Climate Risk and Vulnerability Assessment (CRVA) in Jabbor Rasulov district, Tajikistan a pilot study

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1 Summary

This report is the outcome of a short consultancy on "Piloting the CRVA for EbA approach in Tajikistan". **The main objectives were**:

- to **train** GIZ staff and partner (ACTED, German Red Cross) on the application Climate Risk and Vulnerability Assessment (CRVA) methods according to the GIZ guidebook for Climate Risk Assessment for Ecosystem-based Adaptation
- to **pilot** a CRVA approach together with GIZ staff for Jabbor Rasulov district in the Sughd region in Tajikistan and to understand the benefits and limitations of quantitative as well as qualitative CRVA approaches in the context of a local assessment in Tajikistan (chapter 2)
- to learn about **potentials and limitations of a CRVA** approach with an EbA focus **at a regional scale** (for parts of the Fergana Valley) (chapter 4)
- to discuss how the CRVA approach **compares to the EbA approach of the GIZ in Central Asia** and whether one approach is more suitable for certain conditions (chapter 5 by Gulbahar Abdurasulova, UNIQUE).

1.1 CRVA for Jabbor Rasulov – results from the rapid climate risk assessment

We conducted a rapid CRVA for Jabbor Rasulov district based on existing literature, two workshops and a field visit. Due to the short-term character of this pilot study, many of the conclusions would need to be confirmed by data, further investigation and expert reviews for a more in-depth and sound analysis (for details on potential next steps see chapter 3).

Three main climate risks have been identified to be relevant for the region:

- Risk of damage to houses, roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electric grid), agricultural fields and livestock due to mudflows triggered by heavy rain events.
- Risk of loss of agricultural yield, decreased crop quality, decreased grassland and livestock productivity, soil salinity, lack of drinking water due to droughts and high temperatures
- Risk of damage of houses (roofs), infrastructure (electricity lines), trees (orchards), agricultural fields (soil erosion, damage to seedlings) and health (dust, trauma) due to strong wind.

The most important factors aggravating these climate risks in the region in the last decades are not primarily an increase in **climate related hazards due to a changing climate** but an **increase in vulnerability** due to socio-economic developments. The **most important processes and factors contributing to the high and increasing vulnerability** are:

- **Land degradation** because of overgrazing and deforestation. While overgrazing is mainly due to an increase in the number of livestock due to the collapse of the Soviet Union (26 December 1991), lack of job opportunities, lack of money saving possibilities other than purchasing livestock, a lack of pasture management and deforestation is a consequence of the energy crisis since 1992 and increased demand for firewood.
- **Limited water availability** combined with an increase in water demand for irrigation as well as for drinking water and an inefficient water management and water infrastructure
- **Population growth** of six percent between 2014 and 2016 and a related increase in agricultural area adding pressure on land and water resources.

- Poverty, missing job opportunities, dependency on remittances, as well as **lack of financial capacity and knowledge** lead to poor management and maintenance of pastures, agricultural fields, irrigation infrastructure, wells, roads, bridges and buildings.
- The fact that the watershed is trans-national **without trans-border cooperation** between Kyrgyzstan and Tajikistan regarding water management or disaster risk management.

The most relevant climate risks, mudflows and droughts, are both linked to land degradation, since land degradation on slopes leads to a mobilisation of material and at the same time aggravates the impact of droughts on pastures, fodder availability and livestock.

The risks associated with mudflows are high and can reach disastrous dimensions, however they are limited to specific locations. This might be one reason, why they are perceived as very relevant by stakeholders, even if they affect only a relatively small amount of people. The risks associated with drought and heat are until now less dramatic, however they are affecting a large proportion of the area and population.

Climate change will exacerbate existing problems. Data models show an increase in temperature (almost certain), which will consequently lead to more intense meteorological droughts (very likely) leading to agricultural droughts (likely). Together with other climate impacts (e.g. less melt water from snow) water availability in summer will most likely decrease, while it might increase in winter and early spring. The potential increase of heavy rain events should be considered but (most likely) cannot be verified by observation data or climate scenarios since neither station data nor climate models are able to capture extreme precipitation events in the mountains sufficiently due to their local character.

High risk zones are:

- For mudflows: all exposed elements (houses, fields, roads, irrigation infrastructure) in the vicinity of the river or erosion/mudflow gullies.
- The area north of Khitoy where a mudflow channel built during the Soviet period redirects mudflows making the area prone to mudflows as the river tries to follow its natural course.
- Droughts affect the whole district. Areas with rain-fed irrigation and pastures are more vulnerable than areas with irrigated agriculture due to the combined effect of higher water requirements, lower water availability during the agricultural season and greater water needs in Kyrgyzstan. Water availability is already now insufficient. Further assessments are necessary to understand if drought related risks have a specific spatial pattern.

Due to the strong link between the two major risks and the strong relation to land and water management related problems as well as socio-economic trends, we recommend focussing on **adaptation measures**, which aim for a more **sustainable management of pastures and water resources and a restoration of ecosystem services**:

- Combating land degradation due to overgrazing (e.g. pasture management committees, fencing, pasture plans,…)
- All green and grey adaptation measures related to water management and water harvesting (e.g. reforestation, irrigation, building of reservoirs, …)

Furthermore, **adaptation options focusing on risk hot-spots are recommended**:

- Riverbank stabilisation (green: planting trees along the banks, grey: construction of technical protection measures)
- Improve resilience of road infrastructure (e.g. drainage, bridges, slope stabilisation) and of other critical infrastructure (irrigation, electricity) to reduce vulnerability to mudflows and erosion.
- Improve maintenance and renewal of hazard mitigating structures such as mudflow channels and riverbank enforcements

And finally, **capacity related adaptation measures** are recommended:

- Capacity building measure to increase knowledge in water and land management, strengthening local institutions and self-governance (water and pasture committees, district level departments) and cooperation between institutions as well as cross-border cooperation (adopting a watershed-based approach)
- Measures to improve monitoring and data availability on meteorology, climate, hazard impacts as well as contributing factors (e.g. livestock density, status and maintenance of infrastructure, presence of exposed elements in risk zones, …)

1.1.1 Methodological learning - how did the CRVA methodology perform?

The general concept of the CRVA of gathering information on the factors of the AR5 concept (Hazard, Vulnerability, Exposure, Risk) with workshops, key questions and impact chains including qualitative as well as quantitative information **worked very well** in the context of Tajikistan. Experts with local knowledge (Hans-Jürgen Fülle, Alois Schläffer) not involved in the exercise confirmed the findings of the main climate risks and their root causes as well as the recommended adaptation measures. The **framework** of the impact chains was **expanded** somewhat introducing a **stronger ecosystem and ecosystem service perspective** (see also chapter 5).

Within the ten days in Tajikistan, the team identified the **most relevant risks** and **underlying factors**, developed **impact chains**, defined **potential indicators** to measure factors and impacts and got an idea of the **areas affected by the risks**. As expected, a full assessment including gathering data for indicators and categorisation of values could not be conducted within two weeks. Local data availability is very poor motivating a more expert-based assessment for the key factors. **Next steps for a more complete risk assessment** (which would require approximately five to six additional person months spread over an eight-month period) would include:

- review data availability and collect data for indicators where available (see tables in Annex sections 6.1 to 6.3)
- gather qualitative information of indicators where no suitable data is available (through expert interviews)
- produce maps of specific factors (e.g. type and state of mudflow channels, level of land degradation, quality and damage of infrastructure) from existing data, aerial images, field visits and other sources of information
- test to which extend erosion, mudflows and droughts can be modelled spatially-explicit and to which extend deforestation and land degradation can be derived from earth observation

- conduct a semi-quantitative assessment for each Jamoat or village based on the available information for each indicator with experts of the region (following the Vulnerability Sourcebook approach) and aggregate and interpret results
- identify appropriate adaptation options based on the CRVA (strictly speaking not part of a CRVA).

For a full assessment, it would be key to involve **further experts** with specific knowledge (land degradation, erosion, mudflows, road infrastructure, riverbank reinforcement) and appropriate knowledge of the region at least for the **semi-quantitative assessment** based on data and indicators.

1.2 Consequence for upscaling towards larger areas (Fergana Valley)

Only parts of the findings of this pilot study are representative for the Fergana Valley. This pilot study was focussing on a side valley with its own specific risks (e.g. a new unpaved feeder road shortcutting the old road going through Kyrgyzstan, a valley dominated by pastures that are overgrazed). We would expect that the approaches and **results are transferable to similar side valleys** of the Fergana valley, **however not to the plains** with its intensive irrigated agriculture. A comprehensive study should also incorporate areas upstream (e.g. Kyrgyzstan). **Missing elements to cover the plains are** risks for irrigated intensive agriculture (cotton, sun-flowers) such as droughts or pests, the impact on ground water quantity and quality (salinisation) and the direct impact on health due to heat stress.

As for the pilot study, we expect that **data on hazards and vulnerability factors are scarce**, of varying quality, not harmonised and difficult to access. We thus propose also for the larger area a mix of data driven methods and qualitative approaches based on workshops and expert's assessments.

For droughts, land-degradation, erosion and sediment flows **model-based and remote sensing based approaches** can be used to derive **hazard indication maps**. In this context, the GIZ German Initiative on Climate Change and Technology (**DKTI) project** would be useful to collect the required data for the model input, in particular hazard event data. We recommend to conduct a survey in the DKTI project assessing which data are needed for modelling and monitoring CRVA activities.

When working in a larger geographic area **a two-scale approach might be considered**. **Assessments at a finer scale**, i.e. case studies in selected sub-regions representative for the different landscape types in the Fergana valley could provide an understanding of key risks and their mechanisms. **Impact chains could be developed and indicators identified**. These impact chains and indicators developed for the case studies **would then serve to conduct an assessment for larger areas** within the Fergana Valley. Furthermore, we can assume that also for larger areas, **up-stream and down-stream relations** across administrative borders and countries will be important and that a **trans-national**, watershed based approach would be necessary.

In addition, when covering a larger area do consider that the **identification of adaptation options** requires **additional expertise** (different from CRVA) and **additional time**, since the identification of adaptation options is not strictly part of a CRVA.

Overall, we recommend to consider approximately one year to elaborate an in-depth CRVA for the Fergana Valley with a focus on risks related to land degradation, erosion, mudflows and droughts.

1.3 Relation between CRVA and EbA project

The CRVA method focusses on a risk assessment and not on the identification and selection of adaptation measures. However, a CRVA is a good starting point through the risk lenses and basis for the selection of adaptation measures.

While the Open Standards-based method for Ecosystem-based Adaptation (OS-based EbA - see chapter 5) is more focused on ecosystem services, the impact of climate change on ecosystem services and the possible contribution of ecosystems to adaptation (EbA), the CRVA approach with impact chains focusses more on the root-causes of specific climate risks including but not limiting to ecosystem-based approaches.
For the case study of the Jabbor Rasulov district, we enhanced the impact chain tool to include a stronger ecosystems perspective. The CRVA method can benefit enormously from the OS-based method in strengthening the ecosystems perspective. The application of the CRVA method in Jabbor-Rasulov showed that the conceptual differences (AR4 vs AR5 framework) are minor and that the application of the "Ecosystems lens" on the complex cause-effect relationship (including physical, technical and capacity related aspects) is a good starting point for communicating with stakeholders across various sectors (for more see Chapter 5). We recommend using such an expanded approach for an assessment covering a larger area.

2 CRVA for Jabbor Rasulov District

2.1 General approach of the pilot study

The objective of this pilot study was to carry out a CRVA applying the eight modules of the GIZ guidebook for Climate Risk Assessment for Ecosystem-based Adaptation[1], the underlying Vulnerability Sourcebook[2] and the Risk Supplement to the Sourcebook[3] (Figure 1). Definitions of key terms used in the pilot study are provided in Box 1.

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[1] Hagenlocher, M., Schneiderbauer, S., Sebesvari, Z., Bertram, M., Renner, K., Renaud, F., Wiley, H., Zebisch, M. (2018). Climate Risk Assessment for Ecosystem-based Adaptation – A guidebook for planners and practitioners. Bonn: GIZ. https://www.adaptationcommunity.net/wp-content/uploads/2018/06/giz-eurac-unu-2018-en-guidebook-climate-risk-asessment-eba.pd

[2] Fritzsche K., Schneiderbauer S., Bubeck P., Kienberger S., Buth M., Zebisch M. and Kahlenborn W. (2014) The Vulnerability sourcebook. Concept and guidelines for standardized vulnerability assessments. GIZ. https://www.adaptationcommunity.net/?wpfb_dl=203

[3] Zebisch, M., Schneiderbauer, S., Renner, K., Below, T., Brossmann, M., Ederer, W., Schwan, S. (2017). Risk Supplement to the Vulnerability Sourcebook. Guidance on how to apply the Vulnerability Sourcebook's approach with the new IPCC AR5 concept of climate risk. Bonn: GIZ. https://www.adaptationcommunity.net/wp-content/uploads/2017/10/GIZ-2017_Risk-Supplement-to-the-Vulnerability-Sourcebook.pdf

Figure 1: The Vulnerability Sourcebook, the Risk Supplement and the Guidebook on Climate Risk Assessment for Ecosystem-based Adaptation and the eight modules towards a climate risk assessment.

Definitions of key terms

Risk: 'The potential for consequences where something of value is at stake and where the outcome is uncertain (...). Risk results from the interaction of vulnerability, exposure, and hazard (...).'

Hazard: 'The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In the [IPCC] report, the term hazard usually refers to climate-related physical events or trends or their physical impacts.'

Exposure: 'The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.'

Vulnerability: 'The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.'

Impacts: 'Effects on natural and human systems. In the [IPCC] report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.'

Box 1: Definitions of key terms according to the IPCC[4] and as applied in this pilot study and in the GIZ guidebook for Climate Risk Assessment for Ecosystem-based Adaptation

Due to the short-term character of this pilot study of less than one month, it was agreed to not conduct a full assessment but rather focus on Vulnerability Sourcebook modules 1 to 3. In this chapter, we report on the activities carried out and results of the pilot study. Additional information and following steps

[4] IPCC (Intergovernmental Panel on Climate Change) 2014a: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge and New York, Cambridge University Press. Retrieved 19.01.2018 from https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf

required to complete the assessment as well as lessons learnt from this exercise are described in chapter 3.

We conducted the following activities in the pilot study (structured according to the modules of the Vulnerability Sourcebook):

- Module 1: preparing the risk assessment:
  - A desktop study preparing the stay in Tajikistan (collecting existing information)
  - A training on CRVA methods resulting in a common understanding within the team
  - Understanding the context of the assessment (see next chapter 2.2)
  - Collecting available data on the natural, ecological and socio-economic situation of the pilot area as well as climate data
  - Workshops with experts and stakeholders on potential climate risks
- Module 2: Developing impact chains
  - Development of impact chains based on the workshop results, the field visit and knowledge available within the team
- Module 3: Identifying and selecting indicators
  - This part could only be started during the last day and remains incomplete. See tables in Annex 6.1 to 6.3 and chapter 3.

The work was performed by a team of national and international experts consistent of

- Marc Zebisch, Kathrin Renner (Eurac Research, Bolzano, Italy)
- Gulbahar Abdurasulova (Unique, Germany)
- Jonathan Demenge (independent consultant, Tajikistan)
- Marhabo Yodalieva, Nodir Muhidinov, Claudia Haller (GIZ Tajikistan)
- Nargis Mirbozkhonova (ACTED, Tajikistan)
- Sarafroz Mavlyanov (German Red Cross, Tajikistan)

A first phase of three days included a CRVA training, a definition and sharpening of the context of the CRVA for Rabbor Rasulov distribt and the preparation of workshops by the team.

In a second phase, two workshops were conducted (see facilitation plan in section 6.4 in the Annex):

Workshop 1 took place in Khujand with experts from the regional authorities of Jabbor Rasulov district, i.e.: Agency for land reclamation and irrigation, Committee of Emergency Situations (CoEs), Committee for Environmental Protection (CoEP), Road department, Agriculture department, Geology department, Committee for land management and geodesy and Department for Hydro-Meteorology (Oblast level).

Workshop 2 took place in Jabbor Rasulov District centre with experts and actors from two municipalities, i.e.: heads of two Jamoats, nine representatives from three malhalla committees and four representatives of water user associations (Figure 2).

Figure 2: Workshop participants on day 2

The workshops were organised around the following key questions:

1. Weather and climate related hazards in Jabbor Rasulov district - current situation
    - Which weather and climate related hazards and impacts do you observe in the last decade? Where, when?
    - Which sectors or systems are impacted? Where, when? (roads, agriculture, livelihoods)
    - Which factors besides the weather and climate contribute to these risks? (natural, social, technical, capacity)
    - Where are exposed people, assets or infrastructures predominately located?
    - Do you notice (in the present or past) any trends of increasing or decreasing risks? Why and where?
2. Disaster Risk Reduction and Climate Change Adaptation
    - Which measures already exist, which measures do you propose?
3. Climate Change impacts
    - Did you notice any trend of a changing climate? E.g. increase in temperature, less snow, less water in summer more in winter.
    - How would climate change affect the weather and climate related hazards and impacts?
4. Availability of data and information
    - What data on weather and climate, climate change scenarios, weather related hazards (mudflows, floods, droughts) and impacts of hazards (damage) are available?

Figure 3: Workshop 1: prioritisation of impacts (left) and drawing risk zones on a map (right)

The EbA perspective was added by explicitly asking for ecosystem related factors such as overgrazing and land degradation contributing to a risk and by discussing specifically green solutions as adaptation options such as riverbank reinforcement with trees.

Following the general concept of the Vulnerability Sourcebook and the risk supplement, as a starting point of the CRVA we focussed on current climate risks, i.e. observed impacts and risks related to weather and climate related hazards such as drought or heavy rain events. From this, an analysis can show how existing climate risks may change in future.

The underlying hypothesis are that

- Geographic regions, economic sectors and groups of people are already today affected by climate related risks. Many of these risks may exacerbate with climate change (e.g. droughts, floods).
- We can easier understand causes and effects, i.e. which factors contribute to a specific risk, by analysing past and current events and situations rather than focusing on potential future climate risks.
- Stakeholders usually find it difficult to imagine how a future climate might look like and how to interpret the range of possible climate futures (e.g. ranging from less rain to more rain) due to different scenarios and model uncertainties.

Risks related to climate change and the future climate were considered in a second step by asking "what would happen if temperature increased by 2 °C, heavy rains got more intensive, there would be more frequent droughts".

We documented discussion outcomes on boards using different coloured cards for hazard and vulnerability factors and related impacts and risks. Subsequently, we asked workshop participants to identify the three most important risks for the region by placing sticky dots. Additionally, we asked participants to draw hotspots of specific risks on a map.

During a fieldtrip to Jabbor Rasulov district on day 6 key location related to specific risks were visited. For instance, a channel built during Soviet time to deviate mudflows away from fertile lands, bridges that collapsed due to mudflows and gullies that resulted from inappropriate drainage of roads (Figure 4). At a meeting with representatives of the Kurgoncha community further climate risks were discussed. See documentation in the Annex.

Figure 4: pictures from field trip. Left: erosion after drainage pipe below a road. Right: huge erosion gully leading into Isfana river.

Based on inputs from workshop participants, the field trip, a review of existing studies (see chapter 2.2 context) and further discussion with local experts (Hans-Jürgen Fülle, Alois Schläffer) the local GIZ team and authors of this report developed impact chains and compiled all the available information (see chapter 2.4.2). The main risks are the following:

- Risk of damage to houses, roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electric grid), agricultural fields, livestock due to mudflows
- Risk of loss of agricultural yield, decreased quality, decreased grassland and livestock productivity, soil salinity, lack of drinking water due to droughts and high temperatures
- Risk of damage of houses, infrastructure (electricity lines), trees (orchards), agricultural fields (soil erosion, damage to seedlings), health (dust, trauma) due to strong wind.

