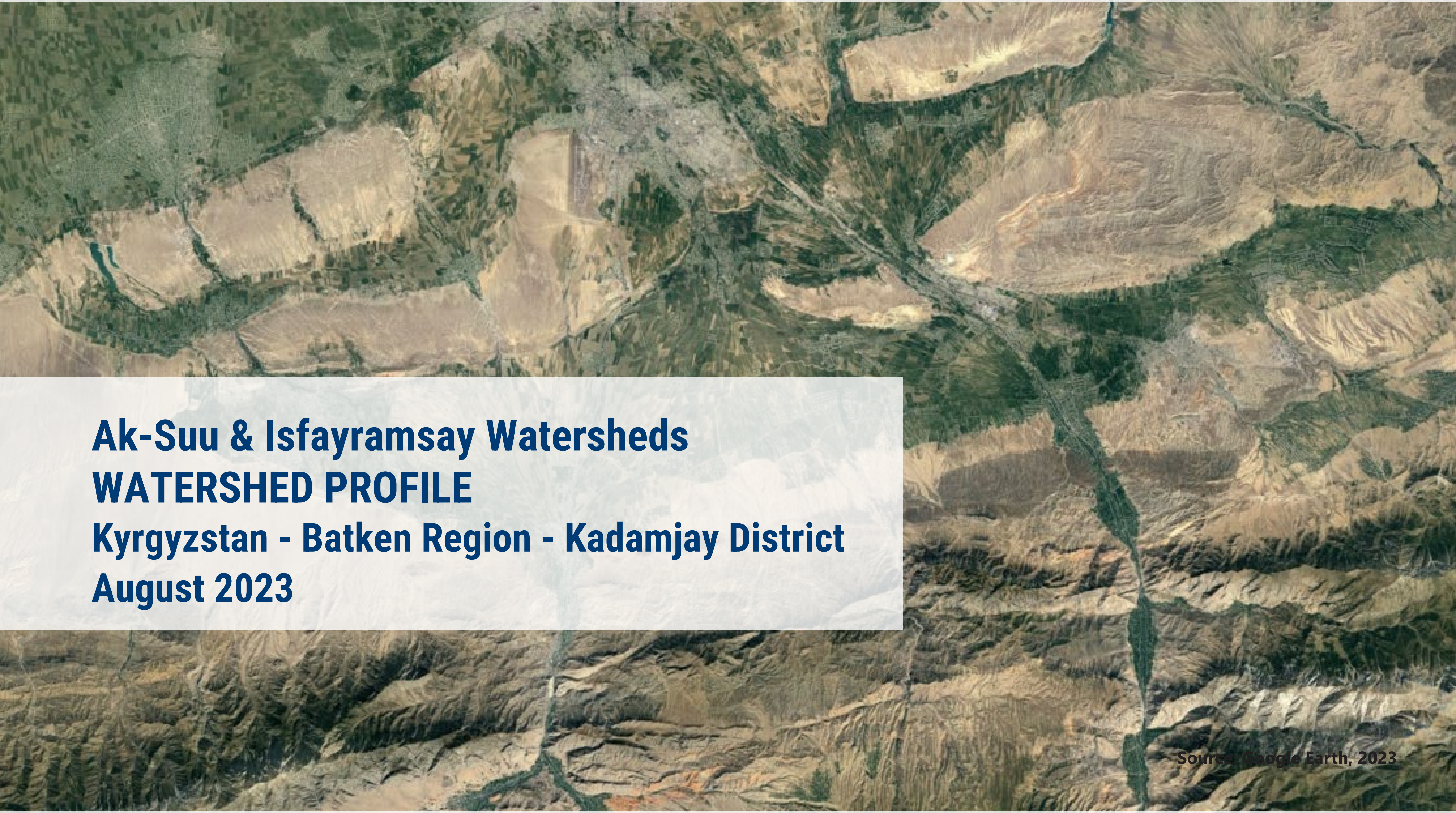
Funded by the European Union



Ak-Suu & Isfayramsay Watersheds
WATERSHED PROFILE
Kyrgyzstan - Batken Region - Kadamjay District
August 2023

Source: Google Earth, 2023

Contents

Source: IMPACT, Isfayramsay 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 susceptibility 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]

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 Fergana 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 21 and 25 August 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: IMPACT, Ak-Suu River guage station, August 2023

Analysis of water discharge data showed the volume of water to have decreased by almost 25% over the last 10 years, with water shortages reported by KIIs to have become routine in LSGs located at the end of the large canals that serve most of the population residing along the border with Uzbekistan (Sepcifically, Alga LSG in Ak-Suu and Ayirbaz LSG in Isfayramsay). Changing patterns of melting and freezing of the glaciers during wet seasons and associated declines and delays in annual water flow 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 (RuVKh) and community Water User Associations (WUAs). The largest canals in each watershed (Nazergiev in Ak-Suu and Kozho-Kayuir in Isfayramsay) were both reported to have large sections where the canal infrastructure had required re-concreting and were the main reason for water shortages in LSGs at the end of canal networks.

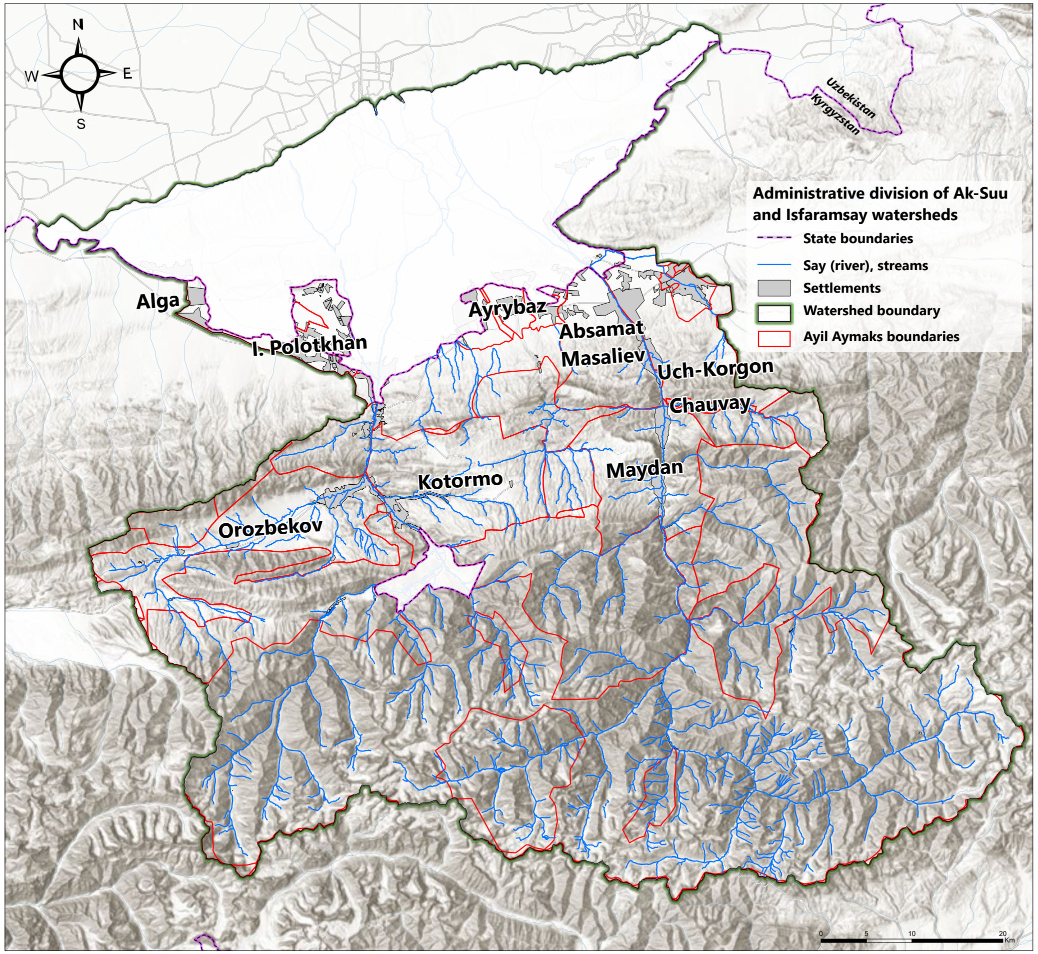
Almost half of on-farm WUA-managed canals were reported to not be concreted, leading to further water loss and lack of network efficiency. This was particularly acute in Isfayramsay, where less than 40% of canals were concreted.

Many communities in Ak-Suu and Isfayramsay watersheds have, with the support of local government, attempted to adapt to changing climactic conditions through the adoption of water-saving techniques like drip-irrigation and by changing to less-water intensive crops. KIIs noted that these approaches were important but required additional external support to make them more widespread and effective.

According to GIS analysis of degraded pasture lands, over 70% of pastureland has completely or partially 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 and overgrazing land capacity. Only Maydan LSG in upper Isfayramsay watershed was reported to have pastures that had not degraded in the last 20 years, although with more and more people from the watershed using it for pasture, it may begin to degrade at a faster rate in the future.

Unlike in many other areas of Batken Region, many women were reported by KIIs to be directly involved in agriculture in Ak-Suu and Isfayramsay watersheds. Women were reported to be involved with community based NRM decision making, but rarely occupied positions of leadership, primarily serving as deputies within village councils. These deputies, as well as representatives from women’s councils, play a major role in ensuring women’s interests are considered during community based NRM decision making.

Map 1: Location of Ak-Suu and Isfayramsay Watersheds in the Fergana Valley, June 2023[a]



Watershed overview

Ak-Suu and Isfayramsay watersheds are located in Kadamajay District, Batken Region of Kyrgyzstan. As of August 2023, the watershed features:

Table 1: The watershed features

Region	Batken
District	Kadamjay
Local Self Governments (LSGs)	
Ak-Suu	4 (Alga, Iskhak Polotkhan, Kadamjay, Kotormo)
Isfayramsay	4 (Aiyrvaz, Maydan, Masaliev, Uch-Korgon)
Villages (Total)	70
Ak-Suu	32
Isfayramsay	38
District Capital	Kadamjay
Population	Official
Households	32,661
Individuals	144,377

Background

The Fergana Valley has one of the most complex water systems in the world. Climate change, population growth, and a lack of multilateral 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 Ak-Suu and Isfayramsay watersheds are two large tributaries that feed the larger Syr Darya river system in the Fergana Valley. Located along the southern end of the Syr Darya river basin, the Ak-Suu (112km) and Isfayramsay (122km) rivers are fed by rainfall, 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 the Ak-Suu and Isfayramsay watersheds.

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.

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.

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

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.

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 Kadamjai District, August 2023

Location	DRM	Water Mgmt.	Land Mgmt.	Women's NRM	Total KIIs
District	1	1	1	0	**3**
Local Self Government	0	6	7	7	**20**
Total	**1**	**7**	**8**	**8**	**23**

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 Isfayramsay Watershed.

To do this, International Alert conducted a detailed desk review of the context in Isfayramsay, 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 August 20 to 28, 2023 in Kadamjay city, as well as Aiyrbaz, Masiliev, and Maidan LSGs in Isfayramsay. The following KIIs were conducted:

Table 4; KIIs conducted in Kyrgyzstan, from August 20 to 28, 2023

Location	Subject	# of KIIs
Kadamjay	Water Resource Management	1
	Community Representatives	2
Aiyrbaz	Water Resource Management	2
	Community Representatives	1
Total		6

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 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. Analysis with more intricate data on precipitation and temperature from governmental sources would allow for a fully calibrated model that delivers more accurate results.

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 Ak-Suu and Isfayramsay watersheds.

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
NSC	National Statistical Committee of the Kyrgyz Republic
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
USAID	United States Agency for International Development
WUA	Water User Associations

1. Hydrological Watershed Analysis

Ak-Suu & Isfayramsay Watersheds
Kadamjay District - Batken Region - Kyrgyzstan

Hazards to effective watershed management

Source: Google Earth, 2023

Source: IMPACT, Private water extraction from Nazergiev Canal, August 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]

Rivers such as the Ak-Suu and Isfayramsay rivers 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 their volumes directly impact the local communities in their watershed, who rely on networks of canals that draw water from the Ak-Suu and Isfayram rivers, 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 these rivers 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 both the Ak-Suu and Isfayramsay rivers 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.

15. National Statistical Committee of the Kyrgyz Republic, Environment In The Kyrgyz Republic, 2017-2021.
16. Ibid.
17. Ibid.

Water management in the Ak-Suu and Isfayramsay 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 rely on both rivers as their main water source for all purposes, including domestic consumption, although KIIs noted that the water is neither pre-purified or recycled. The full extent of the irrigation network and WUA boundaries can be found in Map 2.

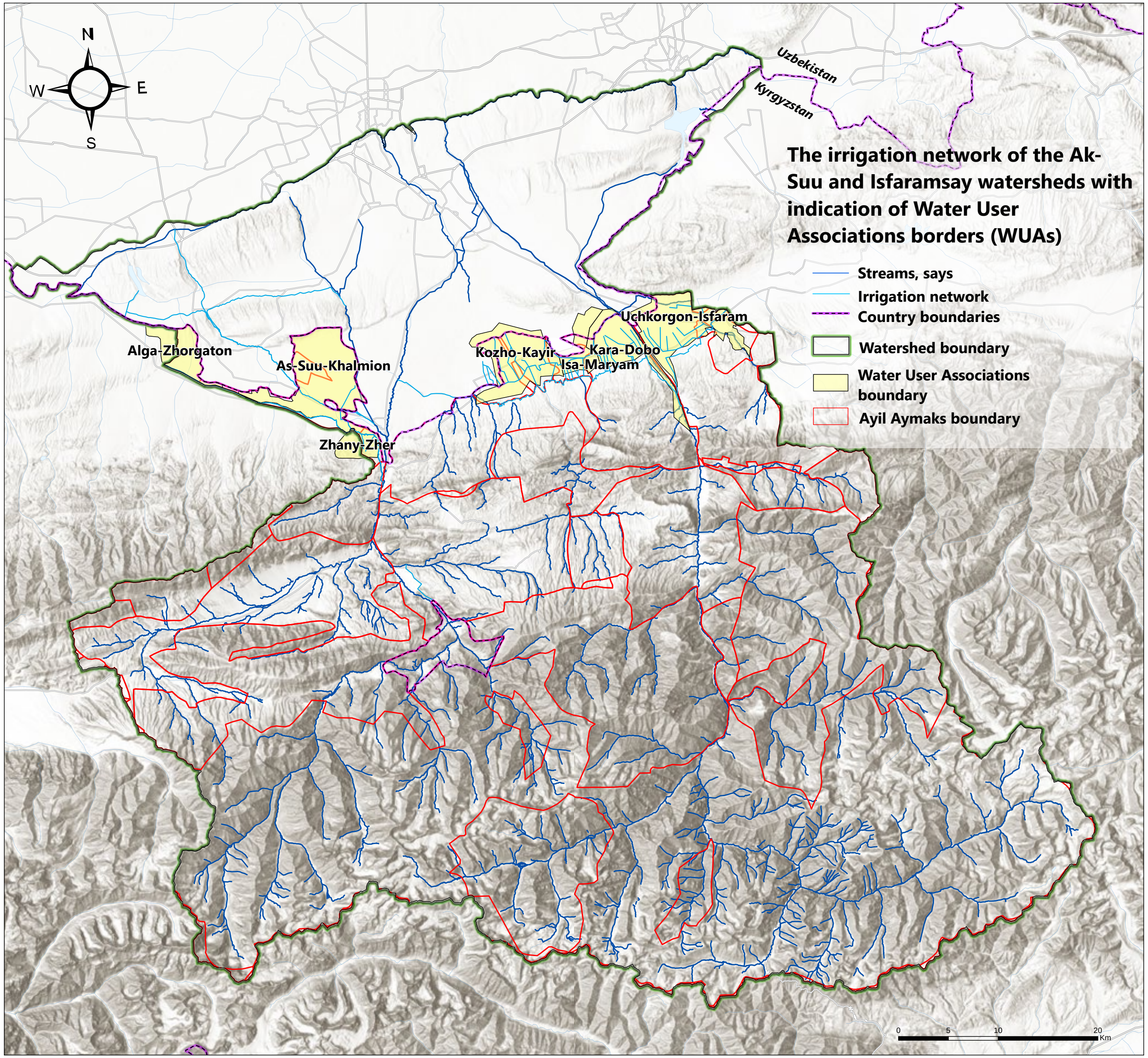
The Ak-Suu watershed has two WUAs, which maintain distribution of irrigation water to Iskhak Polotkhan and Alga LSGs. The Isfayram watershed has 4 WUAs, which provide water to Aiyrbaz, Maydan, Masaliev, and Uch-Korgan LSGs. Only one LSG, Kotormo, did not receive water from the water network, instead taking water directly from the river and from wells. Wells were reported by KIIs to play a large role in the larger water network; in Alga, as much as 50% of irrigation water was reported to be taken from groundwater. WUA representatives Iskhak Polotkhan noted that 7 wells were currently used to support the water network, with an additional 4 planned to be constructed, suggesting an increasing reliance on groundwater in the Ak-Suu basin to support the irrigation network.

