel is partly or could be reactivated, for irrigating (potential)

meadows, pastures or other cultures nearby. There are plans to build a channel (3 km) to the village to improve the general water situation. Plans to provide water from here to the "fertile" river terrace "Lalm" (DP3) on the opposite side of Bartang River (through a pipe/duiker) are regarded as currently not feasible due to high investment costs.

From above Darjomjdara River's gorge a 3 km long irrigation channel brings water to the river terrace "Roj" (DHA1), where formerly 40 ha, currently around 7 ha of hay meadows and arable land are used. The channel was already built before the Russian Revolution and seems to be in good state (see Annex 3.8.2 Fig. 2, 23).

On the other side of Bartang River opposite of Darjomj GES (see below) in the river bed around 9 ha (DHA2) are irrigated; currently under use are 4 ha of hay meadow and around 2 ha of fruit and tree garden. It is not clear whether the water is tapped from Bartang River or from the tributary Badjudara (see Annex 3.8.2 Fig. 11).

In general the soils on Roj and around the village are said to be very good, as they keep soil moisture very well: on most sites irrigation has to take place only three times during the year, while on a few sites this has to happen up to six times.

The system of channel maintenance and water allocation through the Water Users Association (WUA) was not studied in further detail.

As mentioned in 4.1, the permanent water provision of Khovojdara River led in the 1990s to the construction of a hydroelectric power station (GES), which is run today by the village itself. The construction was supported by a development project (MSDSP), physically built however mainly by the local manpower. The GES produces electricity for Darjomj, Razuj and maybe also Ravivd. According to villagers the technique is rather reliable. The river is said to have enough potential for higher power generation (instead of 120kw 150kw or more) by prolonging the down pipe.

Water access for Siponj village

Siponj village receives water from two sources (in Fig. 3 shown the village's two watersheds taken into focus by this project):

- Voj River, which runs through the village before drying up in the summer months
- The permanently running Khodorzhifdara River SW of the village, which has glaciers in its watershed. Khodorzhifdara River provides water not only to Siponj, but also to the village part

opposite of Bartang River and also Ravivd village (through a pipe ("duiker") over the river, as their own river Ravivdara seems not to meet the needs anymore), as well as Dasht village.

When water from Voj River becomes scarce, a channel tapping Khodorzhifdara River of a length of around 1 km feeds the channel system of the village (see Fig. 3). This channel system provides as well households, as their gardens, small fields and hay meadows with water.

The channel from Khodorzhifdara River to Dasht is around 3.7 km long and named after a German (prisoner) engineer Sprott, who is said to have built (or at least planned) it after the 2nd World war. The channel is kept in a very good state, stabilized by stone walls and living tree and bush roots. Everyday a channel warden checks its intactness and regulates its water provision. For avoiding its destruction by frost it is not used in the winter month. A spring close to the village then has to meet the water demand.

The system of channel maintenance and water allocation through the Water Users Association (WUA) was not studied in further detail.

The history and function of an old, now dysfunctional channel high above the village Siponj (marked in Fig. 3) which had tapped the middle reaches of Voj River was not inquired. Most likely it was used for irrigation of arable land on the river terrace above Siponj. The option of its repairing for the aim of raising productivity on some pastures could be studied. However, possibly trade-offs with the water provision need of the village from Voj River have to be addressed: if anyway Khodorzhifdara River provided enough water for the whole village throughout the year, water from Voj River might be free for above mentioned pasture irrigation measures.

As mentioned in 4.1, the permanent water provision of Khodorzhifdara River led in Soviet times to the construction of a hydroelectric power station (GES), which is run today by the company Pamir Energy and that produces electricity for Siponj, Visav and Rasht (maybe also Ravivd, which might also be provided by Darjomj GES). Four guards and engineers from three or four villages are employed. According to villagers this GES has outdated and unreliable technique leading to regular blackouts. The river is said to have enough potential for higher power generation (instead of 80kw 120kw or more) by modern turbines and prolonging the down pipe.

Tab. 5: Ecosystems of the project region and their ecosystem goods as identified by field work. Due to the dissected project region with several watersheds, a calculation of the coverage area of each ecosystem was not reasonable.

Ecosystem	Natural vegetation	Spatial distribution	Ecosystem good	Time of usage
Bartang River floodplain	Wet meadows, riparian forest/bushland (Seabuckthorn *Hippophaë rhamnoides,* Willow *Salix* sp., *Tamarix* sp.), open pebble/sand vegetation	Between villages 2170 – 2225 m asl	Pasture, firewood (Seabuckthorn *Hippophaë rhamnoides,* Willow *Salix sp., Tamarix sp.*), berries (e.g. Barberry *Berberis* sp.); hay from irrigated meadow; fish from small scale fishing, also partly in tributaries	Mainly autumn until snow fall
Village area	Wetlands and forest/bushland replaced by irrigated gardens, fields, meadows and tree plantations	1st fluvial terrace, alluvial fans of tributaries, Darjomj at 2230 m asl., Siponj at 2180 m asl.	Vegetables: e.g. potatoes, cabbage, pumpkin, pepper; fruits: apricots, apples, pears, plums, walnuts; hay, alfalfa; honey	Planting in spring, harvest in summer/autumn
Slopes of Bartang Valley incl. higher river terraces	High-mountain deserts (sensu Walter&Breckle 1994) with dom. Wormwood *Artemisia* sp. and transition to desert steppes (co-dominants e.g.*Kobresia* sp. or Feather Grass *Stipa* sp.)	Between and around villages between 2190 ~ 3000m asl.	Pasture; hay, alfalfa and some cereals from irrigated hay meadow and arable land; berries (e.g. Barberry *Berberis* sp.); shrubs and semi-shrubs (e.g. *Artemisia* sp.) as fuel; medicinal plants; mushrooms (in spring)	Almost all year except when snow cover, esp. spring and autumn pasture, but also for milk-livestock (for term see 1.1) in summer
Steep tributary valleys with forests	Along river narrow band of forests/bushland of Birch *Betula cf. pamirica*, Willow *Salix sp.*, further bush species (e.g. Wild Currant *Ribes sp.* and Honeysuckle *Lonicera* sp.), in lower parts also Poplar *Populus cf. afghanica*)	2200 ~ 3200m asl.	Firewood; pasture; medicinal plants	Summer, most likely also autumn
Slopes of high-altitude tributary valleys (often trough valleys)	Mountain xerophyte vegetation with dom. thorn cushions (sensu Walter & Breckle 1994) and transition to mountain steppes (co-dominants e.g. *Kobresia* sp. or Feather Grass *Stipa* sp.)	~ 3000 ~ 4000 m asl.	Summer pasture; medicinal plants; (illegal) game hunting (mainly Siberian Ibex *Capra sibirica*, but also smaller mammals and birds)	Summer, hunting when?
Subnival and glacier belt with bare rocks	Subnival cryophyte vegetation (sensu Walter & Breckle 1994) and vegetation free rocks and ice	>~ 4000 m asl.	Water	All year long

Forests and bushland

Only little remnants of forest and bushland are still to be found in the nearer and wider surroundings of the villages. According to villagers these wood resources were overexploited since the break-down of the Soviet Union due to a lack of other sources of fuel (coal, gas) for heating and cooking. Since 2012 coal is again delivered to the villages. Also manure is used as fuel.

Besides the two different forest and bushland units confined to water courses and described in more detail in the following two subchapters, stands of wood species with lower water demand could not be assessed. These are in particular once more abundant Juniper stands (three species of *Juniperus* sp.) which are now mainly found on steep, rocky and therefore less accessible slopes up to altitudes of more than 3500 m. Their wood is regarded as very valuable fuel which led to their cutting even in areas remote of the villages. These Juniper species grow very slowly, become very old and hence their rejuvenation takes very long time. According to Breckle & Wucherer 2006, only 0.1% of the original juniper woods in the Pamirs remain; they will disappear without special protection measures.

Single individuals of other wood species were recorded on obviously dry slopes in the "High-mountain deserts" zone up to 3000 m asl. (Barberry *Berberis* sp., Wild Cherry *Cerasus* sp., Wild Rose *Rosa* sp., Bladder Senna *Colutea* sp., Honeysuckle *Lonicera* sp.) and in the "Mountain xerophyte vegetation with dom. thorn cushions" zone (*Berberis* sp., *Lonicera* sp., Wild Currant *Ribes* sp. found up to 3450 m asl.). Their mere presence and the fact that they are often restricted to protected locations (like between large boulders) allow the conclusion that they were once much more widespread and were pushed back in their cover by cutting and grazing.

Hence, the bushlands' stabilizing effect on often very mobile scree slopes is strongly decreased, leading to increasing danger of erosion and landslides.

