Funded by the European Union

Kozu-Baglan Watershed
WATERSHED PROFILE
Kyrgyzstan - Batken Region - Leylek District
September 2023

Source: Google Earth, 2023

Contents

Source: IMPACT, Kozu-Baglan River, August 2023

Data Source Disclaimer

The following report is a product of the analysis of data from the following three sources:

- Qualitative Key Informant Interviews (KII) with officials from district or Local Self Government (LSG) leadership.
- Quantitative data obtained from official requests to the Ministry of Agriculture, Water Resources, and Regional Development, National Statistical Committee of the Kyrgyz Republic, and from district line departments for the Water Authority, Ministry of Agriculture, an Ministry of Emergency Services.
- Open-source data on the internet, including all satellite imagery for hazard analysis.

Official boundaries for LSG administrative areas were publicly available from the Ministry of Emergency Services, and downloaded by the assessment team from Humanitarian Data Exchange (HDX) as of 2021.[1]

It should be noted that the watershed boundaries for the Hydrological Watershed Analysis and Watershed Hazard Analysis differ slightly; the Watershed Analysis considers only the geologic features relevant to the Kozu-Baglan river's waterflow, while the Watershed Hazard Analysis includes settlements, land, and canals which use the water from the river in addition to its distinct geologic features.

Water network data was obtained from the Geo-information portal about water from the Water Resources Service of the Kyrgyz Republic, which provides data online through interactive maps.[2]

No other proprietary data has been used. All data is presented as percentages, or otherwise presented in a way to obscure the actual original values to limit the re-printing of official data as much as possible.

1. OCHA, Humanitarian Data Exchange, 2023.
2. Republic of Kyrgyzstan Water Resource Services, Geoinformation Portal About Water of the Kyrgyz Republic, 2023.

Executive summary

Water resource management of the Syr Darya River basin in the Fergana valley remains one of the regions greatest challenges, as the nations of Kyrgyzstan, Tajikistan, and Uzbekistan have struggled to manage the complex water systems of the Syr Darya river basin in the absence of a long-term common regulatory framework.[3] In the absence of such a framework, increasing population, greater reliance on irrigation agriculture, and the development of hydro power in the Valley have put additional strain on water resources. At the same time, water in the river basin is dwindling due to changing patterns of precipitation and melting glaciers as a result of climate change.[4]

In order to help addressing these challenges, in 2022, Acted, IMPACT and International Alert, with the support of USAID, launched the STREAM project to support natural resources management in local watersheds of the greater Syr Darya River basin that passes through the Fergana Valley. The STREAM project uses an evidence-based approach to identify the watersheds most at risk to resource strain, and then seeks to develop a comprehensive understanding of the main challenges to effective resource management within the most at-risk watersheds, which is used to inform a tailored road map of intervention.

A key outcome of this project is this watershed profile, which examines key hazards to the watershed's population regarding water availability, and its impacts on agricultural and pasture lands. The profile outlines the major hazards, including natural hazards, climate change, and anthropogenic causes, alongside existing structures and methods set up by local governments and communities to manage such hazards. The research work relies on the extensive use of GIS analysis, including remote sensing hazard analysis and river basin modeling. These findings are triangulated with detailed KIIs and quantitative local government data sets on vulnerability data and resource management structures from local authorities between 29 May and 2 June 2023.

The findings have been analyzed by Acted and International Alert and jointly developed into recommendations for improved watershed management to more effectively respond to climate change and other challenges, and to produce a road map outlining a plan for project implementation to address the above-mentioned key issues.

3. Global Water Partnership, Integrated water resources management in Central Asia: The challenges of managing large trans-boundary rivers, Technical Focus Paper, 2014
4. Zoinet, Environment and Security: Transforming risks into cooperation: Central Asia: Fergana / Osh / Khujand area, 2005

Source: Acted, Kayragach canal and gate, March 2023

Nearly all KIIs reported the volume of water to have decreased over the last 10 years, with water shortages reported to be more commonly reported the further down the river the community was located. Changing patterns of melting and freezing of the glaciers during wet seasons and associated declines in water levels during growing and harvest seasons, alongside increasingly irregular precipitation levels were reported to be the main reasons for this.

Aging and corroded irrigation infrastructure was reported to be the main reason for water loss according to Water Management Authorities (RuVKha) and community Water User Associations (WUAs). Both institutions reportedly lack the resources to make sufficient repairs on their own. Less than 30% of WUA-managed canals (3rd and 4th order) had concreted cladding, and were therefore prone to leakage and water loss.

Approximately 79% of the water discharge from RuVKha canals is used for irrigation in Kulundu. Despite having the most efficient canal and on-farm networks, according to RuVKha and WUAs, the water loss in Kulundu is still represents 4/5 of all water lost by the Kozu-Baglan canal system.

Declines in overall water availability were reported to have had a much greater impact on rainfed cultivation than irrigated lands. This has had a large effect on staple grains like wheat and barley, which are typically grown in rainfed areas of the watershed, and increased reliance on the irrigated land as a source for food production.

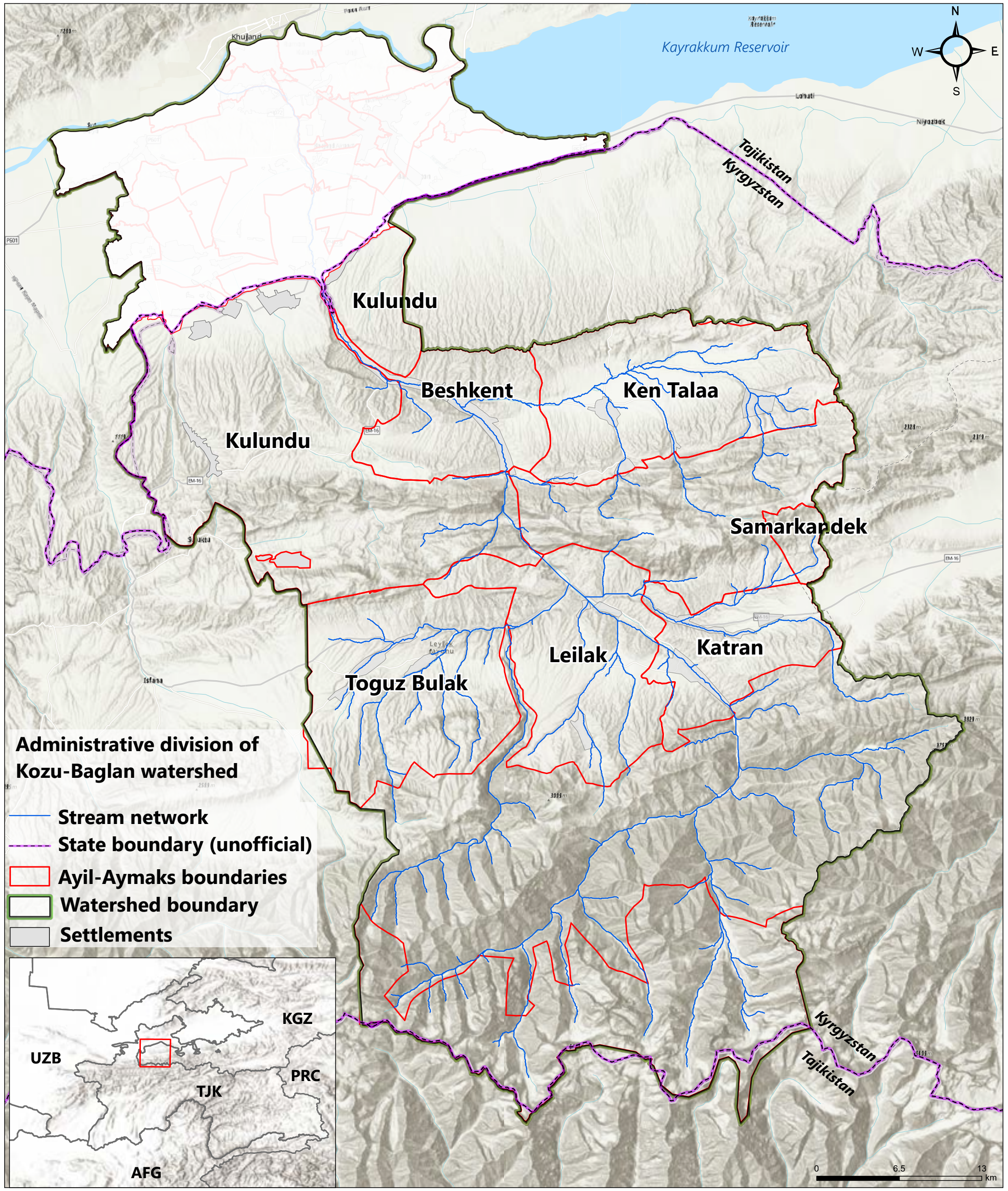
Increased cultivation of vegetables in irrigated areas of Kulundu has sometimes led to water shortages up-stream, due to its large cultivation area and tendency to be prioritized for water discharge. This has led to tensions between the upstream and downstream communities over equitable levels of water usage. The planting of less-water-intensive crops can address some of these tensions.

According to authorities in Leylek district, over 40% of pastureland has completely degraded, and more is at risk of further degradation. This is mainly due to failures of herders to follow formal scheduling, increasing numbers of livestock, overgrazing land capacity, and insufficient disaster management to mitigate the effects of flooding and mudflows on pasture land.

The assessment found most communities to be both vulnerable and unprepared for natural hazards like floods or drought. While local awareness of risks by local authorities and community leadership is high, communities lack financing for disaster resilient infrastructure, and key pockets of the population and nearby infrastructure are highly exposed to major natural shocks.

Although to a limited extent, women were reportedly represented in the natural resource management structures through women's committees. These underfunded committees focus on local concerns with a specific relevance for women. As women remain among the most affected by climate change, primarily due to their traditional roles in collecting water, representation and support of rural women in relation to climate change adaption could be improved through additional support to these committees.

Map 1: Location of Kozu-Baglan Watershed in the Fergana Valley, June 2023[a]



Watershed overview

Kozu-Baglan watershed is a watershed located in Leylek District, Batken Region of Kyrgyzstan. As of August 2023, the watershed features:

Table 1: The watershed features

Region	Batken	
District	Leylek	
Local Self Governments (LSGs)	5 (Beshkent, Katran, Kin-Talaa, Kulundu, Leylek)	
Villages	23	
District Capital	Razzaqov	
Population[b]	Official	Presently living the area
Households	14,512	11,959
Individuals	64,957	53,718

Background

The Fergana Valley has one of the most complex water systems in the world. Climate change, population growth, and a lack of multi-lateral resource management mechanisms have led to a situation of increased pressure for water and arable land while the resources needed to sustain them shrink.[5]

The Kozu-Baglan watershed is one of the most under-stress watersheds in the valley. Located at the end of the Syr Darya river basin, the Kozu-Baglan's 120km long river-source comes from snow and glacial melt in the Turkestan Mountain range. Melting and freezing cycles of the glaciers have accelerated due to climate change in recent years, disrupting seasonal water flow patterns and causing the water supply to dwindle and come later in the year.[6]

In order improve natural resource management (NRM) of water resources in the watershed, IMPACT conducted the following assessment examining the effects of different hazards on the availability of water and associated land resources in Kozu-Baglan watershed.

5. Zoinet, Environment and Security: Transforming risks into cooperation: Central Asia: Fergana / Osh / Khujand area, 2005
6. Special eurasia, Kyrgyzstan and Tajikistan_ causes and analysis of an endless border dispute, 29 September 2022.

a) Local Self Government (LSG) boundaries are from Ministry of Emergency Services and are obtained from Humanitarian Data Exchange. Boundaries are current as of 2021. River data was provided by Acted from an earlier 2015 analysis by HYDROC. Watershed boundary is from HYDROC 2015, and modified by IMPACT and Acted to account for irrigated areas in the north of the watershed.

Methodology overview

The objective of this profiling assessment was to provide an in-depth understanding on the function and challenges of natural resource management. This included factors contributing to overuse or stress of natural resources and natural hazard threats in key watersheds of the Fergana Valley. This information would be used to inform the STREAM project on how to best implement infrastructure and capacity-building activities to improve NRM in the watershed.

To answer this, the following key research questions were asked:

1. What is the current exposure that populations in transboundary watershed face regarding NRM, including threats from climate change, natural hazards, and anthropogenic causes, and how are their impacts likely to affect water resources in the future?

2. How do local governance structures manage key resources, including water allocation, agricultural land use, and pasture management?

3. What are the main challenges faced by local governments to effective NRM in the watershed, in regard to resource management, conflict mitigation, and land use practices?

4. What policy recommendations and recommended road map of implementation should development actors follow to support improved natural resource management in the watershed?

To accomplish this, IMPACT, with the support of Acted and IA, used a mixed-method approach to assess each watershed:

- A satellite imagery analysis using open-source data on key risks from the Global Facility for Disaster Reduction and Recovery (GFDRR) was used to assess each watershed across an assortment of hazard exposure, to priority key areas.

b) Only the population from LSGs reliant on the watershed were considered in this study. Those located within the watershed area, but not part of the watershed Eco-system (for example, Torguz-Bulak) are not considered.

- After the selection of the most at-risk watersheds, IMPACT conducted a detailed profiling of each watershed, to understand the key population risks and vulnerabilities for populations in each watershed. This included the following:

- Extensive desk review of NRM issues from previous research on the topic.

- Primary Data collection, examining how resources were managed and how different hazards impacted the population.

- Detailed GIS hydrological modeling of the watershed and satellite imagery analysis of different hazards to assess the overall impact of different hazards on the watershed population.

- A detailed assessment by International Alert to assess factors contributing to inter-communal disputes and dispute resolution mechanisms for communities within the watershed.

Analysis overview

In order to ensure that STREAM resources were used to maximize the project's impact, IMPACT first conducted a rapid assessment of all 16 trans-boundary watersheds of the Fergana Valley. Following an extensive desk review of previous research of resource challenges within the Fergana Valley, IMPACT identified 6 main hazards that were likely to impact the availability of water and associated resources in each watershed.

All hazards were selected in line with the United Nations Office for Disaster Risk Reduction (UNDRR)[7] Hazard definition & classification review of global hazards index. Each hazard was examined on its own, and then aggregated into their respective hazard groups, defined in the UNDRR. Each hazard was given a weight to account for some hazards having a larger contribution than others to the overall impact of the hazard grouping on both population and agriculture exposure to the hazards.

Each hazard group and its population's hazard exposure were then in turn weighted based on its importance in affecting the availability of water in each watershed, which was used to calculate a single, "Water stress index" indicator indicating the overall level of water stress for the watershed. Ultimately, Kozu-Baglan, Ak-Suu and Isfayramsay watersheds were selected. From this point, all assessment activities focused only on these prioritized watersheds.

Hydrological Watershed Analysis

IMPACT conducted a Hydrological Watershed Analysis (HWA) modelling of the Kozu-Baglan River Basin using a Soil & Water Assessment Tool (SWAT).[8] This model uses elevation, soil, meteorological, and water discharge data to build a scale model of a river basin to track and predict environmental impact of land use, land management and climate change on the watershed. IMPACT's GIS specialists developed the SWAT model using open source meteorological data (precipitation and temperature), Digital Elevation Model (DEM) data, land use data, and soil quality data. This was combined with the average monthly water discharge data recorded at key points in the watershed to produce a full model of flow, soil erosion, precipitation, and sedimentation.

Watershed Hazard Analysis

IMPACT also conducted additional remote sensing analysis of population susceptibility to key hazards that populations and agricultural land in each watershed is vulnerable to. The exact hazards assessed are listed on Table 1 on the following page.

Specialized models using GIS and remote sensing tools for exposure to each hazard were developed by the IMPACT team based on previous research.[9] Data and methodologies used for each hazard are shown in Annex 1. Where secondary data was available, IMPACT triangulated each analysed hazard map with pre-existing risk maps to ensure accuracy.[10] The geospatial data was

7. UNDRR, Hazard definition & classification review (Technical Report), 2020.

8. Texas A&M University, SWAT Input Data: Overview, 2023.

9. IMPACT Ukraine, Area Based Risk Assessment, Bakhmut Raion, Donetska Oblast, Eastern Ukraine, August 2020.

10. Kyrgyzstan National Water Resource Authority, Geoinformation Portal about Water of the Krygyz Republic, 2023.

further triangulated with other secondary sources and primary data collection, both detailed below.

Table 2: Hazard classification according to UNDRR assessed in watershed risk analysis

Hazard group	Hazard
Climate change	Precipitation change Temperature change
Meteorological & Hydrological	Drought
Geohazards	Debris flow/Mudflows Flooding Landslides Earthquakes
Environmental	Pasture degradation
Technological	Industrial hazards
Societal	Disputes

Primary Data Collection

Following the selection of the watersheds for profiling, IMPACT organised direct data collection in each watershed. This involved qualitative interviews with key members of the local government and community who had knowledge of key local resources and how they were managed. In addition to these officials, all of whom were male, the heads of women's councils in each LSG were interviewed to give a perspective on women's roles in NRM and challenges they face. Interviews were conducted at district level (to inform about the watershed as a whole) and each LSG, which included the Ayil Okmotu governing office and WUA when relevant.

Table 3: IMPACT KIIs in Leylek District, May-June 2023

Location	DRM	Water Mgmt.	Land Mgmt.	Women's NRM	Total KIIs
District	1	1	1	1	**4**
Local Self Government	0	3	5	5	**13**
Total	**1**	**4**	**6**	**6**	**17**

Desk Review

In order to triangulate information from the primary data collection and geospatial analysis, IMPACT conducted an extensive desk review of existing literature. This included previous reports on NRM in the Fergana Valley, as well as academic papers and policy briefs. This was done both before, during, and after the primary data collection and geospatial analysis, both as a validation of existing data and to complete information gaps for Tajikistan. A non-exhaustive list of key resources consulted can be found in the list below, with the remainder listed in the referenced footnotes throughout the document.

Water, Peace and Security, Conflicts over water and water infrastructure at the Tajik-Kyrgyz border: A looking threat for Central Asia?
International Alert, The impact of climate change on the dynamics of conflicts in the trans-boundary river basins of Kyrgyzstan, Kazakhstan and Tajikistan, January 2022.
Centre of Development and Environment, Integrated watershed management in Tajikistan, March 2014.
Economic Commission of Europe, Strengthening Water Management and Trans-boundary Water Cooperation in Central Asia: The Role of UNECE Environmental Conventions, 2011
Blue Peace Central Asia, Climate Cryosphere-Water Nexus: Central Asia Outlook, 2018.
Zoinet, Environment and Security - Transforming risks into cooperation: the case of Central Asia, 2005.
WFP, Climate Risk and Food Security in the Kyrgyz Republic: An Overview on Climate Trends and the Impact on Food Security, 2014.
WFP, Climate Risks and Food Security in Tajikistan, 2017
Stucker, Kazebov, Yakubov, & Wegerich, Climate Change in a Small Trans-boundary Tributary of the Syr Darya Calls for Effective Cooperation and Adaptation, Mountain Research and Development, 2012.
University of Central Asia: Mountain Societies Research Institute, Sustainable Land Management in Kyrgyzstan and Tajikistan: A Research Review, 2013.
University of Central Asia: Mountain Societies Research Institute, Challenges of Social Cohesion and Tensions in Communities on the Kyrgyz-Tajik Border, 2018.

Analysis of Local Dispute Resolution

In coordination with IMPACT's primary data collection and desk review activities, International Alert also conducted an analysis of local disputes in Kozu-Baglan Watershed.

To do this, International Alert conducted a detailed desk review of the context in Kozu-Baglan, based heavily on a similar 2022 study on natural resource management in Central Asia.[11] The desk review was used to develop tools that were used for primary data collection.

The desk study also provided an opportunity to review the content of publications focusing resource management issues as they relate to climate, water, and environmental factors, as well as community recommendations and gender aspects of resource management and dispute mitigation.

Primary data collection took place from 25 May - 2 June, 2023 in Batken and Bishkek cities, as well as Kulundu LSG in Kozu-Baglan that borders Tajikistan. The following KIIs were conducted:

Table 4: KIIs conducted in Kyrgyzstan, 6-8 June 2023

Location	Subject	# of KIIs
Bishkek	Water Resource Management	2
Batken	Water Resource Management	1
	Dispute Prevention & Resolution	2
Kulundu	Water Resource Management	1
	Dispute Prevention & Peacebuilding	5
	Pasture Management	1
Total		12

11. International Alert, The impact of climate change on the dynamics of conflicts in the trans-boundary river basins of Kyrgyzstan, Kazakhstan and Tajikistan,January 2022

Information gaps and limitations

IMPACT and International Alert were limited in the level of analysis that they could conduct due to the availability of data and the timelines in which it could be obtained.

Quantitative data on crops and livestock could only be obtained through desk review of datasets obtained from local authorities. These datasets were often limited in their information due to local challenges in record keeping. Very often, only 1-3 years of data was available, limiting

Methodology - Continued

longitudinal analysis of trends.

Similarly, a limited number of hydrological and meteorological monitoring posts in Kyrgyzstan meant that for its hydrological models, IMPACT needed to rely on limited available data from a few specific locations in the watershed, limiting the ability for IMPACT to fully calibrate the SWAT model. Given the lack of data availability, the data used in the model represents the best example of SWAT using open source data. As a result, findings drawn from the SWAT analysis should be treated as indicative, and not used alone to make key decisions on water flow. IMPACT analysed this data alongside secondary data from Leylek district's RuVKha and WUAs, and primary qualitative interviews with key officials to develop a comprehensive picture of the water situation within Kozu-Baglan watershed.

Due to the overall project time frames for data collection being limited, IMPACT needed to limit its GIS analysis to hazard analysis, and did not have time to complete the additional risk analysis before the national workshop where the preliminary findings from this report were presented on 27 September 2023.

Key terms and definitions

Hazard

Hazards refer to a "process, phenomenon or human activity that may cause loss of life, injury or other health impact, property damage, social and economic disruption or environmental degradation."[12] A total of 6 main hazard groups were identified for the watersheds.

Exposure

Exposure is defined as the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.[13] In this assessment, the locations of population and agriculture are considered as part of the exposure component of hazard analysis of the watershed. Datasets on population and agricultural land are derived from global data sources such as WorldPop.[14].

12. Texas A&M University, SWAT Input Data: Overview, 2023.
13. WorldPop, Open Spatial Demographic Data and Research
14. UNDRR, Sendai Framework Terminology on Disaster Risk Reduction, 2023.

Glossary

Term	Definition
AAW	Average Annual Water Yield
ABRA	Area Based Risk Assessment
DEM	Digital Elevation Model
DRM	Disaster Risk Management
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographic Information Systems
Ha	Hectares
HWA	Hydrological Watershed Analysis
IFAD	International Fund for Agricultural Development
KII	Key Informant Interview
LSG	Local Self Government
LULC	Land Use and Land Cover
MoES	Ministry of Emergency Situations
NDVI	Normalized Difference Vegetation Index
NRM	Natural Resource Management
RuVKHA	District-level Water Management Authority
Term	**Definition**
SMI	Soil Moisture Index
SPI	Standard Precipitation Index
SWAT	Soil & Water Assessment Tool
TWI	Topographic Wetness Index
VCI	Vegetation Condition Index
UNDRR	United Nations Office for Disaster Risk Reduction
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WUA	Water User Associations

1. Hydrological Watershed Analysis

Kozu-Baglan Watershed
Leylek District - Batken Region - Kyrgyzstan

Hazards to effective watershed management

Source: Google Earth, 2023

Source: Acted, Kozu-Baglan River, March 2023

Water Management

Water management for irrigation purposes forms the foundation of both natural resource management and the agriculture sector in Kyrgyzstan. In 2021, the total water withdrawn from various water bodies amounted to approximately 8 billion cubic meters, with 96.8% of this water sourced from natural water bodies and 3% from underground sources.[15]

During the same year, about 94% of the Kyrgyz water supply was allocated for irrigation and agricultural purposes. Notably, in the Batken region, an even higher percentage, (98%), of the total water intake was dedicated to irrigation and agricultural water supply.[16]

Small rivers such as the Kozu-Baglan river play a pivotal role in supplying water to irrigated lands, contributing to the irrigation of 76% of all lands.[17] As a results, changes in its volume directly impact the local communities in it's watershed, who rely on networks of canals that draw water from the Kozu-Baglan river, annual precipitation, and groundwater to support both agricultural and pasture land. These resources underpin agro-pastoral livelihoods for the majority of the population living in the watershed area.

Trends over the last decade show water levels of the main river to have declined, in addition to precipitation patterns becoming more extreme and less regular, disrupting harvests and harming crop yields and pasture maintenance, and leading to disputes between communities over equitable water allocation. This is due to the combination of climate change, which has led the glaciers that feed the Kozu-Baglan river to shrink, as well as irregularities in precipitation patterns that households depend upon for agriculture, and poor and degrading irrigation infrastructure, which has contributed to increased water loss from leaking canals.