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 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 with their jurisdictions when required.

RuVHKA manages the main, primary canals that connect to the main river source to the LSG communities, while the WUAs manage the smaller

Map 2: Water User Associations and canal networks, Ak-Suu and Isfayramsay watersheds, August 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.

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, which was reported to be due to a combination of climate change, which has reduced the overall flow of the Ak-Suu and Isfayramsay Rivers by up to 25% over the last decade, and corroding infrastructure, which has contributed to water loss. Much of the irrigation networks were constructed under the Soviet Union, and are made from cement, which has in recent years began to crumble away, leading to an increase in water loss. This was noted to be the case for both the main RuVKHA canals and the on-farm WUA-managed canals.

In addition, some KIs highlighted population growth and the emergence of new settlements, leading to an increase in water use, which also affects water availability. In some cases, this has resulted in the inability of canals to maintain adequate water supplies, affecting critical irrigation needs for vegetation growth, particularly during the vegetation period.

Most of the communities in Kadamjay district are located along the border with Uzbekistan, and receive water from large canals that take water from the south to north running Ak-Suu and Isfayram rivers via canals that run east to west, feeding each community with branching on-farm networks. The Nurgaziev canal serves Iskhak Polotkhan and Alga in the Ak-Suu watershed. The Isfayram watershed has 8 canals, the largest and most important of which is the Kojo-Kayir canal. Both of these canals were reported by KIs to have large extents that lack concrete, leading to large water losses in the LSGs at the end of each canal (Alga and Aiyrbaz, respectively). Table 5 shows the full extent of each canal.

Table 5: Main canals of RuVKHA: corresponding WUAs and LSGs, lengths of canals (km) and irrigated areas (ha)[c]

Watershed	WUA	LSG	Canal	Length (km)	Irrigated Area (ha)
Ak-Suu	Alga-Dzarkoton	Alga	Nurgaziev	35.2	4,417
	Ak-Suu-Khalmion	Iskhak Polotkhan		31	5,669
Isfayram	Kojo-Kayir Isa-Maryam	Aiyrbaz Maidan	Kojo-Kayir Lagan	12	1,500
	Kara-Dobo	Masaliev	Aluish	17.1	231
			Ismat	2	600
	Uch-Korgon-Isfayram	Uch-Korgon	Teshik	23	500
			Anchor	18.6	1,380
			Kara-Kystak	6.7	538
			Ruzdarhan	0.6	450

While WUAs and RuVKHA were reported to have done an adequate job in maintaining and repairing the canal networks when damaged from flooding, a reported common occurrence in all WUAs, additional support was needed to rehabilitate the canals, as repairs where unable to address the overall problem of the network's infrastructure falling apart.

WUAs fund themselves through a surcharge per water liter. This rate varies depending on the time of year (RuVKHA sells to WUAs for approximately 1 som/m^3 ,in the 1st and 4th quarters of the year, and 3 som/m^3 in the 2nd and 3rd quarters. These rates were reported by KIs to have not changed in 20 years. The WUAs in turn then sell to water users based on the number of hectares that are irrigated; this was reported to vary from 1,300 som to 2,400 som, depending on the WUA. Unlike the RuVKHA fees, the WUA fees were reported to have been adjusted over time for inflation. In Masaliev, additional fees were added to assist in repaying loans received from development organizations to rehabilitate the irrigation network. An examination of WUA finances found that the WUAs in Ak-Suu and Isfayramsay had largely kept their budgets balanced.

The poor condition of on-farm networks was also noted by KIs from WUAs., and likely contributed to significant water loss and lack of efficiency. In Alga, KIs reported that at much as 35% of water from the on-farm network was lost due to inefficiency and corroding infrastructure. Further, as table 6 shows, nearly half of all 4th-order WUA on-farm canals in Ak-Suu and Isfayramsay watersheds were not concreted, and therefore more likely to experience water loss. This was highest in Maydan (96%), Uch-Korgan (87%) and Alga (59%) LSGs. In total, 114km of a total of 148km of WUA-managed on-farm networks were not concreted, and responsible for considerable water loss in the water networks.

Uch-Korgon LSG stands out as one of the most WUA networks most in-need of infrastructure support. Despite being 87% earthen canals, it is responsible for 40% of recorded on-farm water discharge. KIs further noted that it water volumes in the LSG had fallen by 1/3 in the previous decade, and the Eshan canal which serves the LSG is currently irrigating a land area beyond it's size and capacity, over stretching resources in the LSG.

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. Unlike in some other watersheds, KIs noted that in both Ak-Suu

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

and Isfayramsay watersheds, procedures were in place to manage water allocation during shortages. At these times, water is first allocated for drinking (with public services like health centres and schools further given priority), then irrigation, with priority given to vegetable and horticulture lands.

During these times of acute water scarcity, the RuVKHA collaborates closely with WUAs, utilizing the department's available resources to address challenges together. Vulnerable groups, such as women and children, were also reported to be prioritized.

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

Water User Associations			Actual Annual Water discharge (1000m^3)	Canal length (in km)		% of Canals not concreted	
Watershed	**WUA**	**LSG**		**3rd order canals (5m^3)**	**4th order canals (1m^3)**	**3rd Order**	**4th Order**
Ak-Suu	Alga-Dzarkoton	Alga	6,310	0	23	0	59%
	Ak-Suu-Khalмion	Iskhak Polotkhan	25,304	26.5	50.9	100%	0%
Isfayram	Kozo-Kayir	Aiyrbaz	15,752	0	32.2	0	6%
	Isa-Maryam	Maydan	5,390	0	42	0	96%
	Kara-Dobo	Masaliev	13,601	0	25.5	0	19%
	Uch-Korgon-Isfayram	Uch-Korgon	22,979	0	61.6	0	87%
		Total	**89,336**	**26.5**	**235**	**100%**	**100%**

Suggested watershed support

- Rehabilitate the canal infrastructure is critical for reduction in water loss.
- The main RuVKHA-managed canals in Ak-Suu (Nazergiev) anad Isfayramsay (Kozho-Kayuir) are responsible for the main loss in water in each watershed's canal network. Rehabilitating these canals will likely have the largest impact in reducing water loss in both water networks.
- WUA on-farm networks need concreting to reduce water loss for 3rd and 4th order canals. Uch-Korgon in Isfayramsay and Alga in Ak-Suu on-farm networks have the greatest lack of concreting reported and are the best candidates for canal rehabilitation.

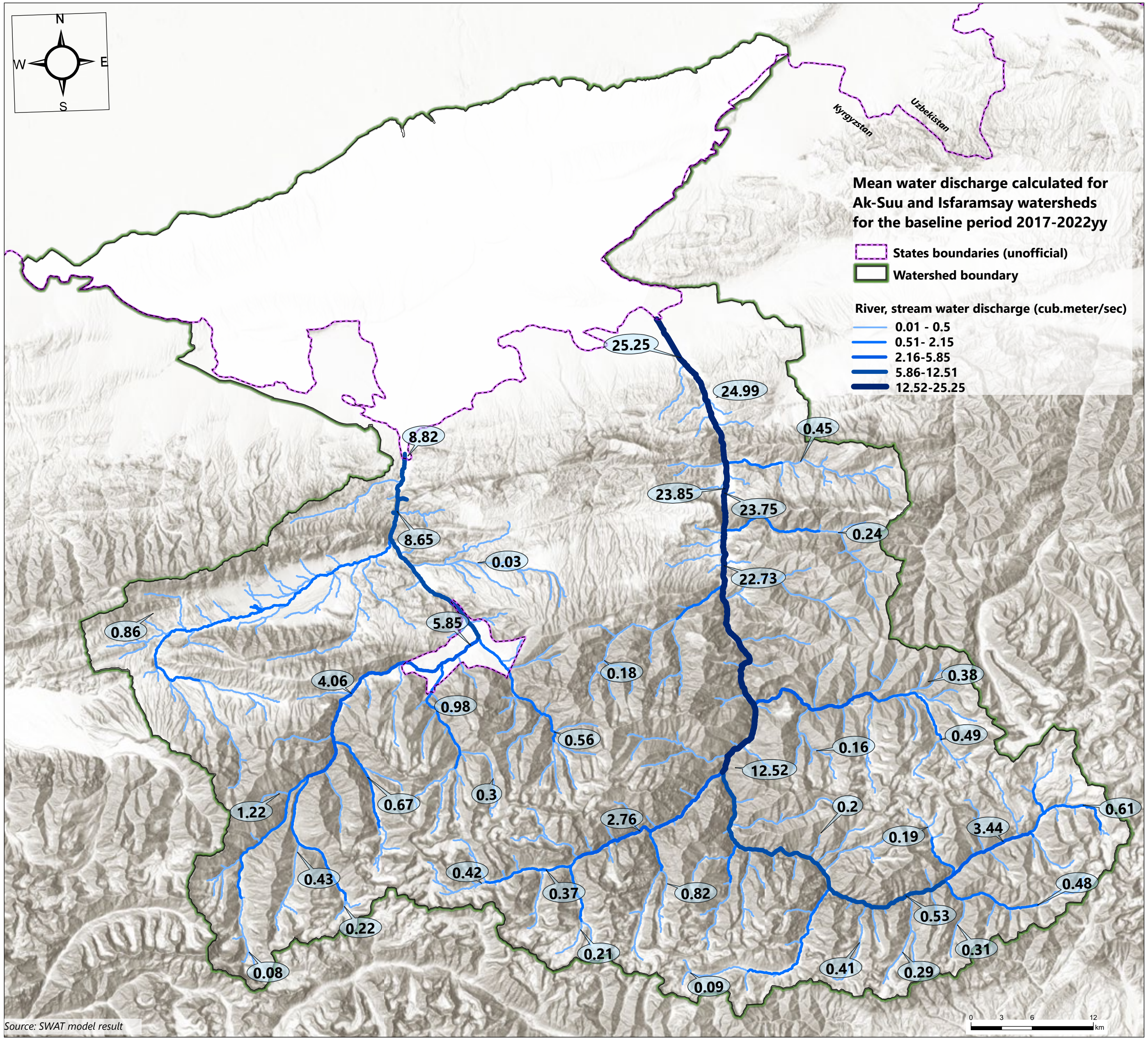
d) Source: Original data is from WUAs.

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 Ak-Suu and Isfayram watersheds for the years of 2015-2022. 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 reaches, or main rivers of each watershed, before flowing north past the main population areas in LSGs on the border and 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 for both Ak-Suu and Isfayramsay rivers as the river travels downstream: In Ak-Suu, flow for tributaries begins at 0.08 m^3/s in tributaries at its source reaching 8.82 m^3/s by the time that the water leaves Kyrgyzstan. In Isfayramsay, this rate is higher, beginning at 0.09 0.08 m^3/s and reaching 25.25 0.08 m^3/s as it flows into Uzbekistan. This highlights potential susceptibility to flooding and inundation of water in border communities, which was reported by KIs to be common in all of the assessed LSGs.

While the map provides insights into water yield and discharge from 2015 to 2022, it is important to consider that all the Hydroposts on the Kyrgyzstan part of both watersheds are both located upstream of the canals, making it difficult to track how much water is taken from the river system for irrigation purposes. Integration of data from Uzbekistan or improved canal water meter technologies can address this gap. Furthermore, KIs noted that the current hydropost technology used was difficult to maintain, and more reliable and easier to use technologies would improve their ability to

Maps 3: Water discharge of Ak-Suu and Isfayramsay watersheds, 2015-2022



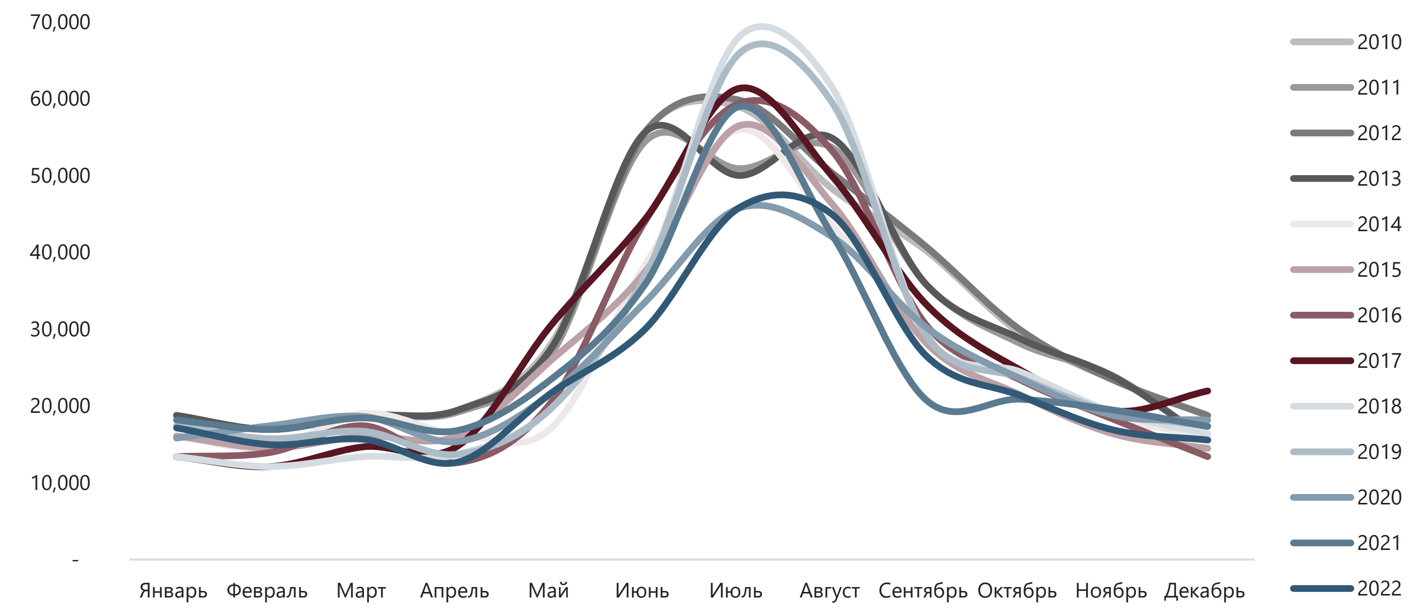
measure water usage.

As noted above, water management issues were reported by KIIs to be linked to aging and corroding canal infrastructure, particularly in the largest and most prominent RuVKHA canals, the Nurgaziev in Ak-Suu and the Kojo-Kayir in Isfayram.

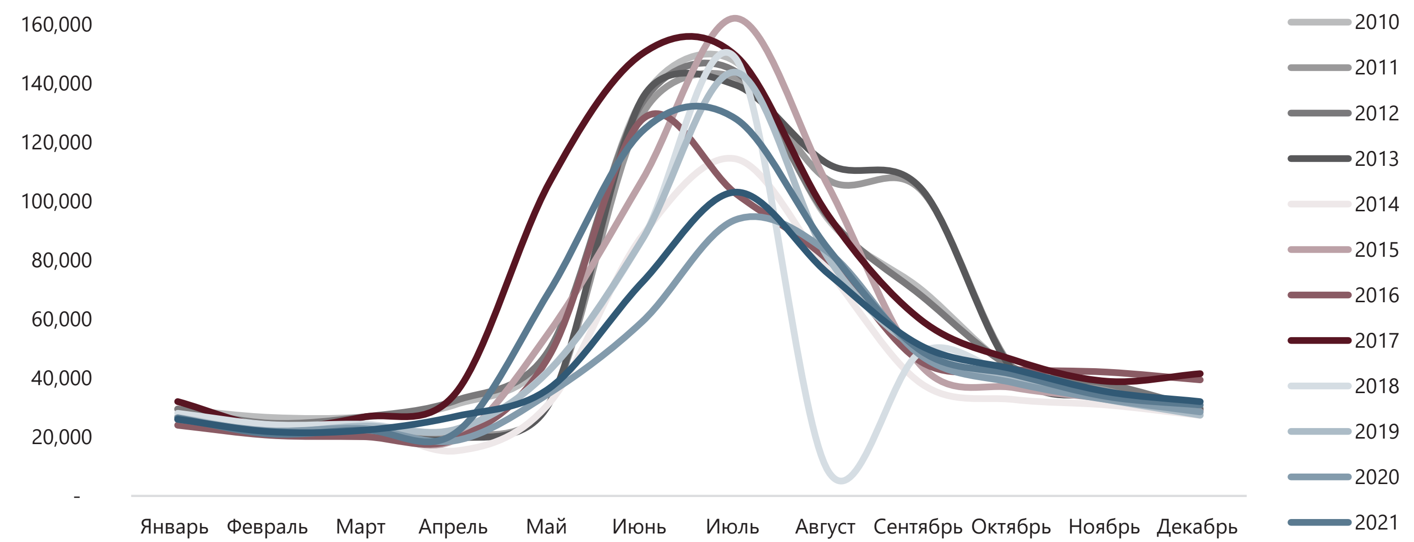
Graphs 1 and 2 examine the monthly trends of water discharge over 13 years, from 2010 to 2022 for both the Ak-Suu and Isfayram Rivers. While water levels vary year on year, both graphs show a noticeable decline in water levels during the peak summer season in recent years, as well as the winter, when discharge levels have typically seen a moderate increase. In addition, water flows seem to peak later in the year, moving from an annual peak in June in 2010 to August in 2022. Overall discharge levels for Isfayram were reported to have declined from over 716,000 km^3 in annual discharge in 2010 to approximately than 545,000 km^3 in annual discharge in 2022. During the same time period, the Ak-Suu river's annual discharge decline from over 376,000 km^3 to under 283,000 km^3. This is a decline in almost 25% of each watershed's total annual surface water.