Floodplain forests/bushland (Seabuckthorn-Willow-Tamarix) with patches of wet meadows

In the floodplain of Bartang River remnants of "azonal forest stands in river valleys, called Tugai forests" (Breckle & Wucherer 2006) are still abundant (see the green polygons in Fig. 4, and Annex 3.8.2 Fig. 3-6+11); however their cover is likely to have been much higher in the past. The dominant species are Seabuckthorn *Hippophaë rhamnoides*, Willow species *Salix* sp. and Tamarisk species (*Tamarix* sp., *Myricaria* sp.); many stands still comprise a liana *Clematis* sp. typical for Tugai forests. Accompanying bush species

are e.g. Barberry *Berberis* sp. and a Wild Cherry *Cerasus* sp. At least in case of Willows tree height (>5 m) might be reached, justifying to use the term "forests".

Especially where the texture of river sediments is fine, wet meadows dominated by gramineous species (Cyperaceae, Juncaceae, Poaceae) are found. Intermixed with above mentioned bushland, old river arms, small oxbow lakes and other depressions with peatland-like vegetation, due to these various site conditions this floodplain ecosystem is very interesting in terms of biodiversity. As example, species like Orchids, Louseworts (*Pedicularis* sp.), Arrow-grass *Triglochin* sp. and other wetland species found here are rare in the surrounding arid landscape.

However, most parts of the river floodplain are not or only patchily covered with vegetation, but with open pebble and sand. Strong winds dislocate the sand, leading to sand storm-like events when the only road can be blocked or even plantations be covered by these sands.

As mentioned by villagers, these floodplain forests/bushlands are used for wood cutting, but also intensively as pasture, especially in autumn. While some of the bush species, especially the thorny ones like Seabuckthorn, withstand browsing pressure well and are rather affected by cutting, other bush species are often completely browsed down to the ground, like the Wild Cherry *Cerasus* sp. and the Tamarisk species *Myricaria* sp. The latter one is a pioneer on fresh river sediments and therefore contributes to stabilizing these sediments against water but also wind erosion. It is also providing conditions for the growth of other vegetation.

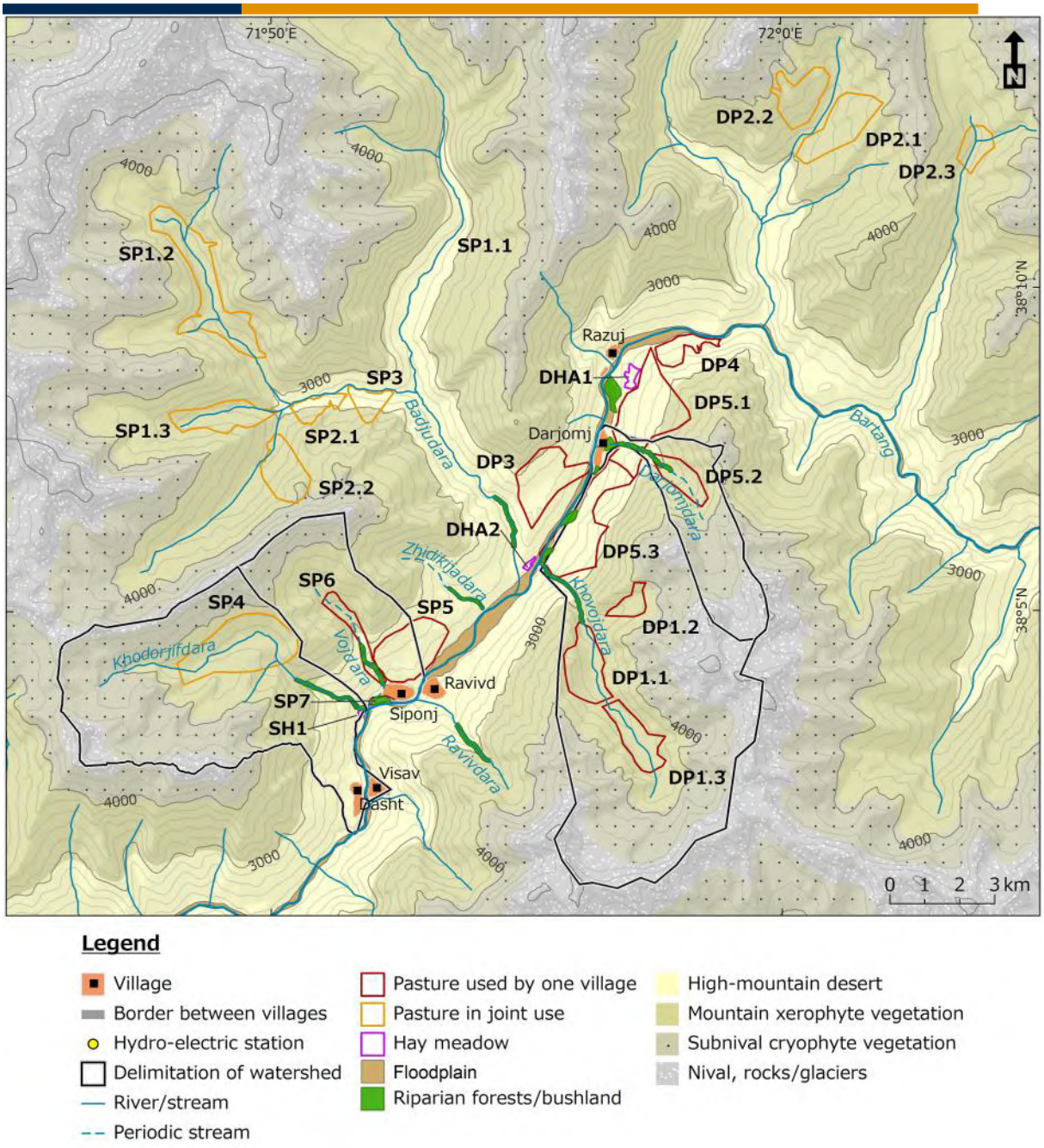

Fig. 4 Addition of coarse vegetation units/ ecosystems to the map of Fig. 3

Hence, both usages – wood cutting and grazing – affect the integrity of this ecosystem, leading to a decrease of wood cover and consequently higher vulnerability to erosion caused by wind and floods. In case of SP7, according to villagers an increase of moisture took place in the last years and at the same time Seabuckthorn decreased, which they see in a certain correlation. Also it was stated that bushcover decreased due to river floods and rather not by grazing and cutting.

Forests of steep tributary valleys (Birch-Willow, partly Poplar)

Today, these Tugai forests are confined to narrow bands along the steep tributary rivers like Khodorzhifdara and Khovojdara (see the green lines in Fig. 3 and Annex 3.8.2 Fig. 3, 4, 7, 8, 11). Naturally these forests would also cover the lower river fans of these rivers where today the villages are located, as here fresh water provision as well as accessibility is best. Only in these lower reaches (like of Khodorjifdara River of Siponj or Darjomjdara River of Darjomj) very little remnants of Poplar *Populus cf. afghanica* (could be *P. pamirica* as well) are found, intermixed with Birch *Betula cf. pamirica*, Willows, Seabuckthorn, Barberry, Hawthorn *Crataegus* sp. and others (Annex 3.8.2 Fig. 3, 4).

On these sites where today the villages are located, in and around the irrigated gardens, hay meadows, and fields, many fruit trees like apricots, apples, pears, plums and walnuts were planted besides cultural forms of Willow and Poplar (most likely Lombardy Poplar - *Populus nigra 'Italica'*). The latter is of importance for house construction, but both species are most likely also used as fuel wood despite their low energetic value.

In case of Darjomjdara River, an especially species rich remnant of this river fan forest is preserved above the village with partly very old tree individuals (e.g Birch, breast height diameter of 40 cm or more). Besides above mentioned wood species also Whitebeam *Sorbus* sp., Wild Cherry *Cerasus* sp., Roses *Rosa* sp., Wild Apricot *Prunus* sp., *Cotoneaster* sp., and Russian Olive *Eleagnus* sp. were recorded. The reason for the woodland's protection from wood cutting was explained as follows: it is protecting the village ("protective forest") from floods, landslides and avalanche winds; all three have the strength to destroy houses and planted trees, which happens from time to time (e.g. in the previous winter avalanche wind was felling old walnut trees).

In the higher sections of the tributaries *Populus cf. afghanica* was not recorded anymore. These forests, mostly of bushland character, consist mainly of Birch and Willows (until around 3200 m asl.) and further bush species (e.g. different species of Wild Currant *Ribes* sp. and Honeysuckle *Lonicera* sp.), accompanied by a diverse meadow-like herbal vegetation.

Birch is highly evaluated as fuel wood and was and is therefore intensively cut. At Khodorjifdara River of Siponj at least the villagers of Siponj, Rasht and Visav are cutting trees. A use gradient with increasing distance and steepness can be observed. In the more distant steep middle reaches of this river (around 2900 m asl.) still very old (breast height diameter of 40 cm or more) and high trees (> 8 m) were recorded, while in the closer lower reaches the Birches show several thinner stems (coppice growth, bush-like, < 5 m). However, due to sufficient water provision their regeneration and growth rates seem to be rather high.