Using SWAT, IMPACT conducted basin modeling to capture the levels of water loss,. The assessment found water levels are projected to continue to decline, and reliance on the Kozu-Baglan river as the main source for livelihoods of most households will increase, putting pressure stakeholders to effectively manage water resources.

15 National Statistical Committee of the Kyrgyz Republic, Environment In The Kyrgyz Republic, 2017-2021.
16 ibid.
17 Water Resources Services of the Kyrgyz Republic

Water management in the Kozu-Baglan watershed involves multiple layers of management, including RuVKha at the district level and WUAs at LSG level. RuVKha and WUAs only manage irrigation water. However, households within the area rely on the Kozu-Baglan river as their main water source for all needs, including domestic consumption. The full extent of the irrigation network are shown in Map 2.

The Kozu-Baglan watershed has three WUAs, which maintain distribution of irrigation water to Kulundu, Beshkent, and Katran LSGs. The majority of Ken-Talaa and Katran LSGs and Leylek LSGs receive water from wells and springs, although the village of Ak-Terek within Leylek LSG and 100 ha of irrigated land in Ken-Talaa LSG are also reliant on the river water (Table 6).
RuVKha undertakes tasks such as supplying irrigation water to WUAs' canals, quantifying allocated irrigation water using specialized measuring devices, and conducting annual repairs on canals. In cases of water distribution disputes, the department assumes a mediating role and provides water to villages during scarcity.

Likewise, the three WUAs are responsible for distributing and measuring allocated irrigation water, as well as maintaining water infrastructure through repairs and canal construction. These WUAs also mediate conflict resolutions between water users when required.

RuVKha and the WUAs distribute irrigation water through gates, and, in elevated areas, pumping stations, which pump water from the river into main canals, and then distribute them to 2nd, 3rd, and 4th order canals, which distribute water into irrigation trays that feed individual farmers' agriculture fields.

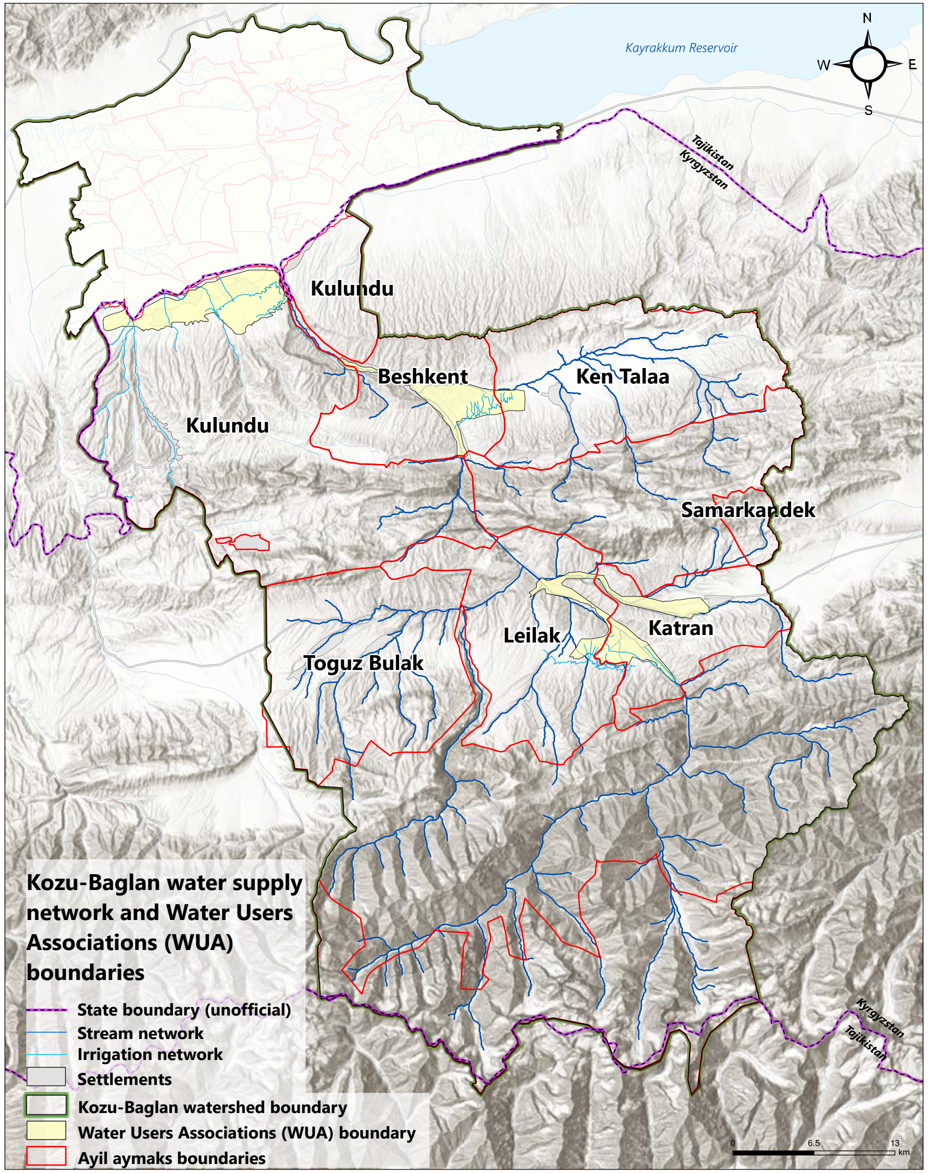
RuVKha manages the main, primary canals that connect to the main river source to the LSG communities, while the WUAs manage the smaller 2nd-order (20m3), 3rd order (5m3/sec), and 4th-order (1m3/sec) canals that make up the on-farm networks within communities.

KIIs reported water users to be primarily concerned about increasing water scarcity. This was believed to be due to corroding irrigation infrastructure of WUAs, much of which was constructed under the Soviet Union. In addition, inadequate maintenance practices (including the lack of major infrastructure repairs), and damage from flooding and mudflows can disrupt and erode the canals further.

WUAs fund themselves through a surcharge per water litre (RuVKHA sells to WUAs for approximately 1 som/ m^3, who then sell it to water users for about 7 som/m^3). However, according to WUA records, the revenue was only enough to maintain the WUAs own operating costs and repairs to maintain current irrigation infrastructure. These repairs were reported to be sub-standard, often addressing cracks and holes in canals and trays by patching them with foam, plastic or cotton. For instance, an examination of the WUAs' finances revealed that the Kulundu-Razzakov, the largest WUA in Kozu-Baglan, faced a 2% budget deficit in 2022, with 17% of the total expenditure allocated to repair-type work. While the other two WUAs were relatively better off.

The poor condition of the canals has likely contributed to significant water loss and lack of efficiency. WUA water records indicated that on-farm irrigation network efficiency was even lower than the main canals. While there were multiple causes for this, KIs mainly attributed this to old and corroded infrastructure. While the main and secondary canals that belong to

Map 2: Water User Association boundaries and canal networks, Kozu-Baglan watershed, June 2023[b]



b) Ayil Aimak boundaries are from Ministry of Emergency Services and are obtained from Humanitarian Data Exchange. Boundaries are current as of 2021. River data was provided by Acted from an earlier 2015 analysis by HYDROC. Canal network is from National Water Resource Service Geoinformation Portal.

Water Management Structures - Continued

WUAs were constructed from concrete, 30% of 3rd order and 61% of 4th order canals were reported to be earthen ditches, which are prone to leakage and water loss. According to RuVKha records, less than half of the 136km of WUA-managed canals in Kulundu are concreted, suggesting that a significant amount of water is lost due to poor infrastructure.

Furthermore, KIIs conducted among WUAs unveiled pressing repair needs in three WUAs, concerns that were supported by a RuVKHa representative. It is worth noting that these main canals are under the jurisdiction of the WUAs, not the RuVHKa.

Specifically, in Katran WUA, the Teshik 2 canal urgently requires partial repairs, with the highest priority being assigned to an 8-kilometer section. Presently, out of the 17-km canal, only 9 km are functional, leaving 250 hectares of land without access to water. The 8-km section suffers from poor water resistance, with some areas entirely eroded by floods or filled with mud. Therefore, the repair work should primarily focus on this section.

The Kulundu WUA faces a similar concern, necessitating the repair of the 22-km Magistral canal (since 55% of the canal was reported to be in the poor condition), with a focus on sections extending up to the 14-km mark, covering the villages of International, Kulundu, and Razzakov. Similarly, in Beshkent WUA, a 9.5-km canal is in poor condition and requires rehabilitation.

Additionally, the condition of canals on the balance of RuVKha is depicted in the Table 5, which shows the comparative water use and efficiency per canal. This data has been sourced and compiled by the Leylek District RuVKha to illustrate the efficiency of the canal network under RuVKha's jurisdiction. It reveals that approximately 79% of the recorded water discharge in Kozu-Baglan watershed is located downstream in Kulundu's Magistral canal. The remainder is split between Kulundu's Mashine canal (5%), Beshkent's Dashrabad canal (9%) and Katran's Teshik canal (7%).

It is important to note that while the primary canal in Kulundu reported the highest levels of water efficiency in the system (85%), due to its comparative size, it was also responsible for 80% of RuVKha's recorded total water loss for the network. Water loss is measured by RuVKha and WUAs by comparing the expected amount of water discharge by the actual measured amount.

WUAs have no other funding sources and are otherwise not supported or connected to RuVKha, who use an official government budget to maintain their own infrastructure. However, in times of acute water scarcity, the department collaborates closely with WUAs, utilizing the department's available resources to address challenges together.

Table 5: WUAs, Canals, and water allocated, lost from inefficiency, and proportional loss of water by canals in Kozu-Baglan watershed, 2022[c]

LSG	WUAs/RuVHKA	Canal	Water discharge provided to WUAs by RuVKHAannually (1000 m³)	Water discharge received by WUAs annally (1000m³)	Water network efficiency
Kulundu	Kulundu-Razzaqov	Magistral	31,309	26,723	85%
	RuVHKA	Mashine	2,045	2,045	100%
Beshkent Ken-Talaa	RuVHKA	Dashrabad	3,400	2,891	85%
Katran	RuVHKA	Teshik	2,945	2,320	79%

Table 6: Efficiency of on-farm irrigation networks of WUAs, water records of WUAs 2022[d]

WUA Name	LSG Served	Water Supply (1000m³)	On-farm Network Efficiency	Canal length (in km)		% canals that are not concreted	
				3rd order canals (5m³)	4th order canals (1m³)	3rd order	4th order
Kyirk-Bulak	Katran	7,223	66%	0	18.8	0%	58%
Kulundu-Razzaqov	Kulundu	21,039	85%	22.1	114.7	100%	67%
Kozu-Bakyirgan	Beshkent Ken-Talaa	7843	55%	23.1	41.6	59%	49%

Suggested watershed support

- Rehabilitate the canal infrastructure is critical for reduction in water loss.
- The Kulundu Magistral canal accounts for nearly 80% of water discharge and also water loss. Repairing the canal will have a major effect in reducing water loss in the canal system.
- WUA on-farm networks need concreting to reduce water loss for 3rd and 4th order canals. Kulundu and Beshkent on-farm networks have the greatest lack of concreting reported and are the best candidates for canal rehabilitation.

c) Source: Original data is from Leylek District RukVKHA. Only calculations based on data are shown.
d) Source: Original data is from WUAs.

Water Discharge & Water Yields

Using the SWAT analysis described in the methodology section, water discharge was calculated using a river basin scale model developed to quantify the rate of water flow in the Kozu-Baglan watershed for the years of 2017-2022. The model considers intricate data on precipitation, soil types, land cover classifications, water discharge data, temperature and elevation, which is then used to simulate the watershed's ecosystem for both current trends and projections. As shown on the map, water accumulates from glaciers in the southern Turkestan Range, collecting in the reach, or main river, before flowing north past Kulundu LSG out of Kyrgyzstan.

Water discharge, shown in Map 3, is the rate at which water flows through a river, stream, or channel at a specific location, typically measured in cubic meters per second (m^3/s). The map shows an increase in overall flow of water as the river travels downstream: river flow that starts at only 0.2 m^3/s at the source reaches 116.7-815.4 m^3/s by the time water leaves Kyrgyzstan, highlighting potential exposure to flooding and inundation of water in border communities. While the map provides insights into water yield and discharge from 2017 to 2022, it is important to consider that a lack of water monitors in the watershed limits the full calibration of the model.

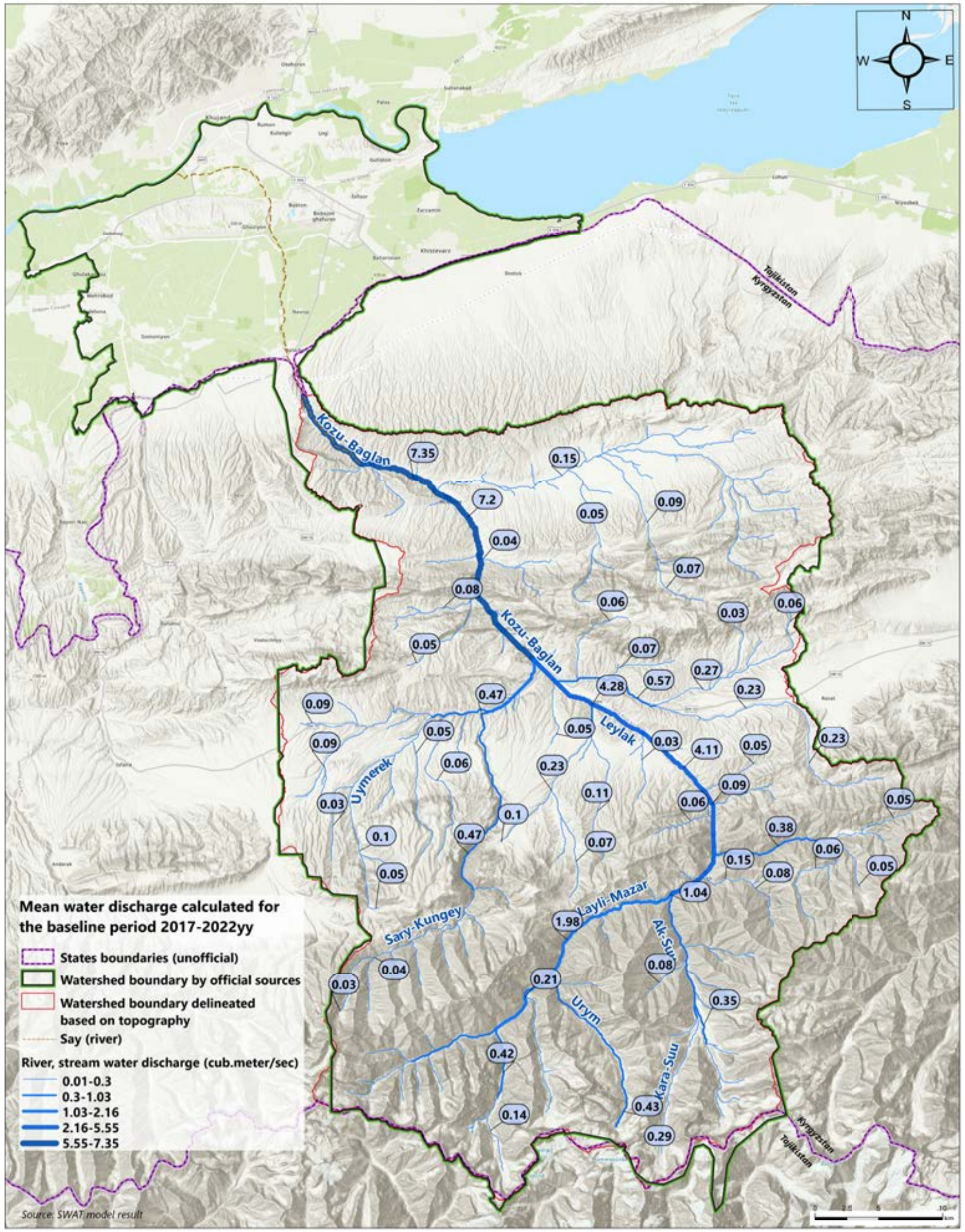
As noted above, water management issues were reported by KIIs to be linked to poor infrastructure. While the overall volume of water discharge and associate infrastructure is smaller upstream than in Kulundu, the water network in Katran, and particularly Beshkent, was reported to be in comparatively much worse condition. On-farm networks were also reported to have proportionally higher water loss.

Graph 1 on the opposite page examines the monthly trends of water discharge over the last 10 years. While water levels vary year on year, there has been a noticeable decline in water levels during the peak summer season in recent years, as well as the winter, when discharge levels have typically seen a moderate increase. Discharge levels were reported to have declined from over 200,000 km^3 in annual discharge in 2013 to less than 115,000 km^3 in annual discharge in 2022, an over 40% reduction in annual surface water.

The main water infrastructure are pumping stations that pump water from the river, which are managed by RuVKHA. There are 5 pumping stations managed by RuVKHA and 4 inter-farm pumping stations, the latter of which are located in Beshkent LSG. Irrigation water from the river, pumped by pumping stations, enters the main canals (another main infrastructure), some of which are on the balance of the Department of Water Management of the Leylek district, and some of them are managed by the WUAs. From these canals, irrigation water is distributed to the agricultural land of farmer via internal canals, ditches/ and flumes of the WUAs.

KIIs revealed differing opinions regarding these noted changes in water volume. Some KIs observed a trend of water shortages for irrigation purposes, attributed to decreased water in the river and precipitation. The KIs also emphasized the unreliability of the water supply system due to aging infrastructure, inadequate maintenance (lack of major infrastructure repair), and recurrent challenges posed by floods and mudflows. While RuVKHA has taken steps to address these risks through initiatives such as constructing mudflow traps and artificial water intakes, the interviews highlighted that Katran, Kulundu, and Beshkent are constrained

Maps 3: Water discharge of Kozu-Baglan watershed, 2017 - 2022



Water Discharge & Water Yields - Continued

by limited funding, preventing them from implementing crucial preventive measures and major repairs. While ongoing maintenance is carried out, the absence of funding for capital improvements raises concerns about the potential for future infrastructure failures, given the deteriorating condition of the canals and trays.

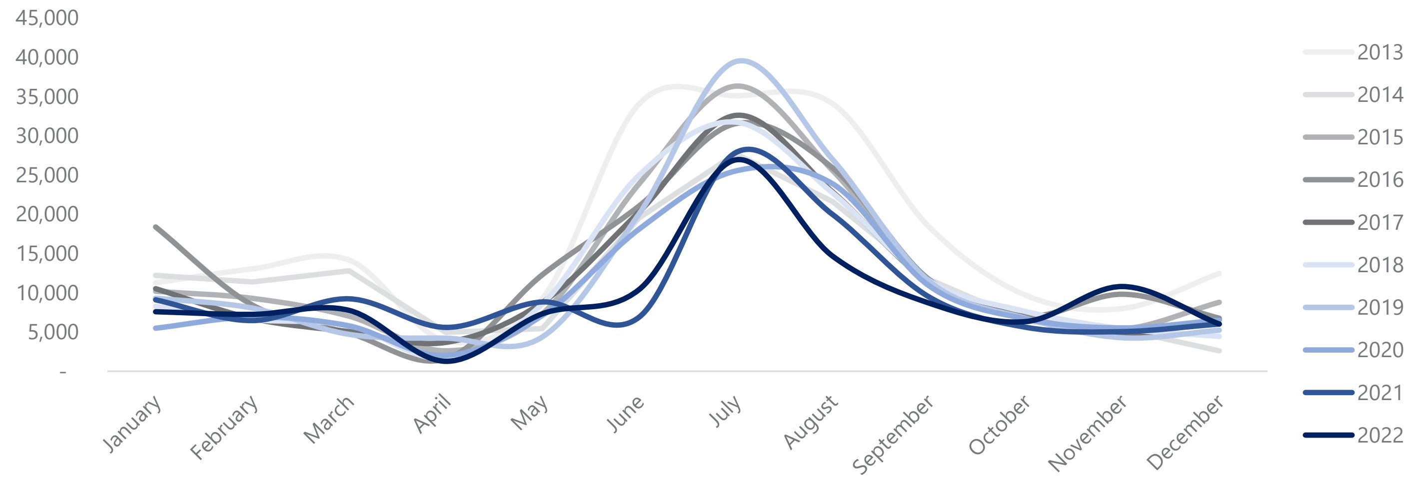
Graph 1 depicts the water runoff trends in the Kozu-Baglan watershed from 2013 to 2022. Despite occasional years with slight increases, the overall trend shows a decline in water discharge during this period, including a decline in the average annual water flow of 43% between 2013 and 2022. Moreover, there have been noticeable changes in the patterns of water flow.

In the initial half of this time frame, there was a notable surge in water flow that typically began in May and extended through September. However, with the passing years, this phase of increased water flow saw a delayed onset by approximately a month, as well as a shortening of the duration of high volume water flows in over the summer of approximately one month, spanning from June to mid-August. More recently, in 2021 and 2022, the increase in water flow only began in June and started to decrease as early as August.

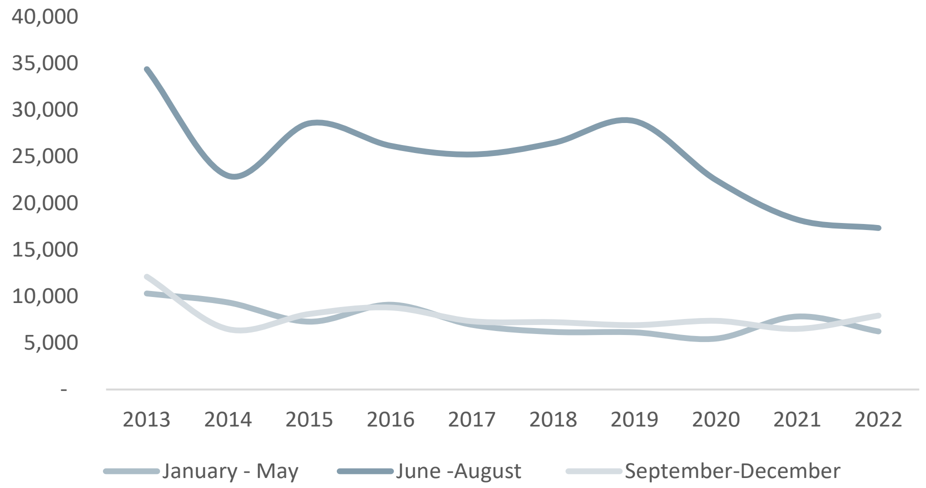
Furthermore, Graph 2 illustrates these changes from 2013 to 2022, broken down into the periods. In all three periods, there were substantial decreases in water discharge. For instance, the average water discharge from January to May during the 2013-2018 period stood at 8,196 m^3, which, in the subsequent period from 2019-2023, decreased to 6,123 m^3, marking a 25% reduction. Similarly, data for June to August for the same compared periods showed a decrease from 27,292 m3 to 21,715 m^3, representing a 20% decline in the average water flow during these months. Additionally, there was a reduction in water discharge from September to December, decreasing from 8,358 m3 to 7,198 m3, indicating a 14% decrease.

These changes have a direct impact on agricultural practices. The delayed availability of water by almost a month leads to water shortages during critical periods and necessitates a one-month delay in the sowing of crops.

Graph 1: Changes in Water discharge levels of Kozu-Baglan watershed, in 1000m^3, 2013-2022.[d]



Graph 2: Seasonal changes in water discharge levels of Khojibakirgan river (2013-2022)[d]



d) Open source data
e) All data provide by KIIs.

Suggested watershed support

- » The Kulundu Magistral canal accounts for nearly 80% of water discharge and also water loss. Repairing the canal will have a major affect in reducing water loss in the canal system.
- » Water levels in the Kozu-Baglan River have declined significantly over the last 12 years. Alternative sources through groundwater and additional water saving techniques are needed to ensure sufficient water for agricultural activities.

In addition to the surface water, communities, especially Leilek and Muras AAs, in the Kozu-Baglan watershed are also highly dependent upon groundwater to meet their irrigation and drinking water needs. Ground water in the Kozu-Baglan watershed belongs to the larger Sulyukta-Batken-Nau-Isfara aquifer, which covers a large number of communities within Kyrgyzstan and neighboring countries.[18] The aquifer covers approximately 3,339 km^2, and sits 50-120 m underground.[19]

According to a UNDP study, groundwater accounts for 38% of all water in the nearby Isfara River basin. While Kozu-Baglan is further west, it exists within a similar ecological zone and therefore likely depends on a similar proportion of water from groundwater. While high, this is notably lower than other watersheds in the area, which usually 60-69% of water originates from groundwater sources.[20] The remaining water is reported to come form glacial runoff (31%), snowmelt (28%) and precipitation (1%).