Graph 3 depicts these changes from 2010 to 2022, broken down by period. As can be seen from the graph, the average monthly volume of water flow in the Isfayram River decreased during two brackets: April-June and July-September. Thus, in the first half of the period (2010-2016), water discharge in April-June and July-September amounted to 62,394 km^3 and 99,733 km^3, respectively; in the second half of the period the volume decreased to 58,929 km^3 and 83,178, km^3 respectively. While during the remaining periods the flow of water remained almost unchanged throughout the period, meaning that the

Graph 1: Changes in Water discharge levels of Ak-Suu watershed, in 1000m³, 2010-2022.[d]



Graph 2: Changes in Water discharge levels of Isfayramsay watershed, in 1000m³, 2013-2022.[d]



volume of water saw a decrease in the spring and summer, when the water is needed for irrigation of agriculture.

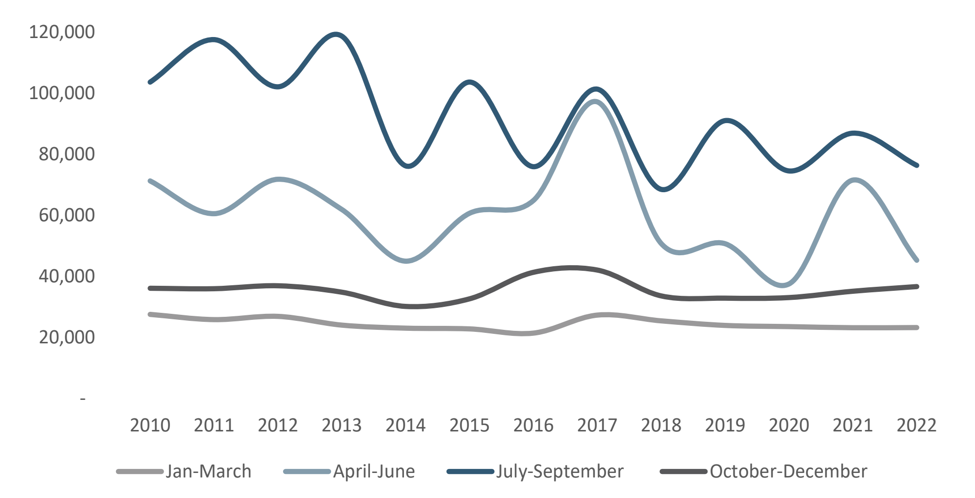
Graph 4 also shows the changes in water discharge, for the Ak-Suu river between 2010 and 2022. Overall, water flow in the Ak-Suu River declined slightly from 2010-2016 to 2017-2022 in such seasons as January-March, July-April and October-December by approximately 2,000 km^3 per season. However, over the same comparable period of time, but in April-June, water discharge decreased significantly from 30,357 km^3 to 24,522 km^3.

These changes, especially during the sowing and growing periods of agricultural production have a direct impact on agricultural practices. The delayed availability of water by almost a month has reportedly lead to water shortages in some areas during critical periods and necessitates a delay in the sowing of crops.

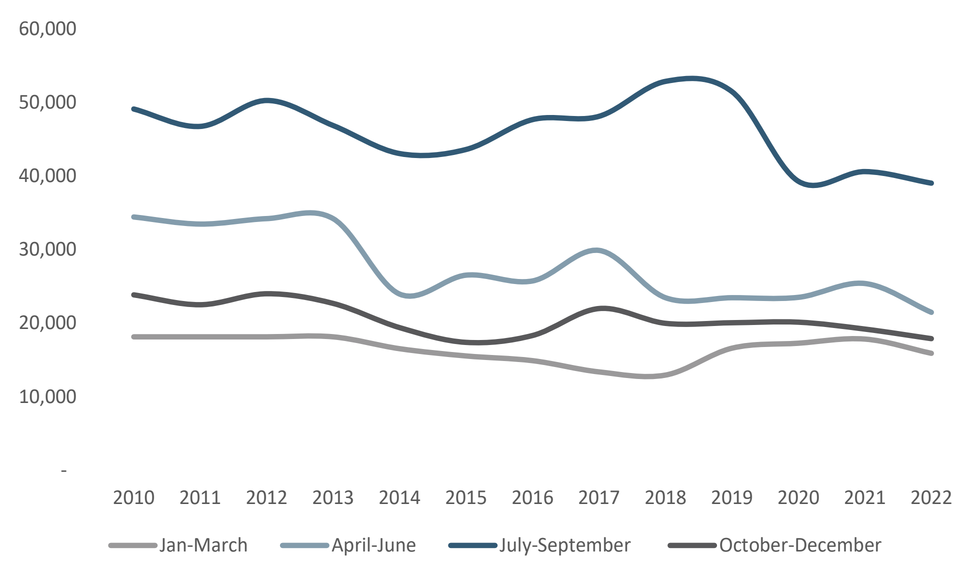
The main water infrastructure are gauge stations that divert water from each river and control the water flow through gates, which are managed by RuVKha. Water is fed from these canals into on-farm networks, which are then managed by the WUAs. From these canals, irrigation water is distributed to the agricultural land of farmer via internal canals, ditches and flumes managed by the WUAs.

Near all KIs noted the decline in water discharge levels and changes in precipitation over time, and attributed this to aging canal infrastructure, including both the canal walls and gates. While RuVKha and the WUAs have been able to make repairs following seasonal flooding and mudflows, KIs noted that larger investment beyond their current capacity

Graph 3: Seasonal changes in water discharge levels of Isfayramsay river (2010-2022) [g]



Graph 4: Seasonal changes in water discharge levels Ak-Suu rivers (2010-2022) [g]



g) Source: Original data is from Kadamjai District RuVKHA.

was needed to fully rehabilitate the canal network and reduce overall water loss.

In the interim, some water users have adopted innovative approaches to address water loss. Drip irrigation has been adopted by some farmers in Masaliev and Maydan LSGs. Other KIs noted specific key needs for the irrigation system in certain LSGs, including improved water regulation and on-farm canal rehabilitation in Iskhak Polotkhan and Aiyrbaz, expansion of the Langan canal, and water tank installation and implementation of a flume system in Uch-Korgon.

The Asian Development Bank and World bank have reportedly committed to supporting the rehabilitation of the Nurgaziev and Kozo-Kayir Canals, although these repairs reportedly would not cover all of the necessary rehabilitation.

Suggested watershed support

- Most water is located upstream, and a significant portion is lost before it reaches downstream where most of the water is used for irrigation. Rehabilitating upstream water infrastructure to reduce water loss may have major positive downstream affects in increasing the water supply.
- Flooding is likely to be a major downstream issue and disaster mitigation measures should be targeted accordingly.

In addition to the surface water, communities, in the both Ak-Suu and Isfayramsay watersheds are also highly dependent upon groundwater to meet their irrigation and drinking water needs. Ground water in the Ak-Suu and Isfayram watersheds belongs to the larger Sokh aquifer, which covers a large number of communities within Kyrgyzstan and neighboring Uzbekistan (mostly located in Uzbekistan).[18] The aquifer covers approximately 1,810 km^2, and sits 72-116 m underground.[19] Compared to other aquifers such as the Sulyukta-Batken-Nau-Isfara aquifer, which lies 50-120 m below the surface, the depth of the Sokh is comparatively similar.[20] The cumulative thickness of the water-bearing strata is 300 m and includes shingle and gravel deposits with loam and clay interlayers.[21]

According to the UNDP study, of all water in the Isfayram and Ak-Suu rivers ground water accounts for 60% and 69%, respectively, which is the highest compared to Sokh (40%) and Isfara (38%). The remaining water is reported to come from glacial runoff (11%), snowmelt (17%) and precipitation (3%) for the Ak-Suu basin, and 13% from glacial runoff for the Isfayram basin, and figures for other sources were not reported.

Many aquifers in Central Asia are composed of a single, large aquifer, or several smaller, connected aquifers, which is the case with the Sokh aquifer. The Sokh aquifer is mainly intermountain external artesian pools with a three-storey structure and generally characterized by availability of ground, sub-artesian and artesian waters. [22]

18. UNECE, Drainage Basin of the Aral Sea and Other Transboundary Waters in Central Asia, 2023.
19. Ibid.
20. Ibid.
21. Ibid.
22. CAWATER, Knowledge base, "Use of land and water resources in the Aral Sea basin", 2023.

These aquifers are fed by an unused water that does not evaporate and seeps into the soil, and forms a key method through which the aquifers are replenished. Evaporation rates in Batken oblast are reported to be high, leaving less water than in other parts of the country to recharge the aquifer.[23] Particularly, the Sokh basin experiences high summer temperatures (30-40°C), and has a low summer dominated rainfall (100 to 150mm per year) leads to high evaporation rates, necessitating more irrigation diversion from the rivers.[24]

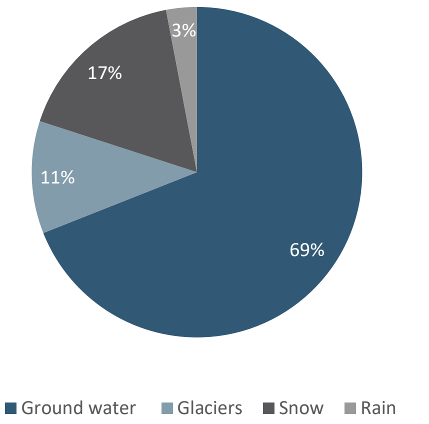
Most of the aquifers in Kadamjai District work through the collection of underground drainage of water into the aquifers, which sits under most of the populated areas of Kadamjai district, which includes the Ak-Suu and Isfayram watersheds.[25]

The trend towards increased diversion of water from rivers for irrigation, in some cases an increase in the area of irrigated land, and greater reliance on groundwater may have an impact on both groundwater and surface water. According to some studies, the increase in the area of irrigated land in the upper reaches of the Ak-Suu and Sokh rivers and in the basins of other small rivers, combined with the low efficiency of irrigation water supply, is leading to significant groundwater depletion.[26] Many farmers in the area have reportedly dealt with the problem of water scarcity by drilling more boreholes as irrigation channels cannot provide enough water, further lowering the water table. The need to drill deeper boreholes each year can lead to tensions among farmers in the area, and reliance on surface and groundwater runoff reduces water availability.

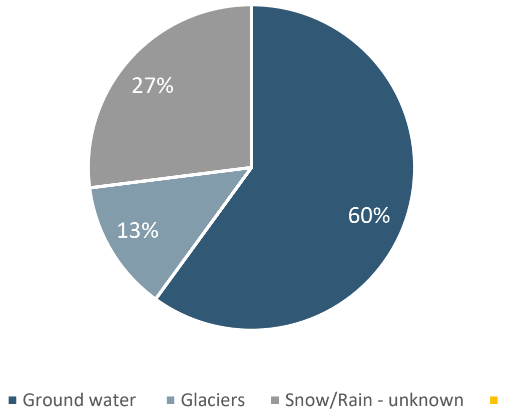
The reliance on groundwater in the short term, medium and long term, necessitates more sustainable groundwater practices will need to be identified in order to sustain water services for agriculture in the watersheds. Given the depletion of surface water, these aquifers may need to be exploited even more heavily to account for larger gaps in surface water supply. This would risk depletion at an even more rapid rate.

23. MDPI, Sustainable Use of Groundwater Resources in the Transboundary Aquifers of the Five Central Asian Counties: Challenges and Perspective, 2020.
24. Gracheva, I., Karimov, A., Turral, H., & Miryusupov, F. (2009). An assessment of the potential and impacts of winter water banking in the Sokh aquifer, Central Asia. Hydrogeology Journal, 17(6), 1471–1482.
25. Mining Complex of the Kyrgyz Republic, Groundwater management: Problems of use and conservation, August 2016.
26. Karimov, A., Giordano, M., Mukherji, A., Borisov, V., & Djumanov, J. (2011). Of transboundary basins, integrated water resources management (IWRM) and second best solutions: the case of groundwater banking in Central Asia. Water Policy, 14(1), 99–111.

Graph 5: Water sources of the Ak-Suu River[f]



Graph 6: Water sources of the Isfayramsay River[f]



f) Source: Data is taken from UNDP' report

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

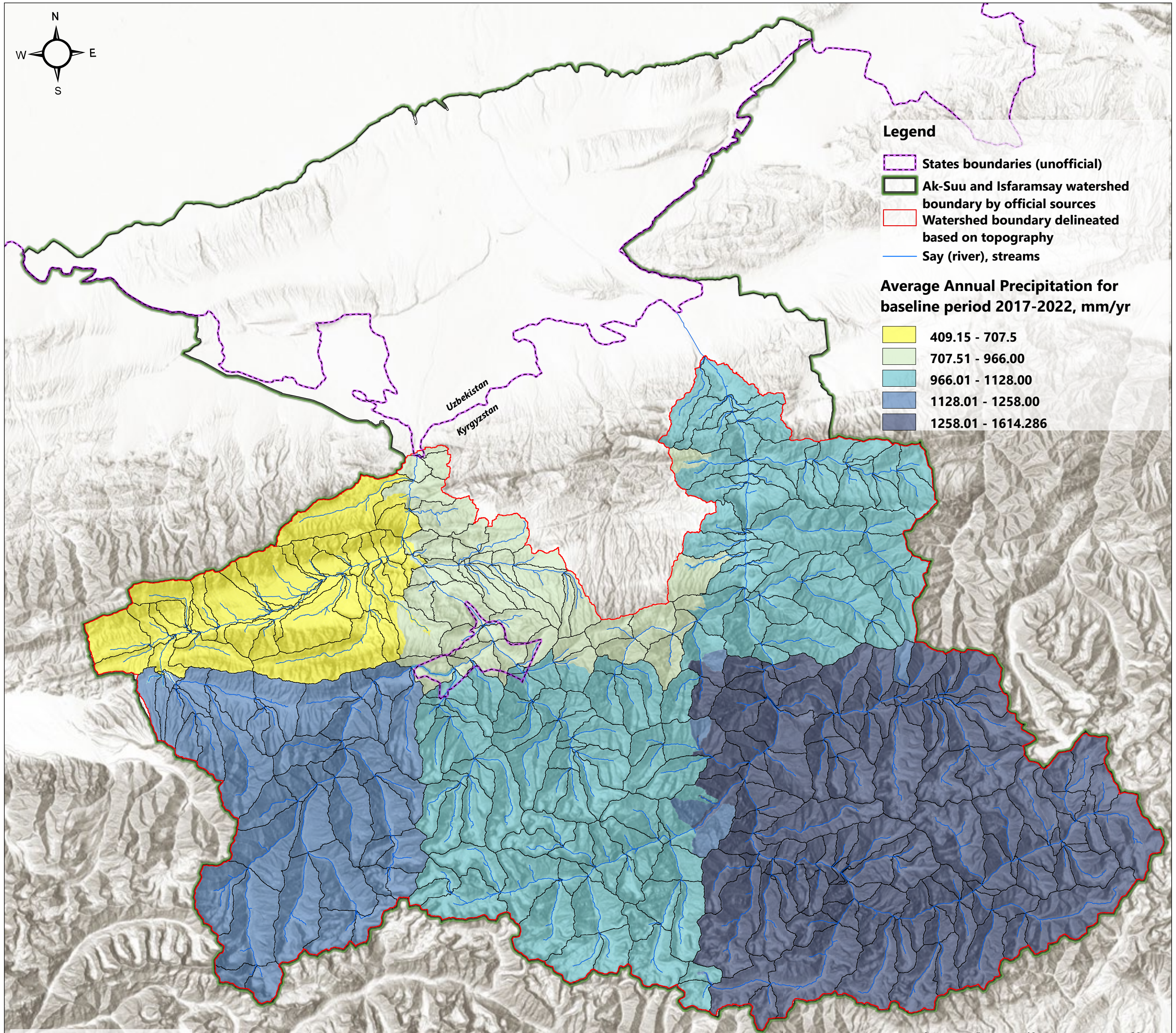
Analysis of data from weather stations in the Isfayram watershed between 2003 and 2021 revealed two key findings: (1) the average volume of precipitation between 2013 and 2021 decreased by almost 156 m compared to the average precipitation in the period 2003-2012 (Graph 7), and (2) the timing of precipitation patterns month on month 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 7-9, rainfall in Ak-Suu and Isfayramsay have historically shown a clear and predictable pattern, with rains beginning in the late fall in September and October, and peaking in winter (December/ January), before declining steadily over the course of water and spring, reaching their nadir in the late summer (August). 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 declined slightly. More importantly, it has increasingly deviated from normal rain patterns as time has gone on. In Graph 7, monthly precipitation between 2003 and 2010 tends to follow the previously noted patterns. However, Graph 8, showing monthly precipitation between 2011 and 2020, shows rainfall patterns to increasingly deviate over the decade, with the rainfall levels both declining overall and peaking later and later, beginning as late as November and peaking in March and April in recent years. In addition, higher than normal levels of rainfall have been observed as late as May and June beginning in 2019 (Graph 8).