2.2 Context

In the Sughd Region the district Jabbor Rasulov is highly sensitive and has a low adaptive capacity to climate related risks and climate change. This CRVA study is the first of its kind at that scale in this area. It is provided (amongst others) as a supporting document to the GIZ for the preparation of the project concept note on increasing climate resilience in Central Asia through Ecosystem-based Adaptation. A CRVA for the much larger area, the Fergana valley, entitled "Climate Risk and Vulnerability Assessment of people's livelihoods and road infrastructure in the Fergana Valley" was produced by UNIQUE for GIZ and published in July 2018[5] based on a literature review.

This study will contribute to the verification of the theory of change of the above mentioned project proposal that is directed at:

- Increased resilience and enhanced livelihoods of the most vulnerable people, communities and regions, and
- Increased resilience of infrastructure and built environment

The current hypothesis is that this could be achieved (amongst others) by mainstreaming climate change into national road infrastructure planning and management processes and implementing ecosystem-based adaption (EbA) measures in proximity of rural road infrastructure and vulnerable peoples' settlements. One objective of this pilot study is to test this hypothesis.

Recently a number of climate change impact assessments were conducted:

- An assessment of opportunities in Tajikistan on "Integrating climate change adaptation and water management in the design and construction of roads" conducted by the World Bank Group and partner organisations was published in 2017[6].
- A case study of climate change impact assessment on transport infrastructure in Tajikistan prepared by CLIM systems, published in May 2018, details on a national level the risks and associated costs of adaptation and no adaption for the transport sector in Tajikistan[7].
- Within the framework of the Tajikistan Pilot Programme for Climate Resilience (PPCR) an assessment on the countries agricultural production and climate change impact modelling[8] has been published.

GIZ has developed a method for identifying and implementing EbA in Central Asia using biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change (UNCBD 2009). In this way EbA integrates ecosystem services in adaptation planning, strengthening ecosystem services to mitigate climate risks. The according method is so far documented in an EbA factsheet/manual entitled "Contributing to Sustainable Development with Ecosystem-based Adaptation" produced by GIZ in 2018[9], and will be soon published as Manual, enabling others to replicate

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[5] https://eba.klink.asia/d/show/664387b1-ba12-4f38-afd6-983f620100fe
[6] http://roadsforwater.org/wp-content/uploads/2018/04/Tajikistan-report-WB-assessment.pdf
[7] https://eba.klink.asia/d/show/036ca220-ec2e-4bc0-b9ab-76210c47d0ea
[8] https://eba.klink.asia/d/show/b419ef23-5a01-4e31-9e29-820e6e7febb5
[9] https://eba.klink.asia/d/show/bfa1d49c-7dd8-45e1-a0dd-99c7831bd2bd

the method. Furthermore, the full description of the steps of the EbA method has been published as book chapter in a Springer Book Series about Climate Change Management[10].

Within the framework of the German Initiative on Climate Change and Technology (DKTI), a new project proposal on technology-based adaptation to climate change has been commissioned recently. The main objective of the project will be to increase the capacity of government agencies to collect, process and share relevant data on climate change, and their subsequent use for adaptation to climate change.

The findings of this CRVA study will be incorporated as experts' consultation/recommendations for enhanced implementation of the following existing and functioning institutions in the district:

German Red Cross implemented a BMZ funded EU DIPECHO project on cross-border disaster risk reduction, "Support for community based institutional structures for disaster risk reduction (DRR) in selected countries of the Central Asia region". In Tajikistan, the Disaster Risk Reduction Project targeted cross-border communities of Western Fergana Valley, namely Isfara and Jabbor Rasulov districts of Sughd province, identified the vulnerability of the community to natural disasters to enhance their capacity of the community to respond disaster reduction and emergency. In this context the Sughd regional branch of the Red Crescent Society of Tajikistan conducted a vulnerability assessment in the village of Kurgoncha, Jamoat Hayoti Naw in Jabbor Rasulov district. Results are documented in a report (in Russian)[11].

Being involved as part of consortium (Helvetas+GIZ+ACTED) for the Phase 1 of the Natural Water Resource Management Project (Phase 1 was completed by November 2018), ACTED developed Aksu DRR Watershed Management plans. The Plans were further integrated into local development processes which includes district and jamoat development plans. During Phase 2 (started by December 2018) of the above mentioned project ACTED is planning for replication of Aksu DRR Watershed Management Plan in Isfana Watershed (Aksu and Isfana two different watersheds). Based on successes and lessons learnt from Phase I, ACTED will replicate in Isfana Watershed the same inclusive, participatory approach towards natural resources management. This CRVA study can contribute to this project by incorporating the developed result into the community-based approach ACTED is following. In addition, the CRVA will assist in the assessment planned within the second phase of the IWRM project financed by SDC and implemented by a consortium of Helvetas, ACTED and GIZ estimation of water availability in zones and subbasins which considers climate change impacts; in developing of plans for water allocation.

Second CAREC Corridor 2 Road Investment Program focusing on Fergana Valley. This project reconstructs the Uzbekistan section of CAREC Corridor 2, which connects Uzbekistan to Afghanistan, Kazakhstan, the Kyrgyz Republic, Tajikistan, and Turkmenistan. This reconstruction will improve connectivity, road safety, and boost domestic and international trade. Currently, national and rural infrastructure planning and management frameworks do not require the integration of climate risk into infrastructure design and village development. The CRVA study can be considered for construction planning to avoid building roads in risky locations and putting both people and their livelihoods at risk.

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[10] https://link.springer.com/chapter/10.1007/978-3-319-72874-2_2

[11] https://eba.klink.asia/d/show/9e7a36ae-13e8-4dc4-b870-29ca0642cf0f

2.3 General description of Jabbor Rasulov district

The pilot study was conducted in Jabbor Rasulov district, located in northern Tajikistan in the Sughd region. Jabbor Rasulov borders with Kyrgyzstan in the South with which it shares the main Isfana watershed. The nearest city and main regional centre is the city of Khujand, about 20 km from the district centre (Figure 5).

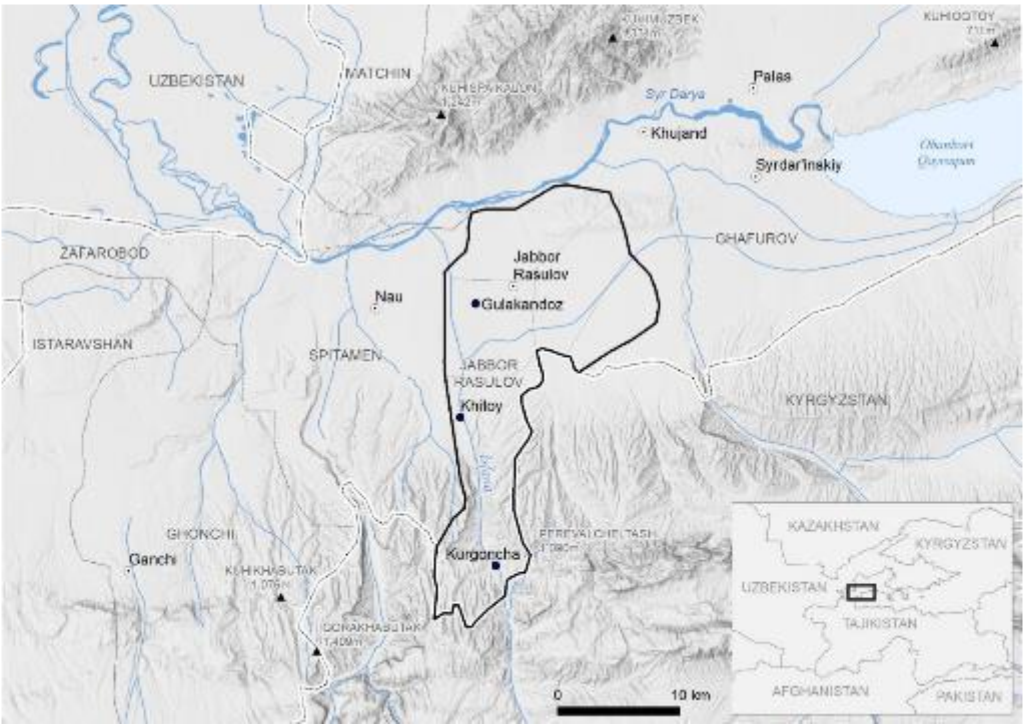

Figure 5: Location map of Jabbor Rasulov district (Eurac research)

Jabbor Rasulov district is located within the Syr Darya basin. The Isfana river, the main river in the district, originates in Kyrgyzstan, runs through the district and drains into the Syr Darya. Over a total area of 328.5 km^2 in this predominantly mountainous district, the elevation ranges from 311 to 1,391m a.m.s.l. The northern part is a fertile plain in the Syr Darya valley, where large settlements and the majority of the agricultural land are located. The district is economically developed and with the help of irrigation channels produces cotton, cereals, vegetables, melons and horticultural crops, there are light and food industries as well as trade[12]. The district consists of one urban-type settlement, Gulakandoz, and five rural communities (jamoats).

Climate

The location of the district in the westernmost part of the Fergana Valley determines the high winds throughout the year. The climate is subtropical, arid. Winter periods are short and mild with rare snowfalls. The average temperature in January is -3 to -5 °C. Strong dust storms can occur over the entire cold period. Summers are warm and for a long period it is hot and arid. On average the temperature in

[12] http://tojkiston.ucoz.ru/index/rajon_im_dzh_rasulova/0-51

the month of July is 31°C, with a possible maximum of 40°C. During those very dry periods strong dust storms and winds form, especially in the month of August. The area receives up to 140mm of precipitation, most of the precipitation falls during winter and in early spring[13].

Situational information

Within the district the pilot analysed the two jamoats located along the Isfana river, namely Gulakandoz in the northern plain and Hayoti Naw in the mountainous south of the district in detail. Gulakandoz is characterised by an urban-type settlement with a variety of economic activities. Agriculture is mostly irrigated. Within Hayoti Naw there are two smaller villages: Khitoy and Kurgoncha (see Table 1 for details). In Kithoy agricultural fields are irrigated by redirecting and channelling water from the Isfana river when it carries enough water between October and May. Agriculture in Kurgoncha is almost entirely rain-fed and thus wheat is predominantly grown. There is no cross-border water management set up with Kyrgyzstan. As was reported by workshop participants all three communities receive most income from local men working abroad. Kurgoncha is dependent on drinking water delivered by trucks. In the very hot and dry summer of 2018 community representatives reported losses of yields of up to 60 % mostly in the cotton and onion production in the Gulakandoz jamoat as those crops are least resistant to a lack of water. Harvest in 2018 year was early due to the anticipated vegetation period and unusual rainfalls in late summer. Strong winds during spring and autumn add the challenge of seedlings having to be replanted multiple times and fruit trees getting damaged.

In all three communities' the population is increasing. Kurgoncha for instance has experienced a growth in population of 20 % over 12 years[14]. Livestock rearing is also increasing in all three locations. Cattle and small ruminants (mostly goats) are herded over communal pastures. Additionally, pastures are temporarily used by livestock from other districts, including larger herds, crossing the pastures unregulated. Overgrazing is very evident on the mountain slopes, in particular close to settlements and roads, with a decreasing vegetation cover and land erosion due to animals moving along the slopes (see also photos in Annex). There are no plans, regulations or pasture committees in place within the district or across-districts. A lack of alternative employment opportunities and alternative ways of saving money, other than purchasing livestock, also leads to an increase of livestock and subsequently pasture overgrazing.

All three communities are potentially threatened by mudflows that happen on average twice a year, mostly in spring-time, occasionally in summer. Mudflows in Jabbor Rasulov usually originate upstream in Kyrgyzstan and get fed by tributary debris flows on the Tajik side. In the past mudflows have destroyed crops, washed away top soils, damaged agricultural machinery, blocked irrigation channels and roads and affected livestock. Overgrazing, degraded, deforested lands in Jabbor Rasulov as well as in Kyrgyzstan have exacerbated the risk of mudflows in frequency of occurring as well as in intensity. There is no warning system or cross-border cooperation in place regarding the risk of mudflows. In the 1960ies a large mudflow channel was built half way between Khitoy and Gulakandoz in order to gain fertile land in the Syr Darya plain thus directing the Isfana river artificially. The mudflow channel is cleaned from accumulated material every three to five years, however insufficiently since the accumulated material over the years has reached a thickness of 8 m. During mudflow events at the bend where the river course

[13] http://tojkiston.ucoz.ru/index/rajon_im_dzh_rasulova/0-51
[14] https://eba.klink.asia/d/show/9e7a36ae-13e8-4dc4-b870-29ca0642cf0f

was redirected northwards the eastern riverbank gets heavily damaged and eroded by debris and water. As a consequence every mudflow carries away bank protections, not-withstanding material and the channel is widened significantly (approximately 5 m every year) as it tries to follow its natural riverbed running northeast. The main road and water pipeline in close vicinity to the eastern bank are at risk of being washed away by future mudflow events.

In the 1960s the construction of a 60 m high dam was planned before the road tunnel just to the south of Khitoy. The dam was never built. Current plans by Tashkent University estimate that such a dam would mitigate the mudflow risk and solve the water shortage problems for the settlements located downstream from it.

Table 1: Information for the three villages within the two Jamoats as provided by workshop participants

Jamoat/Settlement	Population	Livelihoods
Gulakandoz jamoat (383m a.m.s.l.) consisting of six villages and 18 malhallas	46,000	- Agriculture (total 7,700 ha of which 3,360 ha irrigated): cotton (2,000 ha), vegetables, grains; 360 farms with 20-25 members each - Livestock: sheep (40,000), cattle (7,000) - horticulture in greenhouses (lemons) - brick factory, carpet production, shops, e.g. for building material (200 shops) - young men (2,800) work abroad and send remittances - 12 women teams (20 – 26 members in each) work in agriculture and with livestock (paid daily)
Khitoy (655m a.m.s.l.)		- Agriculture (250 ha irrigated Oct to May): mostly wheat, some cotton - Livestock rearing - Women teams pick cotton in other districts - Clay quarry for bricks (cold) – delivered to brick factory - Silk from worms fed with leaves from mulberry trees
Kurgoncha (933m a.m.s.l.)	5,000	- Agriculture (5,000 ha rain-fed, 34 ha irrigated): wheat, fruit orchards (100 ha): apple, apricot, quince, peach) - Livestock pastures - Borrow pit for glass production (sand mostly sold to Uzbekistan) - 30% of workforce working abroad sending remittances

Most important ecosystem services in the region are

- fodder provision and erosion protection from healthy grasslands (closed vegetation cover),
- erosion protection and slope protection form forests (only in Kyrgyzstan some patches of forest remain),
- water storage and water provision from snow in the mountains as well as from natural ecosystems and soils (grasslands, forests)
- food and cash crop provision from agricultural fields.
- riverbank protection by trees along the riverbed

2.4 Climate Information available

2.4.1 Temperature and precipitation

Due to the short period of this consultancy, no own data analysis could be performed. However, some information is available.

- The monthly climate data for the period from 1961-2017 of the HydroMet service from Sughd oblast (see Figure 6) shows a clear peak in temperature in summer with average temperatures around 25°C. Peak of precipitation is in spring, with an absolute peak in April. Summer month (June – September) are very dry with average precipitation sums below 5mm. Projections for changes provided by Hydromet on a monthly scale (unclear source and time frame) indicate increasing temperatures throughout the year with a stronger warming in summer than in winter. Precipitation shows a decrease in early spring and in increase in April and autumn.
- The IPCC regional atlas[15] indicates a clear trend for enhanced warming for Central Asia of 3°C (average RCP 4.5) to 6°C (average RCP8.5). Precipitation shows no significant trend, neither for the past nor for the future. Results show a slight, but non-significant trend for an increase in winter and a decrease in summer.
- For the station in Khujand, data from IPCC GCMS downscaled by the "climate data factory"[16] indicates similar trends. An increase in average annual temperature by 3°C (average RCP 4.5) to 5.4°C (average RCP8.5) and no trend for precipitation in any scenario (see Figure 7 and Figure 8).
- Hydromet Kyrgyzstan produced climate change scenarios for 2021-2051 for Jalal-Abad showing an annual average minimum increase of temperature of 1°C (25th percentile for the RCP4.5 scenario) and a maximum of approximately 2°C (75th percentile for RCP8.5 scenario). Precipitation shows no clear trend (annual change of precipitation ranges from -13 to +21%).[17]

Climate scenarios catch well trends in average temperatures, but available information on average precipitation is much less reliable and scenarios do not agree on trends (see above). Due to the local character of extreme precipitation events they are mostly not represented in global climate models (with raster resolutions of > 100km) or regional climate model (with resolutions between 12,5 and 50km). The missing representation of extreme precipitation events is a general limitation of climate models. To include such events, a much higher resolution of below 5km and a more complex consideration of local specifics (e.g. luv-lee effects in mountains) would be required. However, the general assumption that heavy precipitation events will get more frequent and more intense with climate change is supported by general meteorological mechanisms (higher temperatures → more energy within the systems) and should be considered in a risk assessment, but can, as for most other regions of the world, not be supported by observation data or climate model output.

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[15] https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_AnnexI_FINAL.pdf
[16] https://theclimatedatafactory.com/
[17] https://eba.klink.asia/d/show/495c4ea4-fdd4-4b7b-9d79-afa1c9f023f8

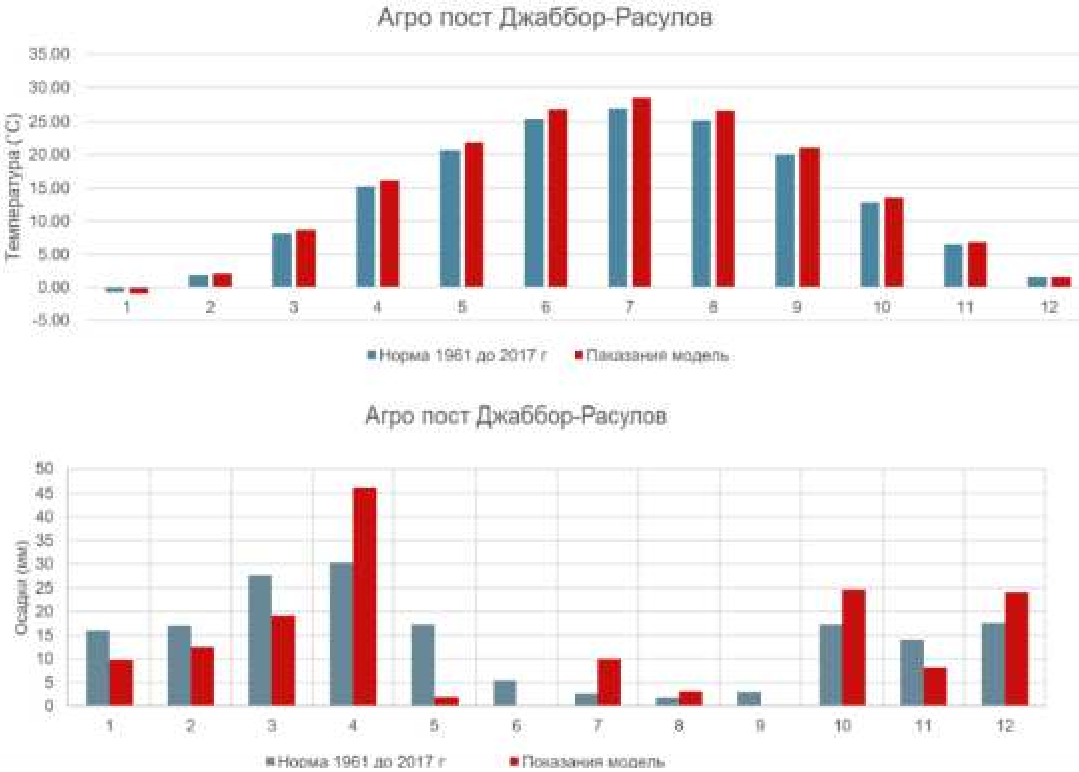

Figure 6: current monthly profiles (blue) for average temperature (top) and precipitation (bottom) for the period from 1961-2017. Future projects (source unclear) in red. Information from weather service of Sughd HydroMet service.