The Aquifers located under the Kozu-Baglan watershed are fed by an unused water that doesn't evaporate and seeps into the soil, and forms a key method through which the aquifers are replenished.[21] Evaporation rates in Batken oblast are reported to be high, leaving less water than in other parts of the country to recharge the aquifer. Most aquifers in Central Asia are composed of a single, large aquifer, or several smaller, connected aquifers, which is the case with the Suluykta-Batken-Nau-Isfara aquifer.[22]

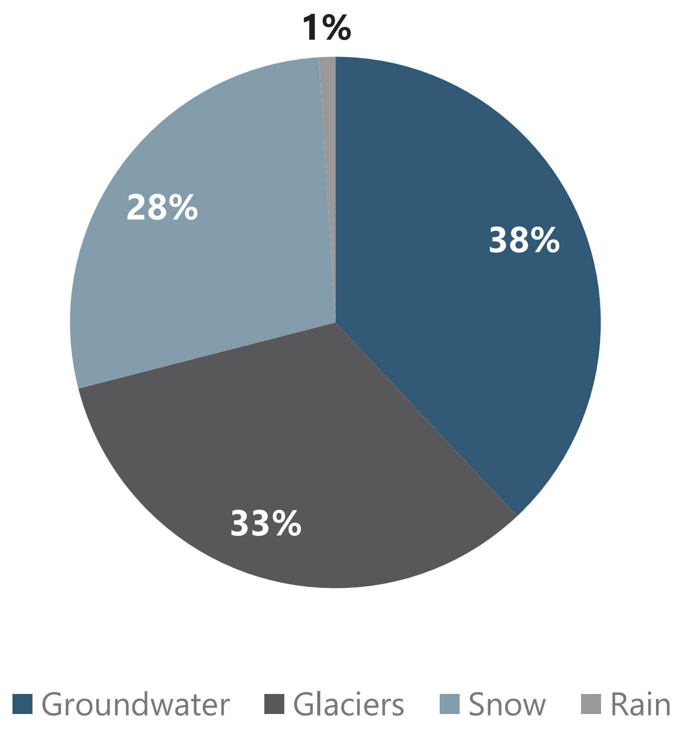
Most of the aquifers in Leylek District work through the collection of underground drainage of water into the aquifers, which sits under most of the populated areas of Leylek district, which includes the Kozu-Baglan watershed.[23]

The concerns regarding groundwater for Kozu-Baglan watershed are well-founded; a study nearby aquifers to those in Kozu-Baglan found that the aquifers were projected to be at risk of depletion by 2030, making the reliance on groundwater feasible in the short term, but for the medium and long term, more sustainable groundwater practices will need to be identified in order to sustain water services for agriculture in the watershed. Given the depletion of service water, which may not have been considered in these studies, these aquifers may need to be exploited even more heavily to account for larger gaps in surface water supply. This would risk depletion at an even more rapid rate. Further analysis by HELVETAS noted that almost all of each aquifer will be at risk of depletion by 2045.[24]

Furthermore, irrigation and industrial activity has put the ground water of the watershed at risk as well; a study from 2020 highlights that irrigation usage has increased salinity of the aquifer to concentrations of 1000-3000 Mg/L^{-1}. Pesticides and nitrogen-containing substances have also been found in the basin, among others in the Fergana Valley.[25]

The depletion of groundwater is linked to a larger issue of aquifer depletion across the region. Many farmers in the area have reportedly dealt with the issue of water shortages by drilling more boreholes since irrigation channels cannot provide enough water, which further lowers the water tables. The need to drill deeper boreholes each year can lead to tensions among farmers in the area. The increased amount of infrastructure also further reduces the available water quantity, and also degrades its quantity, thus negatively impacting the of the farming community.[26]

Graph 3: Water sources of the Isfara River[f]



f) Source: Data is taken from UNDP' report

Suggested watershed support

- Identification of complementary water sources, including groundwater (which will require additional assessments to understand the state of groundwater in the watershed).

18. UNECE, Drainage Basin of the Aral Sea and Other Transboundary Waters in Central Asia, 2023.
19. Ibid.
20. UNDP, Agro-Climatic Resources of the Batken Region of the Kyrgyz Republic", 2022.
21. https://forest.gov.kg/ru/forestries/26/geography
22. MDPI, Sustainable Use of Groundwater Resources in the Transboundary Aquifers of the Five Central Asian Counties: Challenges and Perspective, 2020.
23. MDPI, Sustainable Use of Groundwater Resources in the Transboundary Aquifers of the Five Central Asian Counties: Challenges and Perspective, 2020.
24. HELVETAS, Tajikistan: Support for the Development of an Aquifer Management Plan for the Syrdarya River Basin, August 2021.
25. Ibid.
26. Ibid.

Precipitation Trends

In addition to surface water discharge, precipitation is a major source of water for agriculture in the Kozu-Baglan watershed, both as a direct source for rainfed lands, and as a supplement to water discharge from the river for irrigated lands.

Analysis of data from weather stations in the Kozu-Baglan watershed between 1981 and 2021 revealed two key findings: (1) the overall volume of precipitation has generally remained constant or increased slightly over time, and (2) the timing of precipitation patterns has begun to vary and become less predictable in the last 20 years. These fluctuations in precipitation patterns have a substantial impact on land use practices in the watershed.

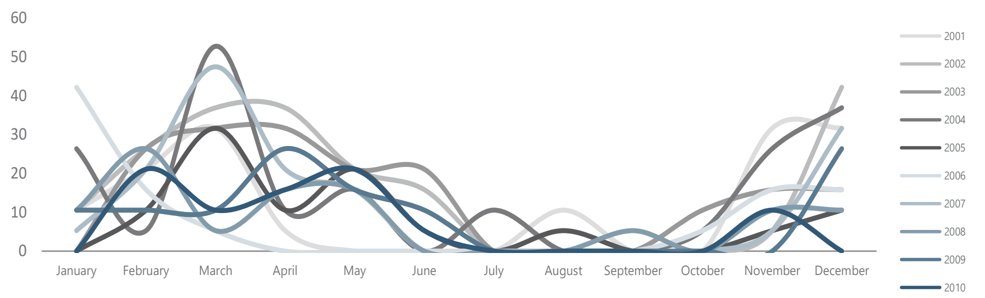
Based on the precipitation data depicted in the Graphs 4-6, rainfall in Kozu-Baglan has historically shown a clear and predictable pattern, with rains beginning in the late fall in October, and peaking at the beginning of spring (March), before declining steadily over the course of spring, reaching their nadir in the summer (June). More broadly, annual precipitation trends tend to follow a cyclical pattern of variability, with intense peaks of precipitation occurring approximately every five to six years.

In recent years, rainfall has increased, and is projected to continue to do so. More importantly, it has increasingly deviated from normal rain patterns as time has gone on. In Graph 5, monthly precipitation between 2001 and 2010 tends to follow the previously noted patterns. However, Graph 6, showing monthly precipitation between 2011 and 2020, shows rainfall patterns to increasingly deviate over the decade, with the rainfall peaking earlier during the fall rains in November, and later during spring rains in April. In addition, in recent years, high levels of rainfall have been observed during the summer in 2020 and 2021 (Graph 6), when flood-level precipitation events were recorded.

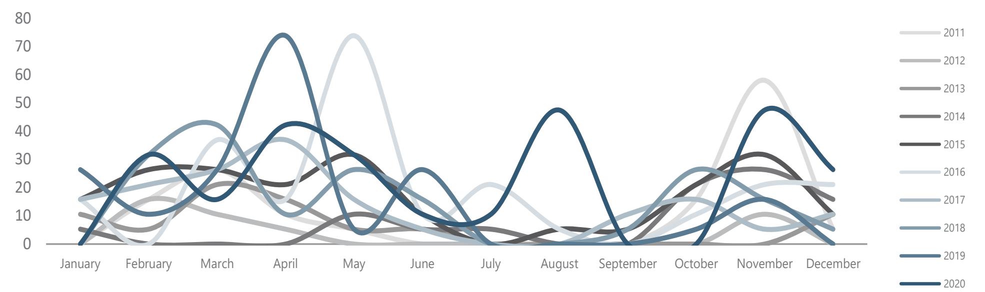
Graph 6 shows average monthly precipitation for 2021, in which extreme deviations in precipitation were recorded, including near record lows in spring precipitation, followed by extreme precipitation in July. This was likely part of a larger 2021 drought that affected much of the Fergana Valley. While data from 2022 and 2023 was not yet available through open-source means, given reports of late rainfall in early 2023, it is likely that the observed irregular rainfall patterns have continued.

Accordingly, the Annual Average Precipitation (AAP) map for the period 2017-2022 (Map 4) indicates significant variations in precipitation across the watershed. Higher-altitude regions in the southern part of the watershed receive more rainfall. The irrigated plains of the lower watershed receive less than 18% of the water received by communities in the middle and upper watershed, which deprives the communities that need most of water and provides additional upstream water that can increase the likelihood of natural hazards like landslides, flooding, mudflows, and erosion downstream, leading to infrastructure damage, and crop loss.

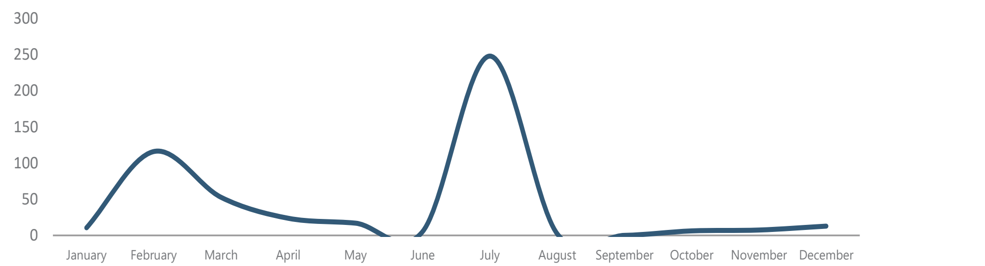
Graph 4: Monthly total of precipitation in Kozu-Baglan Watershed, 2001 - 2010, in average mm per month.[g]



Graph 5: Monthly total of precipitation in Kozu-Baglan Watershed, 2011 - 2020, in average mm per month.[g]

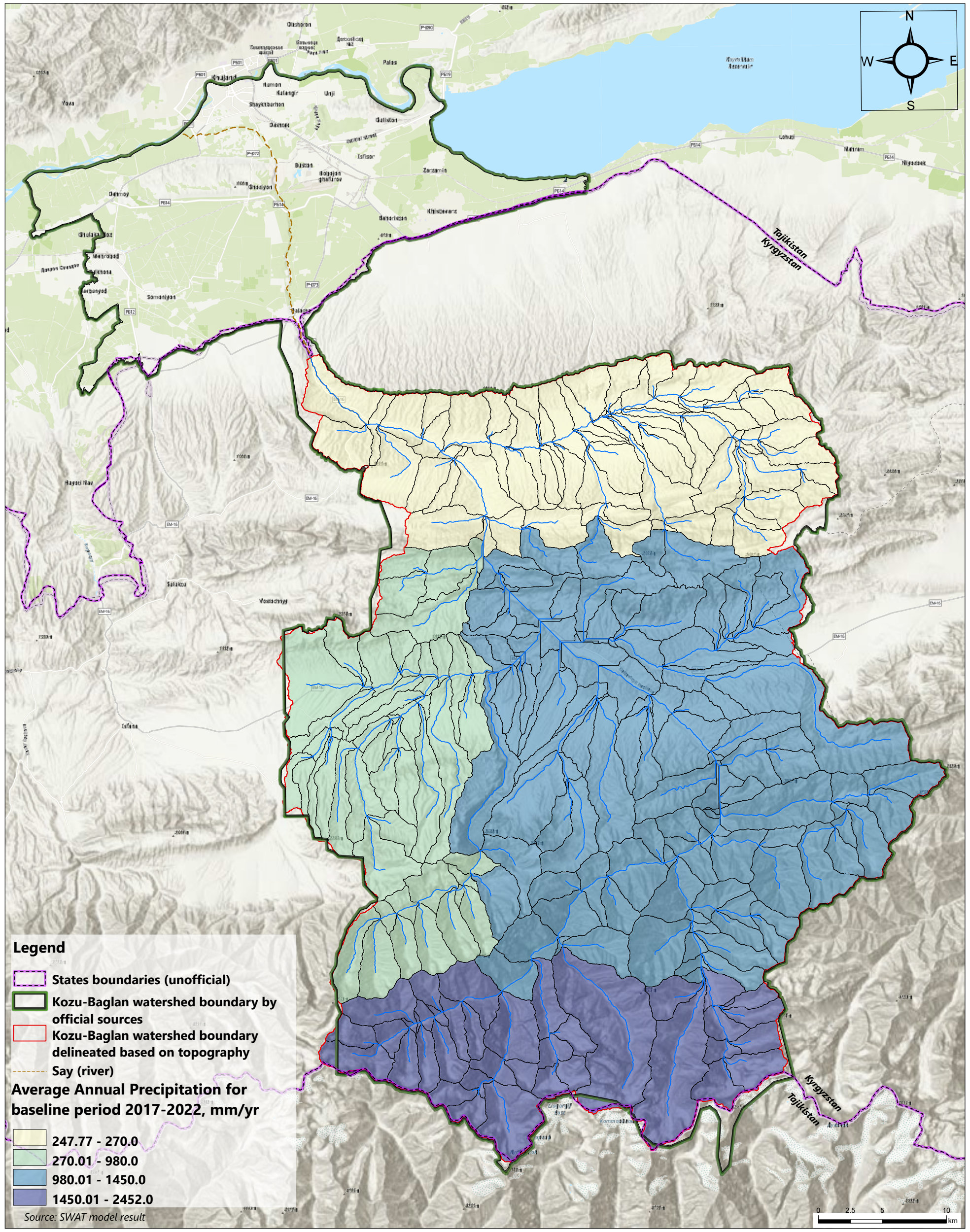


Graph 6: Monthly total of precipitation in Kozu-Baglan Watershed, 2021, in average mm per month.[g]



g) Source: Data is taken from United States National Oceanic and Atmospheric Administration website.

Map 4: Precipitation levels of sub-catchments in Kozu-Baglan watershed, 2017 - 2022



Suggested watershed support

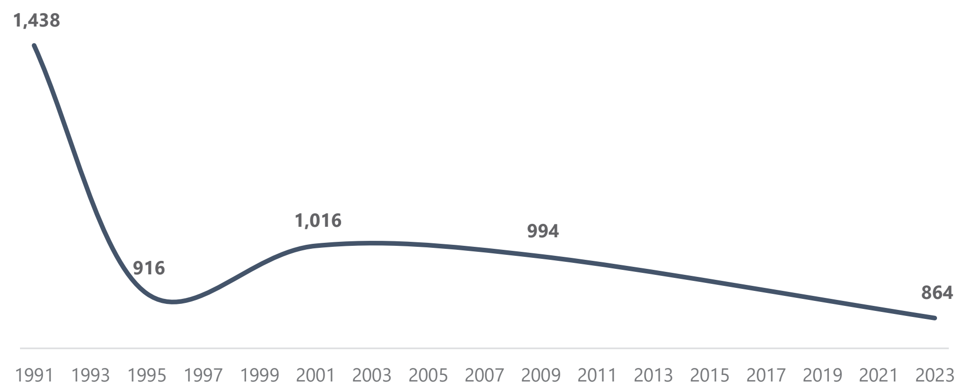
- Precipitation is likely to increase in the future, and it is also likely to occur with greater irregularity, increasing the likelihood of flooding and disrupting crops, particularly for crops grown on rainfed land. Rainwater storage will be useful in supporting continued cultivation as weather patterns change.
- Precipitation patterns are geographically uneven, and the irrigated areas that need it the most also receive the least, increasing dependence on irrigation. Irrigation networks should be supported to reduce water loss, as communities are likely to rely on the river more for agriculture in the future.
- As precipitation is likely to increase, but not in a way that supports current growing and harvest patterns, rainwater harvesting technologies should be adopted to support cultivation.

Glacier and snow melt are important sources for Kozu-Baglan river, composing and estimated 33% and 28% of the river's total water in watersheds in the Leylek area.[27] This is much higher than the typical annual average of 10-20%.[28] The continued shrinkage and eventual loss of these glaciers due to climate change is likely to cause major ecological changes in the region, including loss of biodiversity, loss of irrigated land for cultivation and a reduction in livelihoods opportunities in the region, as well as lower water tables for groundwater due to less water recharging underground aquifers.[29] More directly, melting glaciers also raise the risk of Glacial Lake Outburst Floods (GLOFs) in which lakes form within depressions of glaciers, in which glacial melt can lead to sudden unforeseen flooding which destroy entire villages.[30]

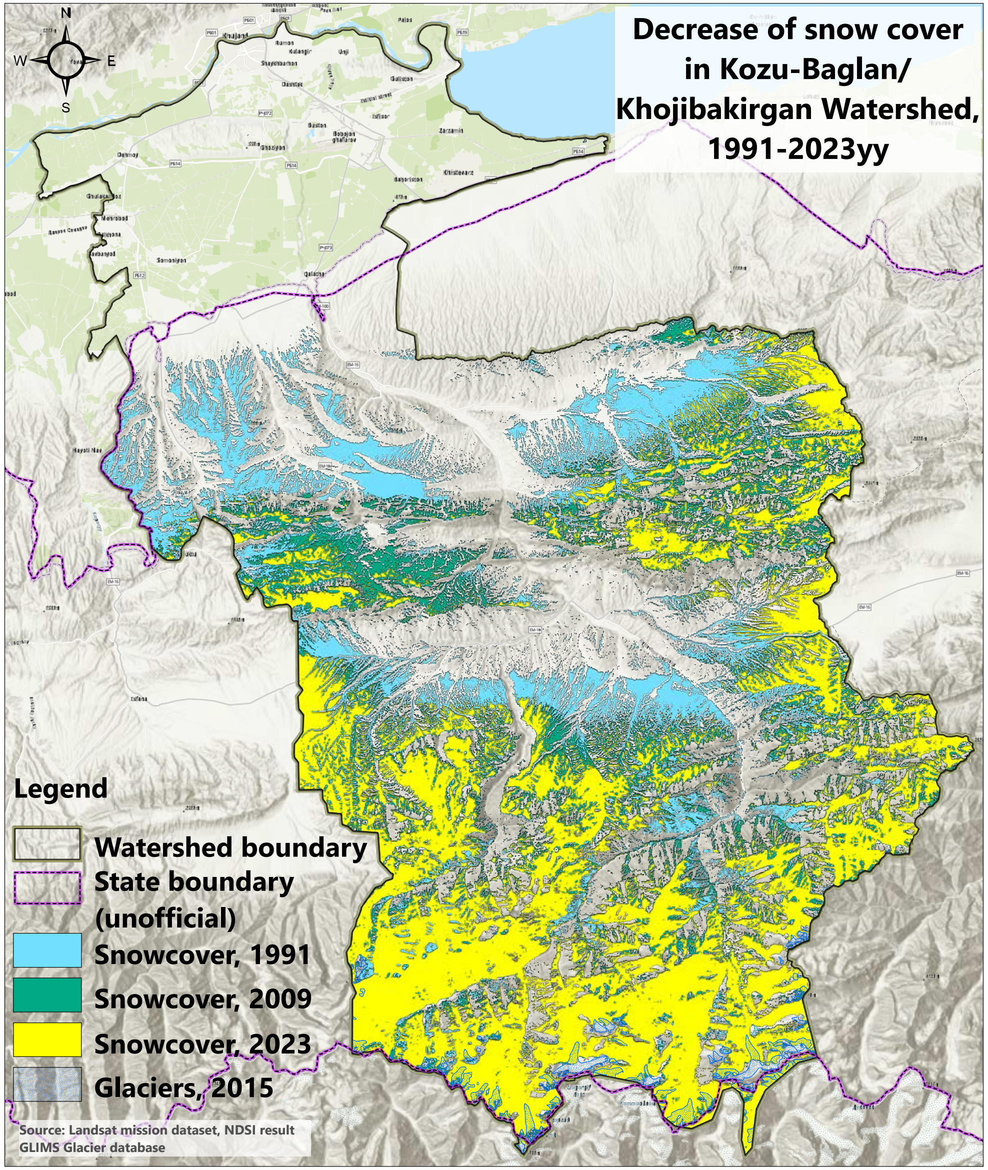
To analyse the melting of glaciers and snow melt, IMPACT conducted a geospatial analysis of the total snow and glacier coverage of the Kozu-Baglan watershed using NDSI and FLDAS data. FLDAS data measures not only the area of glaciers and snow melt, but also the depth and volume of glacier formations. However, the FLDAS data was only available for the year 2000 and later, which covered three of the 5 time periods analysed. Given that climate change research often highlights the late 1990s as an, "inflection point" in which global warming and its associated implications began to accelerate, it was important to analyse snow melt prior to 2000. For this, NDSI data was used. This data covered the geographic area of the snow melt and glaciers, but not thickness or volume.

27. UNDP, Agro-Climatic Resources of the Batken Region of the Kyrgyz Republic", 2022.
28. Central Asian Bureau for Analytical Reporting, Why are Tajikistan's glaciers melting and how dangerous is it for us?, 2021.
29. United Nations Regional Centre for Preventative Diplomacy for Central Asia, Glaciers melting in Central Asia: Time for Action, Seminar report, 11-12 November, 2014.
30. Our World, Kyrgyzstan's Glacial Floods a Growing Risk, April 2023.

Map 5: Total area of snow accumulation in month of February of Kozu-Baglan Watershed, 1991 - 2023



Map 5: Difference in snow accumulation in Kozu-Baglan Watershed in month of February, 1991-2023



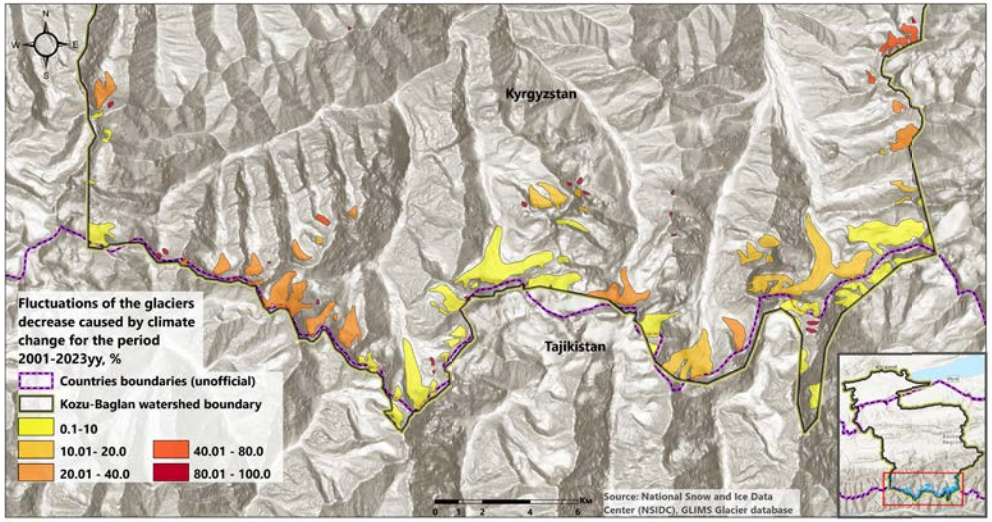
Graph 5 below shows the total loss in area of snow accumulation between 1991 and 2023, annual snow fall has decreased by approximately 40%, similar the recorded decrease in surface water flow of the river. This was most sharply seen in the mid-1990s, but has seen a steady decline since the early 2000s. As map 5 shows snow fall in the early 1990s covered the majority of the middle and upper portions of the Kozu-Baglan watershed. However, since the 2010s, snow cover in the middle of the watershed has declined significantly, and snowfall is now only consistent in the upper watershed.

IMPACT also analyzed the melting of glaciers in the Kozu-Baglan watershed between 2001 and 2023. This included both an analysis of surface area and total volume, using FLDAS analysis of GLIMS data for both analyses, and comparing the two between 2 time periods. Over the 22-year period of assessment, the glaciers in Kozu-Baglan watershed were found to have lost 4% of their area and 5% of their total volume. In addition, 26% of the nearly 100 glaciers that fed the Kozu-Baglan river in 2001 were found to have disappeared.

Looked at Map 6, which shows approximations of glacier size and locations in 2001, more severe glacier loss and shrinkage appears to have affected smaller glaciers, which were more likely to have lost half or more of their size. This suggests that the melting rate for small glaciers is likely similar to or higher than larger ones, and are more likely to disappear first.

As noted, the loss of snow and glacier coverage has already had implications in the overall flow of the Kozu-Baglan river. While water flow can increase initially increase during periods of glacial melt, leading to a period known as, "peak water," it will eventually lead to a decline in total runoff, leading the river water to dry up and decrease long term. Given that most of the reduction in water discharge appears to be due to a reduction in snowfall, rather than glacial melt, it is likely that peak water has not yet been reached, and that preventative measures can still be taken to preserve water flow within the watershed.

Map 6: % Change in Glacier volume of Kozu-Baglan Watershed, 2001- 2023



Suggested watershed support

- Measures to reduce water needed for the irrigation network is critical, as overall surface water flow is likely to decline for the foreseeable future.