In the mentioned middle reaches with old-growth stands wood cutting is only sporadic, done by hunters and shepherds resting on the half way to the hunting areas and pastures. There against, the bush-like stands of Birch and Willow at their currently highest recorded altitudes of around 3200 m asl. are rather not founded in climatic limits, as in the Pamirs following Breckle & Wucherer 2006 Birch and Willows are recorded up to altitudes of 3700 and 3900 m asl., respectively. Here at Khodorjifdara, decades of cutting for the fuel and construction wood (for the shelter) needs of the close summer pasture camp ("SP4 Camp site") located at around 3450 m asl. are obviously responsible for the current altitudinal distribution of these species, even if in the last 5 years this camp was not inhabited in summer (currently not herded cattle here). Only bush species less valuable as fuel like Wild Currant are still found at these higher altitudes.

Similar observations can be stated for Darjomj's Khovojdara River where Birch and Willow are found not much higher than 3000 m asl. due to the close camp "DARJ CAMP1" at 3200 m asl.

According to villagers and judging from satellite images and own photographs similar Tugai forests are still present in the valleys of Darjomjdara, Badjudara, Zhidikijadara and Vojdara, Ravivdara as well as on spring sites above Ravivd.

Hay meadows and arable land

As mentioned in the subchapter "Water" above, in both villages around and near to houses irrigation of gardens, small fields and hay meadows takes place (see Tab. 3 for total sizes per village).

Here in the villages vegetables like potatoes, cabbage, pumpkin or pepper are grown. In fruit tree orchards apricots, apples, pears, plums, walnuts and others are harvested. Hay is needed to feed livestock in the months with snow cover when animals are kept in stables. Good quality hay is harvested from alfalfa hay fields. As most of these activities are for subsistence only it will be difficult to receive figures on yields. However, those amounts of products sold on the local and regional market could give hints on yields and value.

Darjomj uses a big area outside the village for hay meadows and arable land: the irrigated river terrace "Roj" (DHA1, approximately 200 m higher than the village) of which formerly 40 ha were used. Today, around 5 ha are used as hay meadows with a yield of 2.5-3 t/ha. Only 0.15 ha are currently arable land, max. 2 ha would be suitable for this purpose. The reason why not a bigger portion of this land is used is not known. One reason might be that the irrigation channel bringing water from Darjomjdara River needs to be improved. Maybe also a trade-off between irrigating this terrace and providing more water to the village itself exists, as the water becomes scarcer and the river even dries out in summer. Another reason might be that the steep path to the river terrace keeps some villagers from this hard physical work; especially backpacking hay packs of around 40 kg the around 1.5 km direct distance down to Darjomj village is physically very demanding (see Annex 3.8.2 Fig. 10). Transportation with donkeys or horses seems due to the steep descent not appropriate.

The second irrigated area (according to owner 9 ha) outside of Darjomj village (DHA2, see Annex 3.8.2 Fig. 11) in the Bartang River bed opposite of Darjomj GES belongs to one family only. 4 ha of hay meadow are currently used, yielding around 3.5t/ha. Another 0.80 ha are a fruit garden, 1 ha is planted with other trees; the rest is not used.

For both, DHA1 and DHA2 sizes calculated by GIS are given in Tab. 6, contrasting to figures in Tab. 3)

As far as known, Siponj villagers only use one plot of hay meadow area outside of the privatized garden area (SH1). It is a meadow with unknown size (2.5 ha as calculated by GIS, see Tab. 7) in the lower river fan of Khodorjifdara around Siponj GES, yielding in total 12 tons of hay (see Annex 3.8.2 Fig. 4). It is open for use to all villagers. It was not checked whether the area is actively irrigated or the ground water table in the river fan is just high enough for this good hay yield (if calculated figure is correct, would be 4.8 t/ha).

All these hay meadows are grazed after harvest until snowfall (end of November or December) by cattle.

Pastures

Besides a few single plots with complete or temporal exclusion (hay meadows, arable land, gardens) all accessible land in the nearer and wider surrounding of the villages is used as pasture for sheep, goats ("small livestock") and cattle. Therefore livestock keeping can be regarded as the most important kind of land use in terms of its spatial extent; but also following villagers it contributes most to the livelihoods of villagers.

As can be seen from Fig. 3 and 4 and listed in Tab. 6 (for Darjomj) and Tab. 7 (for Siponj) the different pastures are used at different times of the year, distributed over different altitudinal belts and are in big parts located **outside** of the direct watersheds of the villages taken originally into focus of this project. Furthermore, many of these pastures are not exclusively used by one village, but rather managed jointly: Darjomj grazes only its cattle in summer on remote pastures together with those of Razuj, while most of small livestock as well as cattle of Siponj is kept on summer pastures together with the livestock of the villages Ravivd, Visav and Dasht. Outside of the summer season these villages are exclusively their particular surroundings (watersheds).

There was no reliable information on the total pasture area used by each village; the figures given in Tab. 3 (overview on statistical data) are incomplete. Based on the rough delimitation of the single pastures in Google Earth, with the help of a GIS tool the approximate pasture sizes could be derived. These figures are given in Tab. 6 (for Darjomj) and Tab. 7 (for Siponj).

Tab. 6: Pastures and hay meadows outside the village used by Darjomj, partly together with Razuj. The term "milk-livestock" is explained in chapter 1.1 (based on interviews by Qumriya Vafodorova). See Fig. 3 and 4 for their locations.

Numbered short names, as indicated on Fig. 3 and 4	**Darjomj (D)**	**Razuj**	Size from GIS (ha)	Altitudinal range (m asl.)
DP1: Sheep+Goats Summer Pastures of Darjomj	For sheep and goats Darjomj and Razuj villages have separate pastures. Darjomj people bring their livestock (700-800 heads) to the high-altitude valley of Khovojdara. Sometimes the relatives of shepherds from lower villagers also bring their livestock to this pasture. The size is not clear even for land committee staff.			
DP1.1: 1st+4th sheep+goats Summer Pasture Darjomj (30+10days)	From end of May until end of June (30 days) and again around 10 days in September.		195.0	3000 – 3800
DP1.2: 2nd sheep+goats Summer Pasture Darjomj (20days)	From the end of June the small livestock is brought to this pasture for 20-22 days.		59.2	3400 – 4000
DP1.3: 3rd sheep+goats Summer Pasture Darjomj (30 days)	From the end of July until 10 september the small livestock brings to this pasture for 30-40 days.		154.6	3350 – 3700

DP2: Cattle Summer Pastures of Darjomj+Razuj used together	Around 15-20 km way from Darjomj upstream Bartang River in tributary valley of Bizhravdara (DP 2.1+2). Sizes are not known. These remote pastures belong to "governmental resource", not municipal land.			
DP2.1: Supervised Cattle Summer Pasture Darjomj+Razuj	There are 80-100 cattle from Darjomj and Razuj herded by two herders.		222.0	3000 – 4000
DP2.2: Unsupervised Cattle Summer Pasture Darjomj+Razuj, 200-230 heads, June10th-end of July	On the other side of river is the pasture for cattle without herding. About 200-230 cattle are grazing there from 10th of June until end of July.		170.1	3000 – 4000
DP2.3: Unsupervised Cattle Summer Pasture Darjomj+Razuj, 200-230 heads, End of July-September	At the end of July the unsupervised cattle of DP2.2 are brought over a mountain pass to the neighbouring tributary valley in the east until they are collected again in September.		87.2	3300– 3600
DP3: Spring Pasture "Lalm", on daily turns	Only Darjomj cattle and small livestock are grazing there. According to Land commitee workers the area is 60 ha. 20ha belongs to Darjomj and 40ha to Siponj. Used from May until June when the livestock move to the summer pasture. Mainly for small livestock, sometimes the cattle are grazing too (500 small livestock and 20-25 cattle).		234.3	2550– 3000
DP4: Spring pasture (May until June 10th) for 40-50 cattle without milk	From May until 10th of June 40-50 cattle without milk is kept in this place.		79.1	2250– 2700
DP5: Milk-livestock summer and general autumn pastures on daily turns	Only Darjomj people use these pastures.			
DP5.1: Milk-livestock summer and general autumn pasture	Only one part of Darjomj villagers bring livestock to this pasture. Mainly in summer for about 80 milk-livestock, besides the pasture DP5.2. "border between pasture users" separates this pasture from a similar pasture in the south of another group in the village (see DP5.3).		335.1	2250– 3450
DP5.2: Darjomjdara summer pasture for milk-livestock	Only Darjomj people use this place. Mainly in summer for 80 heads of milk-livestock (see DP5.1).		107.6	2700– 3700
DP5.3: Milk-livestock summer and general autumn pasture	Only one part of Darjomj villagers bring livestock to this pasture. Mainly in summer for about 80-90 milk-livestock. "Border between pasture users" separates this pasture from a similar pasture in the north of another group in the village (see DP5.1)		369.7	2200– 3000
Total pasture area used by Darjomj livestock according to area calculations in GIS. Areas following hand-drawn maps.			**2014.0**	
Pasture area used exclusively by Darjomj livestock			**1534.7**	
Pasture area used jointly with livestock from Razuj			**479.3**	
DHA1: "Roj" 40ha irrigated haymeadow and arable land	In total 40 ha. Only 7 ha in use. 5 ha hay meadow land and 2 ha is suitable for agriculture. But now only 0.15ha use for agriculture. 3 households do agriculture. The rest is growing alfalfa (*Medicago* sp.). The harvest for hay is 2.5-3t per ha. In autumn the cattle are grazing there, from Sept. 10th until snowfall (end of November or December).		17.2	2400– 2500
DHA2: 4ha irrigated haymeadow	Belongs to Ulfatsho Oshurov. Total 9 ha. 4 ha hay meadow (harvest ca. 3.5t/ha), 0.80 ha fruit garden, 1 ha trees. The rest is not used now.		4.9	2200– 2210

Tab. 7: Pastures and hay meadows outside the village used by Siponj, partly together with neighbour villages (based on interviews by Qumriya Vafodorova), see Fig. 3 and 4 for their locations.