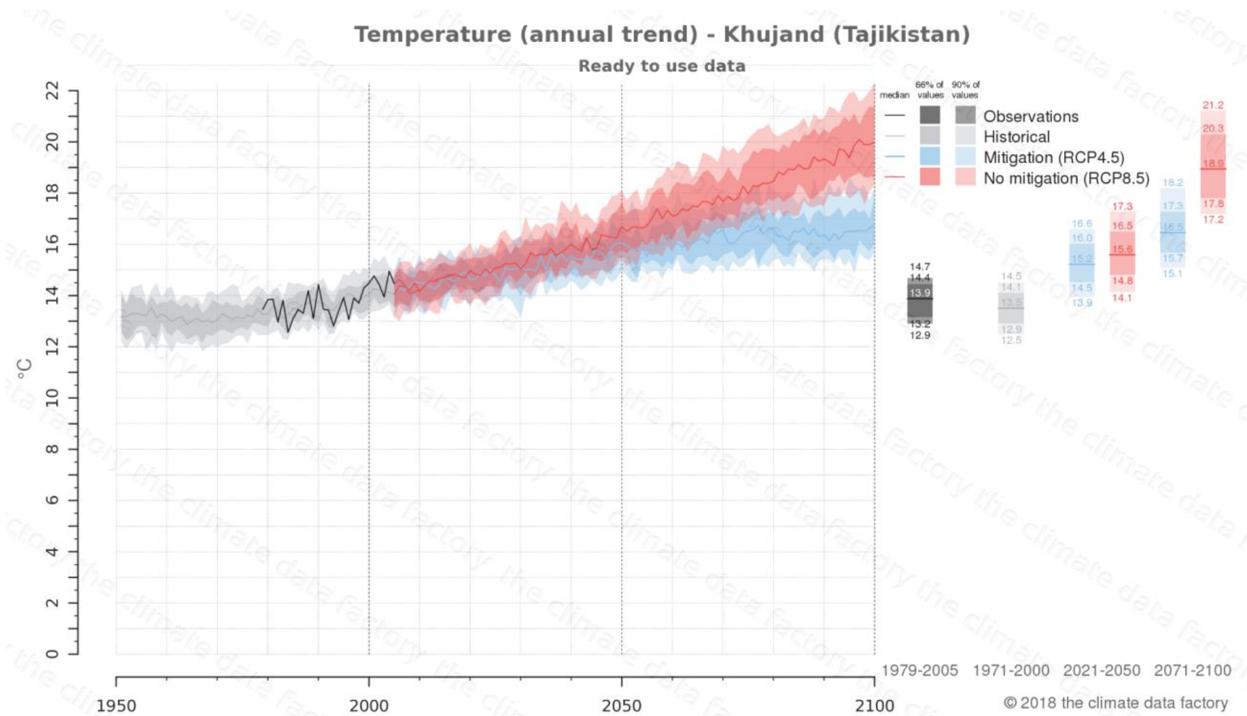

Figure 7: Climate data and scenarios for Khujand. Downscaled and bias corrected from climate data factor: annual mean temperature.

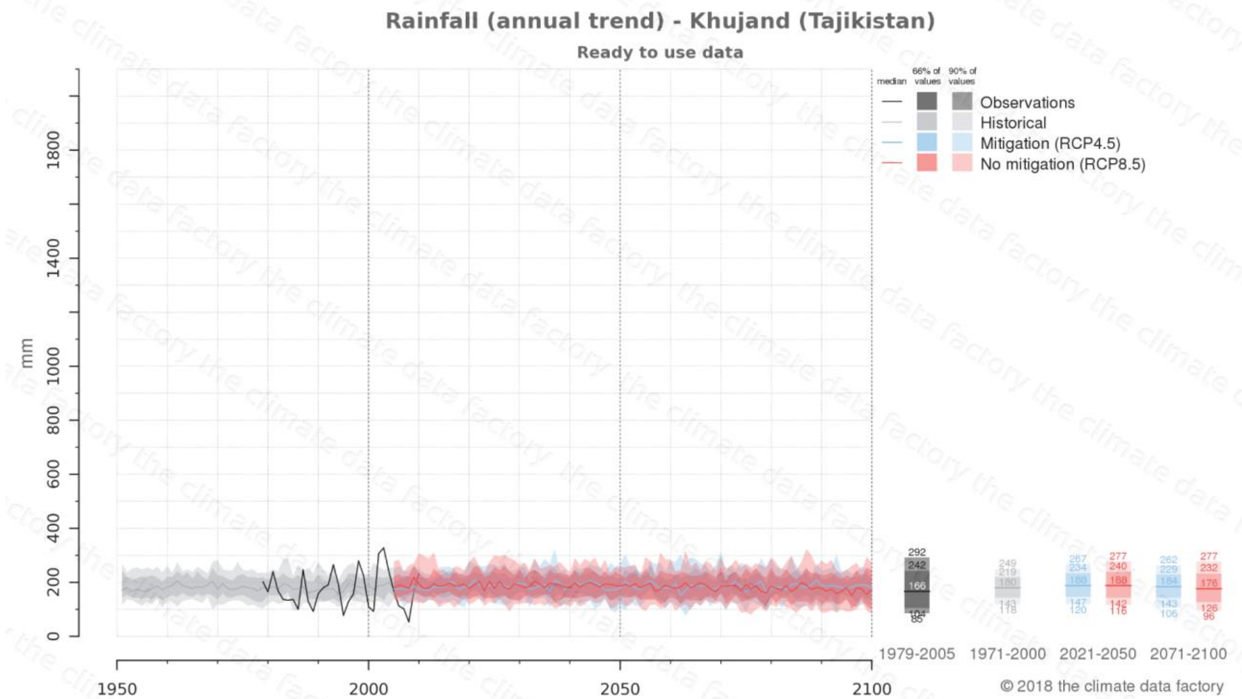

Figure 8: Climate data and scenarios for Khujand. Downscaled and bias corrected from climate data factory. Annual sum of precipitation

2.4.2 Droughts

As an arid to semi-arid area, the region has always been sensitive to meteorological droughts. There are different well-established drought indices for monitoring droughts. The Standardized Precipitation Index (SPI) indicates precipitation anomalies over defined time intervals. Negative values show periods drier than normal, positive values show periods wetter than normal. The SPI12 (12 month anomaly) for Khujand (see Figure 10) shows dry and wet periods, but no trend over for the period 1971 – 2018. In addition, other papers confirm no trend in precipitation deficit. Potentially the region is even getting slightly wetter. Better suited for understanding the risk for agricultural droughts is the SPEI (Standardised Precipitation-Evapotranspiration Index), which includes the effect of increased temperature on evapotranspiration loss. There is no analysis on SPEI done for Fergana Valley, but comparison between SPI and SPEI for Central Asia indicate a trend towards more droughts using SPEI, while the SPI shows no trend for the region (Figure 11). This indicates a potentially increasing risk of meteorological droughts due to rising temperatures.

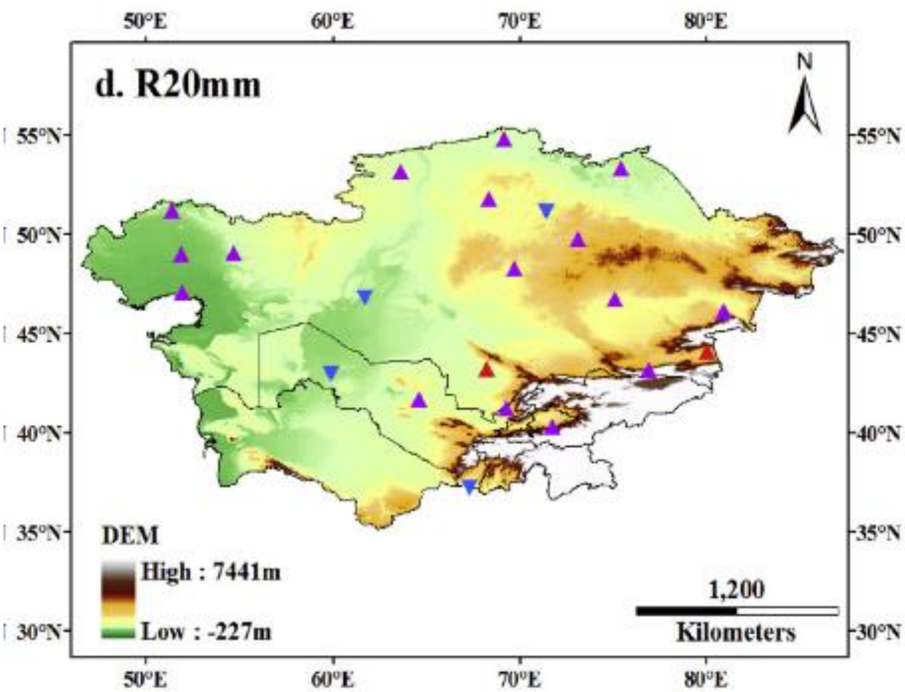

Figure 9: Trend 1938 – 2005 for number of days with more than 20mm precipitation for selected weather station. black down-pointing triangle: negative trend and statistically significant; blue down-pointing triangle: negative but not statistically significant; purple up-pointing triangle: positive trend but not statistically significant; red up-pointing triangle: positive and statistically significant trend. Source: Zhang et al (2017)[18]

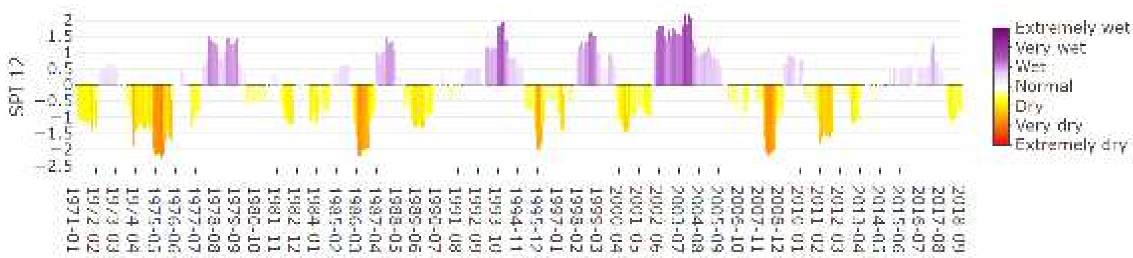

Figure 10: Drought index SPI 12 for the period from 1971 – 2018 for Khujand. Source: JRC global drought monitor[19]

[18] Man Zhang, Yaning Chen, Yanjun Shen, Yupeng Li, Changes of precipitation extremes in arid Central Asia, Quaternary International, Volume 436, Part A, 2017,

[19] http://edo.jrc.ec.europa.eu/gdo

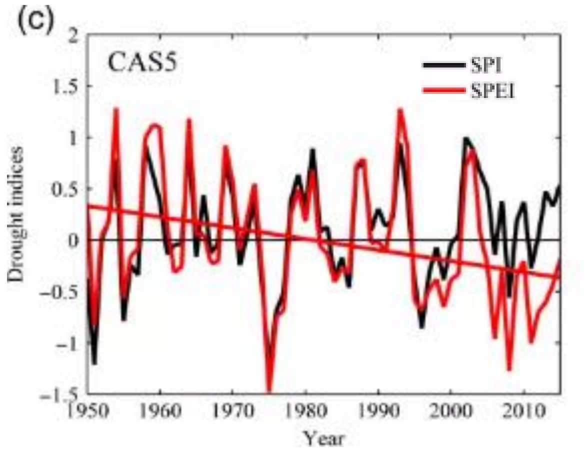

Figure 11: Two drought indices for Central Asia in comparison: black - SPI (only precipitation anomaly) and red - SPEI (including evapotranspiration losses). The effect of increasing drought risk due to increasing temperature is visible in SPEI starting from the year 2000. Source: Hu et al, 2018[20]

2.4.3 Further Steps

A further in-depth analysis should be performed about climate data availability. Potential data sources and limitation are:

- Data for local stations which are important to identify current climate extremes and past trends as well as for downscaling climate scenarios are available from Hydrometeorological services, but with some restrictions regarding temporal resolution and long time series (data has to be purchased). Furthermore, they are usually located in the main valley and do not represent the mountain climate, where some of the climate related hazards start (mudflows triggered by heavy rain events). Data could be complemented by stations from Kyrgyzstan.
- Climate scenarios exist for Central Asia through the CORDEX Central Asia[21]. These data are not bias corrected, but climate change signal can be extracted from this data. It has to be checked if in the scope of existing initiatives this data has already been bias corrected. A bias correction for stations in Fergana Valley would be recommended. Methods for bias-correction and downscaling should be adapted to be able to analyse extreme events.

Out of this data, appropriate climate indices for main triggers could be calculated

- For drought, indices such as the SPEI (The Standardised Precipitation-Evapotranspiration Index) or the climatic water balance could be calculated
- For heavy rain events, indicators such as "# of days > 50mm precipitation" could be calculated. Different thresholds should be tested, since climate scenarios as well as station data (depending on the measurement technique) tend to significantly underestimate heavy rain events.

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[20] Hu, Zeng-Yun & Chen, Xi & Chen, Deliang & Li, Jianfeng & Wang, Shuo & Zhou, Qiming & Yin, Gang & Guo, Meiyu. (2018). "Dry gets drier, wet gets wetter": a case study over the arid regions of Central Asia. International Journal of Climatology. 10.1002/joc.5863.

[21] http://www.cordex.org/domains/region-8-central-asia/

2.5 Climate Risks

During the workshops and the following analysis three main climate risks have been identified to be relevant for the region:

- Risk of damage to roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electric grid), agricultural fields and livestock due to mudflows triggered by heavy rain events.
- Risk of loss of agricultural yield, decreased quality, decreased grassland and livestock productivity, soil salinity, lack of drinking water due to droughts and high temperatures
- Risk of loss due to damage of houses (roofs), infrastructure (electricity lines), trees (orchards), agricultural fields (wind erosion, seedlings) and health (dust, trauma) due to strong wind followed by untimely rains.

All the findings are first order hypothesises based on the available information we collected during the pilot study. Most of these assumptions would need a further proof by external data, further field visits and external experts. The study would also benefit from an additional workshop and field visit in the upper part of the watershed in Kyrgyzstan in order to gather local understanding, assess issues at hand and potential adaptation measures, cross-check findings and test the potential for a trans-border cooperation. The general results are fixed as narratives and impact chains. Work on indicators and potential adaptation options is preliminary. Results are presented as tables in the Annex.

2.5.1 Risk of damage to houses, roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electric grid), agricultural fields, livestock due to mudflows

2.5.1.1 Current situation and impact chains

Mudflows in the riverbed of Isfana river as well as from tributary gullies and mountain slopes lead frequently to damages to houses, roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electric grid), agricultural fields in the vicinity of river and gullies. A potentially increase of mudflow events as well as damage by mudflows has been reported by local stakeholders, but data or independent information to prove this increase was not available during pilot study. The consequences of mudflow are damage to and destruction of houses, roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electric grid), agricultural fields, and livestock. Roads may be blocked hours to few days. In case of a damage to bridges, provisional back-up solutions (e.g. Ural lorry to cross the river) are put into place. We did not get aware of any number of damages, which would allow to better understand the relation between hazard and damages. **The main factor which leads to this specific are summarised in the impact chain** (Figure 14 and the text below)

Hazard events are triggered by heavy rains in the upstream part of Isfana river (Kyrgyzstan and Tajikistan), mostly in spring (Figure 14: Impact chain for). It is not clear, if the potential increase of mudflow events is triggered by an increase in heavy rain events. A detailed analysis of climate data is still missing, but it is expected that a proof of an increase in heavy rain events for the past as well for future scenarios will be difficult (see also chapter 2.4 on climate information).

Erosion and mudflow have to be considered as **intermediate impacts**, since they are not just caused by the heavy rain events (the primary hazard), but also by land degradation (part of vulnerability, see below). According to stakeholders (workshop 2), “most of the mudflow comes from Kyrgyzstan”. Observations from the field and statements from external experts (Alois Schläffer) question this statement. Already the size of the riverbed in Kurgoncha compared to Gulakandoz, but also large sediment streams and erosion between Khitoy and Kurgoncha indicates that several tributaries on the Tajik side of the border contribute to run-off and most likely also to sediment flow and mudflows. Many of these tributaries also originate in Kyrgyzstan, however, satellite images show degraded areas on both sides of the border. These effects also call for further investigation and cross-border interventions at the watershed level.

Exposed elements include houses, roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electricity network), agricultural fields in the vicinity of river and gullies. Caused by population growth and remittance flows the exposure to hazards has increased in the last 20 years due to new houses, increasing number of agricultural fields and new infrastructure (irrigation, power lines). Also, the feeder road to Kurgoncha and its infrastructure (bridges, drainage) is highly exposed to mudflows wherever the road crosses the river, where it is close to the riverbank or crosses erosion gullies (see report on roads in Annex). This **increase in exposure** over the past 20 years is one obvious reason for an increased risk of damage to roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electric grid), agricultural fields and livestock due to mudflows.

However, the main root-cause for increasing risks from mudflows seems to be the high and increasing **vulnerability** of the region.

According to all the information we collected, we assume that degraded **ecosystems** (land degradation caused by overgrazing and deforestation in both countries) lead to degraded **ecosystem services**, namely reduced erosion protections and slope stabilisation increase the susceptibility of the catchment to mudflows. This **land degradation** caused more intense **sediment flows and mudflows in case of heavy rain events.** This process may be the most important reasons for an increased risk related to mudflows. It is mainly caused by an increased number of livestock and missing pasture management. Also transiting livestock from other regions was reported as a reason for overgrazing.

The second most important cause for a high vulnerability may be the **inappropriate construction and maintenance** of roads, bridges, riverbanks, riverbed, and mudflow channels. The field visit revealed, that mudflow channels are not cleaned frequently enough. Roads are not stabilized enough, the dimension and construction of road draining when crossing gullies is not appropriate. For mudflow control, only short-term solution exists (e.g. redirecting the mudflow). Riverbank enforcement is inappropriate and insufficiently maintained. Additional technical as well as green solutions (trees along the riverbank) are missing. Another factor to consider is **excavation of the riverbed by locals** to source building material. For more details see the report of the field visit by Jonathan Demenge in the Annex.

Reasons for the inappropriate construction and maintenance of transport infrastructure and river protection structures are mainly **a lack of capacities such as financial resources, management resources and a lack of knowledge**. Overgrazing is in addition caused by a lack of an effective pasture management.

Also, the **lack of any appropriate monitoring or early warning system** is contributing to the vulnerability of the region. The fact that the villages under consideration are located downstream the Isfana river means early warning would provide half an hour to an hour in advance in case of a mudflow.

Several **socio-economic factors affect the vulnerabilities factors**. Population growth as well as income from remittances (30% of the labour force work abroad) in combination with a lack of money saving possibility such as a reliable bank system lead to an increasing number of livestock which in turn leads to an increase in land degradation. Poverty and a lack of employment opportunities lead to an overall lack of capacity to cope and adapt.

Risk hots spots (Figure 12) are all houses, roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electricity grid), agricultural fields in the vicinity of river and gullies. Furthermore, an area north of Khitoy where a mudflow channel built during the Soviet period redirects mudflows making the area prone to mudflows as the river tries to follow its natural course. The mudflow channel built at Soviet Times (1960's) to redirect mudflow towards west to gain land for agriculture is not maintained properly and full of sediment (only cleaned every 3-5 years). Consequence: mudflow tries to follow its original riverbed and destroy riverbank, irrigation infrastructure agriculture and road.