Soil erosion is the deterioration of land caused by natural forces like strong winds, abnormal rainfall, floods, and wildfires, as well as human activities such as urban expansion, overgrazing, and unsustainable farming practices. [31] This issue poses a significant threat to sustainable agriculture and contributes to landscape destruction and desertification in Kyrgyzstan.

In Kyrgyzstan, approximately 46% of the total agricultural land area, roughly 5 million hectares, is impacted by water and wind erosion.[32]

Batken is among the most affected regions in Kyrgyzstan, where the Kozu-Baglan watershed is located. Research conducted in 2021 shows that the Batken region experiences high to extremely high soil erosion rates.[33]

The SWAT results of the erosion modeling conducted for the baseline period of 2017-2022 have revealed a clear trend: land erosion is more likely at higher elevations, whereas it significantly diminishes at lower and middle elevations (Graph 7). This pattern is shown more clearly on Map 7, where areas exhibiting high and very high levels of soil erosion are primarily located in rocky and mountainous terrain, steep and rugged landscapes, high mountain passes, and precipitous slopes. They are typically situated at elevations of 1,800 meters and above, away from most permanent human settlement.[34]

The areas marked as “not sustainable” for soil erosion are typically composed of pasture lands (approximately 1,200-1,800 meters) in the middle of the watershed. Based on the findings from KIIs, the majority of pasture lands are reported to experience elevated temperatures and are susceptible to erosion. Additionally, the conducted KIIs revealed that the destruction of pastures has occurred due to the impact of natural disasters. The representative of MoES pointed out that even small amounts of rain in pastures can trigger mudflows due to the absence of sufficient grass cover.

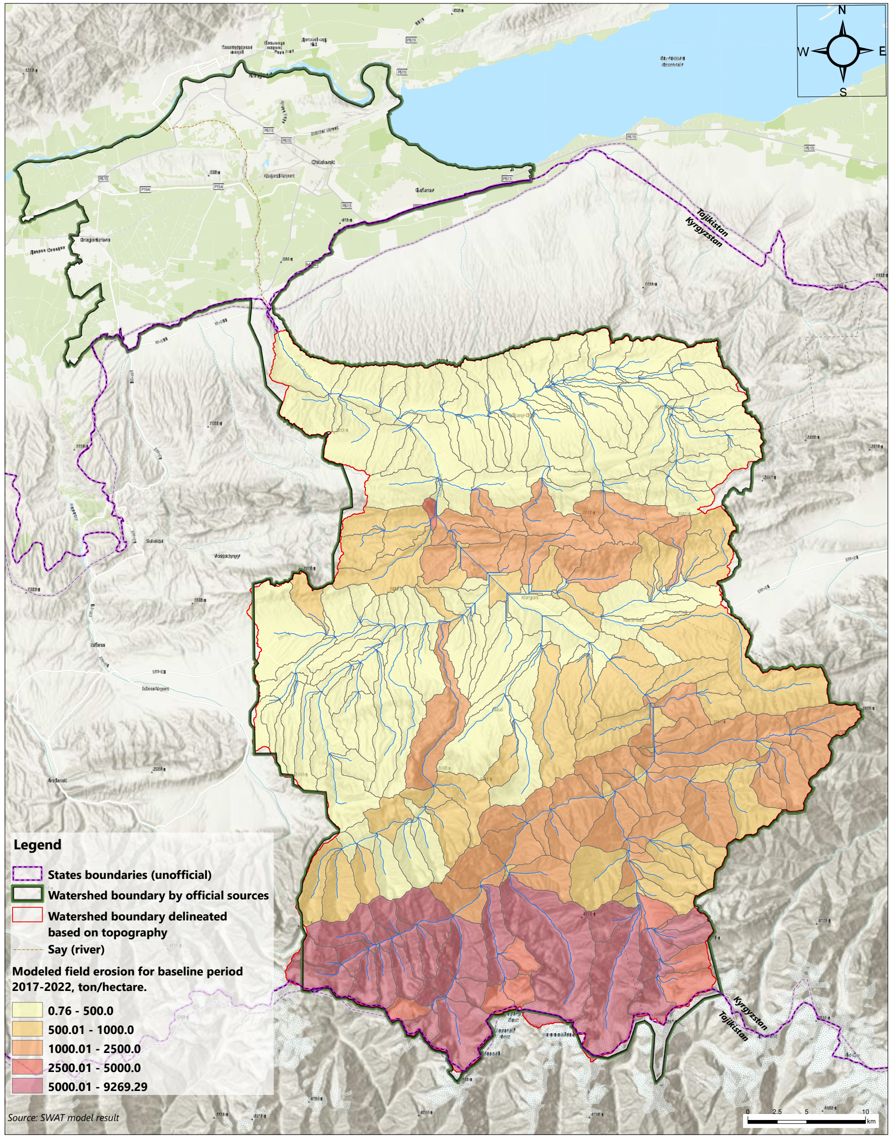
A previous analysis by Acted in 2015 found most of the Kozu-Baglan River basin to be composed of grey soils in pasture areas that had been highly eroded, making topsoil of the watershed highly vulnerable to erosion.[35] Much of the rest of the watershed was stony and even more vulnerable to erosion. Only the irrigated plains were found to be resilient to soil erosion more broadly.[36]

The insufficient grass cover is primarily attributed to improper use of pastures, which is caused by the violation of schedules and rules for pasture utilization by the local communities. Overgrazing occurs when livestock consume grass to such an extent that the roots of the grass are lost, which leads to a decrease in the vegetation cover that plays a crucial role in preventing soil erosion, as reported in the conducted KIIs.

Low erosion areas are 1,100 meters above sea level and below. In general, these are in rainfed areas of the basin and not near high-intensive agriculture, lowering much of the risk major populated communities.

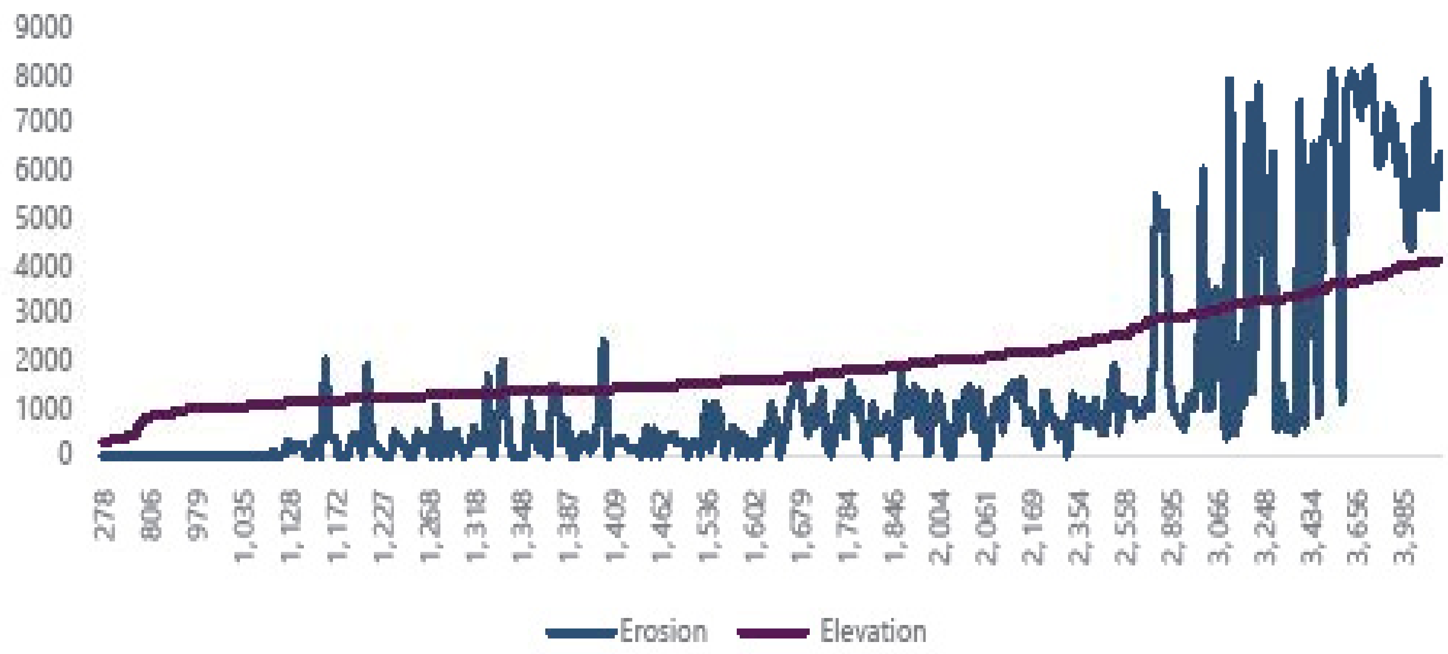
31. [EOS Data Analytics, Soil Erosion Causes, Types, Ways to Reduce And Prevent, September 2022.]
32. [Kyrgyzstan, Land use. Soil erosion in the hills, pasture degradation, December 2016.]
33. [The World Bank, Costs of Environmental Degradation in the Mountains of Tajikistan, December 2020.]
34. Summary report about main findings and conclusions from disaster risk and watershed assessment of Kozu-Baglan/ Khojibarkigan Watershed, February 2015. ACTED,
35. [FAO, Soils Portal: Legacy Maps and Soils Databases, 2023.]
36. Summary report about main findings and conclusions from disaster risk and watershed assessment of Kozu-Baglan/ Khojibarkigan Watershed, February 2015.

Map 7: Soil Erosion in sub-catchments of Kozu-Baglan watershed, 2017 - 2022



However, and exception to this is Katran LSG, and to a lesser extent Leylek LSG, which are located in more elevated areas and are at greater risk to erosion of land and mudflows.

Graph 7: Soil Erosion and elevation relationship in Kozu-Baglan watershed 2022



Suggested watershed support

- Efforts to restore and strengthen soil through improved vegetation should be made in upper-watershed communities to reduce erosion.
- Reforestation and pasture management initiatives can strengthen the soil and reduce the amount of erosion material that feeds mudflow events.

Sedimentation in streams refers to the concentration of suspended sediments and the deposition of sediment onto the stream bed. Rivers and streams maintain an equilibrium between water discharge, slope, sediment load, and sediment size. Changes in this equilibrium can result from climate change, tectonic shifts, or human activity such as dams and irrigation, or urbanization.[37] These shifts can alter a river's flow, resulting in bank erosion and potentially increasing vulnerability to mudslide events.[38]

As part of the SWAT analysis, IMPACT modeled stream sedimentation for the 2017-2022 period. The findings of this analysis indicated that Kozu-Baglan watershed suffers from a high levels of sediment accumulation, which in some places can cause floods/mudslides during heavy precipitation events.

As it shown on the Map 8 sediment accumulation is highest in highly elevated areas, such as the Turkestan Ridge that makes up the river's source, exceeding 4,000 meters above sea level, exhibits elevated levels of sedimentation, with total suspended solids measuring up to 4,100 mg/L.

During the winter months, snow accumulates in these areas. As the warmer seasons arrive, the melting snow, along with rainfall and erosional processes (glacial erosion), can transport a variety of sediments, including stones and their smaller particles, as well as sand and gravel.

Sediment accumulation, and the resulting exposure to mudflows, is highest in Katran, Leylek, and Kulundu LSGs. In these places, the total suspended solids reach 4,150 mg/L, similar to locations near the river's mountain source.

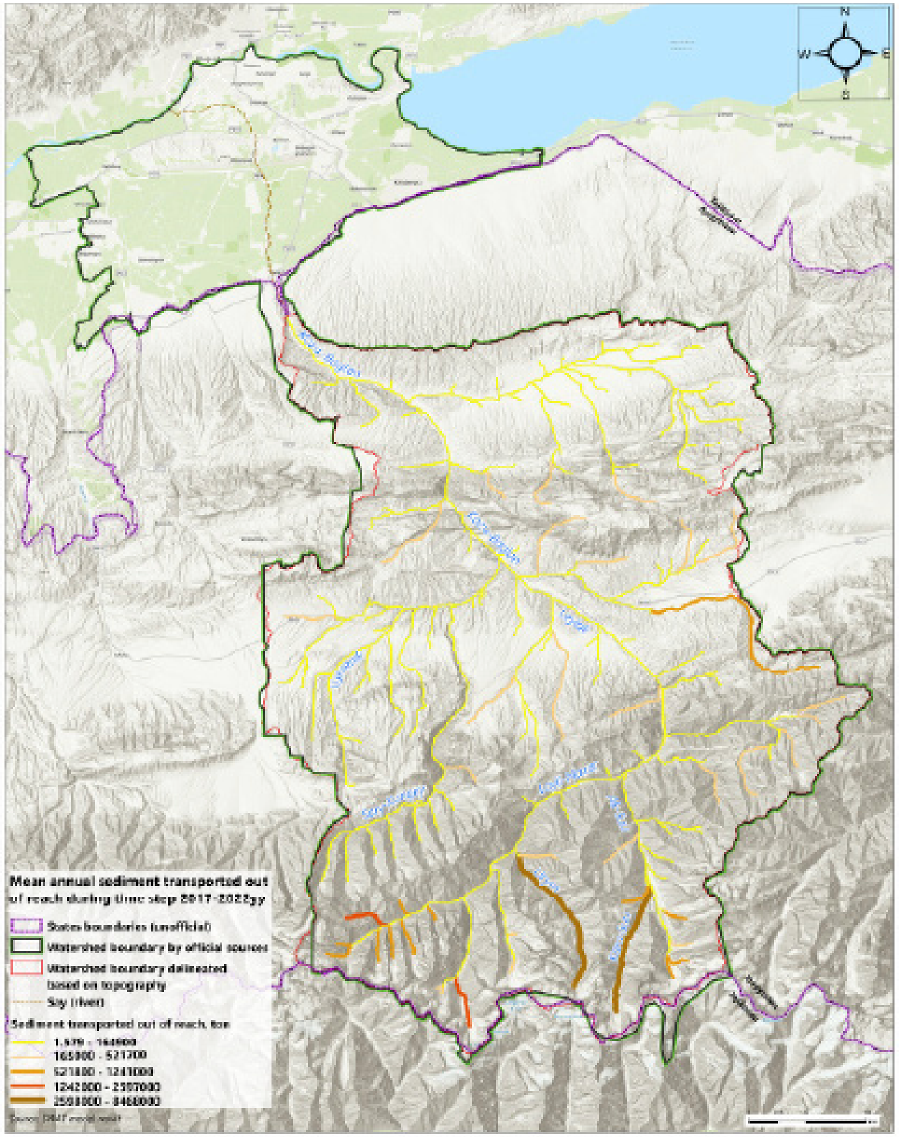
The dangers of mudflows in these areas were highlighted by KIIs IMPACT interviewed in Leylek District. Ministry of Emergency Situations (MoES) documents highlighted major risks of mudflows to populations living in elevated areas and near the main river, highlighting concerns of the river erosion damaging nearby houses and farmland. Interviews with Leylek District MoES staff found that while communities in all LSGs along the river are at risk to mudflows, Katran LSG was the most vulnerable, with approximately 100 people at risk of being harmed by mudflows.

According to a Hazard & Vulnerability assessment conducted by Acted in 2015,[39] mudflows were also the primary concern of communities in the watershed, which follow periods of intense rainfall and glacial melt that occurs each spring.

The report further noted that unsustainable community practices had increased the overall risk from mudflows, including: 1) uncontrolled grazing and deforestation, 2) population growth leading to construction in mudflow-prone areas, and 3) limited public finances prevent necessary preventive measures.

Very few active measures to mitigate the effects of mudflows on communities were reported. Local authorities noted in KIIs that they were aware of mudflow risks but had been unable to implement any prevention measures due to a lack of sufficient funding.[40]

Map 8: Sedimentation of sub-basins in Kozu-Baglan watershed, 2017 - 2022



Suggested watershed support

» Retention walls can prevent the further erosion of riverbanks and protect household shelters and farmland from being damaged.

37. [Peter J. Wampler, Rivers and Streams-Water and Sediment in Motion, January 2012](#)
38. [Springer Link, Dealing with sediment transport in flood risk management, March 2019.](#)

39. ACTED, Summary report about main findings and conclusions from disaster risk and watershed assessment of Kozu-Baglan/ Khojibarkigan Watershed, February 2015.
40. ACTED, Additional Assessment of Risks of Natural Disaster in Ak-Suu and Khoja-Bakyrgan River Water-hseds, 2014.

The climate in Kozu-Baglan sub-basin, Syr Darya, is defined by its valley location. It is dry with hot summers and mild winters. The annual temperature averages 14.4°C, with January being the coldest month, with an average temperature of -0.9°C.

The average temperature has been rising since 2000, with the most significant increases occurring over the past 12 years. For example, between 1992 and 1998, temperatures were around or below the expected average. However, in the following years, they consistently exceeded the norm by 0.6 to 1.70 degrees. (Climate change report by Helvetaz).

As part of the assessment, IMPACT conducted an in-depth analysis of various of bioclimatic variables from WorldClim. WorldClim uses the Coupled Model Intercomparion Project 6 (CMIP6) developed as part of the World Climate Research Programme (WCRP). The CMIP6 models climate change through different Shared Socioeconomic Pathways (SSPs). Each SSP corresponds to a different scenario in which macro variables, including population growth, green technological development, changes in inequality, and management of Co2 emissions are managed globally in different ways. Of the 4 possible SSPs in the model, each representing an increasingly pessimistic scenario as the SSP number increases, with 1 representing an increasingly sustainable world, and 5 an increasingly unsustainable one.[41] Each SSP is roughly equivalent to the Representative Concentration Pathways (RCP) scenarios used under CMIP5, but include additional economic and social causal information and additional model components[42]

41. DKRZ, The SSP Scenarios, 2023.
42. Ibid.

To conduct the analysis, IMPACT selected SSP370, which represents a middle of the road scenario, in which most current climate trends stay the same, but do not worsen. The analysis spanned the baseline period of 1970-2000 to the near future 2041- 2060 within Fergana valley, including the whole Kozu-Baglan watershed. The analysis suggests increasing disruptions to the Fergana Valley's ecosystems due to increasing in annual mean temperature and changes in precipitation patterns, which are consistent with broader climate change forecasts.[43]

As depicted in Maps 9 & 10, a rise in the average annual temperature across the Fergana Valley is expected, particularly in the southwest part of the Valley, with a projected increase in temperature as high as 4 degrees Celsius (°C) in some locations. While not as dire, the remainder of the valley is expected to see dangerous temperature increases as well.

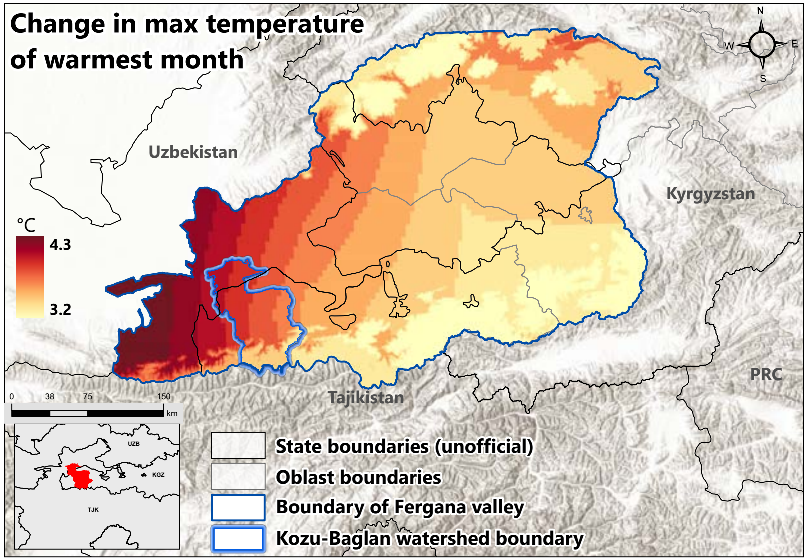
Similarly, the analysis revealed changes in precipitation patterns. Forecasts suggested an estimated increase in annual precipitation of about 40 mm within the elevated and mountainous eastern region of the Fergana Valley, while the centre and western parts of the valley are expected to see a slight decrease in precipitation.

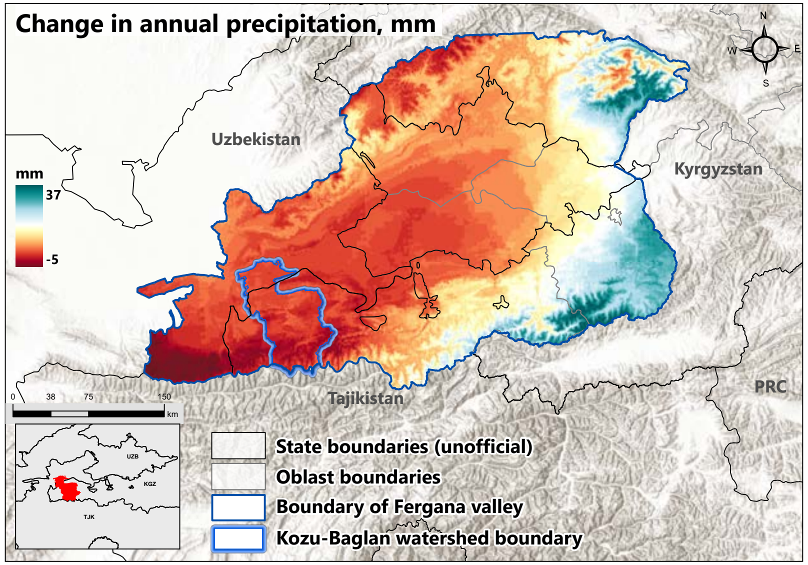
Looking at Kozu-Baglan watershed specifically in Figure 1, the rise in temperature is expected to be more pronounced during the warmest quarter of the year, with less of an increase in colder months. Annual precipitation is expected to increase over time, although it is expected to decrease slightly during the summer while increasing significantly during the winter and spring.

These changes are likely to result in more

43. Muccione, Veruska; Huggel, Christian; Salzmann, Nadine; Fiddes, Joel; Nussbaumer, Samuel U; Novikov, Viktor; Hughes, Geoff, Climate-cryosphere-water nexus: Central Asia outlook. Châtelaine, 2018.

Maps 9 & 10: Projected changes in (a) max. temperature of warmest month and (b) precipitation of driest quarter (1970-2000 / 2041-2060), Kozu-Baglan watershed





g) Including LULC. Human activities impact terrestrial carbon sinks such as forests, through land use, land-use change and forestry (LULC) activities, altering CO_2 exchange (carbon cycle) between terrestrial biosphere system and atmosphere. LULC removals are expected to have minor impacts in future in Ukraine / 2 Excluding LULC / 3 A national climate plan highlighting climate actions, including climate-related targets, policies and measures governments aims to implement in response to climate change and as a contribution to global climate action.

frequent and intense heat waves and drought throughout the valley, as well as increased incidents of flooding, which can have adverse effects on public health and lead to reduced crop yields, thereby posing challenges to food security.[44]

The estimated increase in precipitation within the elevated and mountainous areas of the Fergana Valley may also cause heavy rains in the mountains leading to flooding, mudslides and erosion. According to several recent studies,[45] global warming is expected to decrease snow cover and to cause more precipitation to fall as rain rather than snow. Within the watershed area, the increase of precipitation in the wettest (usually considered as spring and autumn) and coldest periods may cause mudflows and flooding.

Additionally, the region is witnessing a growing number of natural disasters such as mudslides, landslides, and floods. These developments underline the strong link between climate change and challenges related to water resources. To address these issues, immediate action is essential to ensure access to and responsible utilization of water resources in the Kozu-Baglan sub-basin, which is highly susceptible to the risks posed by climate change, particularly the significant increase in temperatures that jeopardize water resources.

The consequences of these changes are likely to result in more frequent and intense heat waves and instances of drought throughout the entire valley, as well as increased incidents of flooding, which can have adverse effects on public health and lead to reduced crop yields, thereby posing challenges to food security.[46]

44. Reyer, C., Otto, I. M., Adams, S., Albrecht, T., Baarsch, F., Cartsburg, M., Coumou, D., Eden, A., Ludi, E., Marcus, R., Mengel, M., Mosello, B., Robinson, A., Schleussner, C., Serdeczny, O., & Stagl, J. Climate change impacts in Central Asia and their implications for development. Regional Environmental Change, 17(6), 1639–1650. 2015.

45. Muccione, Veruska; Huggel, Christian; Salzmann, Nadine; Fiddes, Joel; Nussbaumer, Samuel U; Novikov, Viktor; Hughes, Geoff . Climate-cryosphere-water nexus: Central Asia outlook. Châtelaine: Zoï Environment Network. 2018 and Ombadi, M., Risser, M. D., Rhoades, A. M., & Varadharajan, C. A warming-induced reduction in snow fraction amplifies rainfall extremes. Nature, 619(7969), 305–310. (2023b)

46. Reyer, C., Otto, I. M., Adams, S., Albrecht, T., Baarsch, F., Cartsburg, M., Coumou, D., Eden, A., Ludi, E., Marcus, R., Mengel, M., Mosello, B., Robinson, A., Schleussner, C., Serdeczny, O., & Stagl, J. Climate change impacts in Central Asia and their implications for development. Regional Environmental Change, 17(6), 1639–1650. 2015.