Graph 9 shows average monthly precipitation for 2021, in which extreme deviations in precipitation

Map 4: Precipitation levels of sub-catchments in Ak-Suu and Isfayramsay watershed, 2017 - 2022



Source: SWAT model result

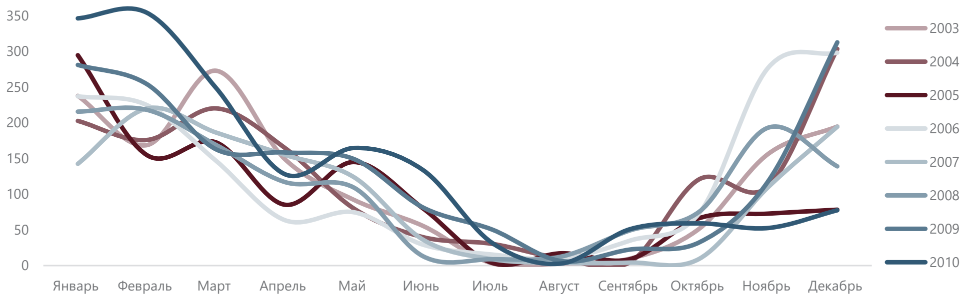
g) Source: Data is taken from United States National Oceanic and Atmospheric Administration website.

were recorded, with rain peaking in March and being almost non-existent after May. 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.

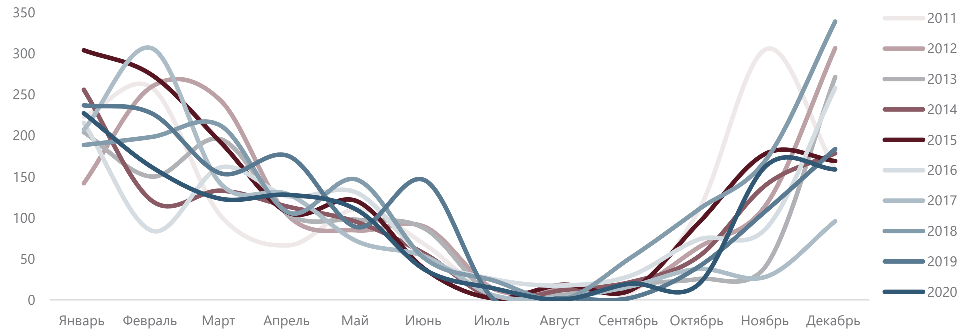
Accordingly, the Annual Average Precipitation (AAP) map for the period 2017-2022 (Map 4) indicates significant variations in precipitation across the watershed. Higher-altitude regions in the southern part of the watershed receive more rainfall, with the highest rainfall found to be in the upper parts of Isfayramsay watershed, followed by the upper portions of the Ak-Suu Watershed. This is normal for most watershed systems.

However, the map also shows that the lower portions of the watershed received comparatively high levels of rainfall as well. The lower portions of Isfayramsay received 61% of the rainfall as its upper portions, and the lower parts of Ak-Suu received 33%. This is much more favorable to irrigated crops than the watersheds further west, making both watersheds some of the more fertile areas for growing rainfed crops in the Batken region.

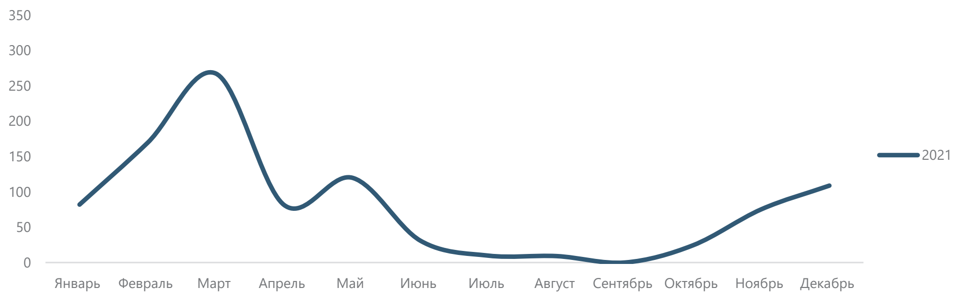
Graph 7: Monthly total of precipitation in Ak-Suu and Isfayramsay Watersheds, 2003 - 2010, in average mm per month.[g]



Graph 8: Monthly total of precipitation in Ak-Suu and Isfayramsay Watersheds 2011 - 2020, in average mm per month.[g]



Graph 9: Monthly total of precipitation in Ak-Suu and Isfayramsay Watersheds 2021, in average mm per month.[g]



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. 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 in both countries 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 support current growing and harvest patterns, rainwater harvesting technologies should be adopted to support cultivation.

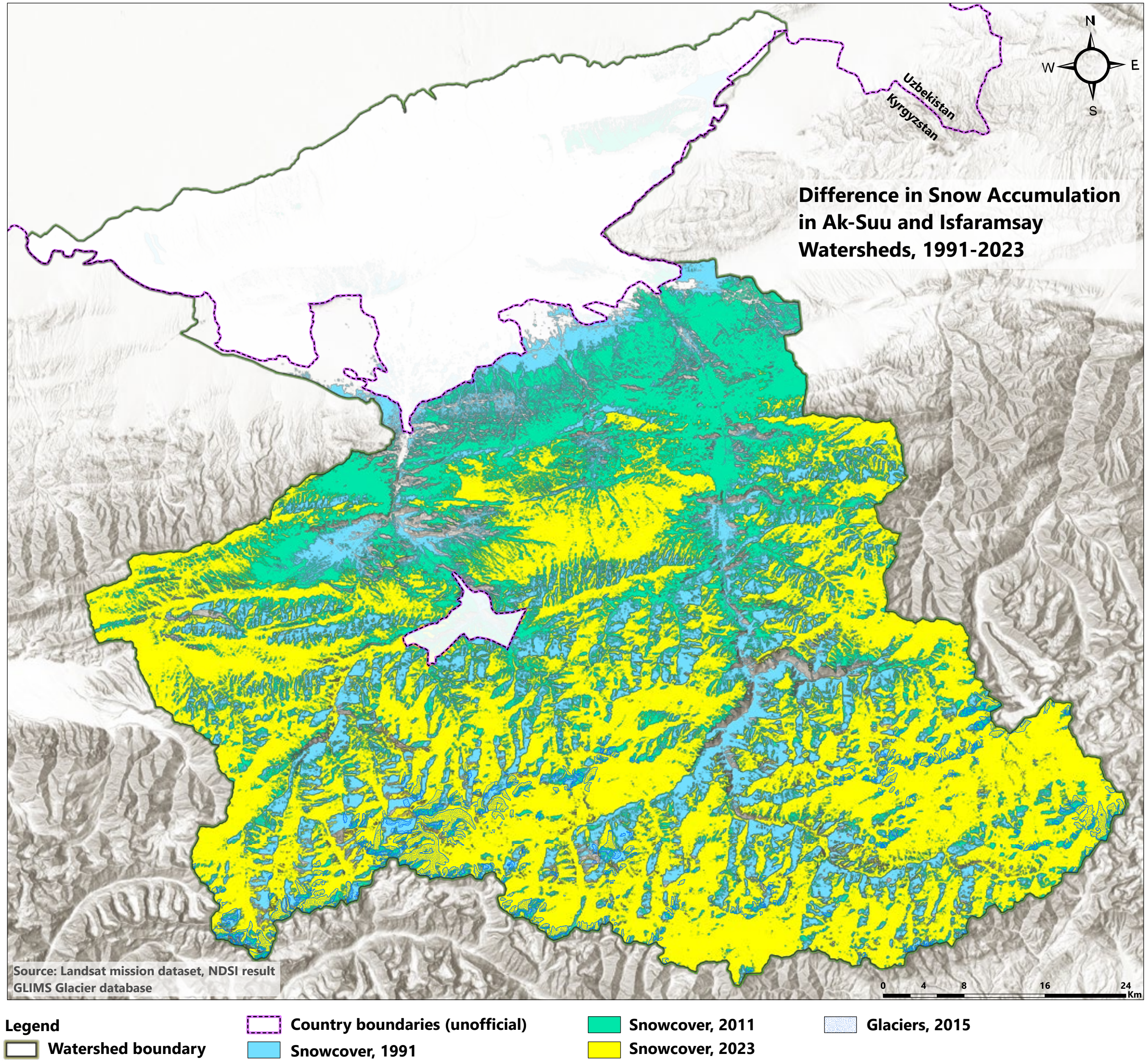
Glacier and snow melt are important sources for Ak-Suu and Isfayramsay rivers. In Isfayramsay watershed, 11% of water was reported to come from glacial runoff, and 17% from snowmelt. In Ak-Suu, 13% of the watershed's riverwater came from glacial runoff, with the remaining 27% coming from snowmelt and precipiation (the bulk of which was likely from snowmelt).[27] This is much higher than the typical annual average of 10-20%, and the highest of rivers in the Batken region by a large margin.[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] Both the Ak-Suu and Isfayramsay watersheds have a large number of GLOFs, which are covered in the Disaster Risk Reduction section of this report.

To analyse the melting of glaciers and snow melt, IMPACT conducted a geospatial analysis of the total snow and glacier coverage of the Ak-Suu and Isfayramsay watersheds 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.

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



For this, NDSI data was used. This data covered the geographic area of the snow melt and glaciers, but not thickness or volume.

Graph 10 below shows the total loss in area of snow accumulation between 1991 and 2023, annual snow fall has decreased by approximately 40%, greater than the 25% recorded decrease in surface water flow of the river. However, as snowfall made up a minority of the water in each river, this likely accounts for a substantial amount of the decline in water levels in the rivers. 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 almost the entirety of the Ak-Suu and Isfayramsay 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. In the lower parts of the watershed, snowfall has completely disappeared.

IMPACT also analyzed the melting of glaciers in the Ak-Suu and Isfayramsay watersheds 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 Ak-Suu and Isfayramsay watersheds were found to have lost 12% of their total volume. In addition, 44% of the nearly 404 glaciers that fed the Ak-Suu and Isfayramsay river in 2001 have lost at least 90% of their total volume, and are at risk of disappearing.

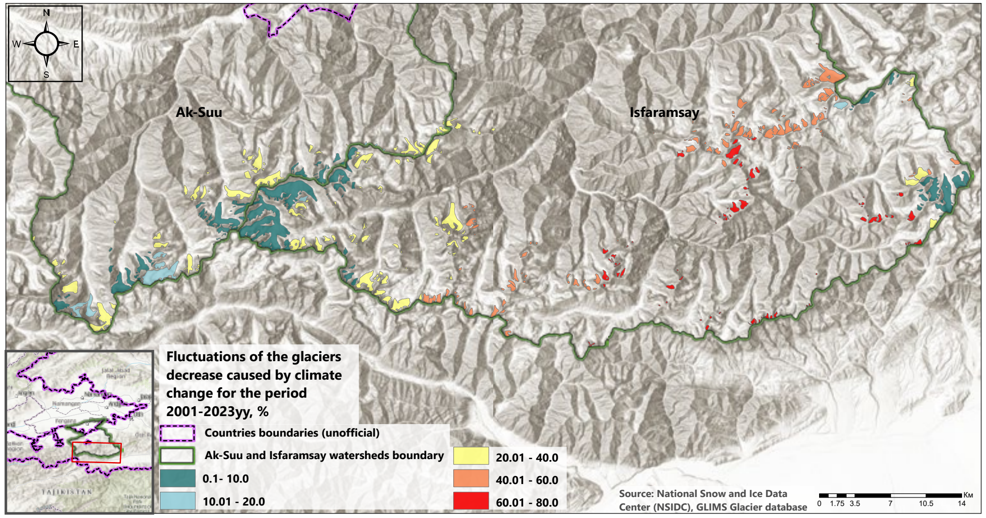
Looking at Map 6, which shows approximations of glacier size and locations in 2001, more severe glacier loss and shrinkage appears to have affected smaller glaciers located further east in Isfayramsay watershed, which were more likely to have lost half or more of their size. This suggests that the melting rate for small glaciers is likely similar to or higher than larger ones, and are more likely to disappear first. In addition, glacier loss appears to have been more acute further east in Isfayramsay watershed, which may be due to differences in elevation, as many glaciers in Isfayramsay are located further down the Turkestan mountain ridgeline. This also explains the higher prevalnece of GLOFs in Isfayramsay compared to Ak-Suu watershed, given the higher instance of melting glaciers.

As noted, the loss of snow and glacier coverage has already had implications in the overall flow of the Ak-Suu and Isfayramsay rivers. 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.

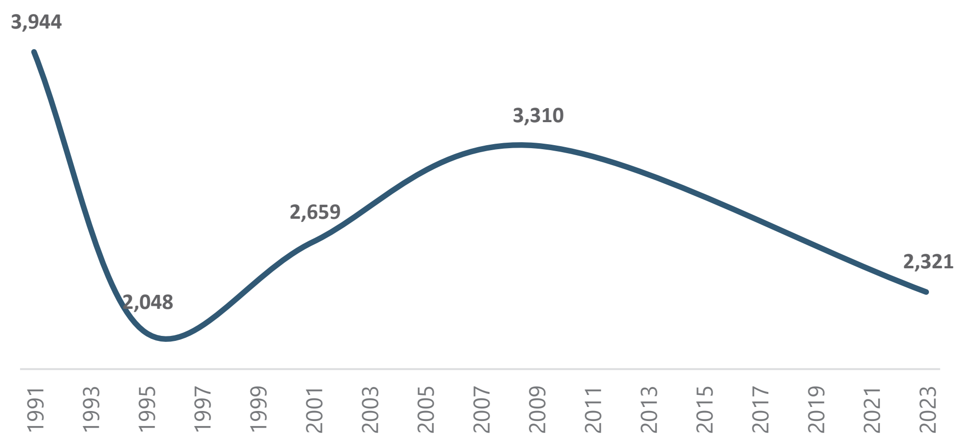
Suggested watershed support

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

Map 6: % Change in Glacier volume of Ak-Suu and Isfayramsay Watersheds, Watersheds, 2001- 2023



Graph 10: Total area of snow accumulation in month of February of Ak-Suu and Isfayramsay Watersheds, 1991 - 2023



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]

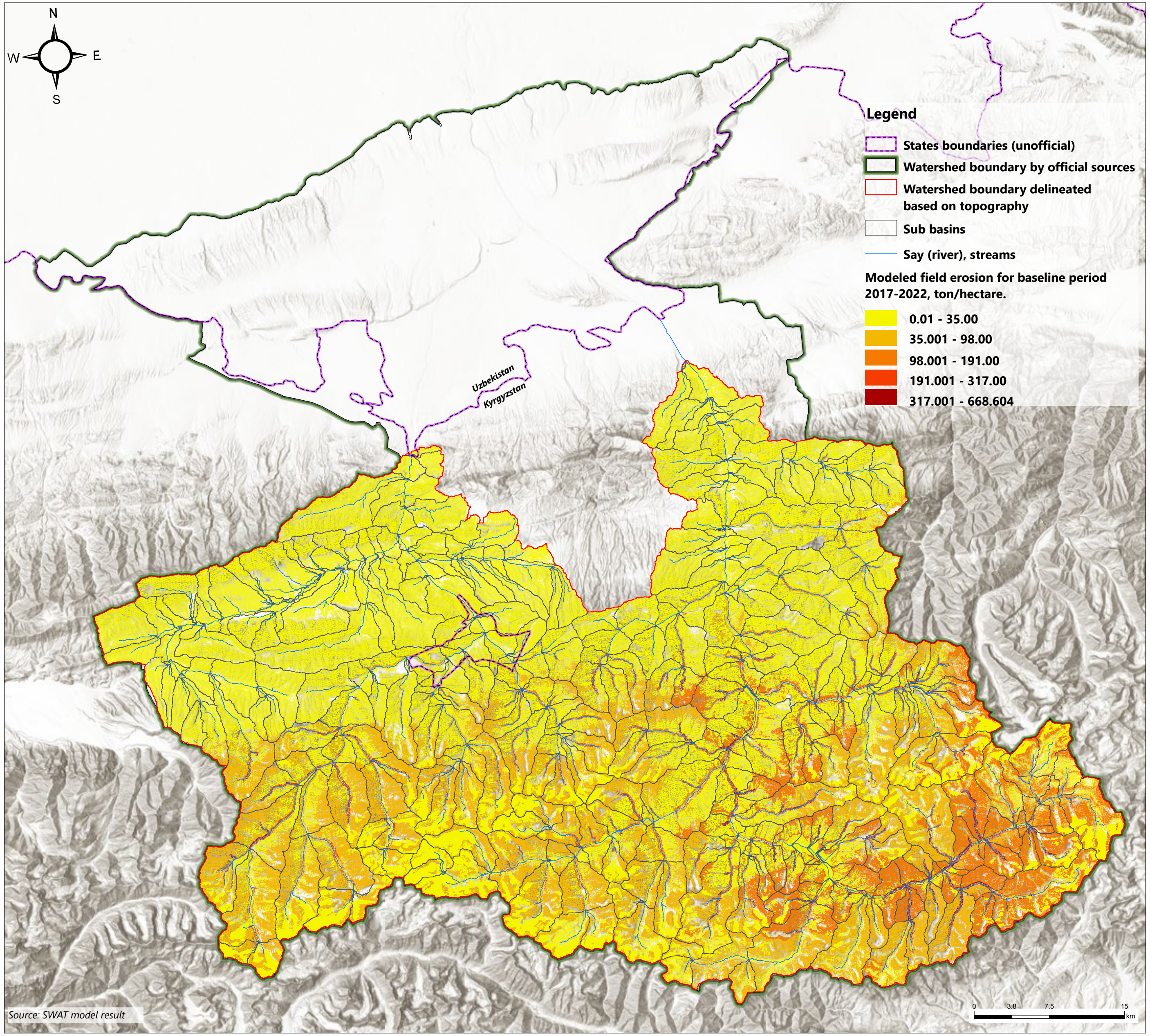
Batken is among the most affected regions in Kyrgyzstan, where the Ak-Suu and Isfayramsay watersheds are located. Research conducted in nearby Leylek district in 2021 shows that the Batken region experiences high to extremely high soil erosion rates.[33]

The SWAT results of the erosion modeling conducted for the baseline period of 2017-2022 revealed a clear trend: land erosion is more likely at higher elevations, whereas it significantly diminishes at lower and middle elevations. 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

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. ACTED, 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 Ak-Suu and Isfayramsay watershed, 2017 - 2022



and are susceptible to erosion.