Pasture Name as indicated on Fig. 3 and 4	Siponj (S)	Ravivd	Visav	Dasht	Size from GIS (ha)	Altitudinal range (m asl.)
SP1: Sheep+Goats Summer Pasture of Siponj, Ravivd, Visav, Dasht (Badjudara)	3 small livestock camps. The livestock from Siponj, Ravivd, Visav, Dasht. Additional from lower villagers, from Rushan villagers and others. 1500-2000 heads. 2 shepherds look after the livestock. Stay together in one camp and move together to the next as follows (SP1.1-3)					
SP1.1: Sheep+Goats Summer Pasture of Siponj, Ravivd, Visav, Dasht (Badjudara)	Small livestock camp SP1.1: from end of May -June (territory not clear).				?	? 2750 – 3750
SP1.2: Sheep+Goats Summer Pasture of Siponj, Ravivd, Visav, Dasht (Badjudara)	Small livestock camp SP1.2: June -August.				386.7	3050 – 3700
SP1.3: Sheep+Goats Summer Pasture of Siponj, Ravivd, Visav, Dasht (Badjudara)	Small livestock camp SP1.3: August -September.				177.6	2900 – 3700
SP2: Supervised Cattle Summer Pasture of Siponj, Ravivd, Visav, Dasht (Badjudara)	45 cattle, during summer herded in two camps, looked after by one shepherd (currently from Dasht). Sometimes cattle of shepherd's relatives from other villages are brought as well.					
SP2.1: Supervised Cattle Summer Pasture of Siponj, Ravivd, Visav, Dasht (Badjudara)	Cattle camp2.1: 25 May-June.				69.6	2750 – 3350
SP2.2: Supervised Cattle Summer Pasture of Siponj, Ravivd, Visav, Dasht (Badjudara)	Cattle camp2.2: June-Sept.15				176.1	3050 – 4050
SP3: Unsupervised Cattle Summer Pasture of Siponj, Ravivd, Visav, Dasht (Badjudara)	60-70 not herded cattle without milk.				71.6	2600 – 3450
SP4: Unsupervised Cattle Summer Pasture of Siponj, Ravivd, Visav, Dasht (Khodorjifdara)	150-200 not herded cattle from Siponj, Ravivd, Visav, Dasht. They move up until the glacier and over the mountain pass to Vojdara.				416.3	3300 – 4000
SP5: Spring Pasture on daily turns	Siponj uses alone. From April until May. Sometimes in summer. Used as well in winter when the snow is not too high.				254.1	2200 – 2900
SP6: Milk-livestock Summer Pasture on daily turns (Vojdara)	Siponj uses alone. From May until September. For 500-600 heads of milk livestock, which move until "old camp" (see Fig. 3). Going higher is not possible for coming back to the village the same day.				95.9	2200 – 3200
SP7: Autumn Pasture (wet grass- and bushland)	Siponj uses alone. From September 10th until snow fall. About 700-800 heads. All place used including the forest wetland for grazing. According to villagers, year by year the moisture became more and the seabuckthorn became less.				11.6	2175
Total pasture area used by Siponj livestock according to area calculations in GIS. Areas following hand-drawn maps.					**1659.5**	
Pasture area used exclusively by Siponj livestock					**361.6**	
Pasture area used jointly with livestock from Ravivd, Visav, Dasht					**1297.9**	
SH1: Hay meadow around Siponj GES	The place around Siponj GES is used as hay meadow. Belongs to all villagers. All together do cutting. Everybody can get us much us he can cut. In total the harvest is 12 tons. After the cutting cattle graze there from September until snowfall. Additionally alfalfa.				2.5	2175 – 2200

For calculating reasonable stocking densities for the different pastures, the information given in Tab. 6 (for Darjomj) and Tab. 7 (for Siponj) should be checked and verified, especially on the exact number of livestock heads, pasture sizes and grazing patterns (e.g. on pastures near the villages, which are used in summer by few animals (milk-livestock), but often in autumn or spring by all livestock of the village).

Only as one example of the only summer pasture used exclusively by one village (Darjomj), the overall pasture size of DP1 (all three parts together, however used for different time spans!) was calculated with 409 ha. The total number of small livestock was given with 700 to 800 heads, of which according to the relation in Tab. 3 (overview of statistics) 20 % are goats. For Azerbaijan Etzold & Neudert 2013 used the conversion factor 0.7 for goats to sheep units (SU), i.e. one goat equals 0.7 SU (based on life weight). With this calculation between 658 and 752 SU are kept during summer on the 409 ha of DP1 which results in stocking densities between 1.6 and 1.8 SU/ha. The different conversion factor to SU have to be checked for Tajik conditions: e.g. for Azerbaijan one cattle equals 6 SU, for Darjomj 7 SU were mentioned.

Spatial and seasonal patterns of grazing and pasture ecosystems

In general the seasonal livestock cycle presented for the Kyrgyz project region (see Zemmrich 2015, Fig.4, p.12) can be confirmed for the pasture use in the two Bartang villages as well. The ecosystems used as pasture at the different times of the year are described in more detail in this subchapter (overview in Tab. 5, management details in Tab. 6 for Darjomj and Tab. 7 for Siponj).

The **lower belt of the project region** is mainly used as pasture in spring, in autumn until snowfall and partly in summer for milk-livestock (see pastures DP3–5 in Tab. 6 and SP5–7 in Tab. 7 and for both in Fig. 3 and 4). For all three seasons these pastures are used on daily turns. Of the ecosystems covered by these lower pastures besides those in the Bartang Floodplain ("Open pebble/sand communities with single bushland patches" and "Floodplain forests/bushland (Seabuckthorn-Willow-Tamarix) with patches of wet meadows", see above in subchapter "Forests and bushland"), the biggest proportion is found within the belt of "High-mountain deserts (sensu Walter & Breckle 1994) with dom. *Artemisia* sp. and transition to desert steppes (co-dom. *Kobresia* sp. or *Stipa* sp.)" reaching to approximately 3000 m asl. This latter vegetation is mainly found on talus deposits of the slopes of Bartang Valley and on the higher river terraces. Besides scattered vegetation on steeper more or less mobile scree sites, on better stabilized slopes with a certain amount of finer soil texture the semi-shrub Wormwood (several species of *Artemisia* sp.) dominates. With its roots reaching depths of 150 cm it is well adapted to the arid climate and occurs on both main slopes of Bartang Valley (here NW and SE slopes). The extensive root system strongly contributes to the stability of the slopes. As well, due to its low palatability during most time of the

grazing period (only after frost it is better palatable) it copes well with grazing pressure. Therefore Akhmadov et al. 2006 even trace dominant stands of *Artemisia* back to overgrazing.

The lack of fuel in the past 25 years led to strong collection of the *Artemisia* semi-shrubs. They are torn out of the soil with their woody root stock and mainly used as firewood for baking bread. Detrimental effects on slope stability are expected, like shown by erosion gullies observed e.g. on the spring pasture SP5 close to Siponj. In the East Pamir collection of semi-shrubs as fuel (mainly Teresken *Ceratoides papposa/Krascheninnikovia ceratoides* but also *Artemisia* sp.) in an often unsustainable way is known as the "Teresken Syndrome" (described e.g. in Breckle & Wucherer 2006 and critically discussed by Kraudzun et al. 2014). Teresken was recorded by the author in the project region only a few times. As it should occur in the West Pamir too, it is not clear whether also excessive collection is responsible for the wide absence in the project region or whether this is rather founded in natural conditions.

On sites with supposedly still finer soil texture (to be understood in more detail) the tiny sedge species *Kobresia* sp. co-dominates or even dominates (see plots D07, D08, D20, S02 in Annex 3.8.4 and their corresponding photographs in Annex folder 3.8.5). Its dense lawns in between the wormwood semi-shrubs seem to be an important pasture resource, especially in spring times (see e.g. on the spring pasture "Lalm" DP3, Annex 3.8.2 Fig. 20–22) while in the dry summer months they seem to be dormant with only nekromass aboveground. The very dense root felts of *Kobresia* sp. might even influence the density of the wormwood semi-shrubs (root concurrence). In any case slope stability is high where both species are growing together, covering up to 80 %. Due to the high contribution of this graminoid species the term "transition to desert steppes" (sensu Walter & Breckle 1994) might be applicable for these sites.