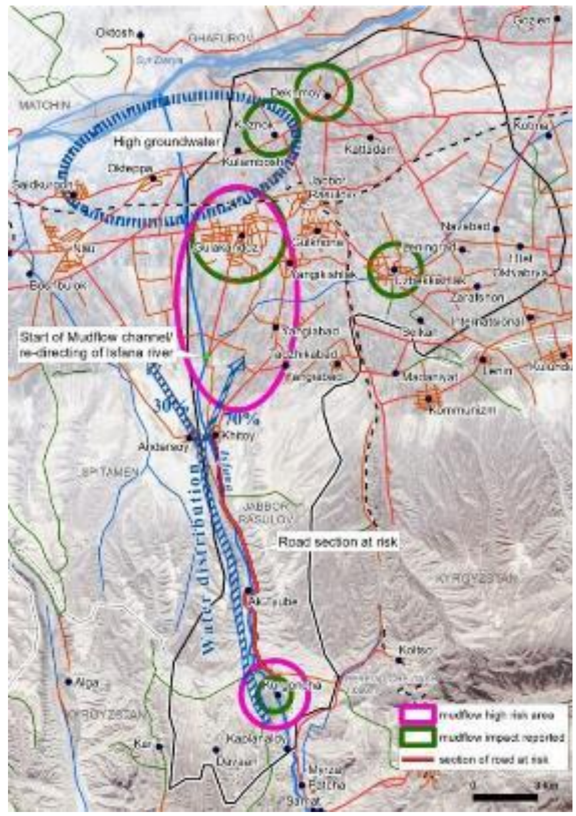


Figure 12: Risk hot spots according to experts and stakeholders (result from workshops)

The detailed map showing potential risk zones for mudflows in Kurgoncha prepared by the German Red-Cross for emergency response provide further indication about potential risk zones. The map was developed based on on-site visits and local knowledge (Figure 13).

Figure 13: Map with potential risk zones for mudflows (red) and emergency response options (shelters, meeting places) (Source: German Red Cross)

2.5.1.2 Potential future situation (until 2050)

Hazard: As mentioned in the climate chapter, a sound and data driven information about an observed or projected trend towards an increasing frequency or intensity of heavy rain events is hardly deductible. However, following the precautionary principle and the often-cited general assumptions about "more energy in the system", a potential increase in heavy rain events should be considered. Hence, future risk *could* increase due to a higher intensity and/or frequency of heavy rain events.

Exposure: If the trend towards new buildings, new livestock and new agriculture fields in potential risk zones continues, risk will potentially further increase in future. On the other side, exposure could be potentially reduced by a proper land planning process.

Vulnerability: maybe most relevant for the future situation is the further development regarding the vulnerability factors. If land degradation proceeds, the risk for mudflows will most likely be aggravated. Since land degradation is a process which can hardly be reverted, this factor might be the most critical for future development and for potential adaptation measures. The further development regarding the inappropriate construction and maintenance of roads, bridges, riverbanks, riverbed, mudflow channels is unclear, but can be potentially improved by a proper management and enough resources for management of this infrastructures. Appropriate adaptation measures improving the management and maintenance of infrastructure are most likely effective measure to reduce the risk of damage to infrastructure.

2.5.1.3 Potential indicators

For a complete risk assessment, indicators need to be identified for the most important factors for all three components (hazard, vulnerability, exposure) for risks. Furthermore, it need to be understood if impact observations or models exist for intermediate impacts (mudflow, erosion) as well as damages. For all selected indicators, potential data sources need to be identified. Data source can be quantitative (e.g. weather data, official statistics, surveys) or qualitative (expert information).

Within the scope of the pilot study, we could only start to identify potential indicators (see Table 2 for an excerpt and Annex 6.1 Impact chain mudflows – factors for the full list). For a full assessment, this table should be further elaborated, most important indicators should be prioritized, and data and information collection should be started.

2.5.1.4 Potential Adaptation options

Adaptation options are, strictly speaking, not part of a CRVA, but should be identified and developed as a parallel process. Hence, we cannot provide sound recommendations as part of this study, however from the preliminary risk assessment some potential adaptation measures are obvious (Annex 6.1):

- Combating land degradation due to overgrazing (e.g. pasture management committees, fencing, pasture plans, …)
- adaptation options focusing on risk hot-spots
    - Riverbank stabilisation (green: planting trees along the banks, grey: construction of technical protection measures)
    - Improvement of the resilience of road infrastructure (e.g. drainage, bridges, slope stabilisation) and other critical infrastructure (irrigation, electric grids) to be less vulnerable to mudflows and erosion.
    - Improved maintenance and renewal of hazard mitigating infrastructures such as mudflow channels and riverbank enforcements
    - See also further targeted measures to renovate and improve road and water management infrastructure in the field report by Jonathan Demenge in Annex 6.5
- capacity related measures:
    - Capacity building measure to increase knowledge in water and land management, strengthening local institutions and self-governance (water and pasture committees, district level departments)
    - Measures to improve monitoring and data availability on meteorology, climate, hazard impacts as well as contributing factors (e.g. livestock density, status and maintenance of infrastructure, presence of exposed elements in risk zones, …)

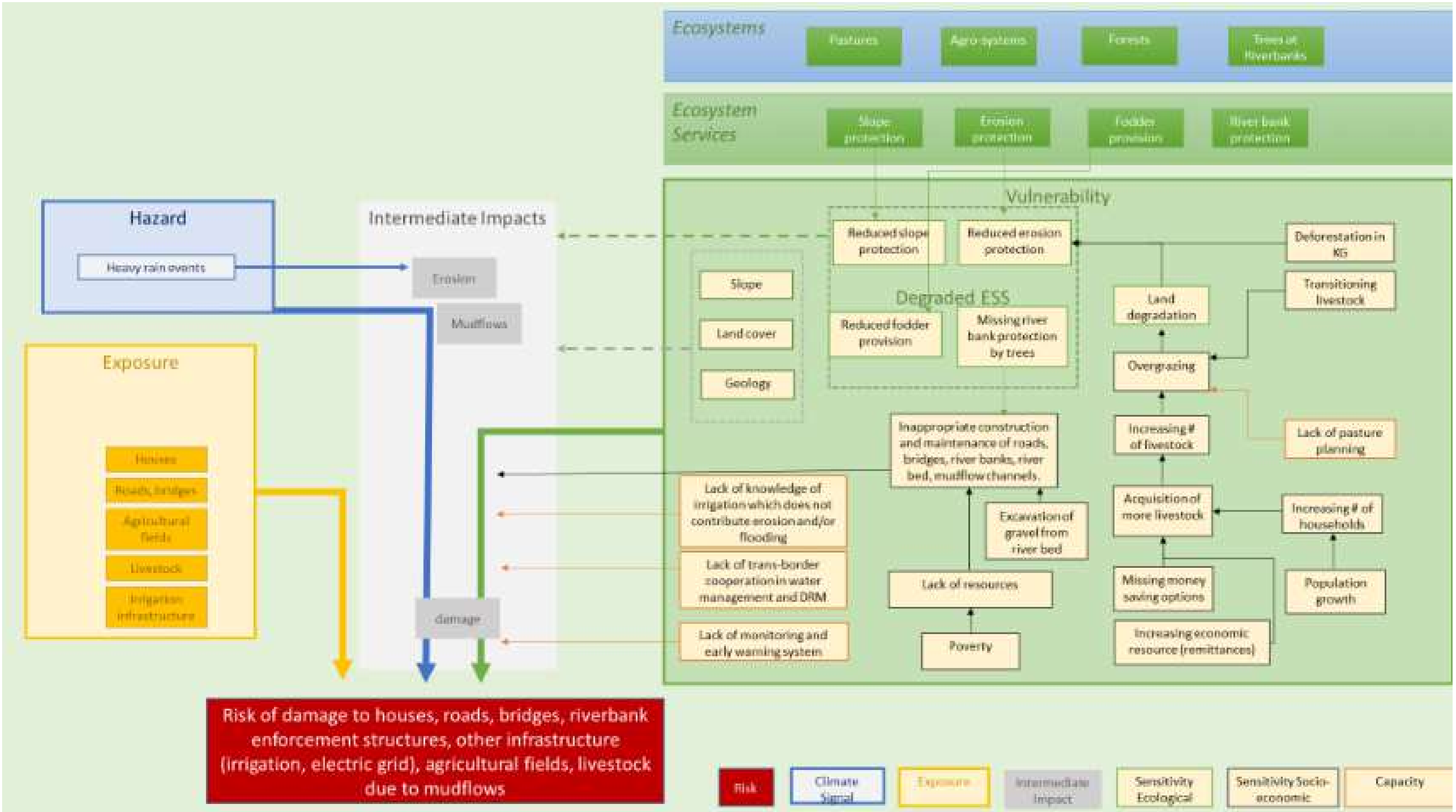


Figure 14: Impact chain for risk of damage to houses, roads, bridges, riverbank enforcement structures, other infrastructure (irrigation, electric grid), agricultural fields and livestock due to mudflow

Table 2: Excerpt of factors, potential indicators, and potential data sources for risk of damage due to mudflow. Full list Annex 6.1.

Component	Factor	Potential Indicator	Potential Data Sources (today / future)
Hazard	Heavy rain events	# days with >50mm	Today: potentially Hydromet, but data has to be paid. Khujand station not representative Future: Climate scenarios but do not represent well heavy rain.
Vulnerability factors influencing intermediate impact	Slope, land cover, soil type, geology…	Slope [°] Soil type Land cover type Geological type	Slope: SRTM Soil: soil institute? Land cover? (from satellite?) Geology? Institute for geology
Intermediate impact	Mudflow	Volume of mudflow (m^3/s)	Model? (based on factors)
Vulnerability – Ecological Factors	Degradation of land	-Satellite based vegetation indices and vegetation cover	Does such a study exist?
Vulnerability – Socio Economic Factors	Overgrazing	-Density of livestock per pasture ha? or per Jamoat?	Agricultural department?
Vulnerability – technical factors	Inappropriate construction and maintenance of roads, bridges, riverbanks, mudflow channels, …	-Long-term solution exist? -Gully well drained -% of riverbank enforced	- Interview: where and why inappropriate infrastructure. - Road department with inventories? - Water department with inventories? - HELVETAS? (water infrastructure)
Vulnerability – Socio Economic Factors	Population growth – increasing number of households → new fields, more livestock.	# of population (Jamoat) # of area cultivated	Webpage of District. Data available through state agency for statistic?
	Lack of pasture planning (no pasture committees`)	Pasture committee exists (y/n)	Information from MSDSP?
Vulnerability – Capacity Factors	Lack of early warning system	Early warning system exists (y/n)	Committee of Emergency Situation (CoES)
	Lack of trans-border cooperation (early warning, water management, livestock management, DRR,	Trans boundary cooperation among emergency departments (y/n) Forest management and erosion control (y/n)	ACTED? -Ministries of Emergency Situation (CoES) in Kg and Tjk? -Forest departments on oblast level in Kg and Tjk
	Missing resources for maintenance (money and labor)	Specific budget for maintenance and reinforcement available (y/n)	CoES, water department
Exposure	**Houses** (vicinity to river / gullies)	Number of houses in vicinity of river	Local government? Manual mapping from google maps
	Households / people (vicinity to river / gullies)	Number of people / households in vicinity of rivers	Estimate from number of houses
	Roads and bridges – vicinity to river or when crossing mudflow gullies	Presence of road and bridges	Road data exists. Bridges – from Open Street Map (OSM) + manual completion
	Agriculture field - vicinity to river / gullies	Ha of agricultural field in vicinity of river	Manual mapping from google maps – or automatic classification from satellite data

2.5.2 Risk of loss of agricultural yield, decreased crop quality, decreased grassland and livestock productivity, soil salinity, lack of drinking water due to droughts and high temperatures

2.5.2.1 Current situation and impact chains

Drought and heat related risks have not been the initial focus of the pilot study. Consequently, less information on this risk was available beforehand. However, during the discussion in the team, the workshops and field visits we came to the conclusion, that drought and heat related impacts on agriculture and water availability are already a quite relevant climate risk within the region. Summer temperatures in 2018 showed a record of up to 50°C during day time. Yield losses of up to 60% (cotton, onions) as well as loss of livestock in summer 2018 due to heat, water scarcity and poor pasture quality have been reported by the stakeholders. Furthermore, a decrease in quality of crops (e.g. tomatoes) and a scarcity of clean drinking water with related health problems have been reported to be a frequent impact of droughts and heat within the region.

Another important factor which contributes to droughts could be a reduced snow cover and an early snow melt in the mountains (of Kyrgyzstan) which leads to more water in winter (more rain, less snow) and spring and less water in early summer. This is based on assumptions and would need to be proven in a more in-depth study.

Most important, the risks related to drought and the risks related to mudflow might even be linked, since drought impact on pastures and agricultural fields increases land degradation and may lead in consequence to a higher susceptibility towards erosion and mudflow.

Therefore, we decided to include the risk of drought into the preliminary risk assessment and generated an impact chain for this risk (Figure 15).

Similar to the mudflow case, the risk has also a trans-border component, since the Tajik part of the catchment depends on water from upstream regions in Kyrgyzstan. Even if there is no reservoir or dam in Kyrgyzstan, according to stakeholder statements extensive water extraction on the Kyrgyz-side of the catchment reduces water availability on the Tajik side.

The region has a system of irrigation channels. For the pilot study it was impossible to get any detailed information on how well the system works and how well maintained it is. It was just clear, that some problems are related to water distribution and not to missing water in general. In the pasture areas, it was reported that no reservoirs exist. The whole situation of the existing water availability, water demand and water management would need further investigation. However, our assumption is, that water management is an important field of adaptation with several green and technical options for water harvesting.

Hazard: The hazard is extreme heat in combination with an absence of precipitation during summer month. While precipitation was always rare in summer, summer temperature is constantly rising with climate change. We assume that evapotranspiration increases due to increasing temperatures leading to meteorological droughts. For the pilot study, there was no time to prove this with data, but existing studies (see chapter 2.4.) indicate a potential trend towards more meteorological droughts, if evaporation losses due to higher temperatures are considered

The consequences (**intermediate impacts**) of a meteorological drought are, depending on vulnerability factors (such as soil, crop type, availably of irrigation, …) **agricultural drought** which then leads to loss of yields as well as **water scarcity** (for irrigation, livestock and humans).

The **vulnerability factors**, which contribute to the risk are partly overlapping with the risk for mudflow.

We assume that **land degradation** aggravates the impact of a meteorological drought by already providing less water storage, less fodder and less crop yield than healthy pasture and agro-ecosystems. Therefore, all factors which have been identified as contribution to land degradation from chapter 2.5.1 have been included into the impact chain.

Furthermore, the **type of agriculture** plays an important role. We assume that rain-fed agriculture is more vulnerable than irrigated agriculture. On the other hand, irrigation is only less vulnerable as long as water supply from ground water or irrigation channels is sufficient and the irrigation system is well maintained and efficient (water saving techniques such as drip irrigation should be preferred).

Soil, particularly in the lowlands have a high infiltration capacity and a low water retention capacity, which makes them particularly vulnerable.

The water management infrastructure is outdated and not well maintained. Water saving technology is missing.

The following capacity factors play an important role

- Missing financial resources to invest in more drought resistant crop cultivars.
- Missing financial resources and knowledge to improve water management
- Missing insurance schemes and missing financial resources for agricultural insurances
- In general, missing financial resources, partly due to decreasing remittances from Tadjik migrant workers in Russia.

Exposure factors include the presence of exposed elements such as agricultural fields, pastures, livestock and humans.

Risk hots spots could not be identified in the scope of the pilot study. This would require a mapping of vulnerability factors (soils, overgrazing), more understanding about the state of the water distribution, irrigation system and about past impacts (yield data in correlation to heat and water availability).

2.5.2.2 Potential future situation (until 2050)

Hazard: due to a robust agreement on further raising temperatures, it is very likely the heat events like in summer 2018 will become more frequent. Due to a lack of precipitation in summer already under current situations, we assume that meteorological droughts become more frequent and more severe in future. This could only be compensated by a general tendency towards more precipitation as it is projected in some scenarios. A hotter climate will also amplify the effect of less snow and more rain in winter and early snow melt leading to more water in winter and less water in summer in the rivers.

Vulnerability: maybe most relevant for the future situation is the further development regarding the vulnerability factors. If land degradation proceeds, the risk for droughts will most likely be aggravated. Since land degradation is a process which can hardly be reverted, this factor might be the most critical for future development and for potential adaptation measures. The further development regarding water management is unclear but can be potentially improved by a proper management and enough resources for water management. Appropriate adaptation measures improving the management and maintenance of water are most likely effective measures to reduce the risk of damage to infrastructure.

Exposure: If the trend towards increasing number of livestock and new rain-fed agriculture fields continues, drought risk will potentially further increase in future. For agricultural fields, exposure could be potentially reduced by an introduction of proper and water-saving irrigation systems.

2.5.2.3 Potential indicators

For a complete risk assessment, indicators need to be identified for the most important factors for all three components (hazard, vulnerability, exposure) for risks. Furthermore, it needs to be understood if impact observations or models exist for intermediate impacts (agricultural drought, water scarcity) as well as damages. For all selected indicators, potential data sources need to be identified. Data source can be quantitative (e.g. weather data, official statistics, surveys) or qualitative (expert information).

Within the scope of the pilot study, we could only start to identify potential indicators (see Table 3 and complete list in Annex 6.2). For a full assessment, this table should be further elaborated, most important indicators should be prioritized, and a data and information collection should be identified and started.

2.5.2.4 Potential Adaptation options

- Combating land degradation due to overgrazing (e.g. pasture management committees, fencing, pasture plans, …)
- adaptation options focusing on risk hot-spots
  - Renovation and upgrade of water management infrastructure for agricultural field (e.g. irrigation channels, upgrade towards drip-irrigation)
  - Introduction of water efficient irrigation for rain-fed agriculture
  - Water saving and water harvesting activities for pasture (reservoirs)
  - Improvement of drinking water supply for villages
  - Road runoff harvesting and road-side tree plantations to increase soil moisture and decrease evaporation
- capacity related measures:
  - Capacity building measure to increase knowledge in water and land management, strengthening local institutions and self-governance (water and pasture committees, district level departments)
  - Measures to improve monitoring and data availability on meteorology, climate, hazard impacts as well as contributing factors (e.g. livestock density, status and maintenance of infrastructure, presence of exposed elements in risk zones, …)

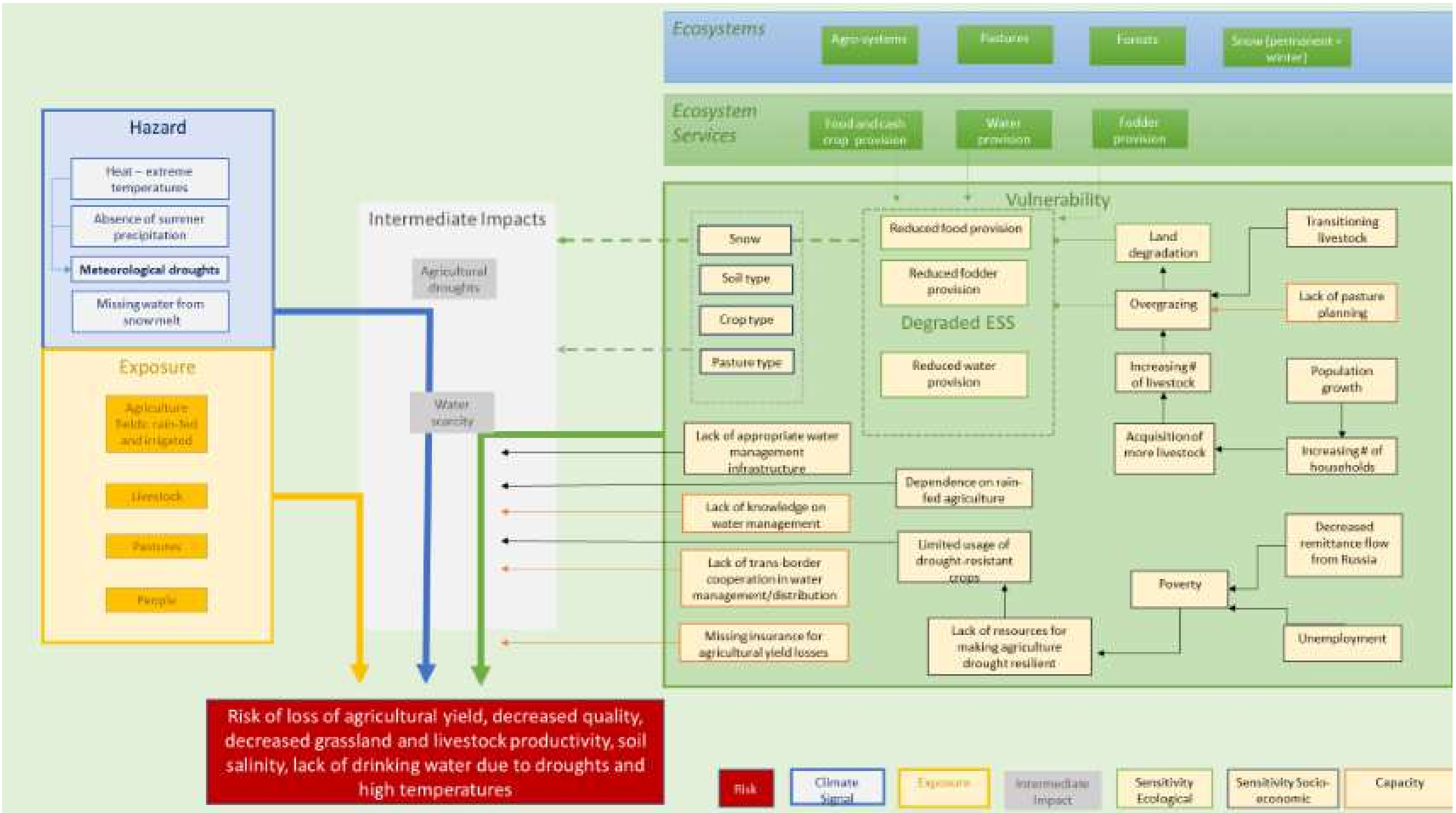


Figure 15: Impact chain for the risk of loss of agricultural yield, decreased crop quality, decreased grassland and livestock productivity, soil salinity, lack of drinking water due to droughts and high temperatures

Table 3: factors and potential indicators for the risk of loss of agricultural yield, decreased crop quality, decreased grassland and livestock productivity, soil salinity, lack of drinking water due to droughts and high temperatures. Data sources could not be evaluated in the scope of the pilot study.