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.

Overall, the inhabited portions of the watersheds shows a low risk overall for soil erosion, making this less of a concern than in other parts watersheds in Batken region.

Suggested watershed support

» Efforts to restore and strengthen soil through improved vegetation should be made in upper-watershed communities to reduce erosion.

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.[35] These shifts can alter a river's flow, resulting in bank erosion and potentially increasing vulnerability to mudslide events.[36]

As part of the SWAT analysis, IMPACT modeled stream sedimentation for the 2017-2022 period. The findings of this analysis indicated that both Ak-Suu and Isfayramsay watersheds suffer from a high levels of sediment accumulation, which in some places can cause floods/mudslides during heavy precipitation events.

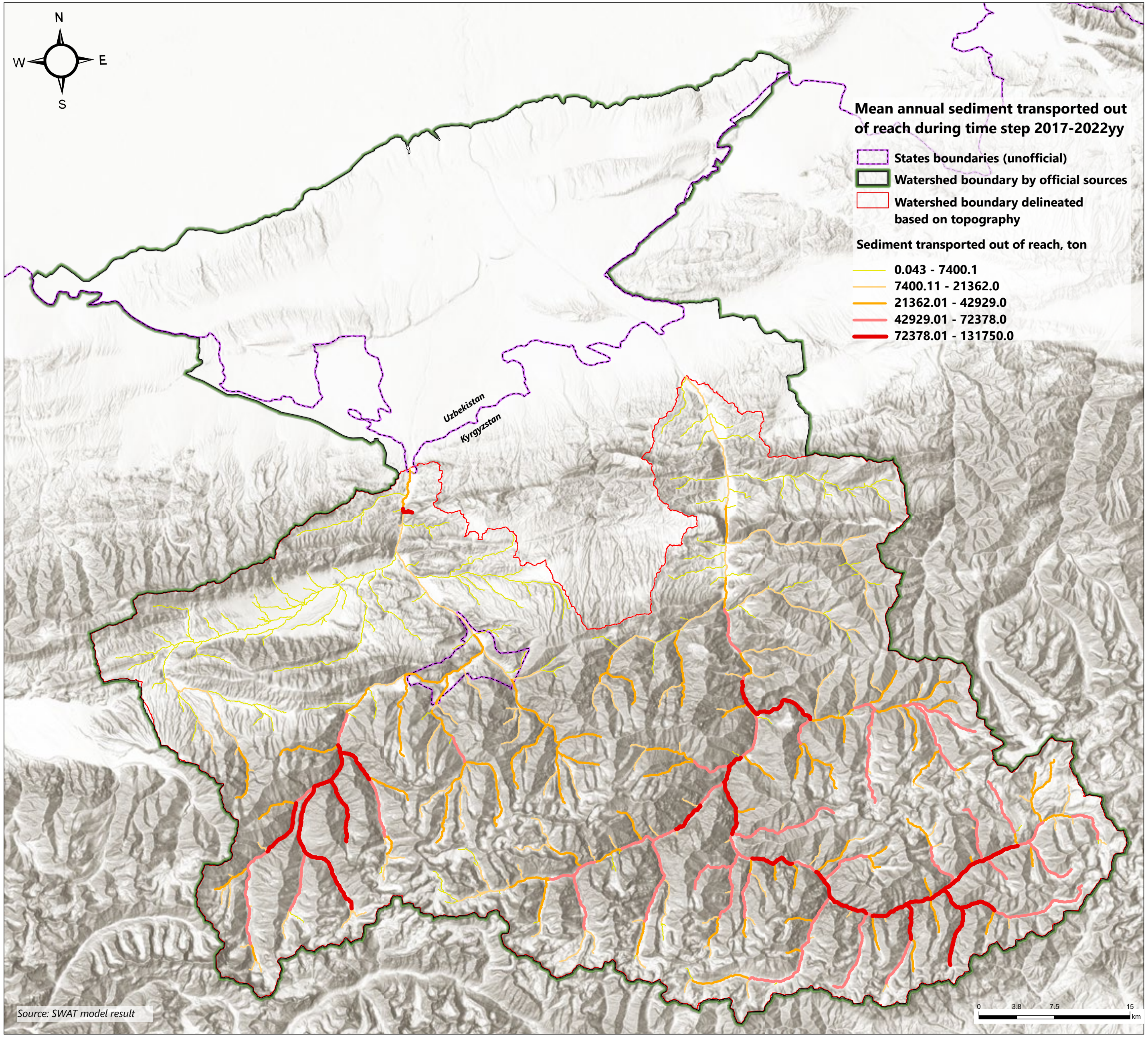
As it shown on the Map 8 sediment accumulation is highest in highly elevated areas, such as the Turkestan Ridge that makes up the river's source, exceeding 4,000 meters above sea level, exhibits elevated levels of sedimentation, with total sediment transported out of the main river (reach) up to 131,750 tons.

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 susceptibility to mudflows, is highest in LSGs further upstream, including Korormo LSG in Aksu and Maydan LSG in Isfayramsay. Interesting some of the areas around Kadamjay town were also found to be be exposed as well. In these places, the total sediment transported out of the reach is between 72,300 and 131,700 tons, similar to locations near the river's

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

Map 8: Sedimentation of sub-basins in Ak-Suu and Isfayramsay watersheds, 2017 - 2022



mountain source.

The dangers of mudflows in these areas were highlighted by KIIs IMPACT interviewed in Kadamjay 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 Kadamjay District MoES staff found that while communities in all LSGs along the river are at risk to mudflows. However, documents and analysis from MoES showed that Kadamjai town and Kotormo LSGs in Ak-Suu watershed to be at a particularly elevated risk.

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.[37]

37. ACTED, Additional Assessment of Risks of Natural Disaster in Ak-Suu and Khoja-Bakyrgan River Water-hseds, 2014.

Suggested watershed support

- Retention walls can prevent the further erosion of river banks and protect household shelters and farmland from being damaged.
- Reforestation and pasture management initiatives can strengthen the soil and reduce the amount of erosion material that feeds mudflow events.

As part of the assessment, IMPACT conducted an in-depth analysis of various of bioclimatic variables from WorldClim. WorldClim uses the Coupled Model Intercomparison 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.[38] 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.[39]

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 both Ak-Suu and Isfayramsay watersheds. 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.[40]

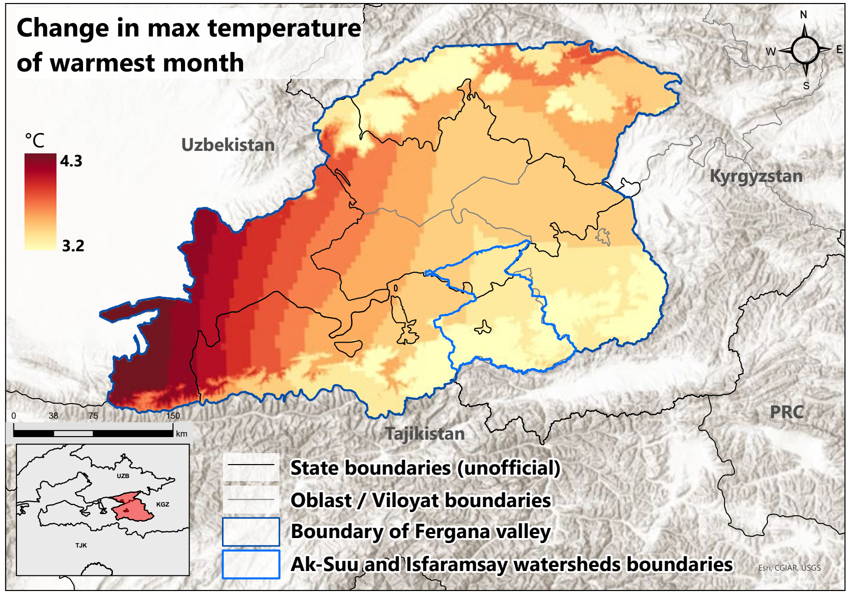
As depicted in Maps 9 & 10, a rise in the average annual temperature across the Fergana Valley is expected, particularly in the southwest part of the Valley, with a projected increase in temperature as high as 3 degrees Celsius (°C) in some locations. While not as dire, the remainder of the valley is expected to see dangerous temperature increases as well.

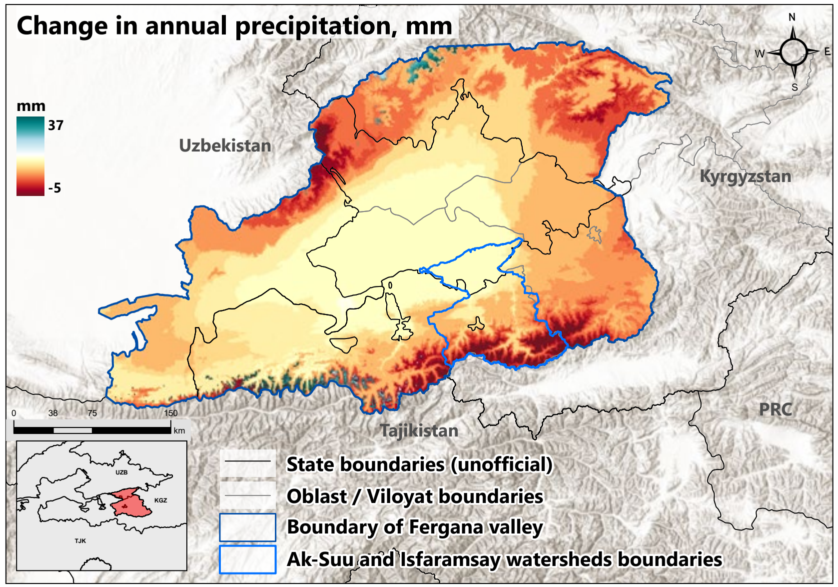
Similarly, the analysis revealed changes in precipitation patterns. Forecasts suggested an estimated increase in annual precipitation of about 40 mm within the elevated and mountainous eastern region of the Fergana Valley, while the centre and western parts of the valley are expected to see a slight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

Looking at Ak-Suu and Isfayram watersheds 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 significantly over time, across all seasons, although these affects are unevenly dispersed - while overall rainfall is expected to continue to slightly decline in populated areas, it will increase significantly in the mountainous areas that make up the watersheds' sources.

These changes are likely to result in more 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.[41]

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





38. DKRZ, The SSP Scenarios, 2023.
39. Ibid.
40. Muccione, Veruska; Huggel, Christian; Salzmann, Nadine; Fiddes, Joel; Nussbaumer, Samuel U; Novikov, Viktor; Hughes, Geoff, Climate-cryosphere-water nexus: Central Asia outlook. Châtelaine, 2018
41. 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.

KIIs with LSG officials reflected these concerns, noting that they have already observed a surge in both frequency and intensity of heatwaves and a noticeable decline in regularity of precipitation, which has affected the seasonal sowing periods and the local economy.

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,[42] 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. KIIs further reported that heavy rain is the main cause of such hazards, in some cases affecting entire communities.

42. 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)

Figure 1. Projected changes in bioclimatic variables of interest, Ak-Suu and Isfayramsay, between 1970-2000 and 2041-2060[g]

+5.07°C Annual mean temperature increase

+3.33°C Increase in max. temp. in warmest month

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

+3.10°C Change in mean temp. in driest quarter

+2.57°C Increase in minimum temperature in coldest month

+12.47mm Increase in precipitation of wettest quarter

+14.72mm Increase in annual precipitation

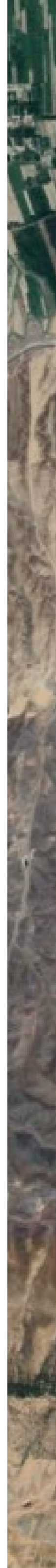
-0.76mm Increase in precipitation in warmest quarter

+6.60mm Increase in precipitation of coldest quarter

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.

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.



2. Watershed Hazard Analysis

Ak-Suu & Isfayramsay Watersheds
Kadamjay District - Batken Region - Kyrgyzstan

Hazards to effective land management

Source: Google Earth, 2023

rce: Acted, Staple grain crops in private plot in Kadamjai District,
gust 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.[43]

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). Additionally, the number of peasant farms in 2023 constitutes 45% of the total operating business entities, underscores the role of agriculture in the economy.[44]

Subsequently, the role of agriculture in the communities of the Ak-Suu and Isfayram watersheds 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, especially during agriculture season, and rising temperatures have already had a major impact on agriculture land within the Ak-Suu and Isfayram watersheds. The combination of these factors have reduced yields (less productivity) of staple grains of both rainfed and irrigated lands, making them less profitable, and eventually leading to decline in sown areas or total discontinuation by farmers. 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 households and communities can help to preserve rainfed lands from deteriorating further.

43. Statistical Committee of the Kyrgyz Republic, Agriculture of the Kyrgyz Republic, 2022.
44. Ibid.

Land in the Ak-Suu and Isfayram 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.