Figure 1. Projected changes in bioclimatic variables of interest, Kozu-Baglan,

- **+2.5°c** Annual mean temperature increase
- **+2.3°c** Change in mean temp. in driest quarter
- **-3.5mm** Decrease in precipitation of wettest quarter
- **+2.9mm** Increase in precipitation of coldest quarter
- **+2.4°c** Increase in max. temp. in warmest month
- **+2.6°c** Increase in minimum temperature in coldest month
- **+7.4mm** Increase in annual precipitation
- **-0.7mm** Decrease in precipitation in warmest quarter

Warmer temperatures and higher rainfall, particularly in the wettest and coldest months could lead to more extreme and unreliable patterns in rainfall and flooding.

Suggested watershed support

- Review crop calendars to determine crops better suited for the expected changing temperature and precipitation patterns.
- Integration of climate adaptation strategies into local development road maps.
- Climate change is expected to worsen precipitation and water discharge patterns in the near to medium term.

2. Watershed Hazard Analysis

Kozu-Baglan Watershed
Leylek Raion - Batken Oblast - Kyrgyzstan

Hazards to effective land management

Source: Google Earth, 2023

Source: Acted, Horticulture in Kadamjai District, August 2023

Agricultural Land Management

Agriculture plays a pivotal role in Batken Region's economy and society, providing essential sustenance, livelihoods, and economic opportunities for its residents. In 2021, the Region's agricultural output amounted to 21,660 million soms (See Annex 1), representing almost 7% of total national agricultural output.[47]

The contribution of agriculture to the local economy was more than four times greater than the total industrial output in Batken (4,546.7 million soms). Leylek district accounts for around 17% of the Batken region's total output. Additionally, the number of peasant farms in 2023 constitutes 45% of the total operating business entities, underscores the role of agriculture in the economy.[48]

Subsequently, the role of agriculture in the communities of the Kozu-Baglan watershed is of vital importance, although it is not understood well at a local level. In order to address this knowledge gap, Impact conducted primary data collection with LSG and district-level authorities and consulted additional detailed studies of agricultural practices within the region. Recent trends in declining and irregular precipitation patterns, falling water yields, and rising temperatures have already had a major impact on agriculture land within the Kozu-Baglan watershed. Declining precipitation has reduced yields of staple grains traditionally grown in rainfed land, increasing reliance on the main river. Drought is already a major concern within the watershed, and is likely to become even more common as time goes on.

Given the increasing reliance on the irrigation network for agriculture land, improving the capacity of the canals and irrigation schemes is critical to reducing water loss and improving the Kyrgyzstan's capacity to meet the livelihoods needs of its population. Additional rainwater harvesting measures within household and communities can help to preserve rainfed lands from deteriorating further.

47. Statistical Committee of the Kyrgyz Republic, Agriculture of the Kyrgyz Republic, 2022.
48. Ibid.

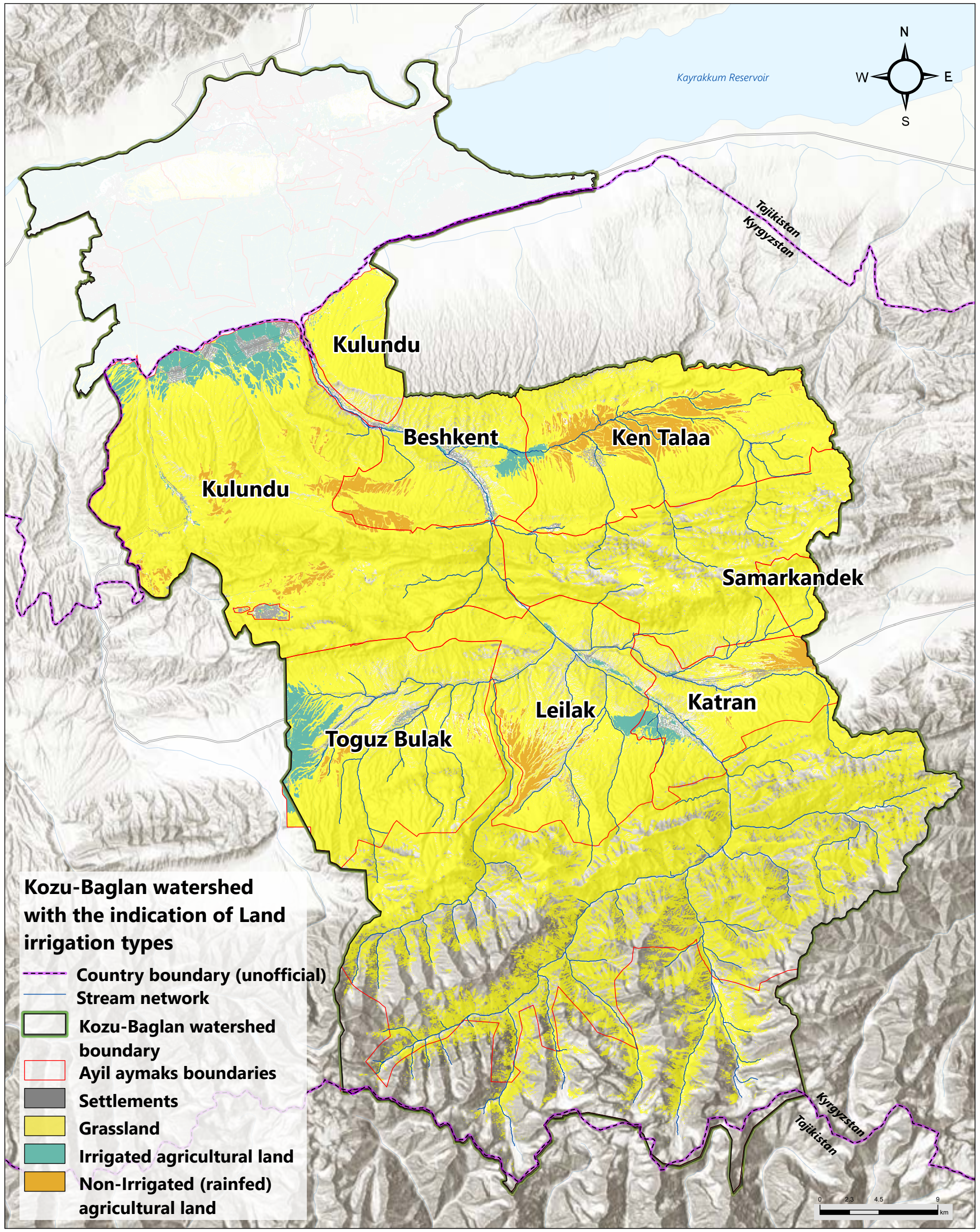
Land in the Kozu-Baglan watershed includes agricultural land, pastures and forests, which are, respectively, under the jurisdiction of the district department of agriculture, the administrations of LSGs and the Forestry Funds of the Ministry of Agriculture.

In Kyrgyzstan, most agricultural land is privately owned (75%), while the remaining and state-owned land (25%). KIIs noted that most privately owned land is evenly distributed between families, with 0.03-0.15 ha per family. Additionally, in some cases there are cooperatives usually formed by groups of different families, coming together to pool resources, specializing in seed production, providing harvest services, utilizing jointly owned land. Land Committees exist at district level to ensure manage the process of land allocation, and each LSG government has a Land specialist to deal with land issues. Pasture land in Kyrgyzstan is the property of the state, and considered public land, although it can be leased to individuals or groups for long periods of time, often for the purpose of pasture land rehabilitation.

As shown in Table 7, there is more than twice as much rainfed land as irrigated land in the Kyrgyz part of the Kozu-Baglan watershed. Most irrigated land (nearly 2,000 ha) is located in Kulundu, though nearly all arable land is in use; only a few hectares in Katran and Kulundu were reported to be barren.

The vast majority of land in the watershed is pasture land. This is particularly prominent in Kulundu and Ken-Talaa, due to their significance in livestock-related activities. The management of these pastures falls under the responsibility of pasture committees, acting as the executive body of pasture user associations under the LSGs.

Map 11: Approximate locations of irrigated and rainfed lands in Kozu-Baglan watershed, 2023



Forests are considered to be extensions of pastureland within the watershed, although only a small portion of official designated forests are actually densely covered in trees. Within the Kozu-Baglan watershed, there are two forests, Leylek and Arka, which are managed by the Ministry of Agriculture. These forests constitute the main public pasture areas for communities in the watershed. They are typically managed directly by the district, and are not part of any LSG's territory, although in the case of Ken-Talaa and Katran, some of Leylek forest sits within their boundaries.

Table 7: Agricultural Land use, by % of land in Kozu-Baglan watershed (in ha), 2022[h]

Land cover type	% of total
Total area of arable land :	11%
Irrigated	3%
Rainfed	7%
Pasture land	76%
Perennial plants (trees)	1%
Barren land	0%
Fodder	2%

h) Source: Leylek District Department of Agriculture, Water Resources and Rural Development .

Most of the population of Kozu-Baglan watershed is primarily engaged in agriculture, which serves as the main source of income for households. KIs highlighted differences based on the rainfed and irrigated land, elevation, and climate change witnessed by farmers of the watershed over recent years.

The KIs indicated differences in crop types based on elevation, which is in the Leylek district is divided into three parts: the lower zone (about 500 meters above sea level), the middle zone (between 500-2,200 meters above sea) and the upper (mountainous zone or more than 2,200 meters above sea level). In the lower zone, which is mostly irrigated, vegetables and fruits are grown. In the middle zone, staple grains and fodder plants (hay, alfalfa, etc.) are grown, and in upper zone mainly potatoes (though very few people practice agriculture in this zone).[49]

Moreover, all KIs also noted that different crops are planted based on rainfed or irrigated lands. In the rainfed lands, staple grains like barley and wheat are grown, while in irrigated lands (plains) perennial grasses (alfalfa), potatoes, corns (grain and field), fruits and vegetables are usually grown. Overall, the main crops grown in the watershed are wheat, barley and vegetables.

A UNDP report on agricultural practices in Batken Region also notes that differences in agricultural practices, and the timing of sowing and harvesting may depend on the elevation and the temperature of the areas in which the crop is grown. Both heat and moisture are available at different periods of time based on differing elevations, leading the sowing and harvest seasons to vary. The report notes a delay of 2-3 days in the sowing of crops for every 100m of elevation up to 2,000m, after which there is a delay of 3-4 days per every 100m, meaning the lower, middle, and upper zones can start their growing seasons over a month apart.[50]

49. UNDP, Agro-Climatic Resources of the Batken Region of the Kyrgyz Republic", 2022.

Overall, the Kozu-Baglan watershed, along with the neighboring Aksu and Isfara watersheds, are less favorable for growing crops than other parts of Batken Region. On average it receives far more precipitation at favorable growing temperatures (5-15 Celsius) during the growing season than Kadamjay, recieving 3 times as much water in the spring, and 1.2 times as much water in the summer, and 1.25 - 2.25 times as much water as other parts of Batken region annually.[51]

50. UNDP, Agro-Climatic Resources of the Batken Region of the Kyrgyz Republic", 2022.
51. UNDP, Agro-Climatic Resources of the Batken Region of the Kyrgyz Republic", 2022.

Annual moisture supply for favorable growing conditions was reported by UNDP to be almost twice as much. However, the watershed area also receives less days with favorable temperatures, and fewer frost free days then the rest of Batken region, making the growing season shorter and more challenging compared to other watersheds.

A crop calendar for wheat and barley (main crops) is illustrated in the Figure 2. The sowing period of these crops usually begins from the end of March to the beginning of April, when the average daily temperatures consistently exceed 5°C. Following sowing, barley and wheat progress through several critical growth phases: emergence (occurring within 11-21 days), tillering (15-25 days after emergence). The booting phase takes place in early May, followed by flowering, occurring approximately 25-35 days from emergence. Subsequently, the crops undergo heading and ripening.

Notably, the period of ripening varies with elevation due to temperature differences. In valley and foothill regions, the major harvest typically occurs toward the end of June and extends into the first half of July. In mountainous areas, harvesting is scheduled for mid-August, while in high mountain zones, the harvest period extends into late August and early September.

KIs did not report any significant changes in agricultural practices or major shifts in the types of crops grown. KIs reported that people across the watershed continued to plant the same crops, and that the seasonality of the growing seasons had not changed.

Figure 2: Crop Calendar for major grain and staple crops in Leilek district, 2022[j]

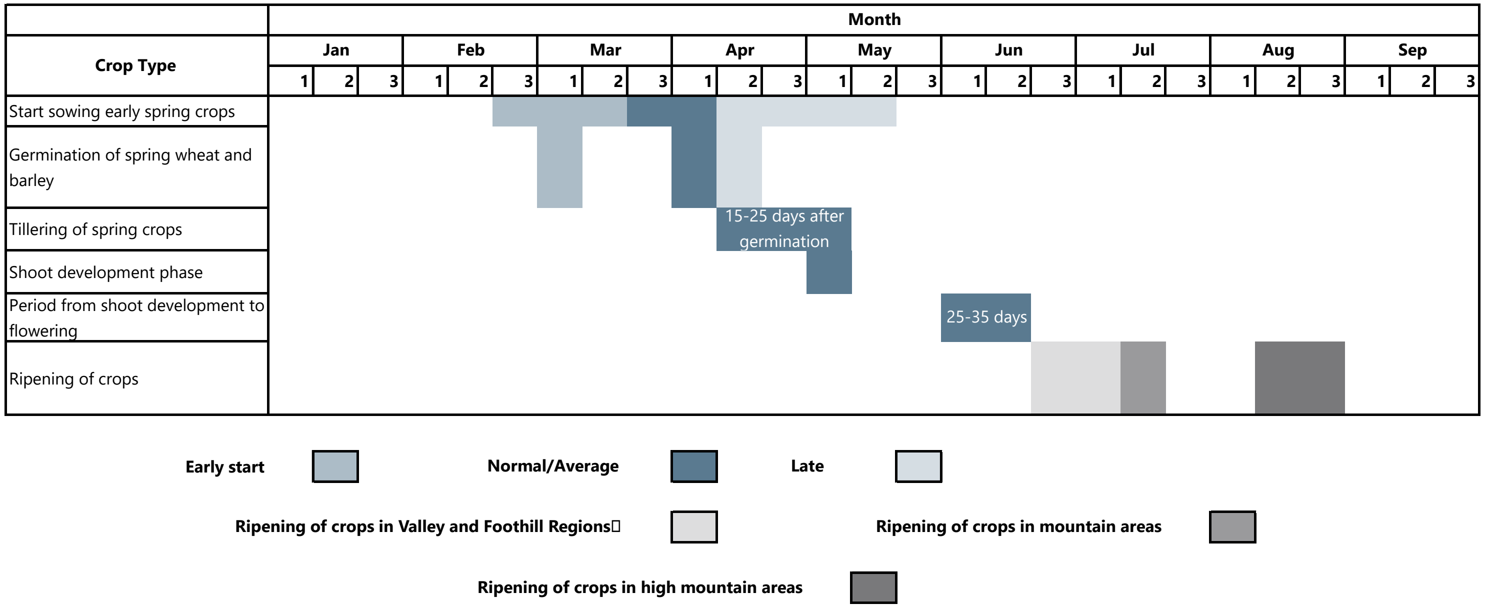


Table 8: Crop yields by centners/hectare, by LSG in Kozu-Baglan watershed, 2022[i]

LSG	Wheat	Barley	Corn	Beans	Potatoes	Vegetables	Horticulture (fruit)	Beans	Grass for animal feed
Katran	21.8	16.3	55.1	0.0	130.4	195.0	85.0	0.0	105.2
Leylek	15.2	15.0	58.1	15.0	130.0	195.0	79.0	15.0	100.4
Beshkent	23.5	11.3	55.4	13.1	131.0	174.2	52.0	13.1	82.4
Kulundu	33.8	15.4	55.4	6.1	131.0	240.0	100.0	6.1	83.3
Ken-Talaa	10.6	12.1	58.6	0.0	130.0	195.0	65.0	0.0	91.8

However, KIs did note that climate change had impacted the regularity of precipitation in recent years, which has harmed crop yields. KIs reported these changes to have mostly affected rainfed land, reducing barley and wheat yields over a 10–20-year period. KIs attributed the decline in grain crops (wheat and barley) and forage cultivation in rainfed lands in the watershed to factors like the lack of agricultural specialists, the effects of climate change (including insufficient precipitation), and a shift towards more profitable (and sometimes more water-intensive) agricultural products.

The UNDP report also emphasized the insufficient humidity in spring grain crops during the growth period in the Leilek district. According to the report, a moisture deficit ranging from 20% to 50% significantly affects the overall yield of these grain crops.[52]

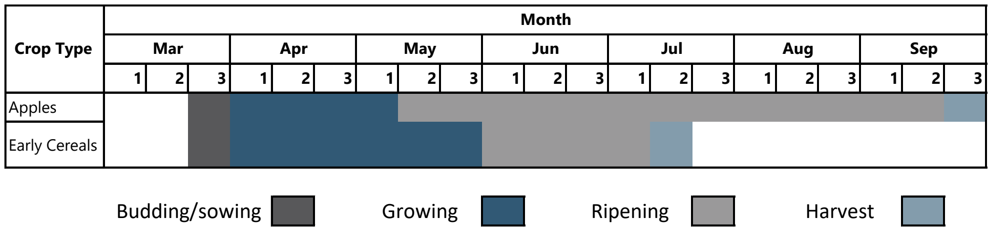
KIs reported that irrigated lands, on the other hand, weathered the effects of climate change better, due to the use of fertilizers and greater water availability. As a result, local governments were reported to be increasing their reliance on the irrigation network for farming. This is likely to result in greater strain on the river basin if the canal network is also not rehabilitated to mitigate water loss.

In addition, KIs reported that the cost of planting crops has not been profitable in the last 3-4 years, accelerating a long-term trend of transformation of arable lands into orchards, which are deemed more lucrative and less water-intensive, and require fewer fertilizers and labour to produce. KIs reported that horticulture land had doubled in the last 20 years.

52. UNDP, Agro-Climatic Resources of the Batken Region of the Kyrgyz Republic", 2022.

Agriculture cooperatives were noted by KIs to be present in all LSGs, although the number of cooperatives and their prominence varied. KIIs noted 3 agricultural cooperative farms in Ken-Talaa LSG, and 2 in Katran LSG, which were focused on seed production or harvesting services, and utilized jointly-owned land. These cooperatives were typically groups of families that had decided to pool resources and take joint-ownership over land an agricultural outputs. The National government provides financial assistance to cooperatives, which is part of a larger national initiative to promote cooperative arrangements as a solution to small-scale production challenges in agricultural practices or major shifts in the types of crops grown. KIs reported that people across the watershed continued to plant the same crops, and that the seasonality of the growing seasons had not changed.

Figure 3: Crop calendar for Apples and Early Serials in Leylek District, 2022.[j]

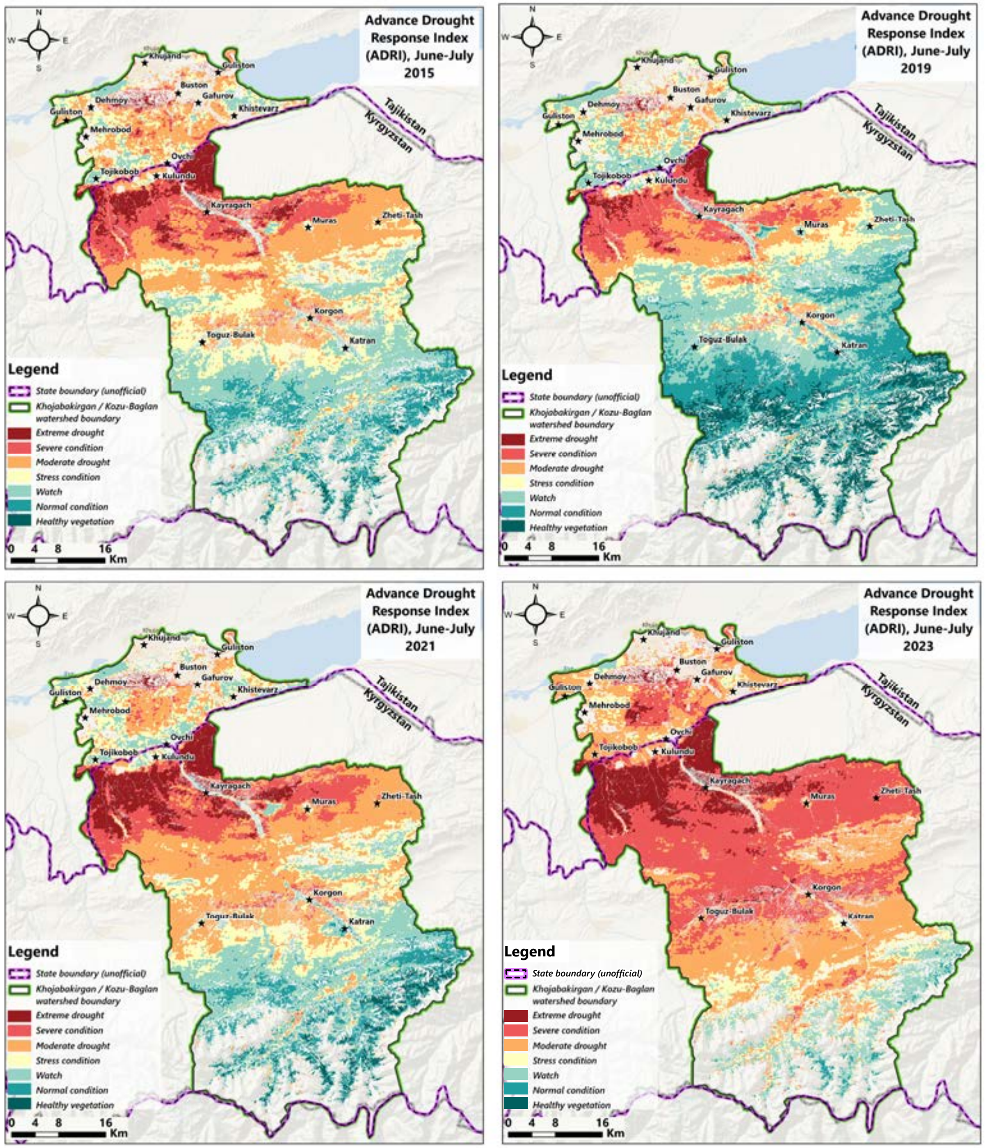


Suggested watershed support

- Examine different crops and growing patterns, the resource inputs required to grow them, and how to adapt crops to changing climate and sowing patterns.
- Identify crops that are more climate resilient and require lower water demands, to increase production when the watershed is under stress.

i) Source: National Statistical Committee of the Kyrgyz Republic .
j) Source: UNDP, 2022.

Map 12: Drought susceptibility by LSG in Kozu-Baglan watershed, June 2022



Droughts are among the most dangerous hazards that communities in the Fergana Valley are exposed to, due to its ability to cause widespread destruction to livelihoods, and the difficulty in mitigating them at a local level. Most recently, in April 2021, a major drought across Central Asia killed over 2,000 livestock across the region.[53] The drought was amplified by dwindling water supplies due to climate change, something the Kozu-Baglan watershed was reported to be vulnerable to.

A recent United Nations Food and Agriculture (FAO) study found droughts to be frequent in the Kozu-Baglan watershed. Moderate droughts, causing a loss of 20% of total crop yields, were found to affect the Batken Region every 5 years, with severe droughts, affecting 50% of yields, found to occur every 12-15 years in the nearby Isfara watershed.[54]

To assess exposure to drought in the Kozu-Baglan watershed, IMPACT developed a composite model, which combined geospatial analysis using the following indices: 1) Standard Precipitation Index (SPI), which measures rainfall, across a set period of months; 2) Vegetation Condition Index, which compares spatial data of vegetation land cover during the same periods of different years to assess change in land cover, and 3) Soil Moisture Index (SMI) which measures the estimated daily soil water content using hydrological satellite imagery data. These indicators were then averaged across each LSG in the basin to produce an estimated score of exposure to drought. The results are shown in Map 12.

The analysis in Map 12 shows most of LSGs to be at a moderate risk to drought, with the exception being communities close to the watershed's mountain sources.

KIIs with Kyrgyz water authorities noted that downstream communities reported more frequent water shortages that those like Katran in upstream areas. This was attributed to both a decline in water levels due to melting glaciers and irregular precipitation, and poor water infrastructure that contributed to high levels of water loss.