The latter term can also be used for sites where species of Feather Grass *Stipa* sp. co-dominate besides *Artemisia* sp. (see plots D08 and S15 in Annex 3.8.4 and their corresponding photographs in Annex folder 3.8.5). In general, *Stipa* sp. and other perennial species of Poaceae (true grasses) are among the more palatable species on these pastures. Hence, with strong grazing pressure their cover is pushed back, while less palatable species (often with thorns, hairs, poisons etc.) are gaining dominance (grazing indicator species) which leads to a general decrease of pasture quality. Therefore, higher cover values of *Stipa* sp. are mainly found on higher (= more remote) and steeper slopes where grazing pressure is less.

Thorny species seen as grazing indicators and even "invasive", as a result of overgrazing, are according to Breckle & Wucherer 2006 e.g. thorn cushions of *Acantholimon* sp. and *Cousinia* sp. As mentioned there, their increasing coverage in "primary *Artemisia* plant communities" decreases the pasture quality, as described for wide areas of the West Pamir. Some of the plots showed significant contributions of these species (e.g. plots D02 and S15 in Annex 3.8.4). They are main elements of the "Mountain xerophyte vegetation with dom. thorn cushions (sensu Walter & Breckle 1994)" at higher altitudes described in the below.

As already remarked in the subchapter on "Forests and bushland" above, embedded in this lower pasture belt are also patchily distributed remnants of bushland even outside of the influence of the main water courses, hinting on their formerly wider distribution.

The **middle belt of the project region** is mainly used as summer pasture (see pastures DP1–2 in Tab. 6 and SP1–4 in Tab.7 and for both in Fig. 3 and 4). This belt is assigned as "Mountain xerophyte vegetation with dom. thorn cushions (sensu Walter & Breckle 1994) and transition to mountain steppes (co-dom. *Kobresia* sp. or *Stipa* sp.)" between approximately 3000 and 4000 m asl.

Only the summer pastures DP1 and SP4 were visited, however when livestock had already left. Seasonal and time constraints and their general difficult accessibility prevented a more thorough study of the summer pastures. Furthermore, most of the summer pastures not visited are located outside of the originally designed project area.

Nevertheless, the two visits to this belt gave first information on the state of the pastures there. A one night stay in the shepherd camp (DARJ CAMP1 at 3200 m asl, a simple stone building) on DP1 after a difficult hike up along Darjomj's Khovojdara River allowed for assessing the plots D10–16 between 3251 and 3414 m asl. on September 28th and 29th, while a one day hike up along Siponj's Khodorjivdara River to SP4 (on October 3rd) succeeded only in assessing the plots S11 and S12 between 3429 and 3479 m asl. (see Annex 3.8.4 and their corresponding photographs in Annex 3.8.5).

As described in literature (e.g. Walter & Breckle 1994), the high proportion of thorn cushions in this xerophyte vegetation cover was remarkable. The most abundant species of this group are of the genera *Acantholimon* and *Cousinia*, but also of *Astracantha* and *Oxytropis* (see Annex 3.8.2 Fig. 13, the plots D11–13, 15, 16 in Annex 3.8.4 and their corresponding photographs in Annex 3.8.5). At the time of the visits the proportion of well palatable species was hardly visible.

Among the exceptions with higher cover of better palatable species like *Stipa* sp. was plot D10 (see Annex 3.8.2 Fig. 14, in Annex 3.8.4) where grazing pressure is low due to difficult accessibility. *Stipa* sp. was also observed from the distance on higher and less accessible sites.

As described for the lower belt before, the high cover of this species of Poaceae (true grasses) justifies the use of the term "transition to mountain steppes" (sensu Walter & Breckle 1994) for such sites. Following this source these "mountain steppes" are mainly located above the xerophyte vegetation hinting also on more humid conditions at higher altitudes. These regions however could not be reached.

The term "transition to mountain steppes" applies also to sites where the cover of *Kobresia* sp. is high, like on SP4 (see plot S11 in Annex 3.8.4 and on Annex 3.8.2 Fig. 28).

The only other plot on SP4 was assessed on a small spring mire (see plot S12 in Annex 3.8.4 under "alpine peatland" and the corresponding photographs in Annex 3.8.5) of which several are found on lower slopes close to Khodorjivdara River (see also Annex 3.8.2 Fig. 29). These very wet grasslands dominated by sedge species *Carex* sp. are obviously preferred sites for the not herded cattle grazing on SP4.

Judging from the impression received during that very short stay on SP4, the grazing conditions are more favourable compared to those on DP1, as the contribution of unpalatable thorny species seems to be lower here and cover of more palatable is higher. This observation may be founded in the fact that no small livestock flock was kept here during the last five years and the pasture might have recovered to a certain extent.

On DP1 of special interest from a fodder resource point of view was the record of a not identified large tussock grass that seems to be confined to sites where sub-surface water is abundant like in scree-flow depressions (see plot D14 in Annex 3.8.4 and on Annex 3.8.2 Fig. 15). The species is obviously rather palatable and an important fodder resource. Its cover could be probably fostered by introducing irrigation measures for those parts of the pasture close to the Khovojdara River where in summer still a lot of water is abundant.

Findings from both visited summer pastures DP1 and SP4 are most likely transferable to the other not visited summer pastures.

Subnival and glacier belt with bare rocks

This highest belt, starting with subnival cryophyte vegetation (sensu Walter & Breckle 1994) from approximately 4000 m asl. onwards and followed by the nival belt with glaciers and bare rocks, could not be visited. It might in parts still be reached by grazing livestock.

Most likely this zone in summer is the more or less safe retreat for Siberian Ibex *Capra sibirica* which however become hunted here from time to time. Where concurrence with domestic livestock allows is not too high (e.g. in steep rocky areas) they also might graze in the middle belt below 4000 m asl. (own observations there, however when domestic livestock had already left).

The size of the glaciers in the watersheds of Darjomj and Siponj could not be assessed. As described in the subchapter "Water" the villages are highly dependent on the water provision of these glaciers, especially when the other rivers are dried out after the last snowfields in their watersheds have melted.

3.3.2 Availability of ecosystem services, ecosystem health and function

Availability of ecosystem goods

Details to the availability of the main ecosystem goods are given in the following subchapters. The availability of ecosystem goods of minor importance like berries, mushrooms or medicinal plants are mentioned only in Tab. 8 below.

Water

People of Darjomj state that their main water source Darjomjdara dries up earlier in summer and provides water (snow melt) later in spring (see Annex 3.8.8). Similar statements were recorded during talks in Siponj for Vojdara River. Another hint in this direction is the Soviet-time topographic map (http://maps.vlasenko.net/smtm100/j-42-072.jpg) from 1988 which treats both, Darjomjdara and Vojdara, as perennial rivers. According to this map in the watershed of Darjomjdara a glacier was present (none in that of Vojdara). It needs to be checked whether a small glacier is still present here or whether its disappearance explains the river's drought in summer.

In general the provision with water is better in Siponj, as it also can deliver water from Khodorjifdara to its neighbouring villages (see 4.3.1). Of advantage for Siponj is the closeness of this tributary to the main village which requires only the maintenance of a 1 km channel providing water after drying up of Vojdara.

Water is scarcer in Darjomj due to the drying up of the main water source Darjomjdara which forces people to bring water from the main river Bartang to their houses during a relevant part of the year. However, in the crucial irrigation season in spring and summer Darjomjdara's water still seems to be sufficient. It needs to be checked whether a trade-off exists between water needs within Darjomj village and the irrigation requirements of the hay meadow terrace "Roj". Another hint on relative scarcity of water is the statement from Darjomj inhabitants that plans exist to bring water over more than 3 km from the village's other tributary but perennial water source Khovojdara.

Wood mainly as fuel

As described before, wood used as fuel from trees, bushes but also semi-shrubs is less available than in the past. Especially near villages the cover of forest and bushland has decreased during the last 25 years, since Soviet-administered delivery of mineral fuel (mainly coal) had ceased (compare for East Pamir in Kraudzun et al. 2014). However, as far as known no detailed studies on this issue (estimating extracted amounts and regeneration potential) were conducted in this part of the Pamirs. While riparian forests and bushland have good potential for regeneration when being undisturbed for a while (e.g. temporary ceasing of cutting, exclusion of grazing), the spontaneous regeneration of the more drought-resistant forests and bushlands like such of Juniper is less likely under the current land use regime leading to their further decrease. (e.g. Breckle & Wucherer 2006). However, since coal fuel is delivered again, the general recovery of forests and bushland but also the abundant semi-shrubs is not impossible. Additionally, increased planting of trees on favourable sites would help meeting the fuel needs.