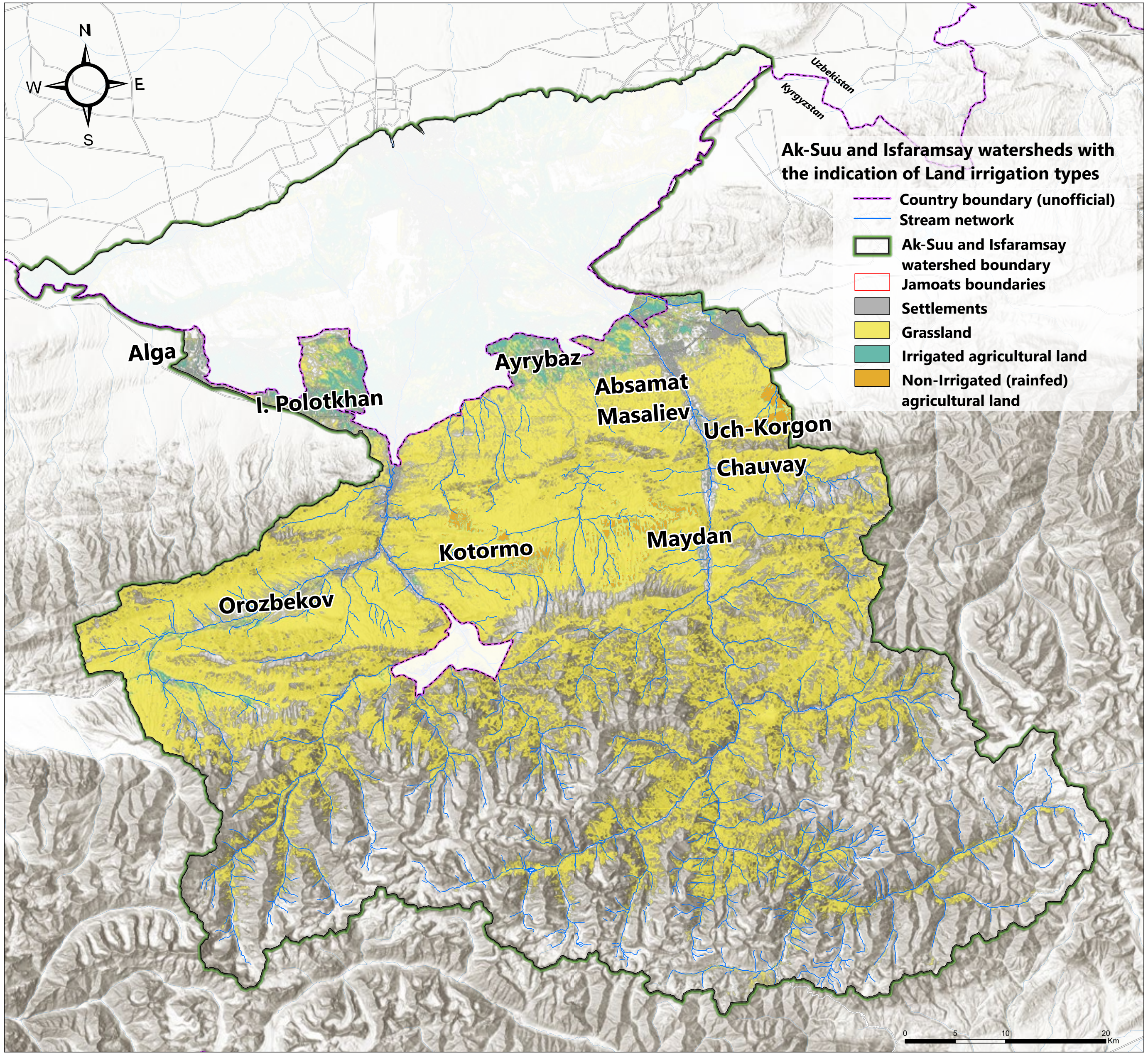
In Kyrgyzstan, most agricultural land is privately owned (75%), while the remaining and state-owned land (25%). Additionally, in some cases there are cooperatives usually formed by groups of different families, coming together to pool resources, specializing in seed production, providing harvest services, 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. Each LSG has designated land in uninhabited areas upstream in the mountains which is used by households from specific LSGs. Alga, Iskhak Polotkhan and Kadamjay city are the exceptions to this, and households from these LSGs do not migrate their livestock south into the mountains.

As shown in Table 7, there is about 50% more irrigated land (about 6,300 ha) than rainfed land (about 4,000 ha) in both the Ak-Suu and Isfyram watersheds. About 1/3 of arable land is state-owned, although the remaining 2/3 is privately held. Nearly all arable land is in use; due to the aforementioned lack of water, Alga LSG was reported to have almost 200 ha of unused rainfed lands due to a lack of water.

The vast majority of land in the watershed is pasture land. This is particularly prominent in Maidan, as well as in Iskhak Polotkhan, Uch-Korgon, Kotormo and Alga (in descending order). The management of these pastures falls under the responsibility of pasture committees, acting as the executive body of

Map 11: Approximate locations of irrigated and rainfed lands in Ak-Suu and Isfayram watersheds, 2023



pasture user associations under the LSGs.

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 Ak-Suu and Isfayram watersheds, there are two forests totaling 140,999 ha, each named after their respective water shed, of which 63% is located in Isfayram, and 37% in Ak-Suu. Both are managed by the Ministry of Agriculture. These forests constitute the main public pasture areas for communities in the watershed.

Table 7: Agricultural Land use, by % of land in Ak-Suu and Isfayram watersheds, 2022[h]

Land cover type	% of total	
	Ak-Suu	Isfayram
Total area of arable land :	7%	7%
Irrigated	5%	4%
Rainfed	2%	3%
Pasture land	34%	46%
Perennial plants (trees)	1%	<1%
Barren/unused land/ Forests	57%	45%
Fodder	1%	1%
Viticulture	<1%	0%
Gardens	0%	<1%

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

Most of the population of the Ak-Suu and Isfayram watersheds are primarily engaged in agriculture, horticulture, and animal husbandry, which serves as the main source of income for households. A minority of households of both watersheds also worked in factories, which include industrial plants that produce asphalt and concrete, and most families were also supported by remittances from family members working abroad.

According to an in-depth report on agricultural growing practices in the Batken Region conducted by UNDP, overall, the Ak-Suu and Isfayram watersheds are moderately warm areas for growing crops, which are considered to be more favorable for growing crops than Leilek district of the Batken region. However, the watersheds receive much less precipitation at favorable growing temperatures (5-15° C) during the growing season the Leilek, receiving 3 times as less water in summer, and 1.25-2.25 times as less water annually.[45]

KIIs on agricultural practices highlighted differences in crop types based on elevation, which in Kadamjay district is divided into two parts: a lower zone (about 500 meters above sea level) and middle zone (between 500-2,200 meters above sea level). Any land above 2,200 m is pastureland used exclusively for grazing. In the lower zone, which is mostly irrigated, vegetables, horticulture and fruits are typically grown, while in the middle zone, staple grains and fodder plants (wheat, barley, corn, esparcet, and safflower) are grown. According to the KIs, grain crops are the main crops in the targeted communities (Table 8).

Furthermore, the KIIs also noted that different crops are planted based on whether the land is rainfed or irrigated. As such, in nearly all LSGs, most of the irrigated lands are used for horticulture and fruit cultivation. These include persimmons, cherries, peaches, apples, strawberries, and raspberries. On rainfed land, staple grains like barley, wheat, and corn, as well as esparcet and safflower are planted.

The aformentioned UNDP report on agricultural practices in the Batken region also emphasized that differences in agricultural practices, and the timing of sowing and harvesting depends 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 by location. These differences result 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. As a result, farmers in the lower zone can start their growing seasons over a month before those planting in the upper zone.[46]

According to some KIs, both watersheds have experienced rising temperatures caused by climate change over the last two decades. These temperature changes have resulted in an up to one-month shift in the early sowing/planting period for crops. leading the planting season for some crops that are normally planted at the end of April to be planted in the middle of March.

A crop calendar for wheat and barley is depicted in Figure 2. The sowing period of these crops begins from the middle of March to the beginning of April, when the average daily temperatures consistently exceed 5°C. Following the sowing period, barley and wheat progress through several critical growth phases, beginning with emergence (occurring within 11-21 days) and 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 before harvest.

Notably, the period of ripening varies with elevation due to temperature differences. In valleys 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.

In addition, according to KIIs, due to climate change, seasonality for crop growth has reportedly changed. KIs in Kotormo, Masliev, and Aiyrbaz LSGs noted that sowing and harvest seasons for vegetables had shifted to approximately one month earlier than the previous decade due to earlier arrival of warm days.

Furthermore, KIs did reported that climate change has also lead to a number of shifts in crop choice and growing practices. Aside from a broader change to horticulture due to dwindling water supplies, KIs in Aiyrbaz and Maydan reported the adoption of drip irrigation to manage lower water levels. In addition, the total amount of ha dedicated to staple grains (wheat and barley) has been

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

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

Table 8: Crop yields by centners/hectare, by LSG in Ak-Suu and Isfayram watersheds, 2022[i]

LSG	Wheat	Barley	Corn grain	Leguminous crops	Oilseeds	Potatoes	Vegetables	Watermelon, melon, pumpkin	Animal Feed	Fruits and berries
Alga	27.7	20	60.1	20.5	0	170.4	152.2	49	63.7	32.8
Kotormo	26.5	26.6	64	0	0	163	158	60	65.8	110.1
Iskhak Polotkhan	27.6	22.6	63	21.5	0	154	155.7	48	71.5	50.5
Kadamjay	0	0	60	0	0	150	153.5	19.4	20	16.5
Masaliev	27.2	0	61.7	22	0	153.1	157.8	49.1	78.6	58.6
Maydan	14.4	11.7	61.8	20	22.1	155	155	45	54.7	41.8
Aiyrbaz	24	18.8	62.9	20	0	160	158	50.2	65.8	41.7
Uch-Korgon	13.6	0	64	19.9	0	147.2	153.9	50.09	125	61.1

i) Source: National Statistical Committee of the Kyrgyz Republic .
j) Source: UNDP, Agro-Climatic Resources of the Batken Region of the Kyrgyz Republic", 2022.

reduced in the last two decades, and some crops, like cotton, pumpkin, and grapes had been discontinued due to a lack of sufficient river water and precipitation.

The analysis of National Statistical Committee of the Kyrgyz Republic (hereafter NSC) data indicates a noticeable discontinuation in the cultivation of specific crops across several LSGs (see Annex). In Aiyrbaz, the cultivation of rice, cotton, and corn (intended for animal feed) has been discontinued. Similarly, Iskhak-Polotkhan LSG reported discontinuations of cotton, oilseeds, and tobacco, while both Masaliev, Maidan and Uch-Korgon LSGs ceased both tobacco and oilseed cultivation. It's important to note that the data covers only the period from 2013 onward, suggesting the possibility of earlier discontinuations of other crops. KIs noted this to be largely due to a lack of profitability, with market incentives and business needs driving crop selection.

In addition, the analysis of agriculture data also tracked the changes and similarities in sown crops, sown areas, and the yield of harvested crops from 2013 to 2022. The analysis revealed that the LSGs in the Isfayramsay watershed primarily sow corn, fruits and berries, vegetables, wheat, and perennial & annual grasses for hay. While the data for LSGs in Ak-Suu watershed reported that similar crops were grown, they also reported growing oilseed, potatoes and barley.

The overall amounts of these crops varied between LSGs. Corn was the most common crop grown in every LSG in both Isfayramsay and Ak-Suu watershed, though the proportions of arable ha dedicated to the crop varied between LSGs.

It is important to note that while the total areas of ha used for crops rose in the LSGs of both watersheds between 2013 and 2022 (between 1 and 43%), in a few cases, remained unchanged in both watersheds, the area (ha) of wheat decreased between 2013 and 2022. This decrease was particularly notable in Masaliev LSG, where the area dedicated to growing wheat decreased approximately 59%, and in Uch-Korgon LSG, which saw a reduction of about 14%.

In Ak-Suu watershed, ha dedicated to wheat decreased in all three LSGs along the Ak-Suu watershed, particularly in Alga, (38%), in Kotormo (22%) and Ishak Polothan (7%). These data on hectares used for particular crops in both watersheds reflect the preferences of farmers, which in this case show that wheat, despite being one of the main crops, has become less preferred for farmers over the past decade, and been

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

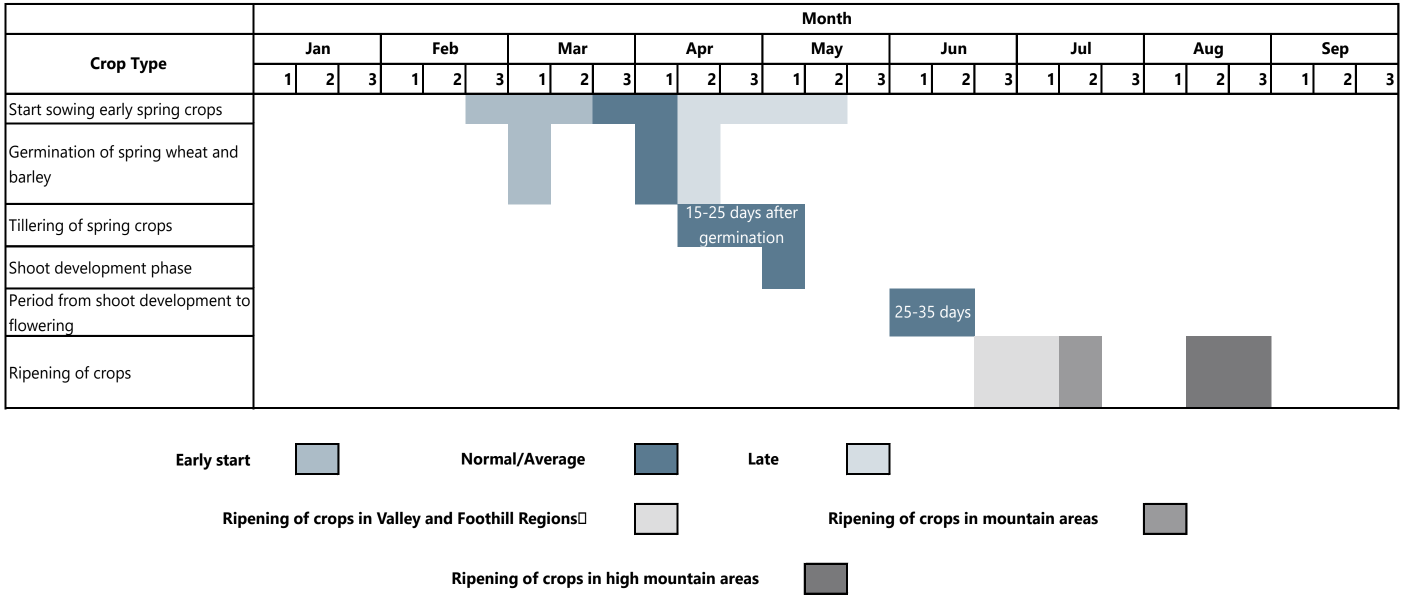
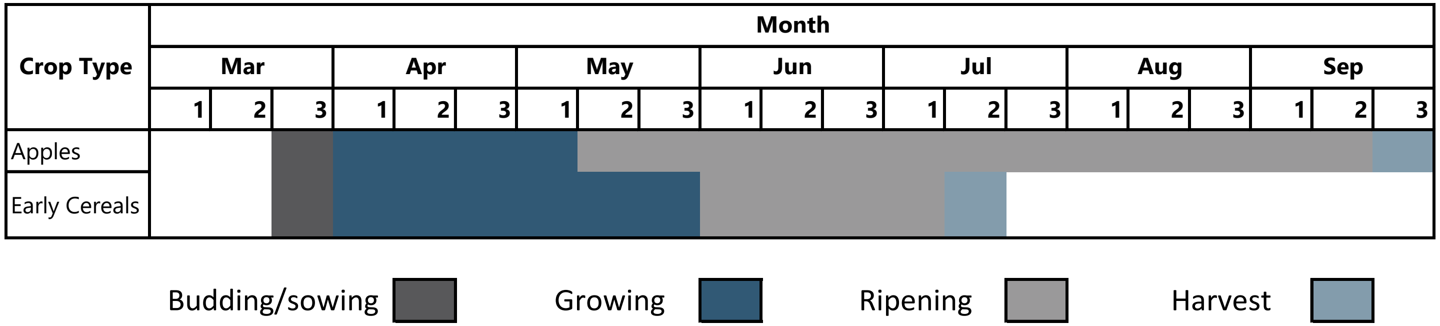


Figure 3: Crop calendar for Apples and Early Serials in Kadamjai District, 2022.[j]



replaced largely by other crops.

Analysis of wheat yields showed yields to have largely remained the same between 2013-2022, as shown in Graph 11. The only exception to this was in Maydan, which is likely linked to changes in rainfall as Maydan LSG is primarly rainfed. As the statistical data did not differentiate between rainfed and irrigated land, more granular data is needed for a more detailed analysis.

The productivity of other crops is illustrated in Graphs 12-14 for both watersheds. Corn yields have been noticeably high compared to other crops, and have increased slightly between 2013 - 2020, supporting farmer's decisions to switch to greater corn cultivation. Most other main crop yields have remained relatively stable over the same period.

Overall, the agricultural data analysis results align with the findings of KIIs, which provide insights into some seemingly contradictory patterns. KIs highlighted climate change had impacted the regularity of precipitation in recent years, which has harmed the yields of crops dependent upon rainfed land, impacting barley and wheat yields over two decades.