Component	Factor	Indicator
Hazard	Heat – extreme temperature	# days with T > 40°C
	Absence of summer precipitation	# days with p = 0mm
	Meteorological droughts	Climatic water balance, SPEI
Intermediate impact	Agricultural drought	Soil moisture anomaly (from satellite data - ESA CCI)
Vulnerability – Ecological Factors	Dependence on Rain-fed agriculture (more vulnerable than irrigated)	% of agricultural area dependent on rain-fed agriculture
Vulnerability – technical factors	Lack of appropriate water management infrastructure (pipes, dwells, water reservoirs, leakages)	m/km of irrigation infrastructure
Vulnerability – Socio Economic Factors	Population growth – increasing number of households → new fields, more livestock.	# of population (Jamoat) # of area cultivated
	Poverty (Decreased remittance flow from Russia unemployment	Remittance share of GDP (which administrative level?) – -unemployment rate
	Lack of pasture planning (no pasture committees`)	Pasture committee exists (y/n)
Vulnerability – Capacity Factors	Lack of knowledge on water management (water saving irrigation, water storage…)	# and existence of water management specialist
	Missing insurance for agricultural yield losses	# of farmers with insurance
	Lack of resources for making agriculture drought resilient (irrigation, drought resilient crops)	# trainings on drought resilient agriculture $ financial support for drought resilience
	Lack of trans-border cooperation with Kyrgyzstan (on water distribution)	Trans-border cooperation exist? (y/n)
Exposure	Agriculture field -irrigated -rain fed	Ha of agricultural field
	Livestock density	# of livestock
	pastures	Ha of pastures
	People	Number of people

2.5.3 Risk of loss due to damage of houses, infrastructure (electricity lines), trees (orchards), agricultural field (wind erosion, seedlings), health (dust, trauma) due to strong wind.

2.5.3.1 Current situation and impact chains

In general, the risks related to strong wind are less relevant than the risks related to mudflows and droughts. Stakeholders reported that frequently strong winds hit the region in spring and autumn with windspeed of up to 30m/s. The consequences are damages at houses (roofs) but also damages to orchards (trees collapse) and to fields which are freshly sown. Furthermore, strong winds contribute to soil erosion, contribute to droughts (hill tops are often dry and barren) and the resulting dust is obscuring road traffic and also related to health issues. Damage to buildings can also cause traumata. Wind can also damage powerlines.

Wind erosion has a connection to land degradation as one of the common causes for climate related risks in the area. The connection is twofold: Wind erosion increased land degradation and degraded land is more susceptible to wind erosion.

Hazard: during the pilot study, we did not discover data related information on wind. However, standard data from the climate station in Khujand should include wind as a standard parameter. But wind in a side valley might be very specific and the station in Khujand not representative for wind. During the site visit we noticed tilted trees clearly showing strong winds in a dominating direction.

Vulnerability: Damage by strong wind on buildings is very much related to poor building material, which is related to missing financial resources. New houses built with support of remittances are often built from better material and are more resilient to wind. A decrease of remittances reduces the capacity to build storm resilient houses.

Exposure: exposed are all houses, powerlines, agricultural fields with no vegetation and orchards.

2.5.3.2 Potential future situation (until 2050)

Hazard: Increasing intensity and frequency of storms is maybe the least proven potential effect of climate change of all climate extremes. Again, the often-cited "more energy in the system" hypothesis motivates the assumption that the intensity and frequency of strong winds might increase, but until there is hardly any evidence for most regions of the worlds. Climate scenarios, as for precipitation extremes, are not able to represent the physics and the scale of storms correctly and are therefore not representing storms very well.

Vulnerability and Exposure: a future development can hardly be projected, but if we assume potentially a growing wealth of the region, at least the capacity to build houses and powerlines in a storm-resilient manner is likely to increase.

2.5.3.3 Potential indicators

See table in Annex 6.3

2.5.3.4 Potential Adaptation options

The main adaptation is to provide resources (financial mean, material) and knowledge (training) for storm resilient construction of buildings and infrastructure. Tree lines and hedge rows placed in strategic locations (e.g. on hill tops and along roads) could protect agricultural fields from wind erosion and to some extent from the impacts of droughts. They provide multiple other advantages for livelihoods, biodiversity, sun protection, dust control and moisture control.

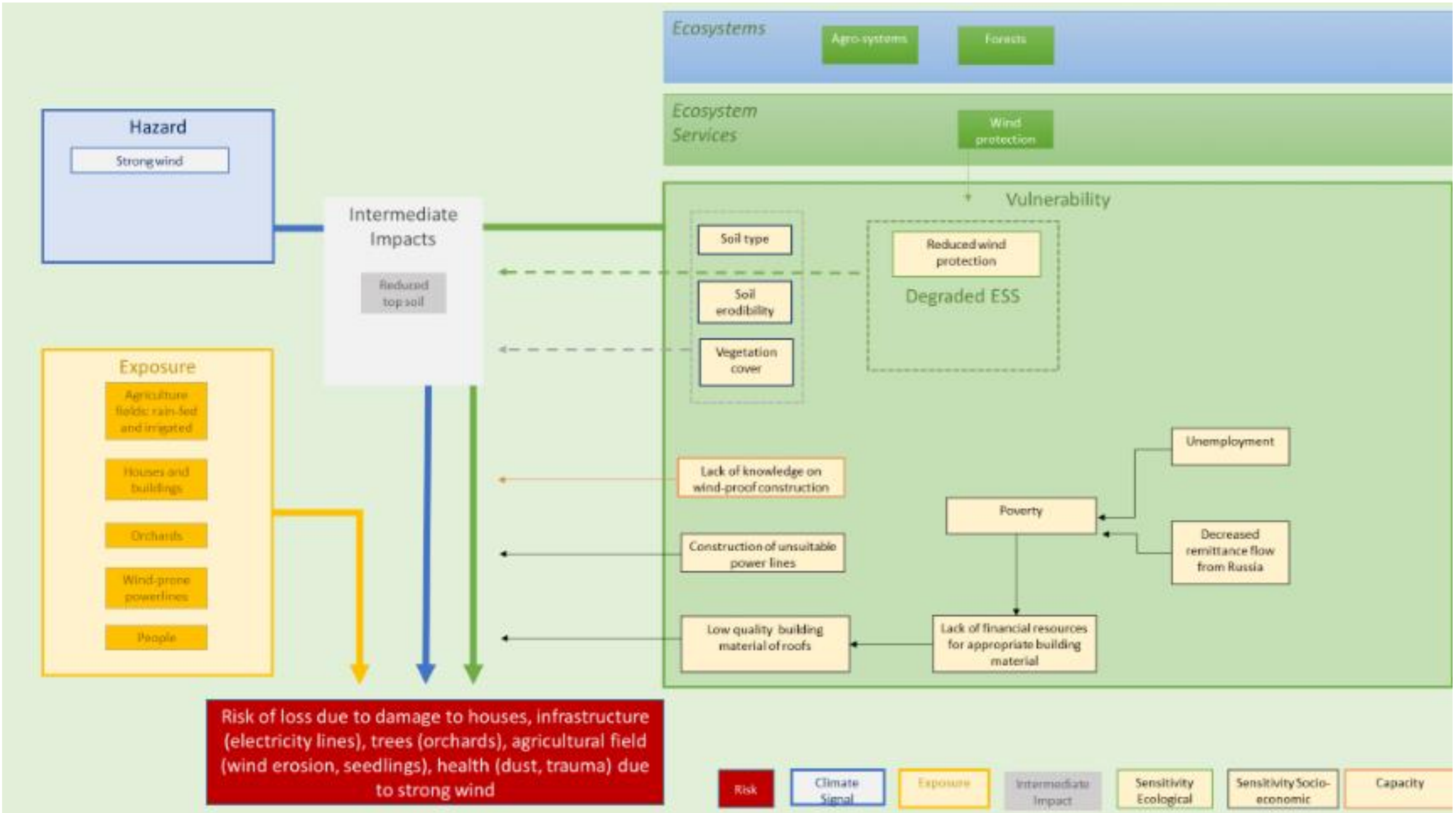


Figure 16: impact chain for risk of loss due to damage of houses, infrastructure (electricity lines), trees (orchards), agricultural field (wind erosion, seedlings), health (dust, trauma) due to strong wind.

3 Missing information, next steps towards a complete risk assessment and learnings from the pilot

The pilot study with its effort of less than one month could only set the scene for an in-depth CRVA. A full assessment of the region would take between 5-6 additional month. In the following we are summarizing in bullet style the steps, which would be necessary for a full assessment.

3.1 Missing information and working steps per module

Module 1: Preparing the Risk Assessment. Module 1 is relatively well covered. Missing aspects include:

- More in-depth review about existing data (climate, statistical data on livestock, population) and in information on past hazards and damages (when, what, why, how much damage)
- Missing baseline data for the region
  - Soil and geology in the full Isfana catchment (as an important factor to understand mudflow susceptibility and groundwater flows and recharge)
  - Land cover and land-cover history (deforestation, new agricultural fields). A potential data source for this would be time series of satellite data.
- Better integration of relevant decision makers, who would afterwards be responsible partner for adaptation measures (local authorities for roads, water management, agriculture, …)
- Clearer picture on the role of Ecosystems and related Ecosystem Services within the catchment.
- Better understanding of the history and the process of overgrazing and land-degradation. Which are the key factors which led to this development?
- For the risk assessment, appropriate spatial units for the risk assessment might be chosen (e.g. municipalities)
- For the future, a defined 30year period should be chosen as reference (e.g. 2031-2060) to analyse climate scenarios.

Module 2: Developing impact chains. Impact chains are well developed. What is missing is a review of impact chains with external experts. We extended the concept of impact chains of the EbA Guidebook by adding two additional boxes showing ecosystems and services provided by those ecosystems relevant for the risk under consideration.

Module 3: Identifying and selecting indicators. Here, we only started to select indicators. The right sequence would be:

- Prioritize factors of relevance for which indicators should be defined. For one risk, the number of indicators should not be much more than ten.
- Define indicators according to data availability.
- Define the methods how information for the indicator could be generated. Consider also non-data driven approaches (e.g. expert based assessment with yes/no or categories from 1-5). Examples for non-data driven approaches could be an expert survey with the key question: “are pasture management plans in place (y/n)”.

Module 4: Data acquisition and management

- Define appropriate spatial units for the assessment (raster cells, municipalities)
- For climate data: collect information from climate stations of the area and bias-corrected climate scenarios from CORDEX Central Asia. Quality check information and compute appropriate climate indices (e.g. # days with > 20 mm precipitation, SPEI, …) (see also chapter 2.4.3)
- Check global data as well as local data
- Consider expert interviews as an alternative or complementary source of information. Semi-qualitative assessments by experts can be performed with the help of defined categories (e.g. from 1=optimal to 5=critical).
- For land degradation, droughts and mudflows we propose to test data driven approaches based on satellite data and models (see next chapter 3.2).

Module 5 - 7: Normalisation of data, weighting and aggregating of indicators, aggregating risk components to risk. Once data and information are collected for appropriate sub-units (e.g. municipalities), the further steps follow the instruction in the Risk Supplement and the Guidebook on Climate Risk Assessment for EbA.

The identification of adaptation option is, in a strict sense, **not part of a CRVA**. A CRVA is an analytical step to identify climate risk and the underlying causes to prepare the selection of adaptation options. However, it makes definitely sense to combine a CRVA with the identification of adaptation options. See for instance recommendations of the "Guidance note for planning, contracting and effective backstopping of a Climate Risk and Vulnerability Assessment".

3.2 Specific option to generate data with models and satellite data

3.2.1 Modelling erosion, sediment- and mudflows – hazard indication maps

Within the pilot study in a seminar with Stefan Steger (Eurac Research) the general option to model gravitational events such as erosion and mudflows were discussed. It can be summarized, that there is no existing simple solution to model such processes on larger scales in a data scarce environment with moderate resources. Existing approaches for hazard maps are either resource intensive and only suitable for smaller regions (physical models) or they are rather static and do not consider climate as a trigger (statistical models – hazard indication maps). In both cases, models require data on observed hazards and impacts to train, calibrate and validate the models.

Stefan Steger proposed the following modelling approach to generate climate sensitive hazard indication maps :

- A dataset for validation could be generated by information on past erosion and mudflow events from local authorities and experts as well as from satellite data (erosion and mudflow areas)
- The modelling approach could be a statistical susceptibility model, combined with a simple model of gravitational processes computing mudflow release likelihoods.
- The units for modelling could be sub-catchments (see Figure 17: Possible spatial reference units for modelling sediment- and mudflow) instead of raster cells to reduce computational effort.

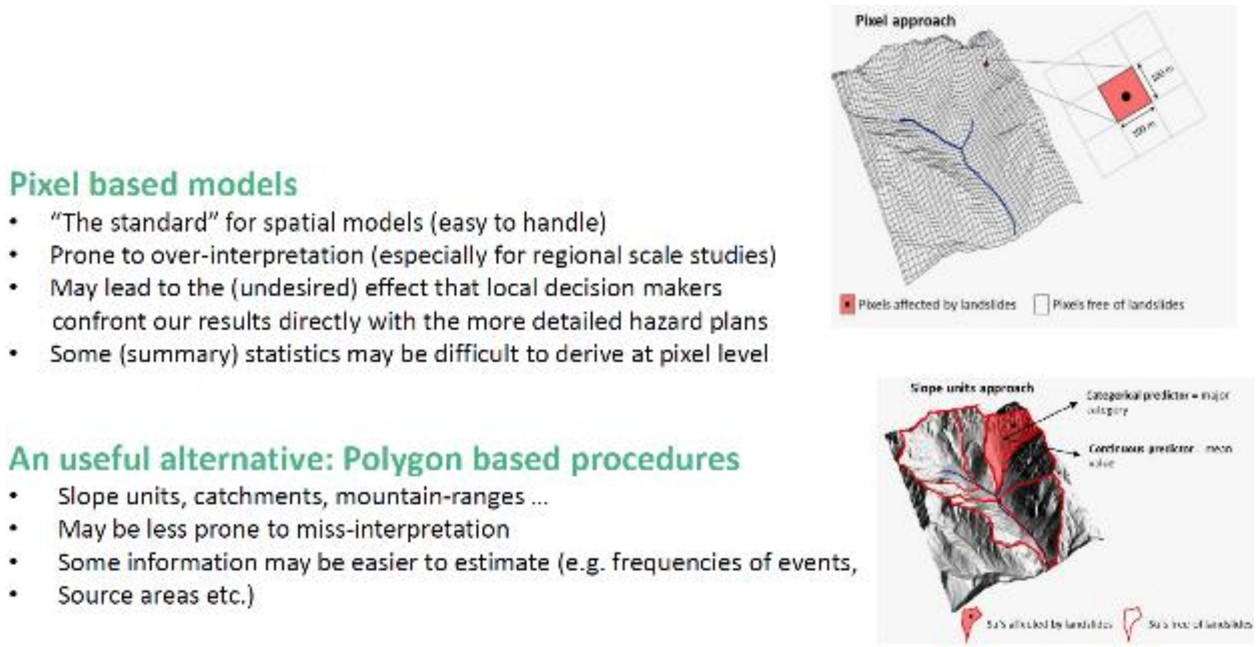


Figure 17: Possible spatial reference units for modelling sediment- and mudflow

3.2.2 Analysing land degradation as one of the root-cause for increased vulnerability

Land degradation due to overgrazing is one of the most important single factors for increased vulnerability. A potential approach to identify past trends and areas, which are affected by land degradation is the use of time series of satellite data. With the Normalized Differential Vegetation Index (NDVI) a robust index for vegetation vigour exist. Time series of satellite data exist since the late 70's which could be used to identify regions with a decreasing trend of NDVI over the last 40-50 years as a proxy for overgrazing. Such information could be translated into semi-quantitative information (1=optimal state, no degradation to 5=critical state, strong degradation) for an assessment or used as input for statistical sediment flow models (see above).

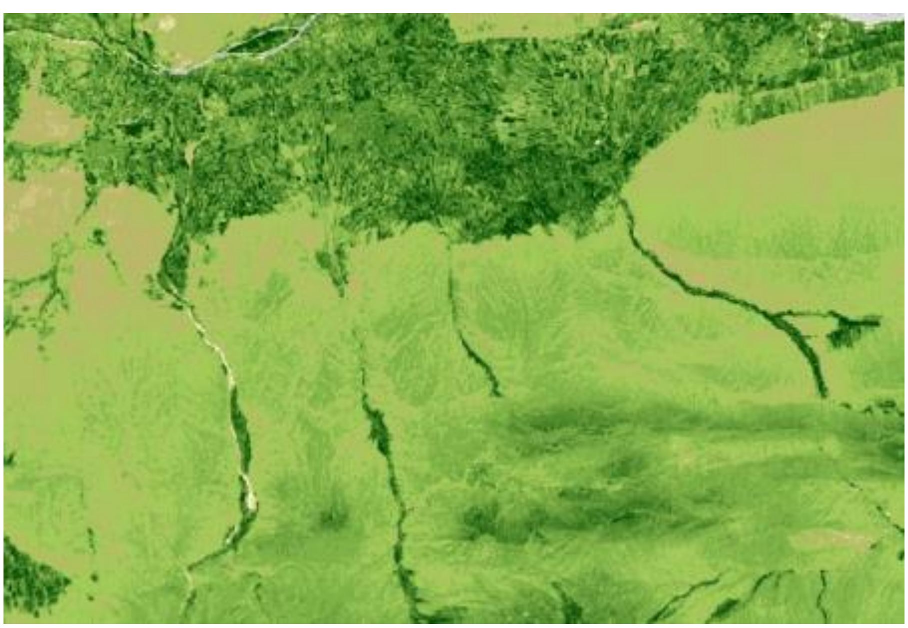


Figure 18: Example of NDVI calculated from Landsat 8 scene from 29.06.2018. Khujand is in the upper right corner, Kurgoncha in the centre of the image. Source: Sentinel Playground. https://apps.sentinel-hub.com/sentinel-playground

3.2.3 Further learnings from application of the CRVA concept in the pilot study

- Climate change aggravates existing risk situations. To analyse potential future risks, it is very important to understand the current climate risks and their complex root-causes.
- Climate related risks are triggered by climate, but vulnerability and exposure factors are more important to explain variations, trends and local hot-spots of risk. Consequently, information on vulnerability and exposure factors is essential for a CRVA.
- The concept of expert discussion and workshops proved to be very useful to reveal specific constellation of an area which lead to a risk (which cannot be revealed with a top-down or purely data driven approach)
- Local officials (e.g. head of Jamoats) might have biased perception on root causes of risk ("it all comes from Kyrgyzstan"). Evidence suggested that participants were not entirely confident to raise problems in front of authorities and heads of Jamoats. It may be useful to find a way of separating power relations and local politics when conducting such an exercise. An assessment should therefore be conducted with independent experts with good local knowledge and understanding of the mechanism of risk (land degradation, pasture, water and disaster risk management).