Pasture resources

Currently there seems to be no general lack of pasture resources, as due to low population density there is enough space for changing at least summer pasture sites from time to time if necessary. However, the common practice to use summer pastures farther away from the villages, hints on limited area of "good" and "suitable" pastures near the villages, where partly signs of overgrazing are evident, especially in the form of in parts strong erosion tracks and a high share of grazing indicator species. In some cases the practice to use more distant pastures (e.g. SP1) is however based on the better accessibility compared to summer pastures directly steep above the villages (e.g. SP4). Recently, as mentioned by villagers, degradation on SP1 became evident ("the pasture became dusty") and a shift to the less convenient summer pasture SP4 might become necessary in the nearer future. Further socio-economic enquiries would help to better understand the whole pasture issue.

Wildlife as target for hunting

No details of hunting practice were given in the chapters before, as the target game species partly occur in several altitudinal belts. The main target game species is the Siberian Ibex *Capra sibirica* **which is said to have been reduced due to poaching**. Hence, hunting this species is illegal, however practiced by many people. This species bares high cultural values; the animal itself is regarded as sacred and its body parts are even seen as medicine. According to traditional rules, only people who are considered as "spiritually

clean" are allowed to hunt up to three Ibexes per year. For hunting, people try to avoid places close to the villages, as they fear fines by police.

Well-meant community-based wildlife management schemes as implemented for the villages Ravmed and Khijez (belonging to Siponj Jamoat) seem to negatively affect the Ibex population in the mountains above Siponj village, as villagers from Ravmed and Khijez allegedly sidestep from their hunting area to Siponj mountains to avoid sanctions.

Marco Polo Sheep (*Ovis ammon*) are not occurring in the project region. They are found further east in less steep terrain.

Other species hunted include among birds Himalayan Snowcock *Tetraogallus himalayensis* and the more widespread but smaller Chukar Partridge *Alectoris chukar*. Hares (*Lepus* sp., not checked which species occurs here) were hunted in the past; maybe their population now is too small. Marmots (*Marmota* sp., not checked which species occurs here) are or were caught in traps.

Ecosystem health and function

Following the definition in the report for Kyrgyzstan (see Zemmrich 2015, chapter 4.4, p. 18: "*The present text considers ecosystem functions as the biological, geochemical and physical processes which take place within an ecosystem and respond to all natural impacts including human activity. As long as these processes provide viable populations of native species, their diversity and natural variability, the ecosystem is considered to be in good or healthy conditions*"), most of the project's area ecosystems are not "healthy", i.e. in the best possible condition. In fact as discussed before, some of them like the forest and bushland ecosystems are heavily disturbed, pasture land is partially degraded by erosion and mainly the increase of less palatable plant species. Details are given in Tab. 8. Although this statement on "not really healthy" ecosystems as also those on ecosystem goods' availability is based on a too short field stay and lot information is missing, which could have been derived from deeper socio-economic analyses and participatory approaches of knowledge generation, it can be explained with the harsh arid climatic conditions which make the ecosystems vulnerable to human impact and which leaves not much alternatives for people using these ecosystems.

Tab. 8: Ecological conditions of ecosystems of the project region, availability of ecosystem goods and the ecosystems' health and function according to field sampling and own observations

Ecosystem	Current vegetation	Number of corresponding sampling plots	Availability of ecosystem good	Ecosystem health & function
Bartang River floodplain	Wet meadows, riparian forest/bushland, open pebble/sand vegetation, irrigated meadows	n=8: D05-06, S06-08, S10, S16-17	Pasture regarded sufficient, firewood decreased; hay in most years sufficient, nothing known about berries and fish	Decrease of forest cover due to grazing and cutting, insufficient regeneration (however potentially high if undisturbed or better managed); less stability of river sediments leading to loss of fertile land. According to villagers too wet meadows require draining to raise productivity (detrimental to high biodiversity value of these sites).
Village area	Irrigated gardens, fields, meadows and tree plantations	None	In most years enough irrigation water for good yields of vegetables, fruits, and hay, however in former times yield of potatoes and vegetables was higher (today new diseases, wrong sorts)	No information on depletion
Slopes of Bartang Valley incl. higher river terraces	High-mountain deserts (sensu Walter&Breckle 1994) with dom. Wormwood *Artemisia* sp. and transition to desert steppes (co-dominants e.g.*Kobresia* sp. or Feather Grass *Stipa* sp.), irrigated hay meadow	n=16: D02-04, D07-08, D18-20, S01-05, S09, S15	Hay obviously sufficient, pasture regarded as sufficient; nothing known about berries and mushrooms; medicinal plants partly overused and affected by grazing; burning material from shrubs and partly semi-shrubs (e.g. *Artemisia* sp.) decreased, most strongly from highly valued Juniper	Pasture degradation through erosion and increase of less palatable plants; Juniper and other bushes on non-riparian sites almost completely vanished from all accessible places due to cutting and grazing. *Artemisia* near villages locally decreased; most likely leading to instability of slopes. Low or slow regeneration potential.
Steep tributary valleys with forests	Narrow band of forests/bushland	n=4: D09, D17, S13-14	Firewood has decreased in most, especially easily accessible valleys, but in some places trees still abundant	In some places tree/bush regeneration good, in others (like Vojdara) and upper reaches hindered by livestock and fuel demand of shepherds
Slopes of high-altitude tributary valleys	Mountain xerophyte vegetation with dom. thorn cushions (sensu Walter&Breckle 1994)	n=9: D10-16, S11-12	Summer pasture regarded as sufficient, partly good (DP2) or depleted (SP1); medicinal plants partly overused and	Pasture degradation mainly through increase of less palatable plants. Regeneration potential low or slow, might be fostered

(often trough valleys)	and transition to mountain steppes (co-dominants e.g. *Kobresia* sp. or Feather Grass *Stipa* sp.)		affected by grazing; decrease of game species especially Siberian Ibex *Capra sibirica* due to poaching	by improved management.
Subnival and glacier belt with bare rocks	Subnival cryophyte vegetation (sensu Walter&Breckle 1994) and vegetation free rocks and ice	none	Water still sufficient from the rivers with glaciers in their watersheds. However, Vojdara (no glacier) and Darjomjdara Rivers (former glacier?) dry up in summer, but on Soviet-time topographic maps from 1988 both are treated as perennial rivers.	Not known, as not visited. Most likely zoo-/anthropogenic impact low.

3.3.3 Vulnerability of livelihoods

Although village workshops on questions of ecosystem goods' provision in the light of changing climate were not held, especially in the initial workshop (see protocol in Annex 3.8.1) and in interviews (see Annex 3.8.8) first ideas on the partly contradicting perceptions of villagers on this issue could be collected. Village workshops to be held in 2016 have to collect these perceptions in a more detailed way to receive a full picture of the local understanding of various phenomena seen as related to climate change

For the same reason of not held village workshops, a detailed assessment of the vulnerability of villagers could not be conducted (including the ranking estimated by contribution to livelihood of agricultural and natural products based on the availability of ecosystem goods and services), as done for Kyrgyzstan (see Zemmrich 2015, chapter 4.3, p. 13). However, it is expected that the general pattern as shown in Tab. 6 there applies to the two villages in Bartang valley too.

In general it can be stated that water availability through rivers (mainly Bartang's tributaries) is as well of most crucial importance for the two villages. Besides direct consumption most agricultural activities depend on irrigation fed by these sources. Without irrigation water also no forage production is possible necessary for feeding livestock in the cold winter months when grazing is not possible.

As well, livestock keeping was mentioned as the most important source of income. Most of the year livestock graze on natural pastures (rangelands) which are in the highest proportion not influenced by river water; their adapted vegetation solely depends on precipitation water which is with probably less than 250 mm per year not much. Regeneration of degraded pastures to more productive pastures is under the

current situation supposed to take place very slowly. The same is thought to be true for the formerly more widespread and today highly reduced non-riparian bush- and forestlands (e.g. Juniper).

Hence, as given in the project's primary assumptions, vulnerability of the villages' livelihoods to climate change is presumably high. A reduction of precipitation amounts would challenge on the one hand livestock production as currently practiced by a decrease of fodder availability. On the other hand the mass balance of glaciers is likely to be affected. The latter of course will be aggravated by rising temperatures leading to higher melting rates up to total disappearance of smaller glaciers in near future. As mentioned before in chapter 3.3.2 this might have already happened for one of the important tributaries (Darjomjdara).

Consequently drinking water and irrigation water provision to the villages might decrease significantly and hence all current economic activities of the villages' inhabitants would suffer.

Hopefully, the assessment of the project partners on these abiotic components in the system can help to clarify the future vulnerability of the mountain inhabitants.

3.4 Discussion of results

Results were mainly already discussed in the respective result chapters. Nevertheless, the heading was kept, to comply the chapter numbering with the already submitted Annex section.