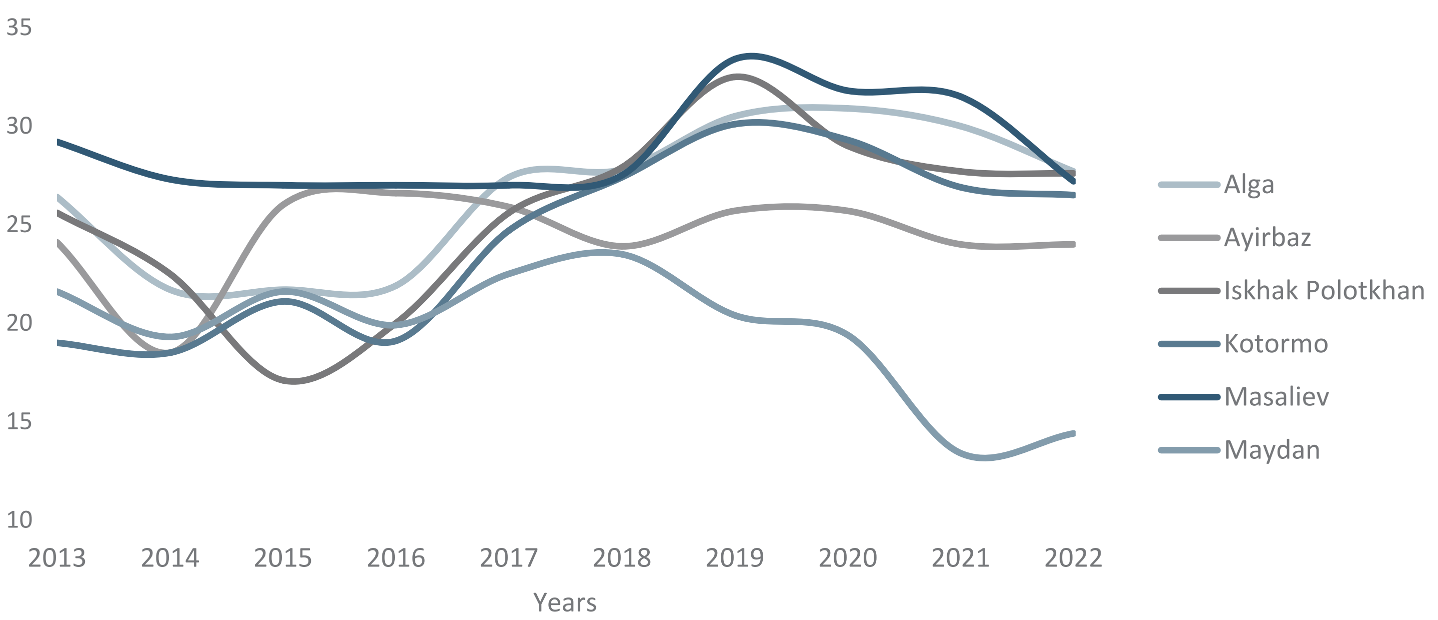
In addition, since most changes in crop choices were reported by KIs to have been market driven, the adoption of high-value crops such as fruit and horticulture has followed a rise in market prices, while tobacco was discontinued due to poor returns.

The decrease in yields of perennial grasses for hay was also mentioned by KIs, who noted that this had had an impact on livestock (see pasture management section), so the decrease in yields may cause an increase in the areas to compensate/satisfy the needs. In addition, several KIs mentioned current efforts to sow different types of perennial grasses to preserve pastures made by international development organizations and the Government of Kyrgyzstan to make pastures more sustainable.

As a result, due to the aforementioned changes in the Ak-Suu and Isfayramsay rivers, KIs in both upstream and downstream areas noted that most households had decreased the amount of grain crops, and shifted to horticulture ann fruits in irrigated areas. KIs in downstream areas further noted a growing reliance on groundwater and underground reservoirs to supplement the lack of precipitation, snowmelt, and glacial runoff.

In Kotormo LSG, where water is taken directly from the river, KIs noted that they still had sufficient water for irrigation purposes, although they had also experienced challenges in rainfed areas due to the decline in precipitation.

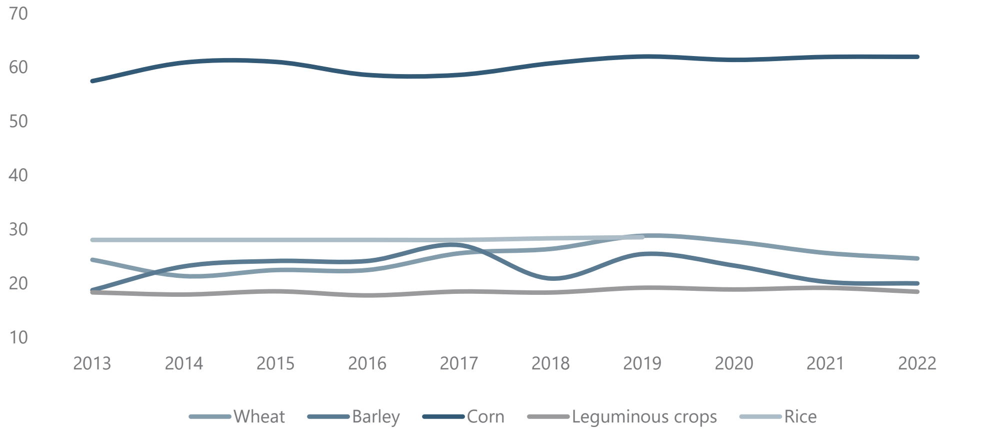
Graph 11: Changes in the wheat yields (in centners/ha) during the period of 2013-2022[k]



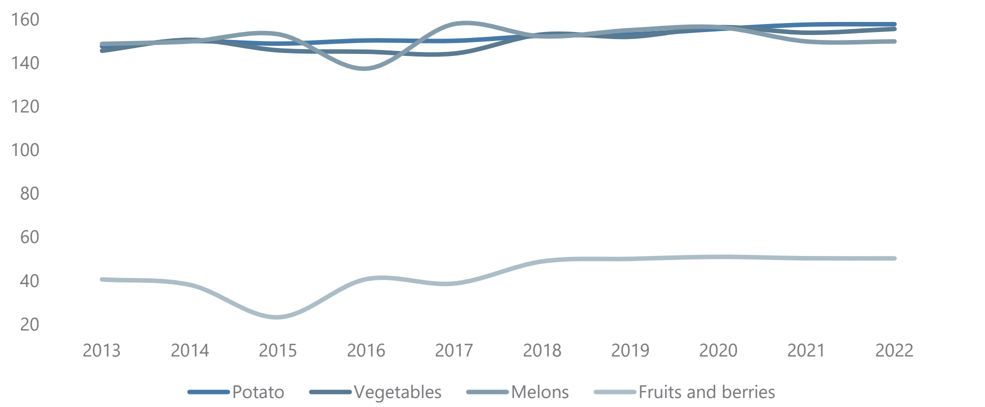
Suggested watershed support

- 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.

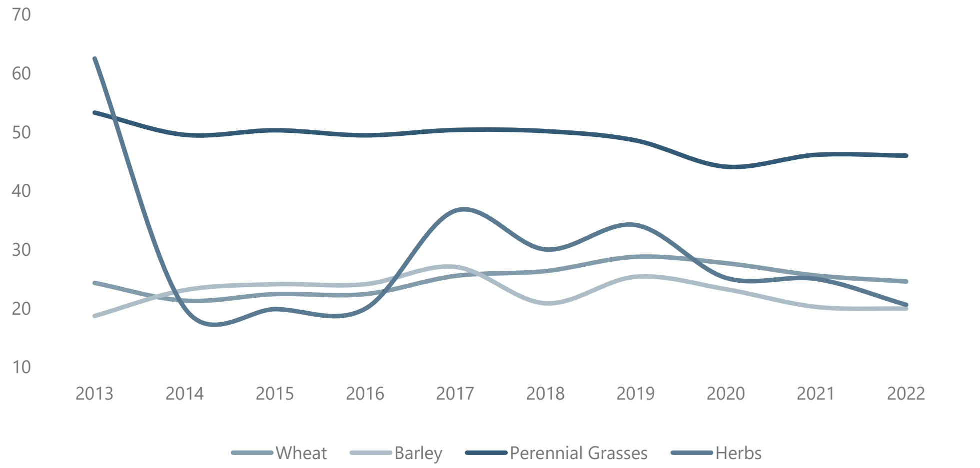
Graph 12: Changes in the main grain crop yields (in centners/ha) during the period of 2013-2022[k]



Graph 13: Changes in main vegetable and fruit crop yields (in centners/ha) during the period of 2013-2022[k]

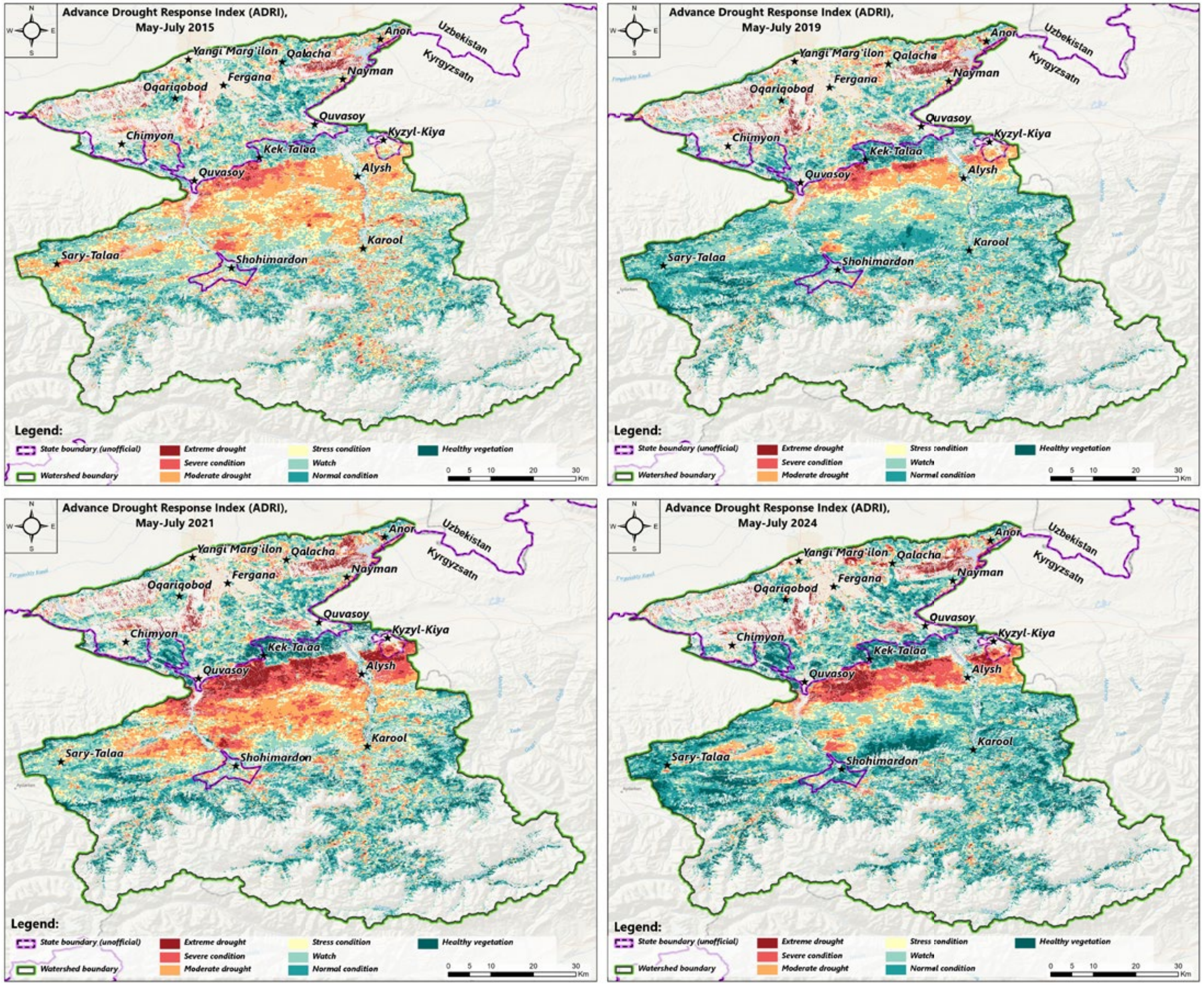


Graph 14: Changes in the main grass crop yields (in centners/ha) during the period of 2013-2022[k]



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

Map 12a: Agricultural land and susceptibility to drought in Ak-Suu and Isfayram watersheds, 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.[47] The drought was amplified by dwindling water supplies due to climate change, something both the Ak-Suu and Isfayram watersheds are reported to be vulnerable to.

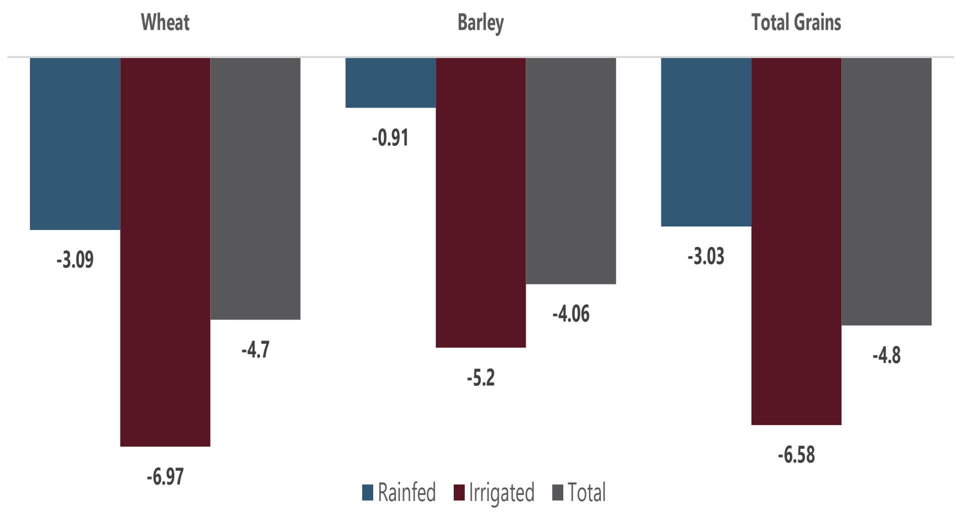
Agriculture, namely crop production, is the most drought-sensitive sector of the Kyrgyz economy, with more than 30% of the cropland affected in Kyrgyzstan, according to a report conducted by United Nations Food and Agriculture (hereafter FAO).[48] Over the past fifteen years, droughts have significantly 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.[49]

A recent FAO study found droughts to be frequent in watersheds in the Batken Region. 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.[50] The report by UNDP also found that the moisture availability of the Kadamjai district, including the areas of the watersheds, is very dry, Kadamjai district was found as hotter compared, for instance, to the Leilek district of the Batken region,

To assess susceptibility to drought in the Ak-Suu and Isfayram watersheds, IMPACT developed a composite model, which combined geospatial

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

Graph 15: Change in average wheat and barley yields in Ak-Suu and Isfayram watersheds, 2022 - 2023[k]



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 susceptibility to drought. The results are shown in Map 12.

The analysis in Map 12 shows most of LSGs in Ak-Suu watershed to be at a moderate risk to drought, while the majority of LSGs in Isfayramsay are at a lower risk to drought. Susceptibility to drought was reported by KIs to be almost entirely linked to climate change over the last 20 years, including declines in both precipitation and glacial runoff. KIs noted that the glaciers that feed the Ak-Suu and Isfayram watersheds have declined by 30% in recent years. Additionally, KIs also noted that a sharp increase in population in the area over the same time period has also put more pressure on water needs, particularly in downstream areas where the population is reliant on the RuVKHA canals for their domestic and irrigation water needs. Upstream communities reported not having experienced major changes in water availability because they typically get their water directly from the Ak-Suu or Isfayram rivers. However, as previously mentioned, changes in precipitation, was mainly mentioned by KIs, had also affected rainfed croplands.

An examination of grain yields between 2022 and 2023 illustrates the impact of climate change on rainfed and irrigated lands. The data from Agriculture department of Kadamjai district, allows to track changes of yields of main agriculture crops distingueshly for rainfed and irrigated lands, which was only available for the last several years (Graph 17). KIs noted 2022 to have been a relatively normal year for agriculture in Ak-Suu and Isfayram watersheds, 2023 was, like 2021, a year with extreme water shortages and reports of drought within the Fergana Valley. While yields of both wheat and barley fell between 2022 and 2023 in all cases, the declines were much larger in rainfed lands than irrigated lands (Graph 17). Other crops, which were mainly grown in irrigated areas, experienced either much more mild declines or slight increases, which the exception of horticulture, which also say a sharp decline in yields.

The longitudinal data from the Statistical Committee of Kadamjai district, alternative data, reveals a relatively stable wheat and barley yields over time, that have declined slightly in recent years among communities in both watersheds (Graph 18). However, it is important to note that the impact of drought on changes in the productivity of these crops as such cannot be tracked due to the lack of data on wheat and barley yields differentiated between irrigated and rainfed areas for at least the last decade. Since as these crops are sown in both lands[51] and given the fact that irrigated areas are relatively better able to cope with insufficient precipitation during droughts by compensating with irrigation water.

On the other hand, knowing that perennial and annual grasses are mainly sown on rainfed land, the changes in the yield of these crops can be informative about the impact of drought. Thus, as can be seen, the yield of perennial grasses showed a steady decline over the period, falling by 13% between 2013 and 2022, while that of annual grasses fell by 67% over the same period, with a sharp drop

in 2014 to around 20 tons, down from 63 tons the previous year. Drought can therefore be seen as a factor, along with other anthropogenic factors, contributing to this significant decline.