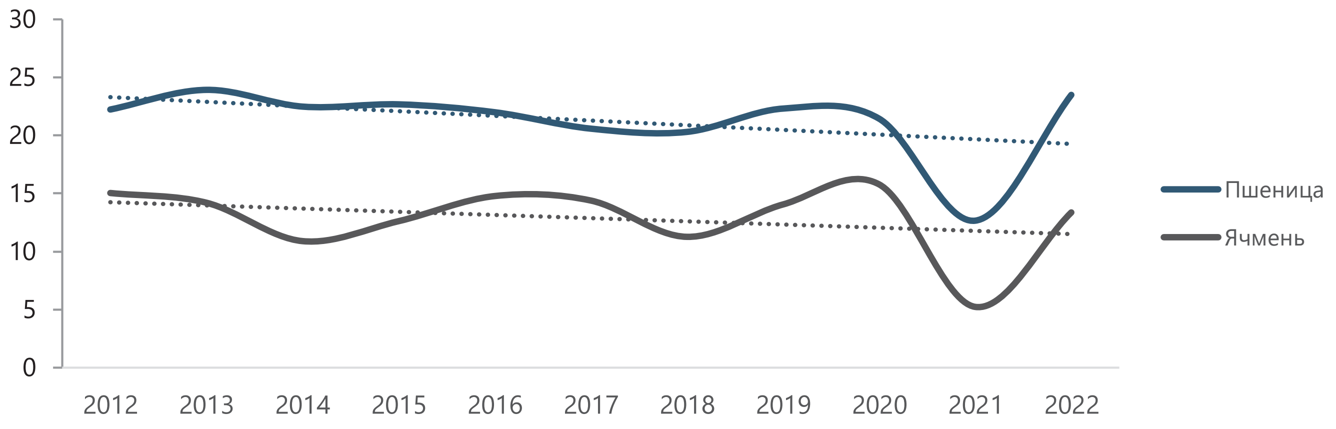
Agriculture, namely crop production, is the most drought-sensitive sector of the Kyrgyz economy, with more than 30% of the cropland affected in Kyrgyzstan, according to a report conducted by FAO.[55] Over the past fifteen years, droughts have significantly increased and national level events have been reported in 2008, 2012, 2014, and 2021, leading to negative impacts on the harvest of grain crops, especially in areas that rely almost exclusively on natural irrigation.[56]

The data from the Leylek District Agricultural department reveals a relatively stable wheat and barley yields over time, that have declined slightly in recent years among communities in the Kozu-Baglan watershed (Graph 8). This decline is particularly pronounced in the average yields of both wheat and barley in the years 2014 and 2021, which coincided with nationwide drought conditions.

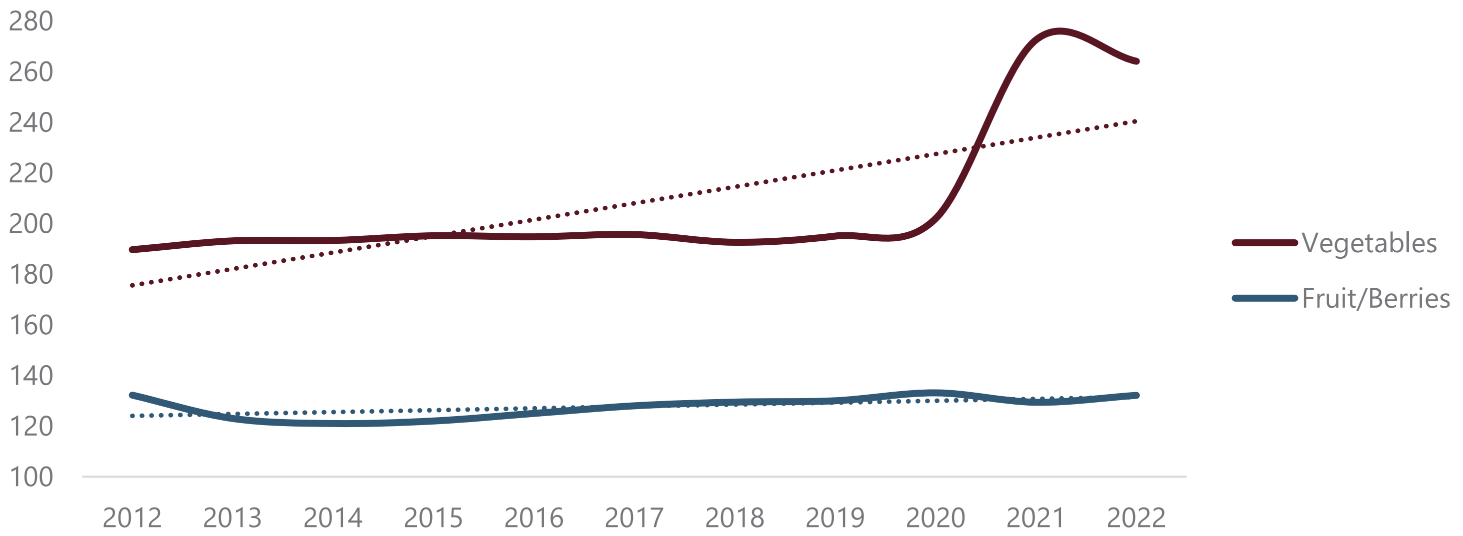
At the same time, vegetable yields have climbed significantly from less than 200 tons/ha in 2012 to over 260 tons/ha in 2022, according to data from the national statistical committee (Graph 9). These trends are likely to continue as water levels

53. The Third Pole, Central Asian drought highlights water vulnerability, July 2021.
54. FAO, Drought Characteristics and management in Central Asia and Turkey, 2017.
55. Ibid.
56. UNESCAP, Building the Central Asia drought information system in Kyrgyzstan: progress and the way forward: feasibility study, 30 March 2023

Graph 8: Average wheat and barley yields in Kozu-Baglan watershed, 2012 - 2022[k]



Graph 9: Average Vegetable and Fruit/Berry Yields in Kozu-Baglan watershed, 2012 - 2022[k]



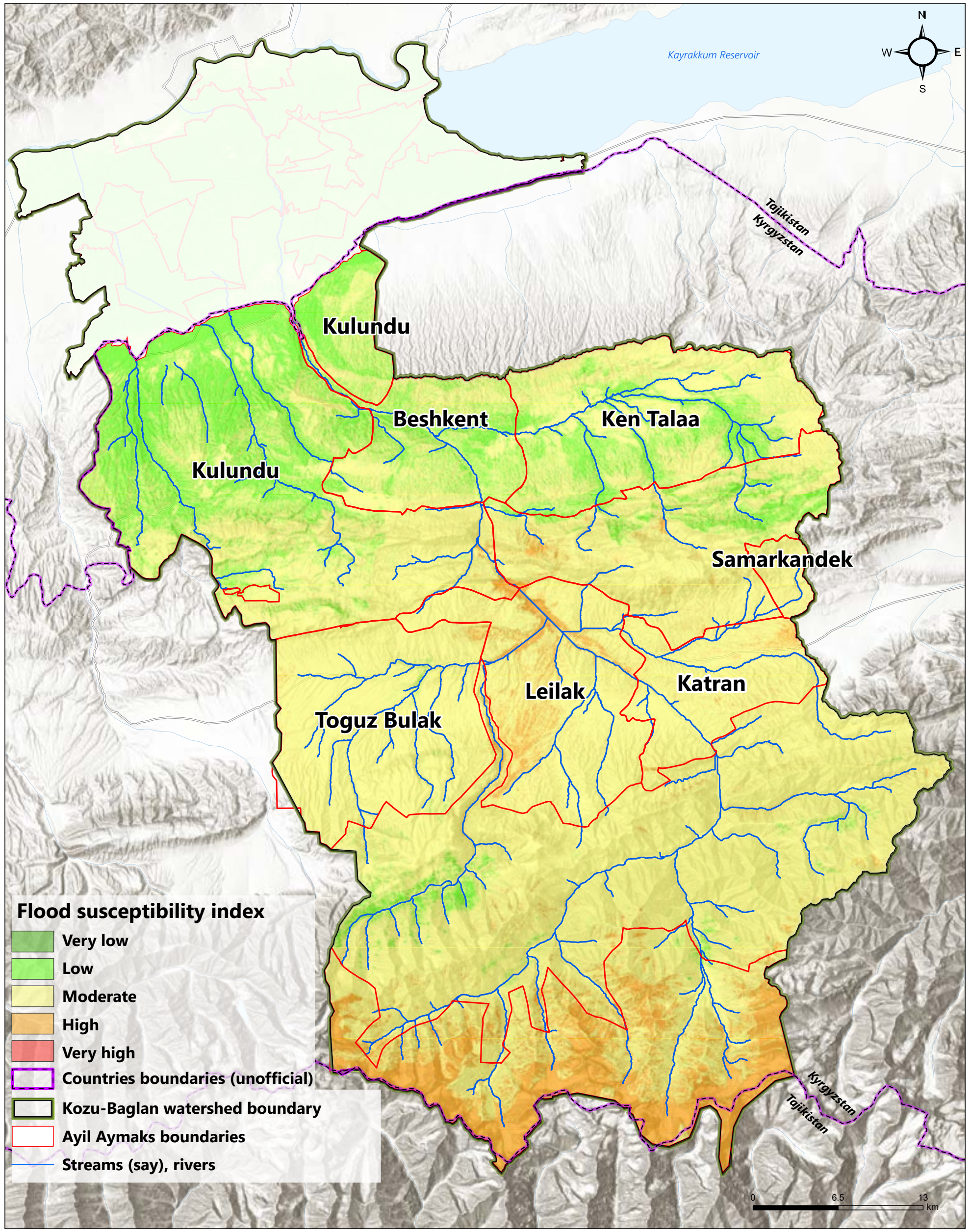
k) Source: National Statistical Committee of the Kyrgyz Republic, 2022.

in the watershed continue to decline.

Suggested watershed support

- Rehabilitation of the irrigation network, particularly in upstream areas where most water loss is occurring, to improve water availability in the event of drought.
- Switching to less-water intensive crops can mitigate drought risk.
- Rainwater saving techniques can reduce the impact of drought in rain-fed areas.

Map 13: Flood susceptibility in Kozu-Baglan watershed, June 2022



Floods are some of the most common hazards in the Fergana Valley, and are alleged to have become more frequent and worse in recent years due to changes in precipitation and snow melt from climate change. Flooding in recent years has caused extensive destruction and fatalities.[57] Flooding can be an isolated event, or occur concurrently with other natural hazards like mudflows.

The flood map 13 takes into account various indicators measuring exposure to flooding, including Topographic Wetness Index (TWI), elevation, slope, precipitation, Land Use and Land Cover (LULC), Normalized Difference Vegetation Index (NDVI), river and road proximity, drainage density, and soil type. Precipitation and slope are the highest-weighted indicators, as their substantial influence can trigger floods by rapidly generating runoff and overpowering inherent drainage systems.

Analysis of the map shows that the areas with the greatest risk of flooding are the high mountains in the Turkestan Range that makes up the watershed's source, and populated valleys of the mid-range elevated portion of the watershed that the main river and its tributaries run through.

In LSG, flooding was noted to have a widespread and more moderate risk, and was mainly due to increased or irregular precipitation in the watershed and lower and flat elevation where water collects more easily. KIIs from Kulundu noted the canal's propensity for overflowing due to its limited water capacity.

Communities were also exposed to flood hazards, although this is likely more due to the overlap between flooding and mudflows. The landscape lacks vegetation, and is covered mostly with sand, soil, and rocks. Without a dense network of roots and plants to absorb water, the potential for greater water runoff increases, becoming a flood as the water flows downhill without significant impediments.

According to the Kyrgyzstan MoEs, flooding is extremely common in the Kozu-Baglan watershed. For instance, on March 31, 2023, following an unexpectedly dry winter, heavy rainfall in Leylek district caused a flood in the territory of Razzaqov City Hall. This resulted in flooding of 7 citizens' properties in the Jany-Abad village and a section of the internal road to Samat village, leading to incurred expenses.[58]

As flooding in the Kozu-Baglan watershed is closely linked with increased or irregular precipitation patterns, the effects of climate change are likely to cause flooding to worsen, as precipitation patterns become more extreme, leading to dryer summers and wetter rainy seasons.

57. World Health Organization (WFP), Floods.

58. MOES, Information on Emergency Situations registered in the territory of Leylek District in the first quarter of 2023, 30 March 2023

Suggested watershed support

» Improvement of canal infrastructure to hand water overflows will reduce downstream flooding damage.

» Digging and reinforcement of drainage ditches to allow water runoff and reduce damage to agriculture and infrastructure.

» Construction of gabion nets can reduce the impact of flooding on communities.

Pasture Management

Alongside agriculture, livestock was nearly as significant as crop production in the gross output of agricultural products, contributing 10.303 million soms in Batken Region.[59] Their products, including meat, milk, and wool, constitute an important part total economic output, which exceeds industrial production by more than two-fold.

Pasture lands form the basis of the livestock economy in rural Kyrgyzstan, and their maintenance critical for maintaining the estimated 51,421 heads of cattle in Kozu-Baglan watershed. These cattle subsist on 89,282 ha of pasture lands managed by pasture union committees at LSG level in Kyrgyzstan. The health of pasture land to support large number of cattle, sheep and goats is an extremely important part of most households' agro-pastoral livelihoods in Kozu-Baglan watershed.

Pasture land in Kozu-Baglan watershed was found to have been extremely degraded, with 43% of the watershed's pasture land having been partially or completely degraded. Further research found pastureland to be so degraded that it was unable to support the entire population of livestock. According to some studies, farmers needed to import as much as half of their livestock feed to support their herds.[60]

Degradation of pasture land was mainly attributed to a lack of meaningful enforcement of pasture use agreements within communities, and a lack of water and reforestation initiatives to support their restoration. Plans are in place by local governments to improve the situation, but require collective action from the population to avoid depleting pastures through excessive and unauthorized use.

Additional land restoration initiatives and education on the reduction of over-use of pastures and forested areas will be critical for maintaining agro-pastoral livelihoods within the watershed.

59. Statistical Committee of the Kyrgyz Republic, Agriculture of the Kyrgyz Republic, 2022
60. ACTED, Summary report about main findings and conclusions from disaster risk and watershed assessment of Kozu-Baglan/ Khojibarkigan Watershed, February 2015.

Source: IMPACT, Pasture land in Kadamjai District, August 2023

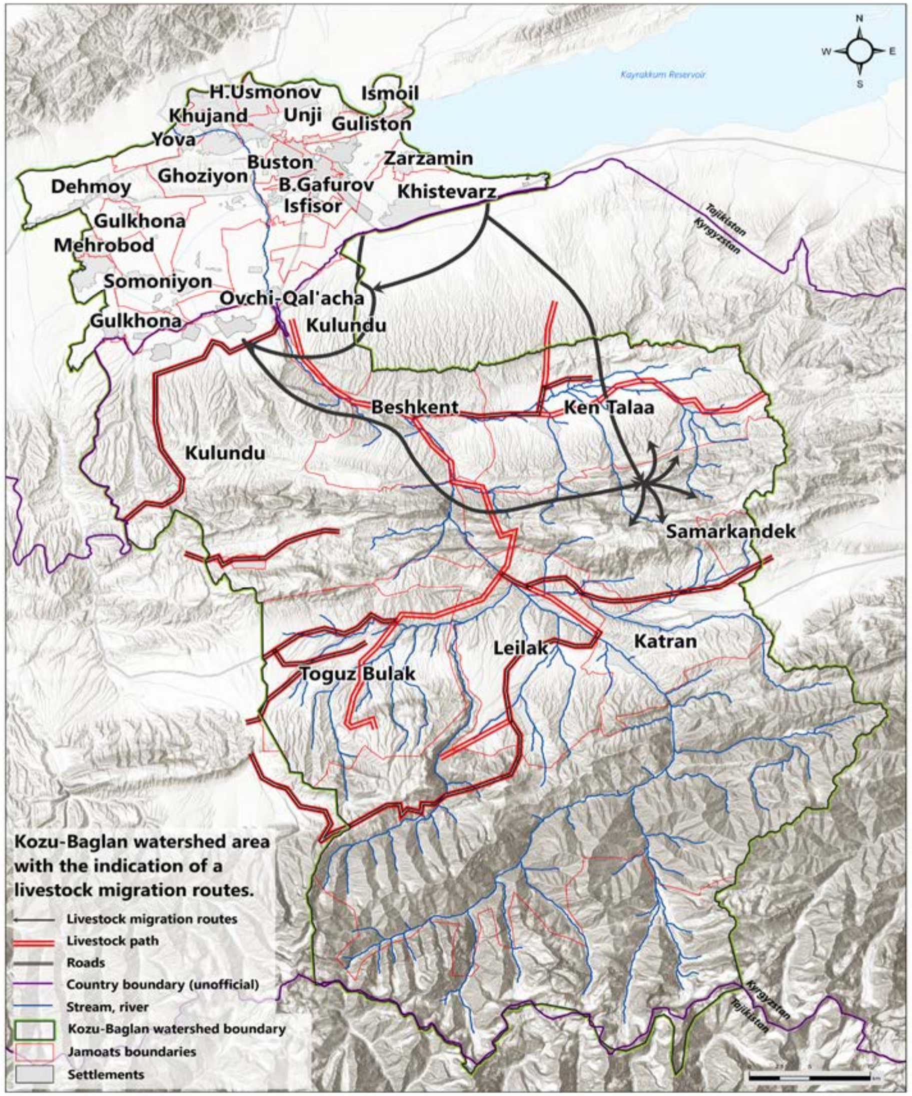
In Kyrgyzstan, the responsibility and control over state pasture lands is under the jurisdiction of local governments. Within this framework, the LSGs have the right to delegate the authority to manage and use pastures to associations of pasture users, where Jaiyt Committees act as executive bodies.

The Jaiyt Committees include representatives of pasture users, local deputies, and appointed representatives from the environmental and forestry authorities and heads of the LSGs. Members of the Jaiyt Committees are elected at the general association meetings from among representatives of pasture users for a period of three years. The chairmen of the Jaiyt committees are elected by a majority vote of pasture users at the suggestion of the head of the corresponding LSG.

The committees oversee various functions, including the development of pasture use communities and annual pasture use plans, implementation of plan provisions, monitoring of pasture conditions, issuance of pasture tickets[61] aligned with the plans, establishment and collection of usage fees, management of income generated from payments and resolution of disputes concerning the use of pastures.[62] All these responsibilities are united by a common goal: to preserve the natural integrity of pastures, ensure their proper and sustainable use, and improve conditions of pastures related infrastructure.

According to KIIs, animal husbandry is a major livelihood activity in the watershed. This practice serves many purposes, including livelihood sustenance and income generation through the sale of meat in markets.

Map 14: Community herding patterns, Kozu-Baglan watershed, 2023



Suggested watershed support

- Introducing a grazing restriction that regulates and controls livestock grazing in a specific area according to a pre-established schedule or calendar.
- Empowerment of new pasture management organizations to better hold pasture users to account and reduce collective action failure that prevent pasture restoration.

According to KIIs of the Agriculture Department of Leylek District, the district produces a sustainable amount of vegetables, milk and meat. An estimated 51,421 heads of cattle subsist on 89,282 ha of pasture lands managed by committees within the watershed.[63]

KIIs also revealed that livestock is typically taken out to pasture during the summer months, with variations in the exact dates and duration. In the summer, cattle are taken to the pastures in Arka and Leylek forests, while in the winter, the livestock are kept in yards and farmers' garden.

The pastures in the Kozu-Baglan watershed are shared within AAs. For example, Katran, Beshkent, Kulundu, and Ken Talaa all share their pastures, often following common migration patterns, and, in some instances, they also use the same migration routes, primarily because they all have pastures within the Arka forest. Likewise, the AAs of Katran and Leilek also share a commonly used pasture area, which can be seen on the map through the movement of livestock. Pasture lands previously used to support communities from further downstream, who now no longer graze their cattle in Arka forest.

Most KIs did not mention specific grazing restrictions on pastures within LSGs. Cattle grazing in forests in Leylek District only occurs during the summer months. Calendar schedules that establish seasonal grazing routes, pasture turnover, movement of livestock, cattle run locations and paddocks used by association members have been issued by few local authorities, though KIIs noted that livestock owners often do not follow these agreements.

61. A pasture ticket is a document granting the right to use pastures for grazing livestock and endowing the pasture user with the status of a member of the association of pasture users.

62. Ministry of Agriculture of the Kyrgyz Republic, Pasture.

63. Data from the Department of Pastures of the Ministry of Agriculture of the Kyrgyz Republic.

To analyze pasture degradation, IMPACT adapted a model developed by the International Fund for Agricultural Development (IFAD) to assess the degradation of pastures in Kyrgyzstan.[64] The analysis compares the change in degraded pastures between 2000-2003 and 2019 to 2022 for the Kozu-Baglan watershed. The findings of this analysis revealed a noticeable degradation across the watershed.

As shown on Map 15, the northwestern part of the map represents the lower zone of the Kozu-Baglan watershed (Kulundu LDG), where only a small fraction of land is designated as pastures due to the predominantly flat terrain. Instead, the area is primarily devoted to irrigated agriculture.

Conversely, in the middle and upper zones, pasturelands are notably more extensive, totaling 89,282 hectares. This can be attributed to the geographical composition of the Leylek district, where roughly 93% of the territory is mountainous, while the remaining 7% comprises valley terrain, which makes the communities within the areas more reliant on livestock breeding.

The map illustrates that pasture degradation has affected the entire watershed area, irrespective of the elevation, approximately 43% of the middle and upper zones suffer from degradation. The preponderance of degraded pasture lands was identified primarily in Ken-Talaa, Katran, and Leylek LSGs, which surround the main forest in the watershed.

A seasonal analysis revealed that most pasture degradation occurred during the winter and spring, with some pasture restoration during the summer.

The Kyrgyz analysis is almost identical to the 44% of degraded pasture land reported by the Pasture Department of the Ministry of Agriculture in Kyrgyzstan. According to this study, a significant part of pastures, with an area of 39,825 hectares was classified as having a low level of fertility and scored less than 20 out of a total 100 points on the bonitet scale.[65]

KIIs note that the main reasons for pasture degradation were a confluence of the over grazing of land (which is linked to herders not abiding by local pasture use regulations stipulating when they may use pastures for designated pasture lands), and insufficient policies to regulate pasture land governed by the LSG pasture committees. For instance, Leilek, Katran, Kulundu, and Muras AAs do not implement any particular grazing restrictions on pastures located within the AAs.
The absence of restrictions in these areas also explains why pastures near villages tend to experience higher levels of degradation, as depicted on the map. Nearby pastures are often exhausted first, resulting in even more pronounced levels of degradation.[66]

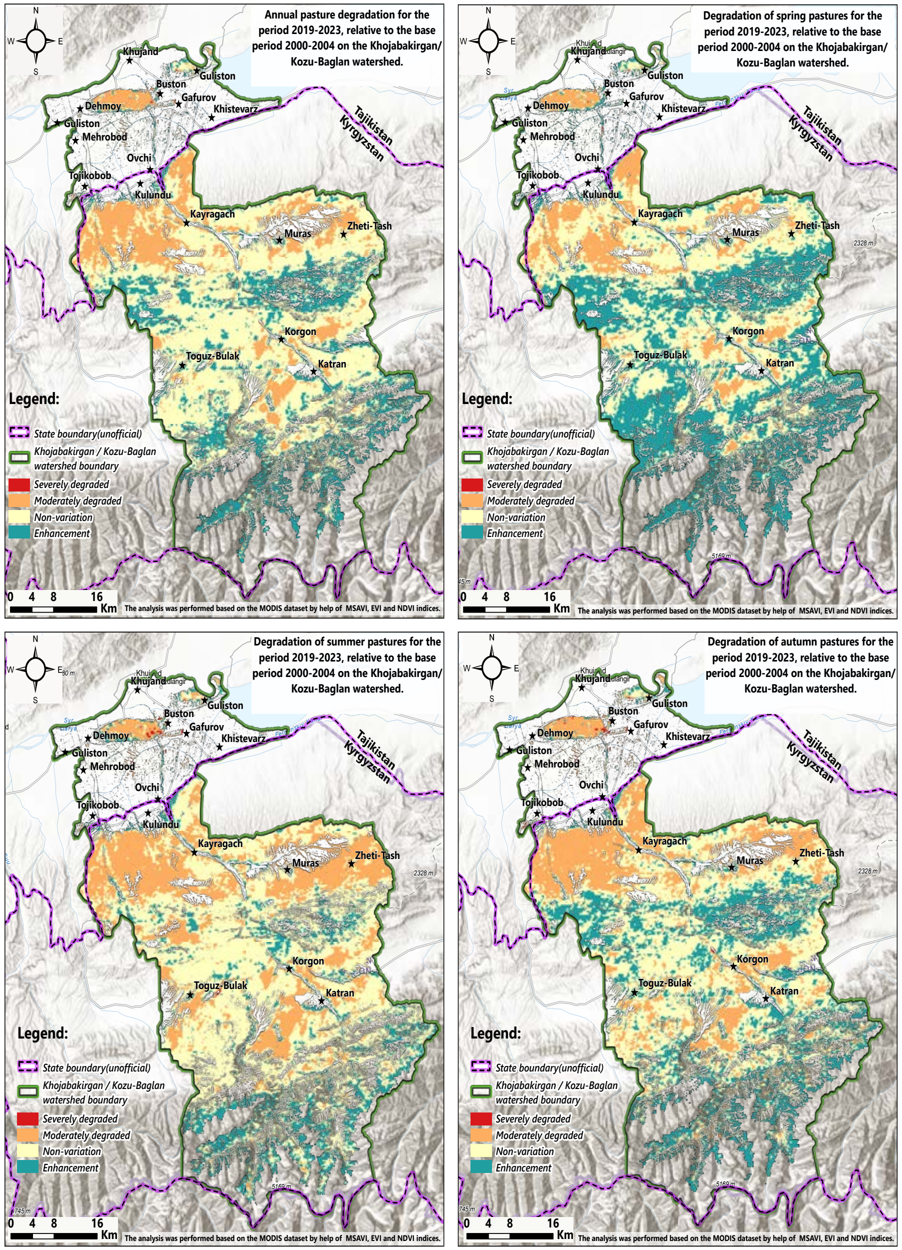
In addition, the pasture degradation compounded by population growth and an increase in the number of livestock that has put additional pressure on the land. Increased heat and irregular precipitation due to climate change has accelerated degradation through the reduction in water supply needed to maintain the pastures.[67] In Beshkent, where mudflows are common, natural hazards were also reported by KIIs to have increased pasture degradation.