Overall Summary: A good CRVA…

- is targeted to the context of the project in which it is embedded (scale, sectors and topics, stakeholder, …)
- is designed as an integral part of an adaptation process (clear link to adaptation planning and ongoing adaptation activities)
- takes time, for stakeholder involvement and gathering data (8 month for a targeted assessment, one to three years for an assessment on national scale)
- is organised in an interdisciplinary and participative manner involving international and local experts as well key stakeholder and decision makers
- is not only an assessment but also a capacity building activity
- considers vulnerable groups, gender issues, green solution (Ecosystem based Adaptation – EbA)
- is combining quantitative approaches with qualitative and expert based approaches
- is presented in a concise way to key stakeholder and decision makers with key messages and appealing visuals (impact chains, maps)
- is mainstreamed into and capitalized for national and local (adaptation) planning processes
- can serve as a requirement and motivation to access funding for adaptation (Green Climate Funds – GCF, nationals funds)

Figure 19: Conclusions on what a good CRVA is. From Zebisch M, Renner K (2018) Guidance note for planning, contracting and effective backstopping of a Climate Risk and Vulnerability Assessment (CRVA), Eurac Research, Bolzano, Italy, internal GIZ Report

4 How to upscale to larger areas

4.1.1 Can the results for Jabbor Rasulov be transferred to larger areas?

Only parts of findings of the pilot study are representative for Fergana Valley, since the focus of the pilot study was mainly on a side valley with specific risks (e.g. new unpaved feeder road to shortcut old road which leads through Kyrgyzstan, valley dominated by pastures with overgrazing). We expect that approaches and results might be transferable to similar side valleys of Fergana valley, but not to the plains with its intensive irrigated agriculture.

Missing elements for the plains might be

- Risks for irrigated intensive agriculture (cotton, sun-flowers, …) such as droughts, pest- and diseases, etc.
- Impact on ground water quantity and quality (salinisation)
- Direct impact on health due to heat

4.1.2 Methodological considerations for a CRVA of Fergana Valley

As for the pilot study for a small side valley, we expect that also for the larger Fergana Valley data on hazards and vulnerability factors is scarce, not harmonised, of varying quality and difficult to access. Therefore, we propose also for the larger area a mix of data driven methods using indicators and qualitative approaches based on workshops and expert's assessments.

For droughts, land-degradation, erosion and sediment flows **model-based approaches** to derive **hazard indication maps** and the use of **satellite data** could be tested. In this context the **DKTI project** could potential help in collecting the required data for the model input, in particular hazard event data. We recommend to conduct a survey within the frame of the DKTI project, elaborating the datasets needed for modelling and monitoring CRVA activities.

When working in a larger geographic area **a two-scale approach might be considered**. **At a finer scale**, case studies for selected sub-regions representative for the different landscape types in the Fergana valley could provide an in-depth understanding of key risks and their mechanisms. **Impact chains could be developed and indicators identified**. Based on these representative case study impact chains and indicators, conclusions could be drawn for the whole Fergana Valley. Furthermore, we assume that also for a larger area, **up-stream and down-stream relations** across administrative borders and countries will need to be considered and that a **trans-national**, watershed-based approach needs to be followed.

Also for a larger area, please consider that the **identification of adaptation options** requires **additional expertise** (different expertise that is required for a CRVA) and extra **time**, since the identification of adaptation options is not strictly part of a CRVA.

Overall, we recommend to consider roughly one year to elaborate an in-depth CRVA for the Fergana Valley with a focus on risks related to land degradation, erosion, mudflows and droughts.

5 Comparison between Open Standards-based method for Ecosystem-based Adaptation (OS-based EbA) and Climate Risk and Vulnerability Assessment for Ecosystem-based Adaptation methods (CRVA for EbA)

By Gulbahar Abdurasulova, UNIQUE forestry and land use GmbH

The Open Standards-based method for planning and implementing Ecosystem-based Adaptation (OS-based EbA method) and the Climate Risk Vulnerability Assessment for Ecosystem-based Adaptation (**CRVA for EbA**) are methods for conducting an assessment on climate change impacts. Both methods have been applied in the context of Central Asia. The OS-based EbA method is based on and adapted from the Conservations Partnership's Open Standards for the Practice of Conservation, the leading adaptive management framework in the field of biodiversity conservation and sustainable ecosystem management. The EbA method has been applied and tested in the pilot watersheds in Kyrgyzstan and Tajikistan within the framework of the regional project on Ecosystem-based Adaptation in High Mountainous Regions of Central Asia implemented by GIZ on behalf of the Federal Ministry for Environment, Nature Conservation and Nuclear Safety of Germany (BMU). The CRVA for EbA method has been piloted in Jabbor Rasulov district, Tajikistan (Steps 1 – 3)[22].

The aim of the current section is to present the comparison between the two methods (including the underlying concepts behind AR4 and AR5), the lessons learned from the application of the CRVA method in Jabbor-Rasulov district, and areas for future consideration. The piloting of CRVA revealed that both vulnerability and risk perspectives can be captured in one assessment, that the ecosystem perspective can be further enhanced[23] within the impact chains tool, and identified the need to elaborate further the adaptation options as a next step after the CRVA assessment.

OS-based EbA and CRVA for EbA methods in a nutshell

Both methods offer systematized guidelines and defined steps to carry out an assessment on climate change impacts (*Table 4* and *Table 5*). The methods collect bottom-up qualitative information, top-down quantitative data, make use of geospatial information, develop future climate scenarios, define indicators for baseline and monitoring, and present the results of the assessments in cause-and-effect chains, also known as impact chains (CRVA) and/or theory of change including result chains (EbA method).

Table 4: OS-based EbA method steps

Step 1	Define thematic and geographical scope
Step 2	Describe the current and desired state of ecosystems
Step 3	Identify conventional and currently observed climate change threats to ecosystems

[22] See Chapter 1 and Chapter 2 for the context of piloting, steps undertaken and the main findings of the climate risk and vulnerability assessment in the Jabbor-Rasulov district.

[23] Note: The Climate Risk and Vulnerability Assessment for Ecosystem-based Adaptation was developed with the ecosystems perspective. The experience from the pilot application in TJK showed that this can be further enhanced.

Step 4	Understand vulnerabilities of ecosystems and communities to climate change
Step 5	Summarize the socio-economic and ecological situation
Step 6	Re-evaluate project scope and goals
Step 7	Identify and select interventions that reduce community vulnerability
Step 8	Implement, monitor, adapt and learn

Source: GIZ 2018.

Table 5: CRVA steps and key means of implementation

Steps	**Key means of implementation**
1. Preparing the risk assessment	Desktop-based; correspondence and interviews with experts and relevant actors
2. Developing impact chains	Desktop-based and workshops with experts for the thematic area(s) at stake; other relevant actors
3. Identifying and selecting indicators for risk components	Desktop-based and workshops with experts for the thematic area(s) at stake.
4. Data acquisition and management	Desktop-based; data acquisition through data transfer, data analysis, expert interviews, questionnaires, etc.
5. Normalisation of indicator data	Desktop-based; experts for the thematic area(s) at stake (particularly for the threshold definition)
6. Weighting and aggregating indicators	Desktop-based
7. Aggregating risk components risk	Desktop-based
8. Presenting and interpreting the outcomes of the risk assessment	Desktop-based for the preparation, dissemination events for the presentation
9. Identifying EbA options	Desktop-based; workshop with key actors for strategy development and planning

Source: GIZ, EURAC & UNU-EHS 2018.

Vulnerability and risk perspectives (AR4 and AR5)

While both methods are designed to conduct assessments for climate change impacts, the major difference has been the terminology used in the underlying conceptual frameworks. The EbA method derives its framework from the IPCC[24] AR4 concept of *vulnerability*, whereas the CRVA method is based on the later IPCC AR5 Working Group II concept of *climate risk* (*Figure 20*). Applied in practice, the objective of the vulnerability assessment within the EbA project has been the development of community-based EbA adaptation strategies for the project pilot watersheds. *Vulnerability* has been defined as a combination of exposure to climate change impacts and other non-climatic threats, sensitivity to climate change and adaptive capacity. The CRVA method focuses on the concept of climate *risk,*[25] understood as a potential consequence, of the interaction of vulnerability, exposure, and hazard.

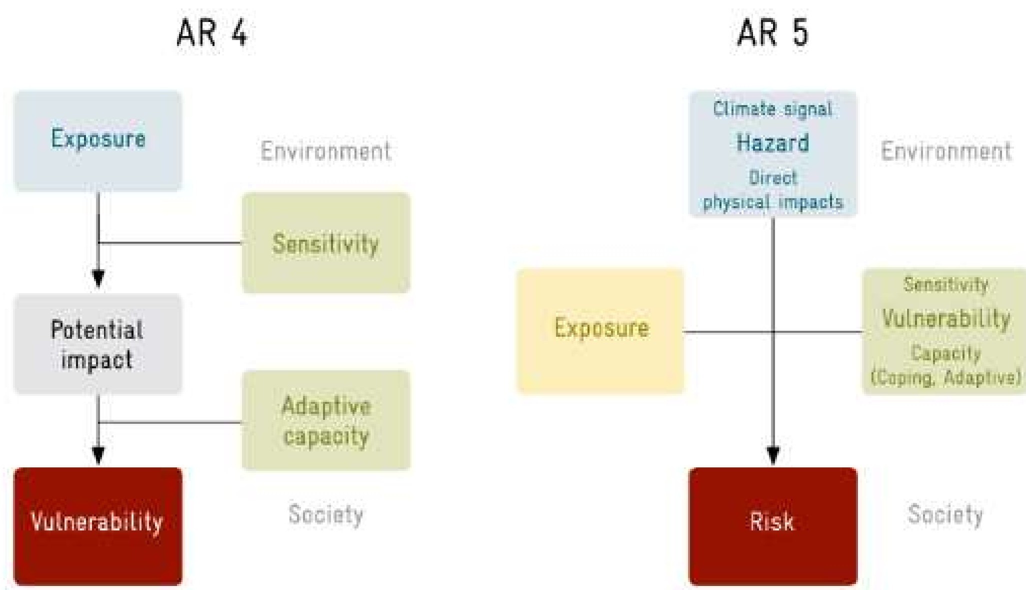


Figure 20: Conceptual frameworks for vulnerability (AR 4) and risk (AR 5) from the IPCC Reports.

Table 6 presents how the AR4 terminology has been translated into the AR5 concepts: the risk concept has replaced the concept of vulnerability. In the CRVA method, vulnerability includes sensitivity and adaptive capacity and the term hazard has replaced exposure. In the [*Risk Supplement to the Vulnerability sourcebook*], it is proposed to treat physical impacts triggered by a climate hazard (e.g. a heavy rain event) as "hazard". They are treated as "hazards" if they cannot be influenced by adaptation measures within the system (e.g. a flood entering a socio-ecological system from outside) or as "intermediate impact" if they can be influenced by the socio-ecological system under consideration (e.g. mudflows triggered by heavy rain but also caused by overgrazing, which could be decreased). In the CRVA method, the concept of vulnerability is broader and includes not only ecological sensitivity (i.e. degraded forests, soils, pastures, etc.) but also socio-economic sensitivity (i.e., weak institutions, poverty, lack of knowledge and

[24] The Intergovernmental Panel on Climate Change (*IPCC*) is the international body for assessing the science related to climate change.
[25] The risk framework seeks to link the adaptation community with the disaster risk community. For more information, see the *Risk Supplement to the Vulnerability Sourcebook* (GIZ&EURAC 2017).

technologies, etc.). Hazard does not only address the climate signals (such as rising temperatures) but also climate-related direct physical impacts.

Table 6: AR4 Vulnerability and AR5 Risk concept factors.

AR4 Vulnerability concept factors	**AR5 Risk concept factors**	**Examples of application of the terminology in the CRVA method**
Exposure	Hazard	*Rising temperature, increased intensity of rain, floods, etc.*
Sensitivity	Vulnerability	*Dependency on agriculture for subsistence (lack of livelihood alternatives), high poverty rates, degraded forest ecosystems due to overharvesting, lack of capacities in NRM planning, lack early warning systems, etc.*
Adaptive Capacity		
Vulnerability	Risk	*The risk of loss of crops due to agricultural droughts*
--	Exposure	*Smallholder farmers, roads, infrastructure, and other assets.*

The role of ecosystem services in the assessments

One of the differences between the EbA and CRVA methods is the starting point of the assessment. The EbA method focuses on ecosystems and ecosystem services first – current and desired state of ecosystems (Step 2) incl. the dependency of people on those ecosystems and their services – and considers anthropogenic threats under the term conventional as well as currently observed climate change related threats to ecosystems (Step 3). It also checks the vulnerability of ecosystems and communities to future climate changes (Step 4) as well as socio-economic factors (Step 5). This enables to identify EbA and other adaptation options to reduce community vulnerability (Step 7).

The CRVA method also considers the state of the ecosystem services as a vulnerability factor (Step 2), which can serve as a point for identification of adaptation options, both conventional and EbA. The state of ecosystems and ecosystem services is assessed under the vulnerability factor in the CRVA method considering additional socio-economic and capacity related aspects. For instance, it may be the case that the community pastures are overgrazed due to increasing number of livestock that is driven both by poverty (subsistence dependency) and increasing wealth (security saving). Degraded pastures illustrate the state of ecosystem services (fodder provision) and the drivers of increasing number of livestock are socio-economic vulnerability factors. Lack of pasture management planning in this case would be an example of capacity vulnerability.

Both EbA and CRVA methods are people-centred covering anthropogenic factors in climate risk, vulnerability and the state of ecosystems as a part of socio-ecological systems. Regardless of the differences in concepts and terminology used, the results of the assessments reveal similar results, the biggest difference being the starting point of the assessment. The starting point for the OS-based EbA method is the assessment of current state of ecosystems and ecosystem services, followed by the identification of changes based on future scenarios. For the CRVA method, the starting point is the identification of a climate risk and the valuation of ecosystem services taking place in the following steps.

Strengthening the ecosystems perspective in the CRVA method

Already with the “Guidebook on Climate Risk Assessment for Ecosystem-based Adaptation” the CRVA method was developed towards a more explicit focus on ecosystems, their services and EbA. Within the scope of the Jabbor Rasoluv CRVA piloting, the Eurac Research and UNIQUE team tested the CRVA method and further enhanced the ecosystems perspective in the application.

The CRVA impact chain framework can be further strengthened by introducing additional components – ecosystems and ecosystem services as two separate components (blue and green boxes on the top right of the impact chain, *Figure 21*). With this addition, in conducting a climate risk and vulnerability assessment, there is a need to first identify ecosystems that are present in the geographical scope of the assessment. For example, in the impact chain in *Figure 21*, the relevant ecosystems to the ‘*risk of damage to infrastructure and livelihoods due to mudflows in the Jabbor Rasulov district*’ are pastures, agro-systems, forests, and trees along riverbanks. Next, the assessment identifies Ecosystem Services (ESS) that are provided by the identified ecosystems and that are relevant to the climate risk and exposure such as slope protection, erosion protection, fodder provision, and food provision. This addition then allows assessing the state of the ESS in the vulnerability component of the CRVA. This can be done by asking the following questions:

- What is the status of ESS which are relevant for the CRVA (healthy, degraded)?
- What are the factors and processes that lead to this degradation? (e.g. overgrazing leads to reduced erosion protection)
- Is climate and climate change itself a factor that leads to a degradation of ESS? (e.g. heavy rain events lead to further erosion, which amplifies land degradation).

In the impact chain below, the state of ESS are “reduced slope protection”, “reduced erosion protection”, “reduced fodder provision”, and “missing riverbank protection by trees”.

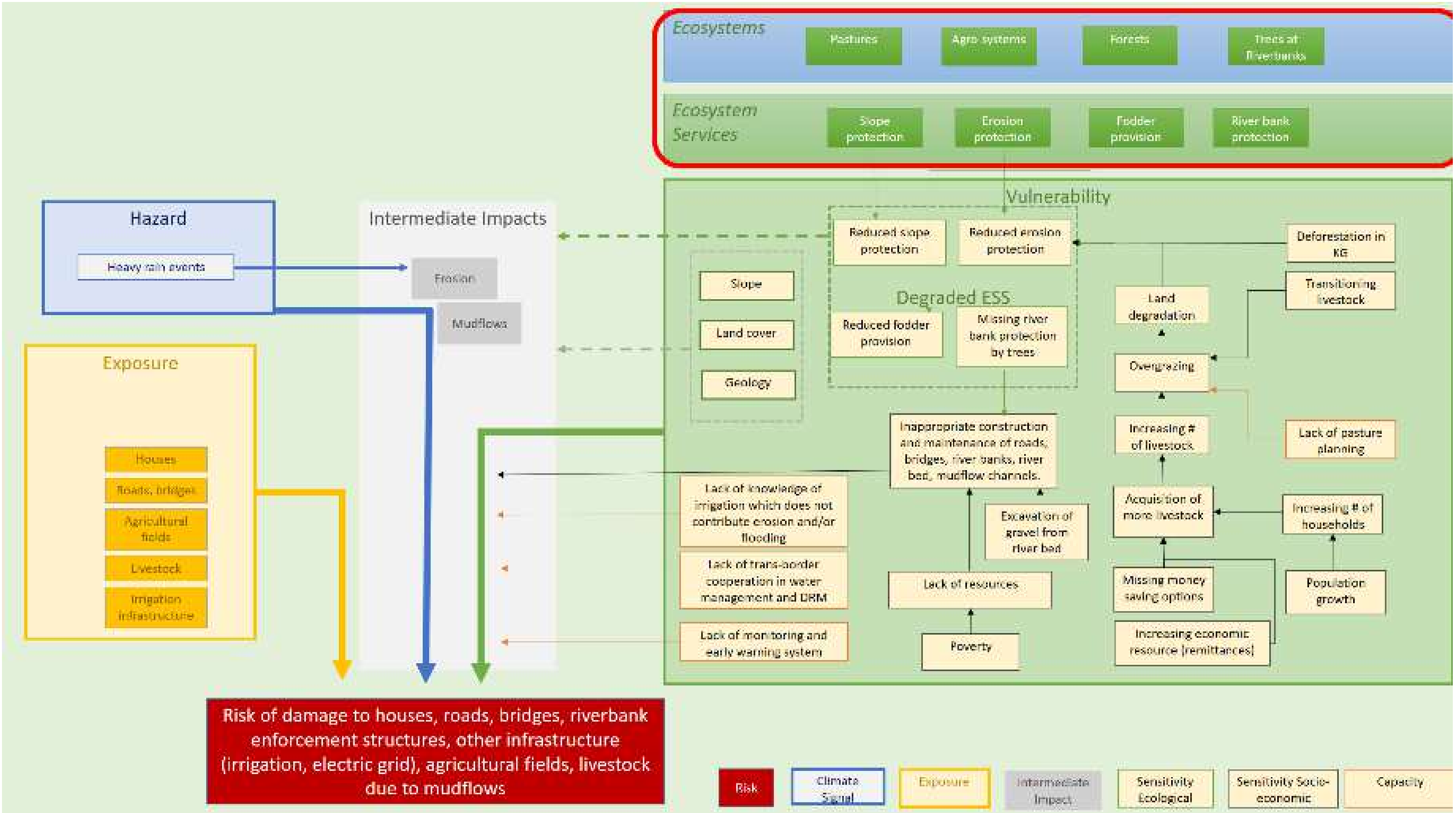


Figure 21: CRVA impact chain for Jabbor Rasulov district, TJK for the risk of damage to infrastructure and livelihoods due to mudflows. November 2018.