3.5 Discussion of methods

Methods are not discussed here as done in detail in Zemmrich 2015 (see chapter 6, p. 22). Some overarching comments are given here in chapter 4. Nevertheless, the heading was kept, to comply the chapter numbering with the already submitted Annex section.

3.6 Recommendations

(1) During the first talks in both villages it turned up that important parts of the pasture life circle are situated outside of the four watersheds taken originally into focus of this project. As livestock keeping is regarded as the stronghold of local livelihood, it is recommended to extend the project region in a way that all relevant pastures are included, also the more distant summer pastures, which entirely could not be visited during this autumn's visit. In contrast to the project region in Kyrgyzstan, where Zemmrich 2015 gave a similar recommendation, this measure would be less complicated, as these summer pasture are not located as the Kyrgyz pastures in a distance of more than 100 km, but rather "only" in a radius of approximately 15 km around the villages. During a summer field campaign the situation and the state of these pastures should be assessed, which applies

as well to those parts of the original four watersheds not visited yet. Better delimitation of the pasture areas and a better understanding on the amount of livestock grazing there at a certain time of the year would allow for calculation stocking densities and hints on carrying capacities (involve existing knowledge how to calculate "norms"). Such an field assessment would also encompass studying ecosystem goods and services not identified and studied yet sufficiently (see below).

(2) For the socio-economic evaluation of all key resource areas, their ecosystem goods and services and their relative contribution to the livelihood, it is necessary to conduct the relevant field studies including village workshops and further more detailed surveys (e.g. household surveys). As recommended for Kyrgyzstan too, this could help to "identify still missing key resources for livelihood and distinguish the most limiting resources". As well, social disparities which are insufficiently understood yet for the Bartang villages, might turn up, leading to questions of different vulnerability of certain groups…
After having reached a level of knowledge as for the Kyrgyz project area, it shall be possible to derive more founded statements on the vulnerability of the local population, especially after findings on projected water availability are obtainable by the project partners.

(3) One focus should be laid on the possible trade-offs of water use (see above in 3.3.1 and 3.3.2, access rights to irrigation water on remoter hay fields vs. drinking and irrigation water demand in the villages), especially in the light of an expected decrease of water availability. The ideas presented above to reactivate old irrigation channels or construct new ones for irrigating pasture areas for improved fodder amount and quality can only be recommended when such questions on trade-offs are clarified. Also for enhancing productivity on existing hay fields this issue is important. Are the hay fields used less than in the past due to water restrictions or due to reduced willingness to maintain water channels and other hard physical work like carrying hay only on humans' back the long way to the village and not e.g. on donkeys or by other means of transport?

(4) Another focus should be on fuel needs for heating and cooking, as this has strongly affected the relevant ecosystems in the past. To which extent coal is replacing or can replace fuel wood from the surroundings? Are there potentials for regeneration of natural stands of bushland/forests (possible trade-offs with pasture use, which prevents regeneration, as well in riparian as non-riparian ecosystems)? Are potential areas for artificial "energy forests" available? Are such artificial forests feasible and sustainable with projected water provision?

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3.8 Annexes

3.8.1 Protocol of initial meeting with the residents of the pilot area

By Qumriya Vafodorova, Umed Bulbulshoev

The initial meeting with the residents of the pilot area under the project Ecosystem based adaptation to climate change in mountain region of Central Asia.

Date:	**25 September 2015 (Siponj), 26 September 2015 (Darjomj)**
Rural districts: Tajikistan	**Siponj and Darjomj villages, Sipong Jamoat, Bartang valley, GBAO,**
Meeting place:	**Siponj and Darjomj villages**
The purpose of the meetings:	**Introduction to the project, identification stakeholders, informing about the project scale, an initial discussion on local steering body for the implementation of the ecosystem based approach to climate change.**

Information about villages

Village Siponj consist of 97 households

328 people are living there (177 male and 151 female).

25 community members took part in the initial meeting (4 female and 21 male).

Village Darjomj consist of 58 households

128 people are living there (60 male and 68 female).

30 community members took part in the initial meeting (9 female and 21 male).

Introduction of the project

During project introduction it was explained to participants in both villages what is the aim of the project, when it started working, why it is aiming mountainous area with small watershed and how the process of selection project areas took place.

The participants were introduced with the projects title, its framework and duration, project partners (MSS, UNIQUE, UCA, GFZ) and their roles in the project realization. It was mentioned that the implementers of the activities of the project will be CAMP Alatoo in Kyrgyzstan and CAMP Tabiat in Tajikistan.

This part of the meeting was aiming to give people the message of climate change and its impacts in livelihoods, identifying the awareness of people about climate change and find out the existed adaptive capacity of the local people toward changes that are in place.

Climate trends and experience on climate change

Participants had to fill the table with information related to weather for all seasons in different years and mention the consequences, if it is related to changes in the weather. Tables are in Annexes 1, 2

Siponj

Villageres in Siponj were mentioning warmest years 1965 -1966 therefore this data was put in the table and as an orientation for the upcoming years. Villagers said that these years starting from the beginning of April they put the summer clothes on. From the 8 of March people began sowing wheat and potatoes. Starting from 2000 the weather gradually has been changed. The weather constantly fluctuates. One day it is too hot, one day cold.

The autumn of the last few years is very rainy.

Additionally villagers were talking about local teacher, who is observing and recording all the changes related to weather.

Darjomj

The villagers said that comparing with the past 10 years – they said – we have less snow now. They said it is becoming warmer during winter and colder during summer. Because of that, the people were more likely to get sick from epidemic influenza and jaundice. The absence of snow in winter time has a negative impact for the soil as well. Due to that the soil will be frozen and loose the productivity.

For spring time they mentioned that they plough the fields earlier than before, due to the low snow in the winter time. Although now villagers plough earlier, due to absence of water in early spring, the process of planting they postpone to later months. As they mention, the rainy days were only until May in previous time, however, now the rain falls even in summer time. Especially this year it was raining until August. Some days there were very intensive raining days that lead to landslides and flood.

In autumn the weather is warmer than it was 10-15 years before. If before it started snowing from the end of November, now it starts from end of December or even later. On top of it the amount of the snow is very less.

For the adaptive capacity for these changes the local people do such things:

- Usage of the small rubber pipes for bringing water to the village when it is needed. The reason is that the water comes late in spring time and dries early in autumn.
- Plough the land early in spring, when the land is soft yet and do the planting late when the water is available.

Ecosystem based adaptation as an approach and as a project

After giving participants the idea of climate change occurrence and its impacts, it was explained to them to what extent it is important to adapt to this changes. This adaptation process should be sustainable and without harming the human ecology. Therefore, EbA project was designed and these villages were selected for piloting this project.

The meaning of the ecosystem based adaptation as approach and as a project was explained to the residents and that this approach will be developed together with local people. This is a pilot project and the process of the implementation of the project will be based on close cooperation and the exchange of knowledge of local people and project partners.

Overview of the process of selection

To the participants of the meeting were given an overview from the beginning of the project activities. The first consortium meeting, first visits to the places and data collection, the second consortium meeting and the process of selecting the area for the pilot project.

The participants also were informed that the neighboring village was selected as well for the sake of comparison.

It was mentioned that the different missions will come with different research topics. First step will be mainly collection information on different aspects and understanding the situation on the place.

For this reason the active cooperation of the residents is necessary.

On the example of the successful JFM project realization in GBAO and unsuccessful project realisation in Van it was explained to the participants that only with the close cooperation of local community and project partners and implementations good result can be achieved.

Expectation of the local people from the project

Following expectation of the villagers were identified from the project:

- Improvement of the life of the local population
- Solving problems in the village that related to hazards
- Bringing irrigation water to the village

Choosing the potential members for local steering body:

Residents identified following persons to be contacted during the project realization, as well as who can be part of the local steering body.

Siponj

- Bodurov Navruz – Secondary school teacher
- Avazbekova Mavlodod – The farmer association member
- Odinaeva Makhbuba – Head of the woman committee
- Shukrikhudoev Komil– Head of youth committee
- Shahbozov Pakhlavon – Head of the village
- Davlatmamadov Sarcor - Secondary school teacher
- Gulomnabiev Haidarsho – Oldest age representative
- Fidoieva Bakhor – Health care point
- Dovutov Khudoinazar – Hydropower electrical station worker
- Mulkamonov Nazarali – Middle ages representative
- Tolibshoev Mamadyor – Leader of jamoat
- Tolibecova Latofat – Head of the education committee
- Zulobiev Imumnazar – Khalifa (religious representative)
- Shodiev Kamar – Head of the FOCUS volunteers group
- Bakhtaliev Bakhtali – Head of Community Organization
- Tolibecov Abdulnazar – Head of the village volunteers

Darjomj

- Oshurov Ulfatsho – leader of Community Organization
- Abdulaseinov Abdulasis – Khalifa (religious authority)
- Toshmamadov Avalbek – The farmer association member
- Navruzov Nizom – Head of the farmer association
- Khudoiberdiev Islom – Accountant of preliminary school

- Yoghibekov Paishanbe - The farmer association member
- Nematuloev Sikandar – Master hydro electro station
- Ruzadorov Garibmamad – Veterinary
- Muborakqadamov Khushqadam – Physical education instructor
- Navruzov Iqbol – School director
- Hasanova Muslima – Teacher
- Khudoiberdieva Guliston - Head of the woman committee
- Roshorvijova Jamol - Librarian

Responsibility of local population:

Responsibility of the local population with the project will be:

- Effective collaboration and providing reliable information to the project members
- Information dissemination to the community
- Distribution of the brochures and booklets
- Active participation on the workshops
- Providing recommendation and suggestion

What projects are being implemented at the moment in the village?