Analysis of longitudinal data from the National Statistics committee (Graphs 10, 11) shows cattle and sheep & goat herds to have

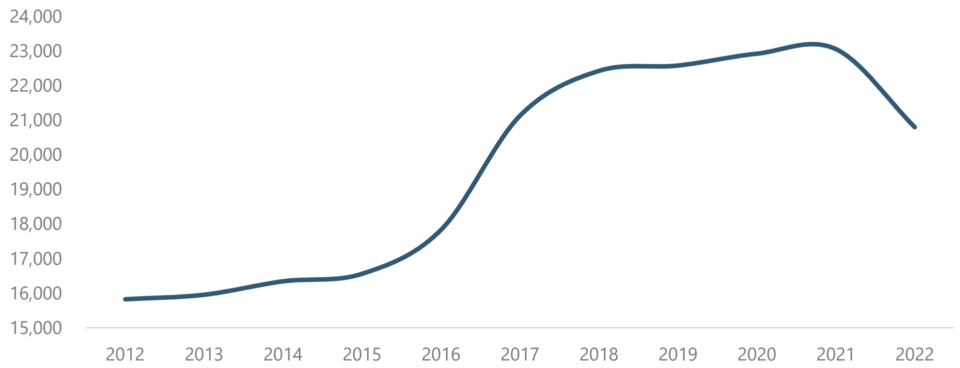
64. IFAD, Technical Note: Pasture Condition Maps in Kyrgyzstan, December 2022.

65. Ibid..
66. Tomaszewska, M.A.; Henebry, G.M. Remote Sensing of Pasture Degradation in the Highlands of the Kyrgyz Republic: Finer-Scale Analysis Reveals Complicating Factors. Remote Sens. 2021, 13, 3449.
67. Borchardt, P., Schickhoff, U., Scheitweiler, S. et al. Mountain pastures and grasslands in the SW Tien Shan, Kyrgyzstan — Floristic patterns, environmental gradients, phytogeography, and grazing impact. J. Mt. Sci. 8

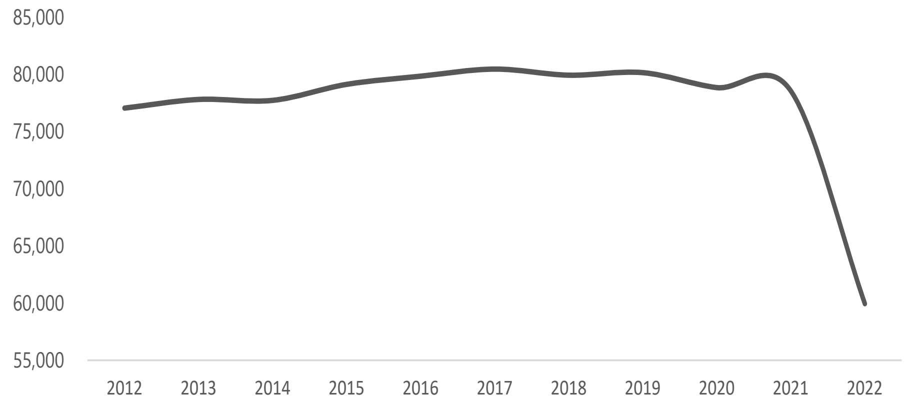
Maps 15: Pasture degradation susceptibility change in Kozu-Baglan watershed, between 2000-2003 and 2019-2022



Graph 10: Number of cattle in Kozu-Baglan watershed, 2012 - 2022[I]



Graph 11: Number of goats & sheep in Kozu-Baglan watershed, 2012 - 2022[I]



increased slightly over time, suggesting that pressures on pasture land in the Kozu-Baglan watershed are likely to continue. A noticeable dip in cattle ownership in 2022 is likely due to an overlap of drought conditions the previous year and the conflict which affected many households and their assets Kulundu LSG.

However, this is expected to be temporary and growth to resume in the near future.

Suggested watershed support

- Pasture restoration is critical to maintaining livelihoods within the watershed. Restorative practices to allow land to recover and be sustainably maintained should be provided to communities.
- Government infrastructure schemes, like those to drill boreholes to provide water to pasture areas, should be supported to improve overall pasture health.
- Pastures can be restored through initiatives such as tree-planting, using alfalfa for foraging and animal feed, and drilling additional wells to improve the water supply.
- Degradation is highest in Ken-Talaa, Leylek, and Katran. Given that Leylek and Katran maintain some governance over official forests in the area, these LSGs would make the best candidates for pasture restoration support.
- Rainwater harvesting, less invasive livestock herding techniques, and tree nurseries to nourish soil can provide holistic solutions to restoring pasture lands.

I) Source: National Statistical Committee of the Kyrgyz Republic, 2022.

Source: IMPACT, Kozu-Baglan River, Leylek LSG, August 2023

Disaster Risk Reduction

Disaster Risk Reduction (DRR) is a cross-cutting issue within watershed basins, as management of key hazards is a critical part of maintaining and improving the sustainability and resilience of a watershed and its associated communities.

Within the Kozu-Baglan watershed, water, land, and the populations that rely on them are highly exposed to major natural hazards, particularly mudflows, flooding, landslides, and earthquakes.

Kyrgyzstan maintains Disaster Risk Management (DRM) capacity via the Ministry of Emergency Services, which provides both prepositioning of disaster support and community-based preparedness training. However, much of the MoES's DRM capacity is linked to responding to disasters after they have occurred, rather than enhancing the resilience of the population and key infrastructure to mitigate the overall effects that disasters can have.

Improved and more frequent trainings for communities, and a renewed focus on infrastructure improvements to resist damage from natural hazards may enhance preparedness and make the watershed more resilient to both natural hazards and climate change.

Earthquakes occur when a sudden slip over a fault line in the earth's tectonic plates occurs due to built-up stress overcoming friction between the plates. This releases energy as shaking waves through the Earth's crust.68 Earthquakes are among the most destructive natural hazards in the Fergana Valley, and have in the past caused large amounts of destruction and loss of human life. While uncommon, the potential severity of damage the earthquakes can cause makes them a major focus of the Ministry of Emergency Services.[69]

Of an average of more than 23,000 earthquakes that occur annually in Central Asia, approximately 13,000 occur in Kyrgyzstan.[70] The highest risks of destruction and human casualties from earthquakes of magnitude 7.3-7.5 may be in areas located in the zone of influence of the Fergana and Issyk-Ata faults.
It is also important to note that earthquakes play a role in causing other natural hazards for these regions, especially landslides, mudflows, and avalanches and therefore is crucial to prioritize measures for monitoring, prediction, and response to mitigate their response.

The most recent major earthquake to occur was the 2011 Fergana Valley earthquake, which occurred in central Batken Oblast and had a Maximum Mercalli Intensity (MMI) of 8 and a Richter Scale Magnitude of 6.1. Across all three countries, 14 people were killed and 86 were injured.

68. USGS, Earthquake Facts and Earthquake Fantasy
69. MOES, Information on Emergency Situations registered in the territory of Leylek District in the first quarter of 2023, 30 March 2023
70. Central Asian Bureau for Analytical Reporting (CABAR)., Earthquakes in Central Asia: Casualties and half a billion damage per year. Kyrgyzstan loses the most, June 2023.

Map 16 illustrates the earthquake susceptibility of the watershed, indicating seismic zoning ranging from 7 to 10, showing significant exposure to earthquakes.

The Kozu-Baglan watershed area ranges between MMI 8 and MMI 9, some of the highest levels of exposure in the region.

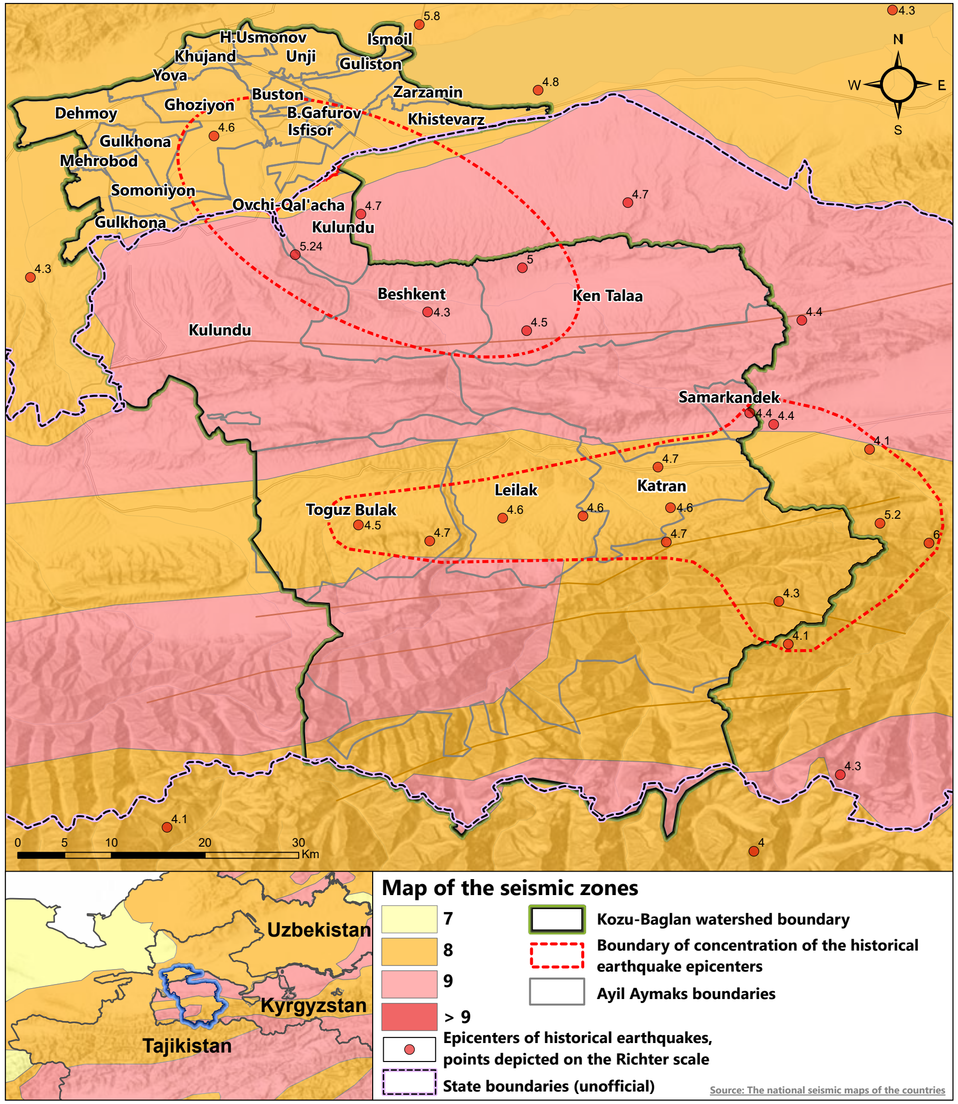
The data was digitized from official government maps outlining major MMI shake zones, and overlaid with historical earthquake epicenters are identified within the watershed's confines. These epicenters present potential hazards to the neighboring villages and their surroundings.

Map 16 further shows the lower parts of the Kozu-Baglan watershed to be a common location of previous earthquakes, highlighting the potential of future quakes and the need to ensure MoES response capacity is prepared in case of future earthquakes.

Suggested watershed support

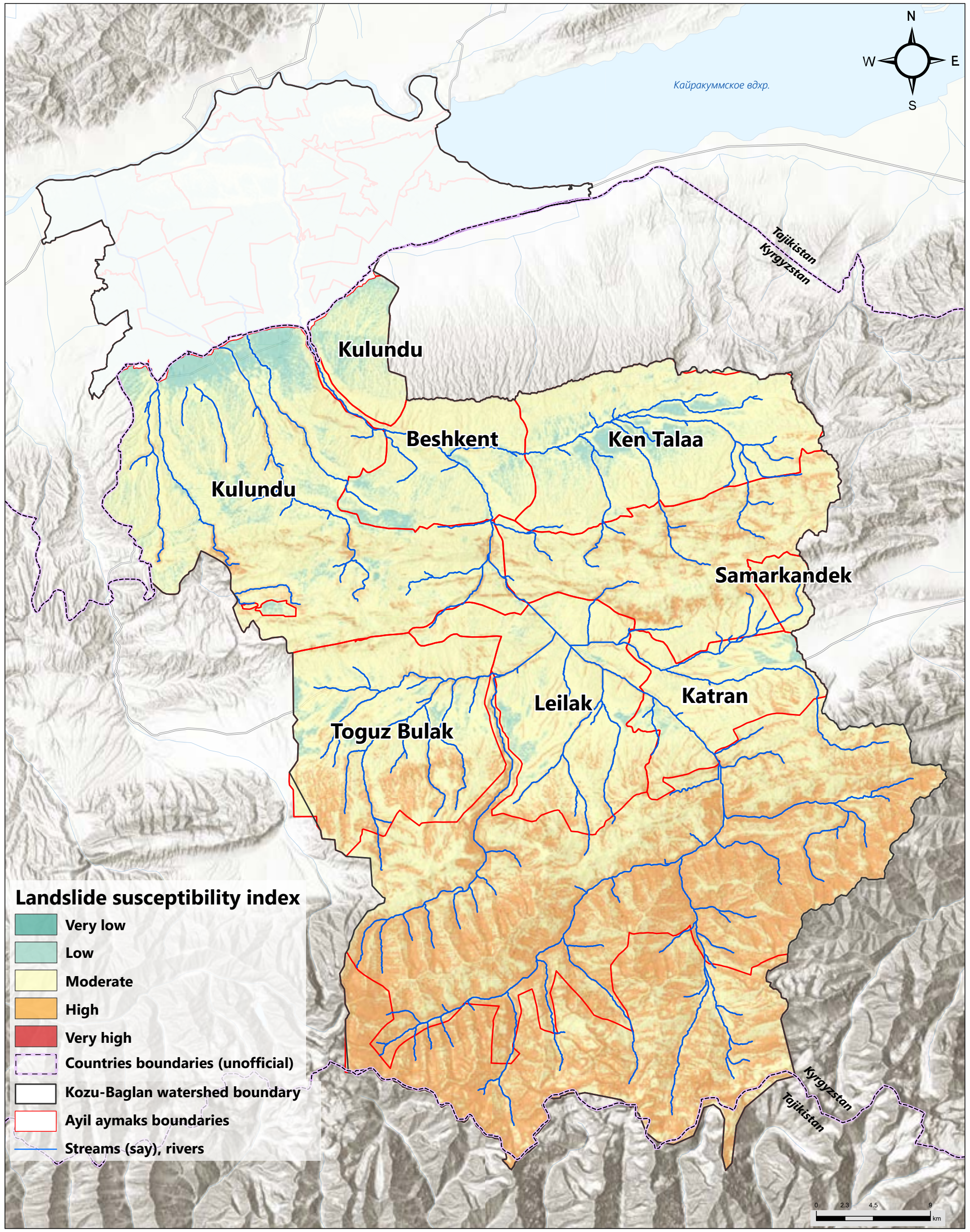
- Mainstreaming of earthquake resistant designs of shelters will reduce the likely damage of a potential earthquake.
- Prepositioning for the event of an earthquake in historical locations can improve response timing in the event of an earthquake.
- Reinforcement of irrigation network can help to reduce larger watershed NRM issues in the event of an earthquake.

Map 16: Earthquake hazard susceptibility in Kozu-Baglan watershed, June 2023[m]



m) Source: Academy of Science of the Republic of Kyrgyzstan.

Map 17: Landslide susceptibility in Kozu-Baglan Watershed, 2023



Landslides involve the downward movement of rock, debris, or soil along a slope, often due to factors like slope angle, rock composition, seismic motion, and the presence of water, etc. Climate change with rising temperatures is expected to trigger more landslides, especially in mountainous areas with snow and ice.[71]

Due to its mountainous terrain, Kyrgyzstan is mostly prone to landslides.[72] Between 1993 and 2010, Kyrgyzstan witnessed over 300 significant landslides, leading to 256 fatalities and annual direct economic losses of 2.5 million USD. Climate change, including factors like wildfires, melting glaciers, and thawing permafrost, is likely to increase the risk of landslides in mountainous areas, making countries like Kyrgyzstan more susceptible to these environmental changes. [73]

Map 17 shows the susceptibility of the areas to landslides. The main indicators of landslides chosen for the map include vegetation, slope, distance from drainage, distance from roads and precipitation. The analysis shows Kulundu LSG to have minimal to no risk of landslides due to its flat terrain.

However, the watershed has a high hazard susceptibility to landslides, particularly in the southern mountainous areas like Katran and Leylek LSGs. The village of Ozgurush, in particular, is at an elevated risk for landslides in particular due to its high elevation and location in a narrow valley. Pasture land north of Katran, where the main forest in the Kozu-Baglan watershed is located, was also reported to be more exposed to landslides, although there are no permanent human settlements in this area.

In addition to higher slopes, a lack of overall vegetation in the mountains also increases the overall risk of landslides, contributing to greater risk. In addition, areas close to stream are more prone to landslides due to saturated soil which is more probable to become unstable, especially during heavy rainfall even or rapid snow melt. A previous study on risks in the Kozu-Baglan watershed also noted that an earthquake can trigger landslides, compounding the overall hazard susceptibility to earthquakes.

Of particular concern regarding landslides is the damage to roads; KIIs revealed that approximately 80% of roads in the Kyrgyz portion of the watershed were not paved, increasing their overall vulnerability to damage from landslides. The Kyrgyz MoES has noted that the roads leading to Ozgurush village in Katran LSG and Churbek village in Ken-Talaa LSG are both at risk of being blocked or damaged due to landslides.[74] These vulnerable sections were reported by KIIs to be between 1-2km in length. Despite this acknowledgment, it is unclear what preventative measures are in place to reduce the overall risk to roads in the watershed.

71. USGS, What is a landslide and what causes once?.
72.F. Caleca, C. Scaini, W. Frodella, V. Tofani, Regional-scale landslide risk assessment in Central Asia, June 2023.
73.X. Wang, M. otto, D. Scheter, Atmospheric triggering conditions and climatic disposition of landslides in Kyrgyzstan and Tajikistan at the beginning of the 21st century.

74. MOES, Inro4mation on Emergency Situations registered in the territory of Leylek District in the first quarter of 2023, 30 March 2023.

Suggested watershed support

- Paving of roads will reduce their vulnerability to damage and length of closure due to landslides.
- Review of safe relocation areas in vulnerable villages in the case a landslide occurs.

In Kyrgyzstan, DRM is managed by the MoES which has departments at district level throughout the country. Under this structure, the Leylek district MoES department manages disaster preparedness for communities in the Kozu-Baglan watershed. KIs from the MoES noted that their office in Leylek maintained both a firefighting department and a civil protection department to support activities.

At both national and local levels, MoES has done extensive work to identify risk-prone areas for different natural hazards, including the identification of specific buildings likely to be affected in the event of an emergency. In addition, prepositioned resources for response and gathering spaces for evacuees have already been identified in case of a major event.[75]

KIs noted that the main natural hazards in the watershed were mudflows, landslides/rockfalls, and earthquakes. Other than earthquakes, at-risk populations tended to be small pockets of people, usually between 20-100 people per village, who were at risk of a particular hazard. This was usually mudflows near the river and in elevated areas and landslides and rockfalls in mountainous valleys. In addition, earthquakes, which were less frequent, posed a risk to every community in the river basin due to their widespread destructive nature.

However, KIIs with District Emergency Services personnel noted that, while the district had done a lot to prepare for potential disasters, very little had been done from a preventative standpoint, and only mentioned one project, a herringbone structure in Kulundu that had been built to protect irrigation infrastructure against mudflows. KIs reported that MoES also works to reinforce riverbanks with concrete to prevent erosion, though this lacks the financial support it needs to make a major difference in reducing overall risk to the population.

In addition, KIs noted that only 20% of roads within the district were paved, making them vulnerable to having entire communities cut off from support during landslides. As many as 11 roads in the Kyrgyz portion of the watershed, totaling 446 and 556 km of total distance, are at risk of mudflows.[76]

Table 9: Roads exposed to mudflow hazards, by minimum and maximum km at risk, 2023[n]

Road Name	Roads at risk to mudflow hazards (km)	
	Min.	Max.
Korgon-Katran-Baul	18	25
Katran-Ozgoryush	0	13
Isfana-Ak-Bulak	1	4
Isfana-Andarak-Kek-Tash	25	46
Beshkent-Margun	4	8
Margun-Darkhum	0	15
Samat-Dzhar-Kuishtak	33	40
Bulak-Bashy-Kairagach	8	19
Kairagach-Kulundu-Arka	5	7
Isfana-Gordoy-Kekre	15	25
Osh-Isfana	337	354
Total	446	556

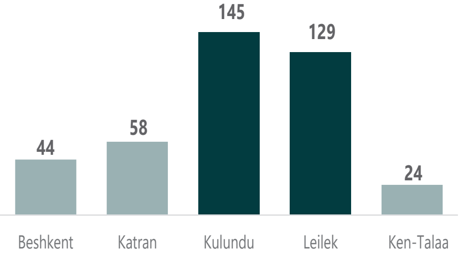
At the community level, while KIIs highlighted the presence of LSG-level funding to support emergency situations, they noted that this funding was often inadequate, and usually was only enough money to support the reconstruction of about 10% of what was normally destroyed by natural hazards. Most emergency preparedness measures at LSG level were done through Ashar, or volunteer work to support larger community needs. This was usually to strengthen riverbanks with gabions filled with stone or clear canals of debris.

KIIs noted that while community trainings were conducted by MoES twice a year, the scope, quality and frequency of these trainings could be expanded to address more hazards, and work more effectively.

75. Republic of Kyrgyzstan, Ministry of Emergency Situations, Monitoring and Forcasting of Emergency Situations within the Regions and Districts of the Kyrgyz Republic, 2023.

76. Republic of Kyrgyzstan, Ministry of Emergency Situations, Monitoring and Forcasting of Emergency Situations within the Regions and Districts of the Kyrgyz Republic, 2023.

Graph 12. Number of household shelters exposed to flooding and mudflows in Kozu-Baglan Watershed, 2022[n]



n) Source: Ministry of Emergency Services, 2022.

Suggested watershed support

- Improve community-level trainings to incorporate a wider scope of natural hazards, and how to best respond from a community perspective. Trainings should also be conducted more frequently than twice a year, and focus on preparedness to reduce the overall effects of major natural hazards on lives and livelihoods.
- Infrastructure projects in the watershed, including canal rehabilitation and water monitoring, should mainstream disaster risk reduction approaches to reduce damage to this infrastructure in the event of a major natural hazard.
- Governments should be encouraged to take more preventative approaches to natural hazards, in order to reduce the harm to people, land, and infrastructure, and to reduce the overall damage from natural hazards.
- Concreting of river banks or installation of gabion nets may have the added benefit of reducing water loss, and should be considered for projects aimed at reducing water loss.

Traditional Gender Dynamics in the Fergana Valley

All of the KIs that IMPACT interviewed from government offices were male. To ensure that female voices and needs were represented by the assessment, IMPACT also conducted interviews with women's committee leaders on the Kyrgyz side of the watershed.