Info Box 1: How to potentially better capture risk perspective (according to AR5) in the OS-based EbA method?

The risk perspective according to the IPCC AR5 concept can be best captured in the EbA method through the utilization of impact chains during the assessment. An impact chain is an analytical tool for establishing cause-and-effect relationships to better understand, systemize and prioritize the factors that drive risk in the system of concern. Impact chains are also an integral part of the situational analysis in the EbA method, known as conceptual model. The conceptual model is similar to the impact chains in the CRVA method. Furthermore, the EbA method entails the elaboration of an explicitly stated *Theory of Change* (impact hypothesis) for prioritized adaptation options. Prioritization of adaptation options is based on criteria such as feasibility, climate robustness, likelihood of effectiveness and available resources (Step 7). The Theory of Change, results chains respectively, for each adaptation option plays an important role in monitoring the effectiveness and success in addressing climatic and conventional (anthropogenic) threats (Source: draft EbA guidelines).Using the tool of impact chains is the backbone of the climate risk and vulnerability assessment as well: it allows the consideration of complex interactions and cascading relationships, which lead to a risk. An impact chain helps to put interrelationships in an analytical framework and serve as a starting point of the assessment. Impact chains help better understand, systemize and prioritize the factors that drive risk in the system of concern. Impact chains always have a similar structure: a climate signal, intermediate impacts, vulnerability factors, exposed elements and a risk (or multiple risks).

Identification of adaptation options

The CRVA for EbA guidelines brings a possibility of supporting adaptation options by linking the risk assessment more directly with adaptation planning through the impact chain tool (see the Info Box 2). Identification of adaptation options is not a part of CRVA method: carrying out a CRVA serves as a basis for the identification of adaptation options. While the identification of the EbA adaptation options is an integral part of the OS-based system (Step 7) and implementation is a part of the framework (Step 8), the CRVA assessment can support the identification of adaptation options as a next separate step after climate risk and vulnerability assessment. The CRVA for EbA Guidebook provides with the guidelines on how to identify adaptation options based on the developed impact chains but such an activity requires additional expertise.

Lesson learned from CRVA application in Jabbor Rasulov district

Both OS-based EbA and CRVA for EbA methods provide a systematized framework for assessing climate change impacts and identifying, implementing and monitoring of EbA measures. The following lessons are learned from piloting the CRVA method in Jabbor Rasulov district:

- **Complementarity of the vulnerability and risk concepts in practice**: Testing and application of the CRVA method in Jabbor Rasulov district showed that it is possible to capture both perspectives in one assessment. Despite the differences in terminology used the EbA and CRVA methods (AR4 vs AR5 terminology), the results of the assessments in the practice are similar[26].

- **Ecosystems perspective can be further enhanced in the CRVA method**: The piloting of the CRVA method in Tajikistan illustrated the possibility to capture both risk and vulnerability angles in carrying out the assessment. Based on the experience gained during the workshops in Jabbor Rasulov district, the impact chain tool framework in *Figure 21* has been adapted to enhance the ecosystems perspective. This modification (introduction of ES and ESS components) makes it easier to frame vulnerabilities in terms of ecosystems for participants, especially for those who have not had any input on the topic of ecosystem services. **The CRVA method can benefit from the EbA method and tools** by strengthening the ecosystems and ecosystem services' perspective in the CRVA assessment. The identified state of ESS will at a later stage serve as an entry point for selecting EbA measures.
- **The risk terminology is easier communicated** especially to the actors across various sectors. This is particularly important and useful when conducting a climate risk and vulnerability assessment involving different stakeholders such as from nature protection and management, hydrometeorology, infrastructure development, and rural development fields.
- **Identification of adaptation options:** there is a further need to identify adaptation options based the findings of CRVA piloting in Jabbor Rasulov district. Identification is not strictly a part of the CRVA method framework – the CRVA findings (impact chains) serve as a starting point for the identification of adaptation options. It is seen as a separate next step and requires additional expertise. Facilitation guidelines for CRVA workshops would be helpful to complement the guidebook for the practical implementation.

[26] Note: Even though the OS-based has not been applied in the same district to have comparable results, the EbA practitioners and experts' opinion confirmed that a systematized assessment would result in similar outcomes.

Literature used for chapter 5:

GIZ & EURAC. (2017). Risk Supplement to the Vulnerability Sourcebook. Guidance on how to apply the Vulnerability Sourcebook's approach with the new IPCC AR5 concept of climate risk. Bonn: GIZ. Retrieved from http://www.adaptationcommunity.net/wp-content/uploads/2017/10/GIZ-2017_Risk-Supplement-to-the-Vulnerability-Sourcebook.pdf

GIZ, adelphi, EURAC, & University of Salzburg. (2014). The Vulnerability Sourcebook: Concept and guidelines for standardised vulnerability assessments. Bonn: GIZ.

GIZ, EURAC, & UNU-EHS. (2018). Climate Risk Assessment for Ecosystem-based Adaptation - A guidebook for planners and practitioners. Bonn: GIZ.

GIZ. (2018). Contributing to Sustainable Development with Ecosystem-based Adaptation. Manual how to help people adapt to Climate Change through green solutions. Bishkek: Regional Project "Ecosystem-based Adaptation to Climate Change in high mountainous regions of Central Asia."

GIZ. (2018). Solutions in Focus: Ecosystem-Based Adaptation from Mountains to Oceans. How people adapt to climate change by using nature. Bonn and Eschborn: GIZ.

Statz, J., & Mislimshoeva, B. (2018). 'Open Standards -based Method for Planning and Implementing Ecosystem- based Adaptation' and 'Participatory Rural Appraisal'. Comparison of two methods for village-level climate change adaptation planning.

6 Annex

6.1 Impact chain mudflows – factors

Component	Factor	Potential Indicator	Potential Data Sources (today / future)	Adaptation Measures linked to Vulnerability (preliminary ideas)
Hazard	Heavy rain events	# days with >50mm	Today: potentially Hyrdomet, but historical data has to be paid. Khujand station not representative for heavy rain. Future: Climate scenarios do not represent well heavy rain.	
Vulnerability factors influencing intermediate impact	Slope, land cover, soil type, geology…	Slope [°] Soil type Land cover type Geological type	Slope: SRTM Soil: soil institute? Land cover ? (from satellite?) Geology? Institute for geology	Land cover: reforestation, pasture management (see below)
Hazard / Intermediate impact	Mudflow	Volume of mudflow (m³/s)	Model? (based on factors)	Mitigation: riverbank re-enforcement (see below)
Vulnerability – Ecological Factors	Erosion	Loss of soil on m³/ha	Model? (based on factors)	
	Degradation of land	-Satellite based vegetation indices and vegetation cover	Does such a study exist?	Pasture management, pasture committee, regulating amount of livestock, … Monitor livestock, Developing fodder production and storage (hay, straw, …)
Vulnerability – Socio Economic Factors	Overgrazing	-Density of livestock per pasture ha? or per Jamoat?	Agricultural department?	
	Transiting livestock from different districts	# and type of livestock transiting	Agricultural department?	
	Increasing number of livestock	# of livestock	Agricultural department?	
	Deforestation in Kyrgyzstan	% of forest areasee	Global forest change cover (landsat) (eurac will check) check with GIZ Kyrgyzstan	Transnational reforestation program?

	Cutting trees for fuel (Kyrgyzstan and Tajikistan)	Reports on illegal logging (KG)		
	Population growth – increasing number of households → new fields, more livestock.	# of population (Jamoat) # of area cultivated	Webpage of District. Data available through state agency for statistic?	
	Poverty - Decreased remittance flow from Russia - unemployment	-people living below poverty thresholds -GDP - Remittance share of GDP (which administrative level?) - unemployment rate	- from Jabbor Rasulov government. Which numbers are available -WFP report on poverty at district level?	
	Increasing economic resource (remittances) → leading to acquisition of more livestock			
	Missing money saving options			
	Lack of pasture planning (no pasture committees`)	Pasture committee exists (y/n)	Information from MSDSP?	
Vulnerability – technical factors	Excavation of gravel from riverbed for construction material			
	Inappropriate construction and maintenance of roads, bridges, riverbanks, mudflow channels, -Missing long term – only short term solutions for mudflow protections measures (e.g. redirection for mudflow) -Roads: inappropriate drainage when roads crossing mudflow streams / gullies -Lack of riverbank enforcement (green [trees] or grey)	Long-term solution Gully well drained % of riverbank enforced	Interview: where and why inappropriate infrastructure. Road department with inventories? Water department with inventories? HELVETAS? (water infrastructure)	Riverbank re-enforcement with trees Training on road engineering
Vulnerability – Capacity factors	**Lack of trans-border cooperation** (early warning, water management, livestock management, DRR,)	Trans boundary cooperation among emergency departments (y/n) Forest management and erosion control (y/n)	ACTED? -Ministries of Emergency Situation (CoES) in Kg and Tjk? -Forest departments on oblast level in Kg and Tjk	
	Lack of early warning system	Early warning system exists (y/n)	Committee of Emergency Situation (CoES)	

	Lack of knowledge of irrigation which does not contribute erosion and/or flooding (irrigation may contribute to erosion)	# and existence of water management specialist	-Oblast department -Agency	Training on appropriate irrigation Introduction of appropriate
	Missing resources for maintenance (money and labor) of infrastructure (cleaning channels, cleaning mudflow channels, riverbank reinforcement/protection)	Specific budget for maintenance and reinforcement available (y/n)	CoES, water department	Supporting water department
Exposure	**Houses** (vicinity to river / gullies)	Number of houses in vicinity of river	Local government? Manual mapping from google maps	
	Households / people (vicinity to river / gullies)	Number of people / households in vicinity of rivers	Estimate from number of houses	
	Roads and bridges – vicinity to river or when crossing mudflow gullies	Presence of road and bridges	Road data exists. Bridges – from Open Street Map (OSM) + manual completion	
	Agriculture field - vicinity to river / gullies	Ha of agricultural field in vicinity of river	Manual mapping from google maps – or automatic classification from satellite data	
	Livestock	# of livestock in vicinity of rivers	Estimates from local experts	
	Presence of **irrigation** infrastructure (vicinity to river / gullies)	m/km of irrigation infrastructure in vicinity of rivers	Map showing irrigation infrastructure (available from water department?)	

6.2 Impact chains droughts – factors

Component	Factor	Indicator	Data Availability (today / future)	Adaptation Measures linked to Vulnerability
Hazard	Heat – extreme temperature			
	Absence of summer precipitation			
	Meteorological droughts	Climatic water balance		
Vulnerability factors influencing intermediate impact	Soil type, crop type, type of pasture – level of degradation			
Hazard / Intermediate impact	Agricultural drought			
Vulnerability – Ecological Factors	Dependence on Rain-fed agriculture (more vulnerable than irrigated)			
	Soil Cover destruction - erosion	m^3/ha of soil loss		
Vulnerability – Socio Economic Factors	Limited usage of drought-resistant crops and its varieties			
	Overgrazing – degradation of land	Density of livestock per pasture ha/ Jamoat Satellite based vegetation indices		
	transiting livestock from different districts			
	Increasing number of livestock	# of livestock		
	Deforestation in Kyrgyzstan	% of forest area		
	Cutting trees for fuel (Kyrgyzstan and Tajikistan)	Reports on illegal logging (KG)		
	Population growth – increasing number of households → new fields, more livestock.	# of population (Jamoat) # of area cultivated		
	Poverty Decreased remittance flow from Russia unemployment	Remittance share of GDP (which administrative level?) unemployment rate		
	Lack of pasture planning (no pasture committees`)	Pasture committee exists (y/n)		
Vulnerability – technical factors	Lack of appropriate water management infrastructure	m/km of irrigation infrastructure		
Vulnerability – Capacity Factors	Lack of knowledge on water management (water saving irrigation, water storage…)	# and existence of water management specialist		
	Missing insurance for agricultural yield losses			
	Lack of resources for making agriculture drought resilient (irrigation, drought resilient crops)			
	Lack of trans-border cooperation with Kyrgyzstan (on water distribution)			
Exposure	Agriculture field (irrigated, rain fed)	Ha of agricultural field		
	Livestock density	# of livestock		
	pastures	Ha of pastures		
	People	Number of people		

6.3 Impact chains strong winds – factors

Component	Factor	Indicator	Data Availability (today / future)	Adaptation Measures linked to Vulnerability
Hazard	Strong wind	# days with windspeed > 30m/s		
Vulnerability – Ecological Factors	Vegetation cover – erodibility + soil type	% vegetation cover		
Vulnerability – Technical factors	Building material of roofs (low quality material of roofs)	Categories: Good, moderate, poor		
	Construction of unsuitable power lines	Categories: Good, moderate, poor		
Vulnerability – Socio Economic Factors	Poverty Decreased remittance flow from Russia unemployment	Remittance share of GDP (which administrative level?) unemployment rate		
Vulnerability – Capacity Factors	Lack of knowledge wind-proof construction			
	Lack of financial resources for good building material	Average income / person		
Exposure	Agriculture field -irrigated -rain fed	Ha of agricultural field		
	# of houses and buildings	# of houses and buildings		
	Orchards			
	Wind-prone Power lines	Km of lines		
	People	Number of people		

6.4 Workshop facilitation

Workshop 1

Date and time: 22/11/2018 **Venue**: GIZ Khujand Office

Participants

GIZ and Partners: Nodir, Marhabo, Gulbahar, Nargis, Jonathan, Sarafroz, Marc, Kathrin

External:

- District representatives:
  - Agency for land reclamation and irrigation (Water department)
  - Committee of Emergency Situations (CoEs)
  - Committee for Environmental Protection (CoEP)
  - Road department
  - Agriculture department
  - Geology department
  - Committee for land management and geodesy
- Oblast: Hydromet
- National: Red Cross Society

Objectives:

- Data availability of climate data and climate scenarios
- Hazard occurrences (mudflows, flash floods, droughts, storm, …)
- Impacts (road blockages, damages to bridges, problems for agriculture and pastures)
- Ongoing and planned adaptation activities
- Trends of non-climatic drivers such as socio-economic developments (migration, agricultural systems, deforestation, increase in livestock, …)

Outputs/documentation:

- short CRVA report (in Russian)
- final impact chains

Language: Russian/Tajik

Facilitation plan:

DAY 1						
Time		Topic	Method	Content and guiding questions	Material	Responsible
9:00	10 min	Welcome and Introduction		Agenda, workshop objectives, short intro EbA round table		Nodir, Claudia
9:10	10 min	Presentation of CRVA method			Powerpoint	Marc
9:20	20 min	Climate data and scenarios	Presentation	- Discuss Key questions (print out) - Collecting Answers on Pin board (Hazard, impact, vulnerability, exposure) and maps	Pinboard, cards, pins Map, sticky notes	Hydromet
09:40		Discussion on hazards and impacts:				Gulbahar & Nodir
10:30	20 min	Coffee Break				
10:50		Clustering and structuring impact chains		-use red-dots to identify most relevant factors		
11:30		Road impacts and interventions			Presentation Pinboard, cards, pins Map, sticky notes	Gulbahar, Jonathan
12:00	90 min	Lunch break				
13:30	15 min	ACTED			video	Nargis
13:45	15 min	Red Crescent Society/German Red Cross	Presentation		powerpoint	Sarafroz/Bakhtiyor
13:45	60 min	Review of impact chains and Assessment of high risks	Two groups	Use results from morning to improve impact chains -use red-dots to identify most relevant factors	1 Pinboard, cards, sticky dots	
15:00		End of workshop				

Workshop 2

Date and time: 23/11/2018

Venue: Jabbor Rasulov District centre

Participants

GIZ and Partners: Nodir, Marhabo, Gulbahar, Nargis, Jonathan, Sarafroz, Marc, Kathrin

External: Heads of two Jamoats, nine representatives from three mahalla committees, four representatives of water usage associations, Water department

Objectives:

- Weather and climate related hazards – current situation
- Disaster Risk Reduction and Adaptation existing
- Climate Change impacts in the future
- Availability of data and information

Outputs/documentation:

- Internal documentation
- Capacity building and coordination between communities

Language: Tajik/Usbek

Facilitation plan:

DAY 2						
Time	Duration	Topic	Method	Content and guiding questions	Material	Responsible
9:00	10 min	Welcome and Introduction		Agenda, workshop objectives, short intro EbA round table		Nodir, Claudia
9:10	10 min	Presentation of CRVA method			Powerpoint	Marc
9:20	20 min	Climate data and scenarios	Presentation	- Discuss Key questions (print out) - Collecting Answers on Pin board (Hazard, impact, vulnerability, exposure) and maps	Pinboard, cards, pins Map, sticky notes	Nodir
09:40		Discussion on hazards and impacts				Gulbahar
10:30	20 min	Coffee Break				
10:50		Continue from before the break		-use red-dots to identify most relevant factors		
11:30		Road impacts and interventions			Presentation Pinboard, cards, pins Map, sticky notes	Gulbahar, Jonathan
12:00	90 min	Lunch break				
13:30	15 min	ACTED			video	Nargis
13:45	15 min	Red Crescent Society/German Red Cross	Presentation		PowerPoint	Sarafroz/Bakhtiyor
14:00		Adaptation measures	discussion			
15:00		End of workshop				

6.5 Field Visit Isfana River: Jamoats of Gulakandoz and Hayoti Naw, consisting of villages of Khitoy and Kurgoncha

(by Jonathan Demenge; with additional comments and guidance by Frank van Steenbergen and MetaMeta Research)

Date: 24.11.2018

Participants: Marc, Kathrin, Gulbahor, Claudia, Marhabo, Nodir, Jonathan

The purpose of the visit was to better understand climate risks associated with mudflows along the Isfana river, understand how the road infrastructure interacts with climate risks (i.e. is affected by climate hazards and contributes to their impacts) and look at the potential for climate resilient roads. We followed the Isfana River upstream, driving South towards the Kyrgyz border beyond which the river and most of its tributaries originate.

1. Stop along the canal built during the Soviet period (1960s)

We cross Proletarsk, the district headquarter, Gulakandoz and the outskirts of the city where individual houses seem to be equipped for roof water harvesting to irrigate the small plot in front of them (an interesting practice that contributes to climate resilience and could be generalised). We cross the fields – mostly cotton[27] - largely bordered by mulberry trees (used for silk). Fields are irrigated through water pumped from wells (probably fed by the Isfara water system), while gravity does the rest.

After a while, we cross a dike and literally plunge into the canal: all dry in surface. The Canal is about 50 m wide and 1.5 meters deeps, while it used to be much narrower and around 8 meters deep. We are told the canal was mainly built to evacuate the mud coming from Kyrgyzstan, mostly during the summer months. Apart from stones and soil ("mud" carried by the mud flows), the riverbed is littered with garbage (which is an issue when water from the canal is used for drinking purposes.

Mud flows here are often 60 m3/s, but can reach up to 150 m3/s during peak time. They usually start in KG when it rains there, and take around 1 hour to reach this spot. People are informed by the inhabitants of Kurgoncha (about 25 km upstream). But there is no early warning system and no protocole for communication in place to inform them on the Kyrgyz side.