Siponj

1. FOCUS Humanitarian - built a dam, formed a team for emergency situation, conducted trainings, Installed container and stuffed it with the equipment for safely stay in the event of flooding, set alarm system.
1. MSDSP – Established the VO and SUDVO net is working on building the bridge.

Darjomj

2. FOCUS Humanitarian - Installed hydrometers. Installed containers in the safe areas in case of emergency. Installed container and stuffed it with the equipment for safely stay in the event of flooding.
3. MSDSP – Established the VO and SUDVO net, organized microloan funds.

Annex 1. Table of climate trend (Siponj)

Seasons	1960-1970	1970-1980	1990-2000	2000-2015	Results
Spring	Warm ploughing in March	Moderate	Moderate	Cold, unstable, ploughing in April	-
Summer	Stable warmth	-	-	Not stable, many extreme events	-
Autumn	Less raining	-	-	More raining	-
Winter	Cold winter in the right period	-	-	the peak of the cold period starts from 11/01-25/01	-

Annex 2. Table of climate trend (Darjomj)

Seasons	USSR	1990-2000	2000-2015	Results
Spring	Late spring, late ploughing, raining until May	-	Early spring, early ploughing, no irrigation water	Late planting
Summer	Warm	Warm, no rain	Colder, continuous raining	Affect agriculture
Autumn	Cold, snowing from November	Cold	Warmer, no snow	
Winter	Cold, a lot of snow	Cold	warmer, snowing in the end of December	More diseases

Annex 3.

Photos from the meeting in Siponj

Photos from the meeting in Darjomj

Annex 4. List of contact persons in Siponj

#	Names		Contact details
1.	Bodurov Navruz	Secondary school teacher	
2.	Avazbekova Mavlodod	The farmer association member	934243858
3.	Odinaeva Makhbuba	Head of the woman committee	938504710
4.	Shukrikhudoev Komil	Head of youth committee	
5.	Shahbozov Pakhlavon	Head of the village	
6.	Davlatmamadov Sarkor	Secondary school teacher	934294579
7.	Gulomnabiev Haidarsho	Oldest age representative	
8.	Fidoieva Bakhor	Health care point	935244168
9.	Dovutov Khudoinazar	Hydropower electrical station worker	938178203
10.	Mulkamonov Nazarali	Middle ages representative	
11.	Tolibshoev Mamadyor	Leader of jamoat	937310448
12.	Tolibecova Latofat	Head of the education committee	934618831
13.	Zulobiev Imumnazar	Khalif – religious representative	-
14.	Shodiev Kamar	Head of the FOCUS team	934751062
15.	Bakhtaliev Bakhtali	Head of Community Organisation	
16.	Tolibekov Abdulnazar	Head of the village volunteers	934777252

List of contact persons in Darjomj

#	Names		Contact details
	Oshurov Ulfatsho	Leader of Community Organization	934310242
1.	Abdulaseinov Abdulaziz	Khalifa – religiouse representative	900504702
2.	Toshmamadov Avalbek	The farmer association member	934619439
3.	Navruzov Nizom	Head of the farmer association	
4.	Khudoiberdiev Islom	Accountant of preliminary school	935655091
5.	Yoghibekov Paishanbe	The farmer association member	
6.	Nematuloev Sikandar	Master Hydro Electrical Station	93440516
7.	Ruzadorov Garibmamad	Veterinary	
8.	Muborakqadamov Khushqadam	Physical education instructor	
9.	Navruzov Iqbol	Secondary school director	938161786
10.	Hasanova Muslima	Teacher of secondary school	-
11.	Khudoiberdieva Guliston	Head of the woman committee	-
12.	Roshorvijova Jamol	Librarian	-

3.8.2 Photo-Documentation Bartang Valley (as file only)

Attached as file "Annex 3.8.2 – Photo-Documentation Bartang Valley.pdf"

3.8.3 Data Sheet: Site conditions and vegetation on representative sites of the watershed (as file only)

Attached as file "Annex 3.8.3 – Datasheet_EbA_Assessment_MSS.pdf"

3.8.4 Protocols of field sampling in representative ecosystems (as file only)

Attached as file "Annex 3.8.4 – DataInput_EbA_Bartang_sortedVegetationUnits.xlsx"

3.8.5 Images of plots from field sampling (vegetation, soil) (as jpg files only)

Attached as folder "Annex 3.8.5 – PlotFotos_Bartang.zip"

3.8.6 Land use and ecosystem details in Google Earth

Attached as file "Annex 3.8.6 – Tajikistan_Bartang_JE_Dez2015.kmz"

3.8.7 Land use and ecosystem details for GIS

Attached as file "Annex 3.8.7 –….shp"

3.8.8 Interviews on natural hazards and general questions of livelihood (by Qumriya Vafodorova)

Attached as file "Annex 3.8.8 – Interviews on natural hazards and general questions of livelihood.xlsx"

4. Concluding remarks for both project regions

In both reports, the present one on the project region in Bartang valley Tajikistan as for Zemmrich 2015 for Kyrgyzstan, all collected information is presented, however partly as electronic appendices due to the amount of information (interviews, photographs, plot and GIS data etc.).

The GIS data for both regions allow for further elaboration during the run of the project. A vast selection of photographs illustrates the conditions in both project regions. In case of theKyrgyz project region most photographs contain GPS information allowing after further steps to introduce an illustration layer to the GIS which might be useful in the further run of the project, maybe also for monitoring purposes. In case of the Tajik project region the photographs are assigned to the plots; with some elaboration also here the depiction in the GIS would be possible.

The raw data of the ecological assessments are given as tables. Please note that no calculation on potentially available soil moisture (Nutzbare Feldkapazität NFK) has been done yet. Especially for Tajikistan soil texture with mainly high fractions of skeleton and the consequently shallow soils are likely to lead to comparably low values. In general, under these arid conditions it stays under question how, where and when water is stored in these soils. Regarding the fact of dust-dry soils until the depth reached by digging and presumably much deeper roots especially of the mostly dominating semi-shrubs (see Walter & Breckle 1994) or other adaptive measures of other co-dominants (obviously dormancy of species like *Kobresia* sp., *Poa bulbosa* etc. in the dry summer months (i.e. ephemeroids) and high contribution of annuals) the value of such calculations is not clear yet. In case of the Kyrgyz project region with its much deeper soils with lower contents of skeleton, the calculation of NFK might be more useful. However for both project regions the intensity of sampling should be higher to yield reliable results plus details on climatic features would be helpful (yearly precipitation and (potential) evapotranspiration) to judge NFK values.

Zemmrich 2015 gave in her chapter 6 (Discussion of methods) remarks that a field campaign of only around two weeks or less with the current set of field methods cannot

answer all questions on past, current and future conditions, especially under still unclear effects of climate change.

In case of the Tajik project region the late time in the vegetation period (unavoidable due to organizational and safety constraints) was in parts detrimental to the identification of some ecosystem details (e.g. partly dried or withered vegetation components); also due to already short days and cold nights the higher but crucial parts of the villages' activity ranges could not or only insufficiently be visited.

Therefore it is recommended to **visit** for similar works such mountainous regions **in June and July**, when days are long, nights are less cold and vegetation can be observed in its best state (height of development).

Like conducted for the Kyrgyz project region a **detailed socio-economic study should take place first**, to leave less questions open on the distribution and usage patterns of ecosystems, their goods and services. At least one week should be allowed for each village, including enough time for analyses of the results.

Furthermore, enough time should be available **beforehand**, to conduct **desk studies** on all already existing information (as well socio-economic, biotic and abiotic), to go to the field well prepared. Due to organizational constraints this was not possible for the two field stays described in the two given reports.

This and a more detailed explorative field visit beforehand would have also avoided the fact that for both project regions the area in focus was chosen too small, restricted to watersheds which are not decisive for the ranges of activities of the villages.

For a more detailed ecological study afterwards, all areas used in fact by the villages should be visited with enough time for sampling sufficient plots (two weeks per village), in order to capture all existing and used vegetation stands in different altitudinal ranges under different site conditions.

However, still ways have to be found how such or similar studies can be conducted in the future solely by regional staff. Possibly the vast majority of questions for Ecosystem-based Adaptation can be answered by detailed participatory surveys in the villages, leaving less efforts for the assessment of the corresponding ecosystems.