KIIs noted that gender dynamics in the Fergana Valley tend to enforce separate spheres of work and socialization, where women tended to engage in household work, while men were involved in agricultural activities and livelihoods outside of the home. Many KIIs noted that the physical nature of water management and agriculture, women were often limited from participating. KIIs asserted that women had equal access to farming implements and financing, but were often not given opportunities because, unofficially, employers were concerned about pregnancy leading them to have to take leave from their jobs. This is reflected in a 2012 study by CAWATERinfo found that 97.5% of Kyrgyz households considered women to have lower status than men in their households.[77] These factors contribute to a situation where women are often excluded from WUAs and other NRM decision making bodies at local levels.[78]

KIIs clarified that the issue of remittances complicated this somewhat; with men outside of country, women often stepped up and established businesses or cattle farming, often with the money sent home by their husbands.

These gender disparities in representation were reported to have had major consequences. For example, women often found it difficult to assert their beliefs and concerns within their community, or to obtain land. When they could buy land, women were reported to often be allocated less land than male members of their communities due to their gender.

Women's participation in NRM

These aforementioned dynamics had a major impact on women's levels of participation in NRM. As noted, women were typically excluded from participation in pasture meetings and WUAs, which, along with their often rigid social roles as home-makers, prevented them from gaining the knowledge and experience needed to meaningfully participate in these meetings.

As a result, most women's main interface with NRM issues within their communities are typically through designated women's committees and women's health committees. These groups represent women's issues and provide community-based support as needed.

KIIs reported that the responsibilities for women's committees involved a variety of key tasks, including domestic violence prevention, promoting women's education, working on health-related matters, and dispute resolution.

Women's committees typically have small budgets, between 10,000 C and 80,000 C per year. While this did reportedly allow the women's committees to organize major events, some KIIs expressed frustration that there were often no funds for more meaningful activities, like preventing domestic violence.

Women's NRM concerns

According to most KIIs, most women's concerns revolved around the collection of water. Women are often expected to collect water for their households, which can be difficult in places like Katran and Leylek LSGs where they must travel very far from their homes to find water. This can be very dangerous if they are not escorted by a male friend or family member. Lower water levels and irregular rainfall due to climate change has made this more difficult, and forced women to travel farther than usual to collect water for their households, where they may be at risk of harm from men from other communities.[79]

More generally, KIIs from women's committees had similar concerns to men about the overall availability of water for both home needs and agriculture, as water from the river is used for both on the Kyrgyz side of the watershed. These similar concerns also extended to pasture availability and overgrazing of animals.

In addition, KIIs noted the need for education and training on water conservation and more efficient farming practices, as this will reduce the overall stress of women needed to venture as far for water.

Suggested watershed support

- Women's committees in each LSG form the main interface through which to engage on women-specific issues and programmes. The development community can support women's specific issues through supporting and strengthening these women's committees via engagement and funding.
- Addressing shortages in water availability due to climate change will have direct positive protection outcomes on women, who will not have to travel as far unescorted to collect water for their families.

77. CAWATERinfo, Empowering women in water resources management in Central Asia, 2012.
78. The World Bank, Promoting women's Participation in Water Resource Management in Central Asia, 20 January 2021.
79. Otunchieva, Water burden of rural women in the climate change context: case study of Shybran Village, Kyrgyzstan, from Practical outlook on gender issues in the water resources sector, 2020.

3. Local Dispute Resolution

Kozu-Baglan Watershed
Leylek Raion - Batken Oblast - Kyrgyzstan

Analysis of local dispute causes and resolution dynamics

Conducted by:

international alert

Source: Google Earth, 2023

Case Study: A Collective Approach to Mitigating Water Tensions

In 2023, residents of the Ak-Aryk and Razzaqov villages in Kulundu LSG faced an acute water shortage for both drinking and irrigation. Climate change-induced seasonal fluctuations led to an abnormal delay in the flood period of the Kozu-Baglan River, the sole source of drinking and irrigation water for several settlements in Kyrgyz Republic and Republic of Tajikistan.

Ak-Aryk and Razzaqov villages were among the most heavily affected by this scarcity, which further escalated tensions with the upstream villages of Kulundu. Despite local authorities' recommendations to transition to drought-resistant crops, Kulundu farmers had been cultivating water-intensive crops, worsening water scarcity for communities downstream.

Onions, a high-profit and water-intensive crop, was one of the main crops grown in Kulundu due to higher market prices and consistent demand. However, these were not sustainable given water scarcity in the watershed.

To address this issue, in response to the water shortage, the local authorities in Leylek district proposed that upstream Beshkent and Katran LSG temporarily halt the operation of their three pumping stations, which had a combined capacity of 1,300 liters per minute. This aimed to augment the water flow downstream to the distressed villages of Ak-Aryk and Razzaqov. As a result of the temporary suspension of the pumps, the water flow in the Kulundu Canal increased to approximately 2.7 m^3/sec. This provided the downstream villages, Ak-Aryk and Razzaqov, with the water they needed.

While this addressed the immediate water shortage, it also raised concerns about the response from residents in Beshkent and Katran LSGs, who were dissatisfied that the affected villages in Kulundu LSG continued to use the same water volumes for onion cultivation.

These upstream residents questioned the fairness in compromising having to provide some of their water supply when villages within the same LSG as the affected villages had not reduced any of their water usage.

Representatives from Beshkent AA observed that during the water shortage period, many fields of Kulundu were planted with onions. The representative from the WUA commented that they had expected the water to be diverted to support grain crops, but much of the cultivation was for onion cultivation, which consumes much more water. As a result, tensions over water built between Kulundu and downstream villages of Razzaqov and Ak-Aryk that were experiencing water shortages.

To address these challenges and reduce water-related inter-community tensions within the watershed, local authorities have organized field trips with local activists to promote community understanding. Additionally, a water distribution schedule has been put in place: Kulundu LSG receives water three days a week, while Razzaqov and Ak-Aryk have access for two days.

This case serves as a clear illustration of the dispute potential inherent in water resource scarcity and inefficient water management. Kyrgyzstan is facing significant internal water shortages and inter-communal tensions within its boundaries, which must also be managed in coordination with larger water sharing issues.

Suggested watershed support

- Strengthening coordination between communities; establishment of a dialogue platform between residents of Kulundu, International, Razzaqov, and Ak-Aryk villages would foster shared responsibility in water management and climate change adaptation.
- Reform water conservation policy; develop and implement water conservation policies, considering measures like reducing water losses and ensuring equitable distribution. Engage local communities in the policy-making process to reflect their needs accurately.
- Crop diversification: promoting the cultivation of less water-intensive crops in upstream villages through awareness campaigns and education.
- Efficient water use; promoting efficient irrigation methods like drip irrigation and sprinkling, and encourage financial and technical support from governments, non-governmental organizations, and international donors to support these measures.
- Infrastructure development; investment in modern water infrastructure and irrigation canals to enhance water use efficiency and prevent water loss.
- Education and training; implementing information programs and training for farmers on water conservation and efficient agricultural practices to encourage adaption to climate change to increase crop yields.
- Strengthening local institutions; enhancing the capacity of local water management institutions (RuVKHA, WUAs) for equitable water distribution, conflict resolution, and planning for climate change impacts to ensure sustainable water management.

4. Recommendations

Kozu-Baglan Watershed

Leylek Raion - Batken Oblast - Kyrgyzstan

Key recommendations from assessment findings

Source: Google Earth, 2023

National Ministries:

- Key national ministries of the Kyrgyz Republic are recommended to develop measures to address the progressive shortage of water in the regions and changes in river hydrological regimes in response to climate change. These measures should be integrated into national policies, strategies, and planning frameworks.

District Line Departments:

- The Water Resources Service under the Ministry of Agriculture of the Kyrgyz Republic, Leylek District State Administration and LSG bodies of Leylek District are recommended to:
- Collaborate with non-governmental and international organizations to carry out an information and awareness campaign on the specifics of irrigation rates for certain crops, the necessity of crop rotation, and the implementation of moisture-saving technologies.
- Organize dialogue platforms that involve representatives from local authorities, water management institutions, and local water users. These platforms should enable exchange visits and regular online meetings.
- The Leylek District State Administration, LSG bodies of Leylek District and development partners are recommended to develop climate change adaptation measures based on consultations with local communities and integrate them into Development Plans.
- The Leylek District State Administration and LSG bodies of Leylek District are advised to collaborate with the Ministry of Agriculture of the Kyrgyz Republic and the National Academy of Sciences of the Kyrgyz Republic to explore opportunities for diversifying the crop structure to stabilize and increase the income sources of local communities.

Development Organizations:

- Consider supporting small-scale projects focused on introducing drought-resistant crops and promoting modern water-saving irrigation technologies, with the possibility for future replication within local communities, including:

Water & Natural Resources

- Studying and incorporating the best international practices for enhancing the natural resource management system.
- Installation of a gauging station to facilitate accurate monitoring of water volume in Kozu-Baglan River.
- Exploring the potential of an automated water accounting system, which includes automatic water meters, remote reading systems, and software for data processing and analysis.
- Repairing or replacing sluice gates in the Kulundu canal system is necessary to minimize losses of distributed water and increase the volume of water delivered to end users.
- Ensure the improvement natural resource management capacity of the water resources in Kozu-Baglan watershed through dedicated trainings on the water infrastructure implemented under stream, as well as water management practices to more equitably distribute water between communities within the watershed.

Pasture Restoration

- Degraded pasture lands should be restored order to ensure more sustainable pastoral livelihoods. This should be done through a three-pronged approach of improved rainwater harvesting, vegetation restoration, and trainings on improved holistic livestock and land management in order to restore pasture ecosystems.
- Improved natural resource management of grazing areas through trainings that sensitize the population to the pasture management planning schedules and methods.
- Climate smart livestock production should be implemented, improving animal health and disease prevention through improved land management, improving feed/fodder conversation an production that is nutritionally improved, and Silvo-pastoralism initiatives to support the integration of trees and grazing livestock on the same land to support more healthy environments for livestock.

Agriculture & Livelihoods Support

- Support to communities for climate smart agriculture to sustainably increase productivity of farmers and enhance the resilience of communities to the impacts of climate change. This includes the promotion of agricultural techniques such as drip irrigation and improved seed varieties to withstand flooding or drought, trainings on integrated pest management practices.
- Improve overall resource efficiency of household agriculture production through the reduction in usage of chemical fertilizers, improved farm equipment and maintenance of farm inputs, linked with sustainable irrigation strategies and water harvesting practices.
- Development of business models for new crop types that are more climate sensitive, with training plans and capacity-building trainings conducted to ensure adoption of new crops and growing strategies.

Disaster Risk Reduction

- Support should be given to the Ministry of Emergency Services to conduct further trainings on disaster risk reduction strategies at LSG level for communities in the water shed to improve preparedness in case of future natural hazards.

Methodology for Kozu-Baglan watershed, focus on hazard exposure to population and agricultural land

Hazard	Data sources	Methodology
Earthquake	National Almanac of Seismic Belts, manually digitized from print documents, from Academy of Sciences Epicenter data is from United States Geological Survey (USGS)	Seismic belt data was manually digitized from print-based open-source maps to determine which zones were vulnerable to what Modified Mercalli Index (MMI) level of earthquakes. This was combined with epicentre point data of previously recorded earthquakes via the richter scale (1961-2023). The most vulnerable areas were demarcated based on the historical data.
Pasture Degradation	Data Sources based on IFAD Analysis of Pasture Degradation in Kyrgyzstan (2022), which are all measures taken from LANDSAT satellite imagery: Normalized Difference Vegetation Index; Enhanced Vegetation Index; Soil Adjusted Vegetation Index; Modified Soil Adjusted Vegetation Index; Normalized Difference Moisture Index; Normalized Burn Ratio; Vegetation Condition Index; Vegetation Health Index.	Following methodology outlined in the IFAD Technical Note on Pasture Condition maps in Kyrgyzstan (2022), A series of satellite imagery indexes were calculated using Landsat-based Spectral indices, comparing the period of 2000-2003 and 2019-2022. Each period was analyzed for irrigated land, rain-fed land, and pasture land, which were then compared across periods. The change in pasture areas was anlysed between the 2 periods, and shows on the map. For more information, please see: here.
Flooding	Digital Elevation Model (DEM) from ALOS PALSAR (ALOS PALSAR); Road Network, Rivers, and Drainage Density data from Open Street Map (OSM); Normalized Difference Vegetation Index (NDVI) from Sentinel-2 data; Soil map of the KB watershed prepared with accordance SDC project in 2013. (as it was in PDF format in was digitized and converted into GIS format); Land Use Land Cover data from ESA WorldCover, derived from Sentinel-2	10 criteria were used for analysis. Topographic Wetness Index (TWI), Digital elevation Model (DEM), Slope (from DEM from ALOS PALSAR), Precipitation (NOAA), Land Use Land Cover from ESA WorldCover, ALOS PALSAR DEM, NDVI (Sentinel-2), Rivers and roads were taken from OSM using the euclidean distance method in ArcGIS (per metre), Drainage Density was calculated by identifying canals in OSM, and calculated using the line density function in ArcGIS, unit meter per square kilometer. Soil data was divided into 5 main texture types based on its absorption capacity (light loam, medium loam, heavy loam, clay, and rocks). The indicator values were divided into categories corresponding to a different range of values. These were re-classified to values between 1 and 5, and then each of the 5 variables was given a different weight. Topographic wetness index had the greatest weight followed by soil types and their ability to absorb water,followed by roads, slope, and vegetation.
Drought	VCI Data from MODIS EVI (2001 - 2022) SMI Data from the European Commission SPI Data from Copernicus European Drought Observatory	Overall drought hazard was calculated in Google Earth Engine based on accumulated vegetation condition index (VCI). Satellite derived vegetation health data from spring and summer months between 2001 and 2020 (MODIS EVI) was used. Methodology adapted from UN Spider. This analysis was combined with an analysis of the Standard Precipitation Index (SPI), which measures rainfall and Soil Moisture Index (SMI) which measures the estimated daily soil water content using hydrological satellite imagery data over the same time frames. These results of these indicators were broken into a 1-4 scale by severity, and then averaged across indicators to produce a final score.
Landslides	Normalized Difference Vegetation Index (NDVI) from Sentinel-2 Satellite; DEM slope data from ALOS PALSAR; Distance from Roads - Open Street Map (OSM); Distance from Streams - DEM & OSM; Precipitation: NOAA	This model used a similar approach to flooding, identifying 5 key criteria, dividing the different possible values into ranges, and giving ordinal values for each range from 1-5. Each criteria was then given a different weight based on its importance in contributing to landslides. Most important was slope, followed by precipitation, then NDVI, then distance from stream and roads.
Water Discharge **Water Yields** **Precipitation** **Soil Erosion** **Sedimentation**	All Indicators calculated through Soil and Water Assessment Test (SWAT) Modeling, developed by the University of Texas A&M, using the following data: Temperature & Precipitation data (1981 - 2021); from National Oceanic and Atmospheric Administration; Water Discharge data (2013-2022): RuVKHa & Open Sources; World Meteorological Organization; Digital Elevation Model from ALOS PALSAR; Soil Map - National Sources from FAO Land Cover Classification System (LCCS)	SWAT is based on creating a simulated model of the watershed. A digital elevation model is created, and then the boundaries of the watershed are defined. Flow direction and flow accumulation is given, and criteria are given on the area of hectares for each sub-basin of the entire watershed, which the programme computes. These sub-basins are defined as unique entities within the larger river basin in which are served by tributaries of the main river., Within each Sub-Basin, Hydrological Response Units (HRUs) are calculated. Each HRU has a specific value for LULC, soil, and slope which is uniform across the HRU. Meteorological data is put into the model, which includes temperature and precipitation per day weather data. Solar radiation, wind speed and relative humidity are also included in the model. Based on this, the model calculates discharge, which includes the water volume of all tributaries and streams. From this, calculations on the key indicators are made. Based on the information, the model simulates the potential soil erosion, sedimentation,water yields, and precipitation in each HRU. It simulates the discharge of water in the reach channel (main channel).
Snow Melt	Landsat Collection 2 Sattelite data using Normalized Difference Snow Index (NDSI), 1991 - 2023	To compute the changes in snow coverage, IMPACT computed the overall areas of snow coverage using the NDSI from 1991, 1995, 2001, 2009, and 2023. These were years selected to demonstrate regular intervals over the last 30 years of glacier change, with the exact years selected by the quality of data (images with cloud coverage coulud not be used). All data was taken from the month of February, the hight of winter in the Fergana Valley.
Glaciers	Glacier Volume Change is from Famine Early Warning Systems Network (FEWSNET) Land Data Assimilation System (FLDAS) data providedby by NASA, Glacier Area Change is from Global Land Ice Measurments from Space (GLIMS) Datasets	Analsis for the change in glacier area compared the area of glacier location and coverage between 2001 and 2023, comparing the GLIMS sattelite imagery and computing and subtracting the area of each glacier between both periods. Analysis for glacier volume was provided by the FLDAS database. This was aggreagated by IMPACT and compated between 2001 and 2023.

Climate Change	Historical bio-climatic variables and model for the future 2041-2060 from WorldClim.	The analysis for climate change uses World Clim data, which is a database of high spatial resolution global weather and climate data, which uses historical climate data based on data collected over time. It does climate projections using the CMIP6 downscaled future climate projections. Four Shared Socio-economic Pathways, or climate change scenarios, are measured. IMPACT selected the 370 model for this assessment. IMPACT chose to assess the middle-near term in climate change, 2041-2060. Statistics were then calculated for the specific Kozu-Baglan watershed area, including descriptive statistics, and took the average value for the watershed area. The maps show the range of the areas in total.
General datasets	Administration boundaries from Ministry of Emergency Services (MoES). Rivers, Roads, Buildings from OSM.	

Table A1: Production of main types of industrial products, 2021-2022

Production of main types of industrial products	Unit of measurement	2021	2022
Hard coal and lignite	1,000 tons	654.9	765.2
Crude oil	1,000 tons	12.1	11.8
Meat and edible offals of cattle, pigs, goats and horses	tons	999.1	987.3
Butter of all kinds	tons	0.4	1,221.4
Vegetable oil	tons	73.1	119.1
Processed liquid milk	tons	47.0	124.8
Cereal flour	1,000 tons	4.7	4.3
Shoes	1,000 pairs	1.1	1.3
Construction bricks, floor blocks and similar products, ceramic, non-fire-resistant	1,000,000 units	10.2	21.2
Prefabricated concrete building structures	1,000 tons	0.5	0.5
Furniture	1,000,000 soms	103.3	112.9
Electricity	1,000,000 kWh	1.4	-

Table A2: Number of operating business entities by type, 2022-2023

Number of operating business entities	2022	2023
Small	1,114	1,246
Medium	388	386
Large	124	124
Peasant (farm) farms	32,311	32,865
Individual entrepreneurs	36,511	37,635
Other	361	371
Batken region	**70,809**	**72,627**

Table A3: Volume of gross output of agricultural, forestry and fishing products in current prices, by territory (million som), 2017-2021

Batken Region	2017	2018	2019	2020	2021
Total	14,644.6	15,700.3	15,806.1	17,799.1	21,659.8
Agriculture industry	**14,210.3**	**15,290.0**	**15,337.9**	**17,297.4**	**21,290.0**
Crop production	7,392.8	7,869.2	7,883.5	8,775.6	10,986.7
Cereals & legumes	2,238.7	2,299.2	2,574.6	2,765.2	3,479,4
Potato	715.7	740.6	657.5	714.9	1,132.2
Vegetables	1,207.7	936.4	1,167.7	1,134.6	2,227.9
Cotton	0.6	1.9	5.4	4.8	7.0
Tobacco	31.8	34.1	104.8	74.2	20.8
Melon crops	54.7	22.5	44.4	50.5	32.1
Fruit and berries	2,448.5	3,191.5	2,613.7	3,153.5	2,923.9
Grape	167.7	140.1	173.8	150.3	126.5
Other	527.4	502.9	541.6	727.6	1 036.8
Animal husbandry	**6,817.5**	**7,420.8**	**7,454.4**	**8 521.8**	**10,303.4**
Livestock & poultry	4,471.7	4,595.9	4,660.6	5,439.9	7,030.2
Raw milk	2,047.6	2,519.6	2,487.7	2,772.1	2,903.7
Eggs	183.2	187.7	186.8	200.9	243.1
Wool	7.0	6.9	20.9	7.4	9.3
Other	108.0	110.7	98.4	101.5	117.1
Services provided to agriculture	**411.0**	**386.6**	**443.5**	**478.0**	**341.7**
Forestry	**23.3**	**23.7**	**24.7**	**23.7**	**28.1**
Fishing industry	**-**	**-**	**-**	**-**	**-**

Water Stress Index Prioritisation

As discussed in the introduction, for the initial rapid assessment, all hazards were selected in line with the UNDRR[80] Hazard definition & classification review of global hazards index. Each hazard was examined on its own, and then aggregated to their respective hazard groups, defined in the UNDRR hazard index. Each hazard was given a weight to account for some hazards having a larger contribution than others to the overall impact of the hazard grouping on population groups.

The impact of each hazard was compared against the population's hazard exposure, equally weighted between population density of people and the amount of agricultural land identified by satellite imagery as being exposed to the impacts of each hazard. These were multiplied together to determine the overall risk levels to each watershed community.

Each hazard group and its population's hazard exposure was then in turn weighted based on its importance in affecting the availability of water in each watershed, which was used to calculated a single, "Water stress index" indicator indicating the overall level of water stress for the watershed. Data sources and weighting of each indicator are shown in Table T1 to the right, and the final results of the weighting are in map A1 below.

80. UNDRR, 2023.

Map A1: Prioritisation of Trans-boundary Watersheds in the Fergana Valley by Water Stress Index, March 2023

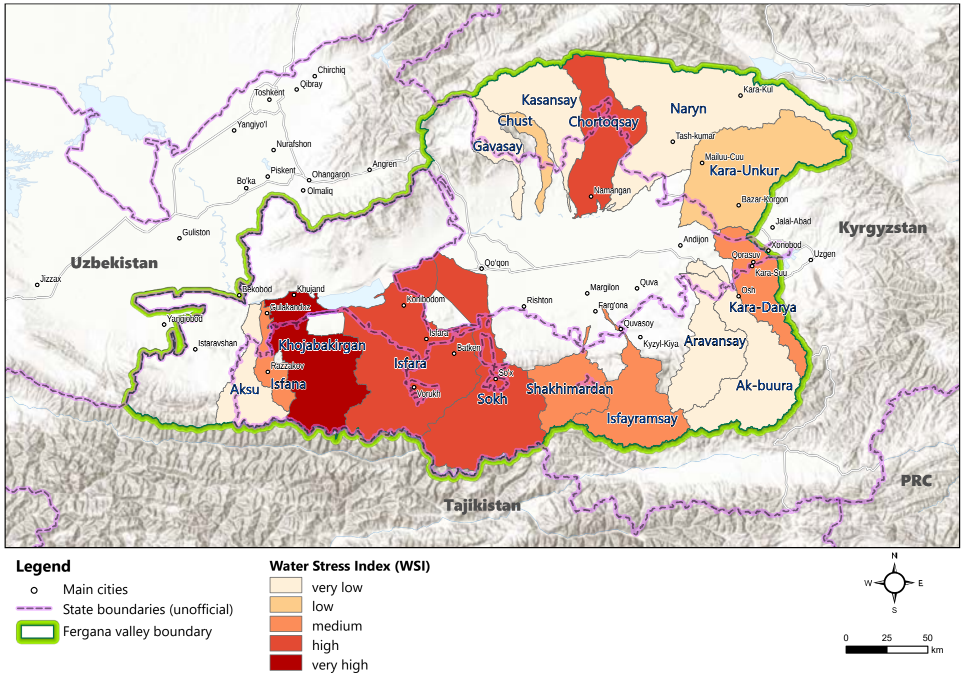


Table A4: Water Stress Index Indicators, hazard groupings, and weighting of indicators to create composite water Stress Index.

OID	Hazard Group	Weight	Hazards	Weight	Indicator	Dataset
1	Land degradation	0.1	Soil degradation	0.3	Soil salinity	Landsat-8 spectral index
2				0.4	Soil water erosion	RUSLE model: topography, soil clay component, rain erodibility, land use
3				0.3	Dust storm susceptibility - soil and wind erosion	Sentinel-5 Aerosol index; Wind speed
4	Climate change / temperature related hazards	0.1	Heatwave	0.4	Heatwave	Heatwave index - 20 year; Heatwave index change 10/10 years
5			Drought	0.6	Drought severity	VCI - 20 year[81] ; Temperature changes
6	Climate change / precipitation-related hazards	0.3	Water scarcity	0.7	Water balance	Change in snow density (1961-1990 vs 1991-2020); Snow cover (current); Water availability (stream power); Precipitation yearly mean
7	Societal hazards	0.3	Conflict	1	Dispute incidents	Number of dispute incidents
8	Technological hazards	0.2	Technological hazards	1	Presence of other hazardous materials	Number of hazardous industrial facilities, mines, and radiological storage locations
9	Hazard exposure components			0.5	Agricultural land	
10				0.5	Population density	

81. UN-SPIDER, Recommended Practice: Drought monitoring using the Vegetation Condition Index (VCI), 2023.


Source: Google Earth, 2023