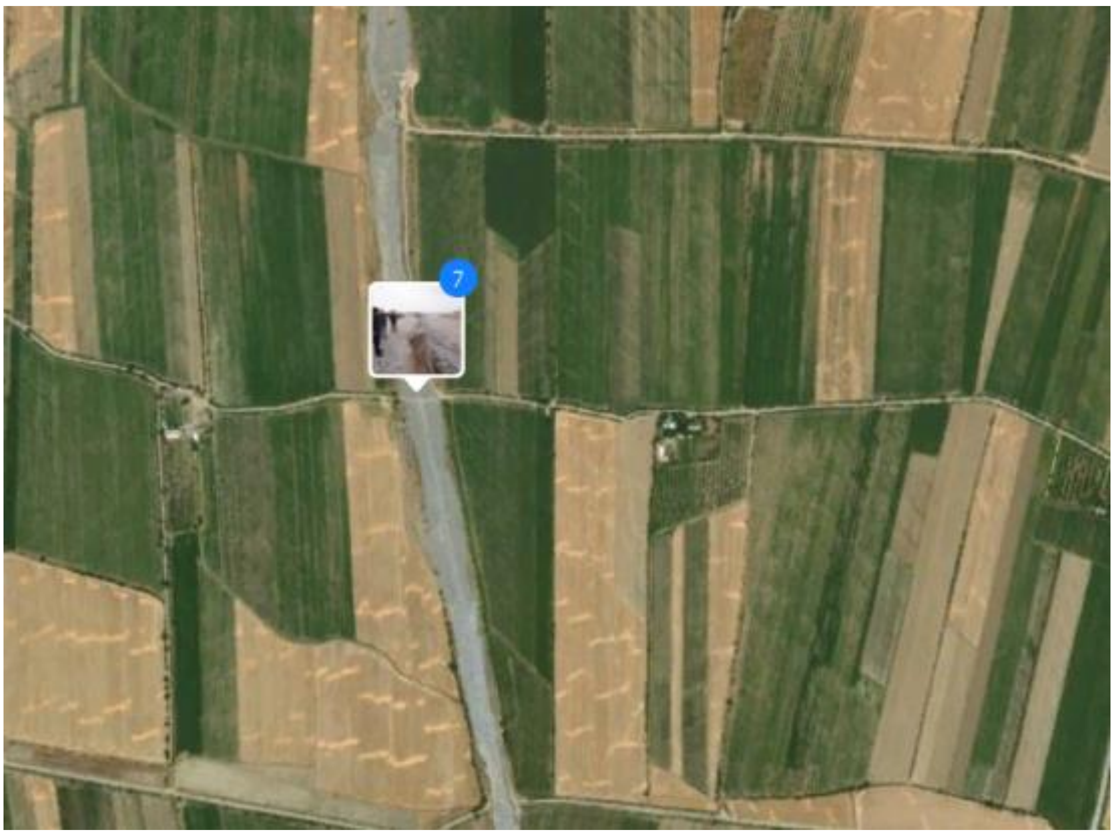
When the level of the river goes up, the vibrations of the river can be felt from a distance, it increases progressively, the muddy river remains unpassable for an hour, further eroding the river banks, carrying garbage and sometimes small animals ("1000s of livestock are washed away", exceptionally human victims) and threatening to overflow, and then recedes after an hour to become again passable, and dry

[27] Cotton yields in the Kolkhoz used to be 60t/ha; today they are only 15 t/ha. The reason seems to be the lack of water and access to agricultural outputs.

after a few hours. The way is then cleaned and compacted with the head of machinery to facilitate crossing.

The canal used to be cleaned and emptied regularly during the Soviet period, but it is not maintained anymore, hence the shallow and wide aspect. Funds are collected (100 Som/year/hh) for maintenance it but this is not sufficient. Dykes have been built to contain the mudflows and protect the fields.

When the level is low, the water can be used to irrigate the fields (if pumped the turbidity must seriously damage the pumps…). Otherwise people mostly use wells (40 were built in the area) for irrigation. Other rivers are used, although we are told villages in Kyrgyzstan use most of the water for their own needs in summer (cabbage, tomatoes and tobacco are cultivated), so that small rivers and canals often run dry.



Map 1. The canal

Plate 1: the riverbed

2. Stop at the bend, where the river was redirected to the North-North-West to develop the city of Proletarsk.

During Soviet times, the river was redirected from the North-East to the North-North-West, in order to develop the city of Proletarsk/Gulakandoz. The ancient bed of the river is still visible on the aerial view, and when mudflows happen the river has the tendency to go back to its original riverbed. Along the canal are:

- few remaining patches of a tarmac road that has been washed away by the river (and the soil with it). It is beyond repair.

- next to it, a lined irrigation canal (see Plate 2), partly open, partly consisting of a pipeline

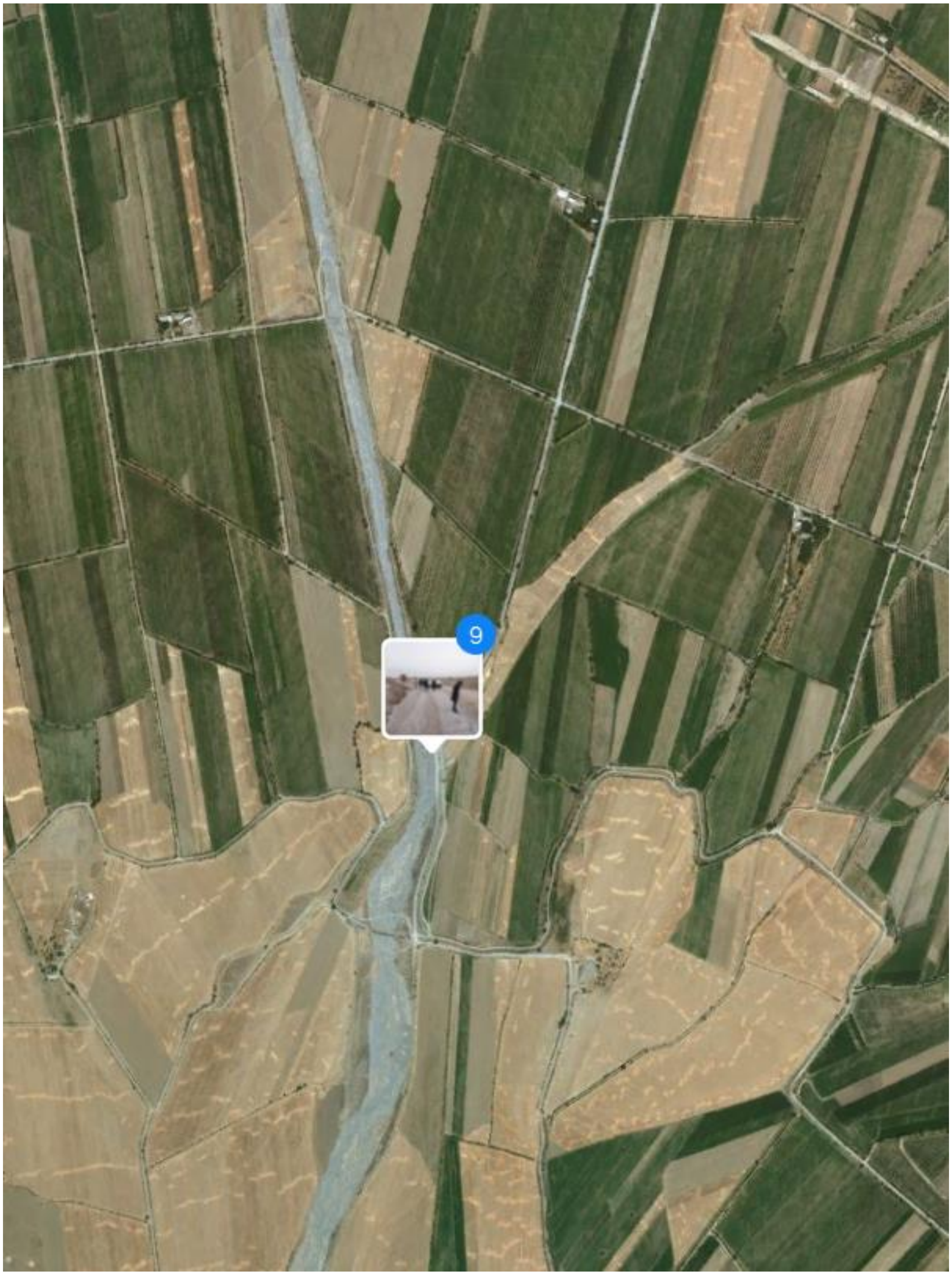
- adjacent to the canal, a dirt road (local road) that was built 20 years ago as an alternative to the original one with community's money (TjS 60'000).

Risks:
- overflow, erosion of agricultural land and siltation (already happening in places)
- erosion/loss of the water canal, leading to loss of infrastructure and loss of irrigation facility for the irrigated land and trees bordering the canal. If the canal cannot be repaired quickly, conditions could include loss of the harvest (short term consequence), loss of trees (medium- to long-term consequence: if non irrigated for a whole season, assets are lost) as well as long-term inability to irrigate the fields (in case the canal is damaged beyond repair).
- permanent damages to the road, requiring a realignment of it and further loss of agricultural land.

- Potential threat to the city nearby in case the mudflow is big enough and allowed to flow freely towards it.
Measures taken: - elevated banks (soil) - gabions on the river-bed to redirect the flow: they have been washed away - Gravel accumulated in the bend every year to protect the banks: also washed away every time.
Suggestions: - Concrete blocks attached/boulders to protect the bank, and concrete slabs in the bend. The irrigation channel is very vulnerable and will soon be damaged. - correction of the river trajectory on the inside of the curve to diminish the action of the river on the outside of the curve, upstream of the bend and on the right bend to increase the radius of the curve and dragging inside the curve to concentrate the flow on the inside of the curve (at the moment, the trajectory of the river is such that the flow is directed on a small portion and on its weaker point: see map 2, aerial view). Although it is a massive intervention, it would probably diminish the erosive action of the river at its weaker point. - The road embankment need to be re-enforced, in order to help contain the river when the level is high. **Substantive and urgent measures are required on this spot to address the issues and risks associated with mudflows. Given the potential risk for the cities of Proletariask and Gulakandoz, the mobilization of resources beyond the *jamoat* would be clearly justified.**

Plate 2: from the left: the river-bed, remaining patches of an elevated road, the irrigation canal, the local road pointing toward the ancient riverbed and the city of Proletarsk/Gulakandoz

Plate 3: the external bend of the river, 8m above the canal. Observe the buried (rusty) pipeline linking two portions of the irrigation canal at the feet of the team, on right bank. On the left bank (the inside of the bend), some concrete slabs remain.



Map 2. The “bend”. The river flows South to North: notice the “S-shaped” curve, bouncing back the flow of water and increasing the erosive power of the river where the original river-bed once was.

3. Khitoy

On the way to Khitoy, the ditch along the road is seriously eroded. The runoff has dug as deep as one meter along the road, which is starting to collapse.

Risks: **-** Further erosion and damage to the road and loss of agricultural fields
Measures taken: **-** Diverting the water towards from the ditch to the fields drain (temporary solution)
Suggestions: - Consolidation on a priority basis of damaged road bits to limit further destruction (spot maintenance) - Refilling the ditch with gravel - Scour checks: small "check dams" (consisting of bigger stones or stone walls) to reduce the velocity of the water and enable the sediments to deposit. - Cleaning the channel from garbage to avoid clogging it (stagnating water on the road). Generally, canals and drains should not be used to dispose of garbage. - Potential change to road design: downslope road crowns to limit stagnation of water and limit the size of the ditch **"Roads for Water suggestions"** - Roadside plantations to maintain the soil in place, provide livelihoods, decrease wind erosion and limit dust (Note that this measure was mentioned by participants during the workshop). - Generalise the use of turnout ditch: diverting systems to enable road water harvesting and use of supplementary water into rain-fed fields.

Plate 4. Erosion due to the runoff, threatening the stability of the road, and the fields

Plate 5. Erosion due to the runoff, threatening the road; garbage management issue.

4. Khitoy

A stop in the new residential area of Xitoy, under construction, enables us to spot the impact of mudflows in the river below. These destroy the irrigation channels upon which irrigated agriculture depend. Hence after each mudflow the initial part of channels has to be rebuilt.

The impact of overgrazing on the hills and slopes around are clearly visible, on both sides of the river, leading to degrades pastures and erosion gullies that seem to contribute to lower productivity, mudflows and siltation. Officially, the district has 60’000 sheep and 20’000 cows, for a population of 140’000 inhabitants, although in reality numbers are much higher; in addition, transiting flocks visit the area, triggering further degradation. Later, a fenced cemetery with long grass enables us to see the difference between grazed land and non-grazed land.

Risks: - land erosion - reduced productivity of pastures - siltation - mudflows - destruction of assets
Measures taken:

- apparently none so far
Suggestions: **-** fencing of critical areas to enable regeneration (plus sowing pastures and pasture management). - Forestation of degraded areas (in Tajikistan and Kyrgyztan) and sustainable land management in particular. - check dams in erosion gullies (gully plugging) to limit the flow of water and enable the slopes to stabilise.

5. Stop at the site of planned dam

We now borrow the alternative road that was built up when the Kyrgyz authorities closed the border crossing in 2015. The gorge gradually narrows down along the river into a small canyon. ADB has invested USD 1million to make “captages” (underground water catchment) in 2008, although these were destroyed by mudflows and had to be rebuilt. An irrigation dam was planned at this site, but never constructed due to the collapse of the USSR. At a planned cost of US$ 10 millions, it was meant to hold 10 millions m3 and irrigate a surface of 4’000 ha. A 300m long diversion tunnel was built and is now used for the road.

The dam would certainly help regulate the flow of the river, although with peaks of 150 m3/s and given the amount of sediments carried by the river, the feasibility should be studied, and regular cleaning would be required. However, the topography would certainly make a good location for a reservoir to store water for the dry season and a mean to regulate the flow of the river. Coupled with other measures, it could be contributing to climate resilience of the socio-economic system by addressing mudflows, droughts and protecting the infrastructure. A feasible alternative could be a flow-through dam (see below).

Risks: - mudflows, - erosion of agricultural land and siltation (already happening in places) - destruction of the infrastructure
Measures taken: - captages
Suggestions: - Flow-through dam for flood control. Potential design (example of Wadi Tanuf, Oman): 

Map 3: the canyon along which the irrigation dam was planned (North side). The map shows the secondary erosion channels that contribute to siltation and building up high water levels in the Isfara River.

6. Erosion along the road threatening the road

Culverts that concentrate the runoff have triggered significant erosion through the pastures next to the road. Deep gullies (up to 3 m deep) have formed, eroding the pastures and potentially the road.

Risks: - unchecked erosion of pastures and loss of topsoil. - irreversible damage to the road. - more siltation and erosion downstream.
Measures taken: - none
Suggestions: **Alternative options for the evacuation of the runoff:** - more dispersed culverts, with a cemented apron under the gully and a settlement pool to spread the water and decrease the amount of water flowing or - rolling dips on the road to enable the runoff to be evacuated on the road; or - fords/ that would spread the water over a larger area, depending on the amount of runoff. This would indeed be the best option, interceptin the runoff to irrigate pastures and potential reforested areas. **Downstream:** - gully plugging: stone walls in the gully to decrease the flow of water and keep the soil in place, potentially with trees and roots ("green gabions") - revegetation (trees and sowing) of degraded slopes. **Upstream:** - Above the road: check dams/stone walls in the erosion gullies to slow down the flow of water and enable sedimentation, creating greener and potentially fertile areas for plantations. - Revegetation of degraded slopes and enclosures in critical areas. **Note: these measures would not only protect the road infrastructure, but potentially highly reduce the amount of sediments that make it into the canal and contribute to mudflow.**

Plate 6. Gullies triggered by the culvert

Plate 7. Erosion gully upstream

7. Culverts triggering erosion

At five different spots when approaching Kurgoncha, the road crosses small ephemeral streams that have shaped the landscape into narrow but deep valleys. In order to protect the road, 3 years ago each crossing was equipped with a large (1m wide) culvert that concentrates all the runoff into one spot. Since there is no pan at the exit of the culvert, the runoff exiting the culvert cascades down the slope with a lot of energy and has dug a 10 m deep canyon. It destabilises the slope, and the proximity of gully and eroded slope to the road threatens the road.

Risks: - unchecked erosion of pastures and loss of topsoil. - irreversible damage to the road. - more siltation and erosion downstream.
Measures taken: - none
Suggestions: - Equip the culvert with a proper pan, followed by a check dam and a settlement pool in the end (although it is likely that culverts are just not the right solution in such configuration) or - preferably replace the road and culvert by a cemented ford that would spread evenly the water over the whole surface, and keep the moisture in the soil **In addition: upstream and downstream** - revegetation of the slope (shrubs, grass sowing, reforestation) - check dams, depending on the flow of water - Gully plugging: stone walls/gabion boxes/green gabions in the erosion gully to limit the velocity of water and create sedimentation; - The canyon could be temporarily transform into water pounds, until the siltation fills in the ponds. The proximity of houses (about 15 houses, part of Kurgoncha but 1km before) would make the presence of water ponds and vegetated areas easy to maintain and profitable. **Note: Given the amount of destruction done in only 3 years, urgent action is required on these spots, or massive damages will occur on the road infrastructure. This would also contribute to reduce siltation and mudflows.**

Plate 8. The catchment area leading to the culvert

Plate 9: The erosion gully formed, and aggravated by the culvert

Plate 10. The erosion gully seen from inside the culvert (height: approximately 10m)

Map 4.

8. Kurgoncha

The issue of droughts, high temperatures and water shortages is confirmed by the local authorities. In addition to the Isfana riverbed, our respondants also confirm the presence of 26 sites where local mudflows occur. They mention that mudflows were not so much of a problem in the past, but have become a big issue over the last decades.

In addition, they mention that sheep died in the pastures last summer, as there was not enough fodder due to water scarcity. Also, the price of fodder doubled last year (fodder from KG used to be cheaper). Wells are stilted and also need to be repaired. They have also identified a site for a reservoir (which would not need to be lined, as the soil is not too permeable according to them).

They also mention that the biggest problem is the lack of drinking water. Irrigation channels are used but the water is polluted.

Further, we go to see the bridge at the centre of the village, where due to flash floods the level sometimes rises 1 m above the banks. The bridge was rebuilt in 1985. The German Red-Cross is involved in the emergency response, and has built hazards maps and plans for the village. An excavator is used to drag the river, and mounts of soil have been put in places to protect the road and houses.

Suggestions

- Reinforcement structures and vegetation would be required to protect the river banks
- Study the possibility to increase water recharge through infiltration ponds and trenches to increase the amount of groundwater available for irrigation AND drinking purposes from the wells

Plate 11. The bridge in Kurgoncha

Plate 12. The river embankement

At the entrance of the village, a bridge is under construction to cross a seasonal stream that flows on top of a dirt road that comes down from the hill (or rather: the dirt road follows the river bed…)

Suggestions:
Bridge and stream:
- extend the pillar on the left to prevent erosion around the pillar
- extend the concrete slab with stones to prevent erosion after the slab.
- revegetation on the banks to limit erosion to the fields downstream of the bridge.
- potentially (green) gabions in adequate locations before the riverbed to protect the embankments and slow down the river flow and facilitate infiltration.

On the dirt track:
- stone pavement (or other type) to protect the dirt road while not decreasing the permeability of the soil.
- rolling dips to direct the flow on one side of the dirt-track

Plate 13: bridge under construction

For technical information and guidance, a useful resource is:

https://wocatpedia.net/images/d/d7/Ministry_Agriculture_Ethiopia_Community_Based_Watershed_Management_Guideline_2005_Part_1_B_b.pdf

Government of Ethiopia

Additional data requirements:

- data on Isfana River discharge in Kurgoncha and downstream is required.

- data on erosion along secondary erosion channels: mudflows start in Kyrgyzstan, but it seems also very likely that overgrazing, erosion and bad land management in Tajikistan also contribute to the mudflows; also, a large degraded areas upstream but situated in Tajikistan seem visible on the map. Further inquiry is required.

- transect drive in Kyrgyzstan (along with Tajik citizens to that they understand the process)

- Data on fodder scarcity and death of livestock.

Addition suggestions:

- in general, roadside plantations to address water erosion and soil degradation, wind gusts and wind erosion, limit dust, provide shade, increase moisture content, and provide additional livelihoods.

- Early warning system in Kyrgyzstan, cross-border cooperation.

- Better roads-water integration at the institutional level, cross-sectoral cooperation between agencies and between jamoats/district.

- Cross-border resource management groups.

- Separate drinking water systems (using wells rather than irrigation channels, captages, spring capture). Road water harvesting could contribute to better groundwater recharge.

- Proper garbage management would also limit the contamination of river flows and of the canal.