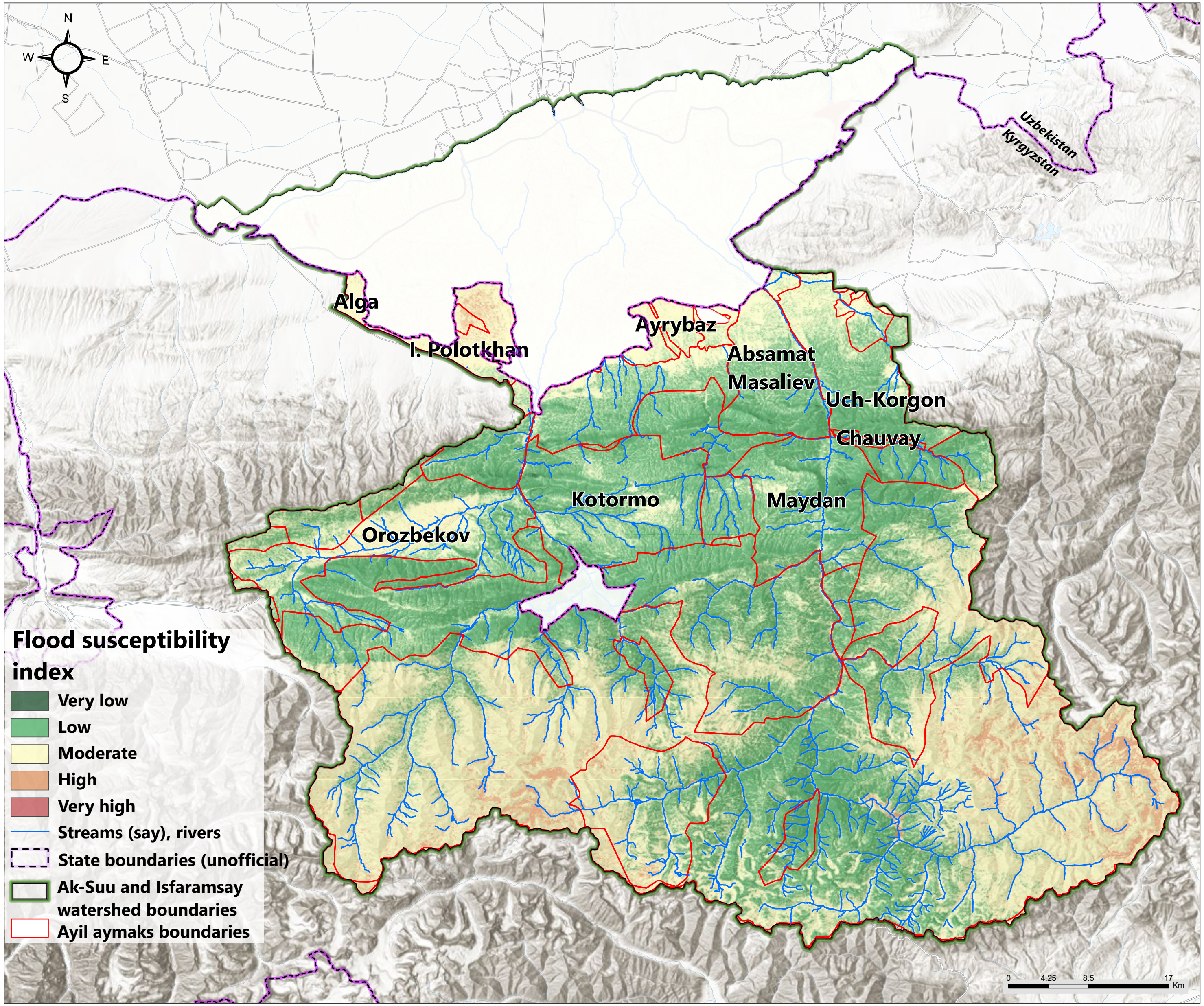
51. According to available data from the Kadamjai District Agriculture Department, the irrigated area under wheat accounted for 59% of the total sown area, while barley accounted for 28% in 2022.

Suggested watershed support

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

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

Map 13: Flood susceptibility to LSGs in Ak-Suu and Isfayram watersheds, 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.[52] 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 susceptibility 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 plains that make upmost of the irrigated growing areas along the border with Uzbekistan. While no areas within the watershed are assessed to be of extremely high flood susceptibility, Iskhak Polotkhan LSG and some of the extremely mountainous areas are whon to have high flood susceptibility, while Alga, Aiyrbaz, Uch-Korgon, and parts of Kotormo, Masaliev and Maydan LSGs have moderate susceptibility to flooding.

KIs within the Kadamjay department of Emergency Services noted that flooding was extremely common in Kadamjai District. Flooding tended to threaten both

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

houses and irrigation infrastructure, which KIs in several LSGs noted often had to be repaired my the WUAs or RuVKHA after a major flood event. KIs from Uch-Korgon also noted that the RuVKHA canal's limited water capacity often lead to it overflowing and causing flooding in the immediate areas.

National MoES documents supported these findings, noting at least 180 houses in Isfayram and 496 houses in Ak-Suu which were at risk of mudflows or flooding. KIs noted that at community level, communities have tried to increase their overall resilience by planting trees to strengthen the soil and build fences and barriers to protect their properties from flooding.

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.

Source: Acted, Pasture Land in Kadamjai District, August 2023

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.61 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 38,056 heads of cattle and 97,452 sheep & goats in Ak-Suu and Isfayram watersheds. These cattle subsist on 106,956 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 Ak-Suu and Isfayram watersheds.

Pastures play a critical role in both the economy and ecosystem of the Ak-Suu and Isfayram River Basins, particularly on the elevated, more mountainous parts of the watershed. Managed through pasture unions 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 Ak-Suu and Isfayram watersheds.

Pasture land in Ak-Suu and Isfayram watersheds were 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.

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.

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.

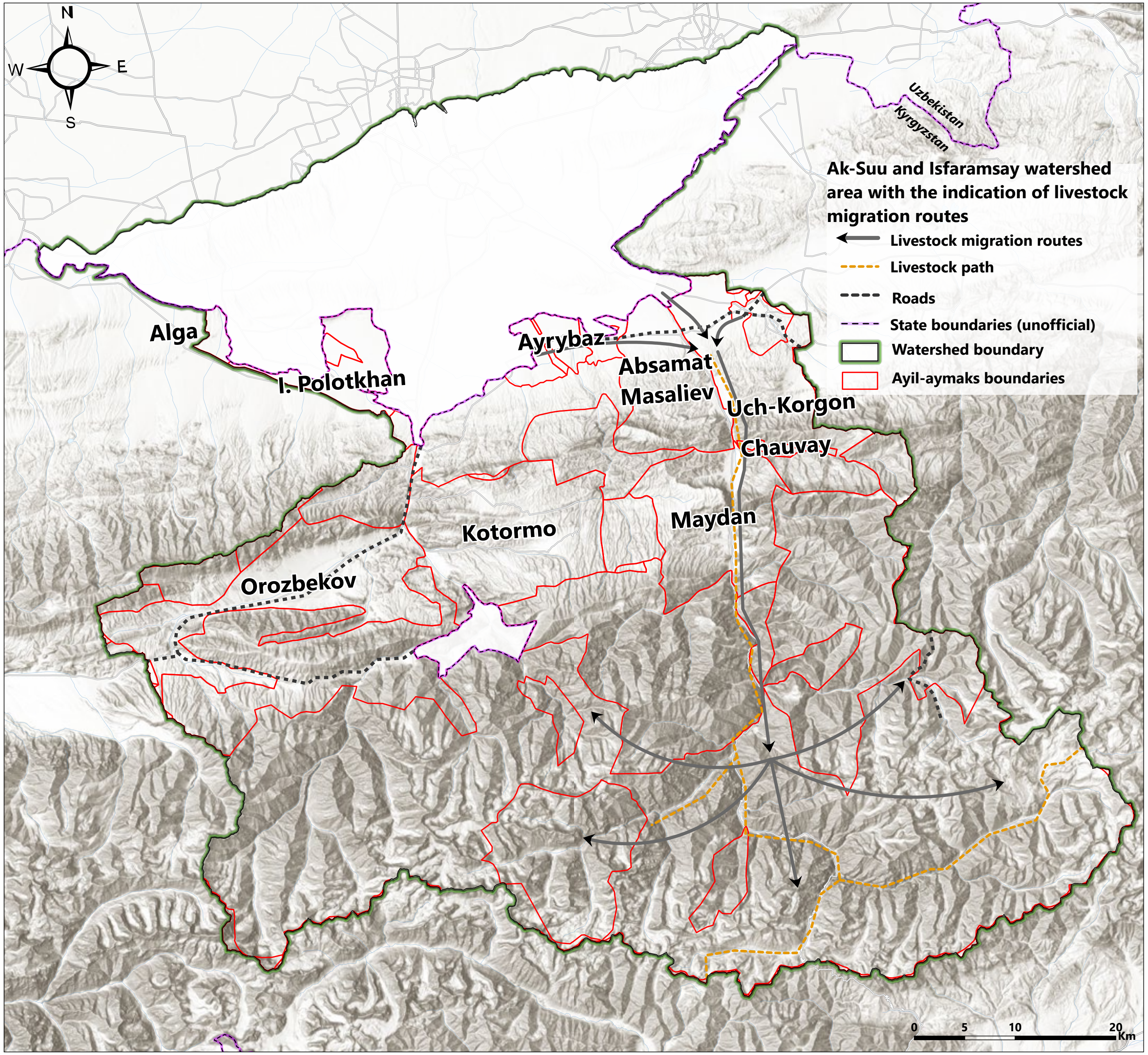
The Jaiyt Committees include representatives of pasture users, local deputies, and appointed representatives from the environmental and forestry authorities and heads of the LSGs. Members of the Jaiyt Committees are elected at the general association meetings from among representatives of pasture users 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[53] 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.[54] 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 economic livelihood activity in the watershed. This practice serves multiple purposes, including livelihood sustenance and income generation through the raising of animals for the purpose of meat sales at markets. Many Kis mentioned that ongoing efforts to enhance livestock productivity, welfare, and product quality through breeding and improved feeding practices are taking place in Alga, Aiyrbaz, Kotormo, Maidan, and Uch-Korgon.

53. 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.
54. [Ministry of Agriculture of the Kyrgyz Republic, Pasture.]

Map 14: Community herding patterns, Ak-Suu and Isfayram watersheds, 2023



According to KIIs, livestock is typically taken out to pasture during the spring and summer months, with variations in the exact dates and duration. Each LSG's Jaiyt committee manages a designated area of for pastures, which are located in the southern mountains. Households take their cattle there in the late spring and summer to these designated areas. Alga and Iskhak Polotkhan LSGs are the exception, where households do not migrate their cattle and instead graze them on fallow land. In the winter, the livestock are kept in yards and farmers' garden.

The lack of sufficient pastures for grazing was raised by several KIs. Communities in Uch-Korgon and Masaliev lacked sufficient pastures for the total number of animals, while nearly all KIs in Isfayram watershed noted that their pastures were very rocky and lacked sufficient vegetation for animals.

KIs in both Maydan and Iskhak Polotkhan noted restrictions in accessing remote pastures before the late spring, but also noted that many households ignore these restrictions. In other LSGs in Ak-Suu watershed, KIs reported having no restrictions at all on pasture usage.

Suggested watershed support

- Identify different locations for livestock grazing that can avoid over-grazing and destruction of pasture land.
- Empowerment of new pasture management organizations to better hold pasture users to account and reduce collective action failure that prevent pasture restoration.

To analyse pasture degradation, IMPACT adapted a model developed by the International Fund for Agricultural Development (IFAD) to assess the degradation of pastures in Kyrgyzstan.[55] The analysis compares the change in degraded pastures between 2000-2003 and 2019 to 2022 for the Ak-Suu and Isfayram watersheds. The findings of this analysis revealed a noticeable degradation across both watersheds.

As shown on Map 15, the northern parts of the map are primarily urban build-up and irrigated agriculture lands, with only small areas available for pasture lands. most of the pasture areas that make up the mid-level zones of each watershed are highly degraded, with over 72% of pasture land, over 80,000 ha, reported as degraded over the last 20 years.

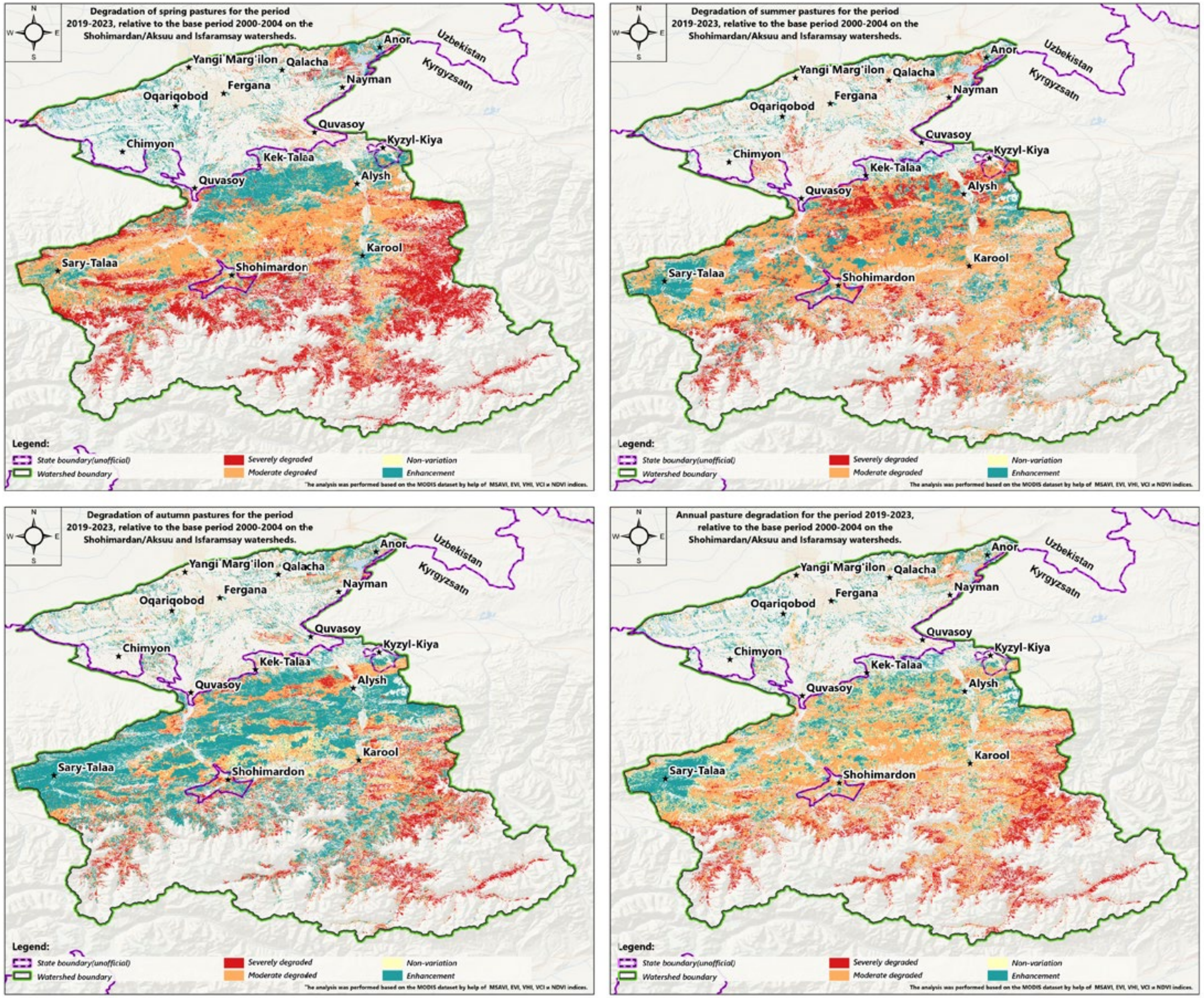
The map illustrates that pasture degradation has affected the entire watershed area, irrespective of the elevation. Degradation is noticeably worse in Ak-Suu than Isfayramsay, primarily due to large areas of Maydan being having less affected. This was supported by KIIs, which also highlighted shrinking pasture lands over time, due to the increase in livestock, ineffective pasture management, and failure by the Jaiyt committees to enforce practices to rotate pasture uses between communities. Households were reported to often use pastures outside of designated months, and not use those that were designated by the Jaiyt committees, leading to over grazing.

In addition, an increase in the population and number of livestock was reported to have increased pressure on the existing pasture land, increasing the overall level of degradation due to overgrazing.

KIs further noted that the higher levels of pasture degradation in Ak-Suu were likely linked to communities keeping their animals in the same place and not migrating to far away pastures. KIs in Isfayram also noted that issues with pasture degradation were mitigated by large, mostly untouched pasture areas in Maydan, which are

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

Maps 15: Pasture degradation susceptibility change in Ak-Suu and Isfayramsay watersheds, between 2000-2003 and 2019-2022



Pasture Degradation - Continued

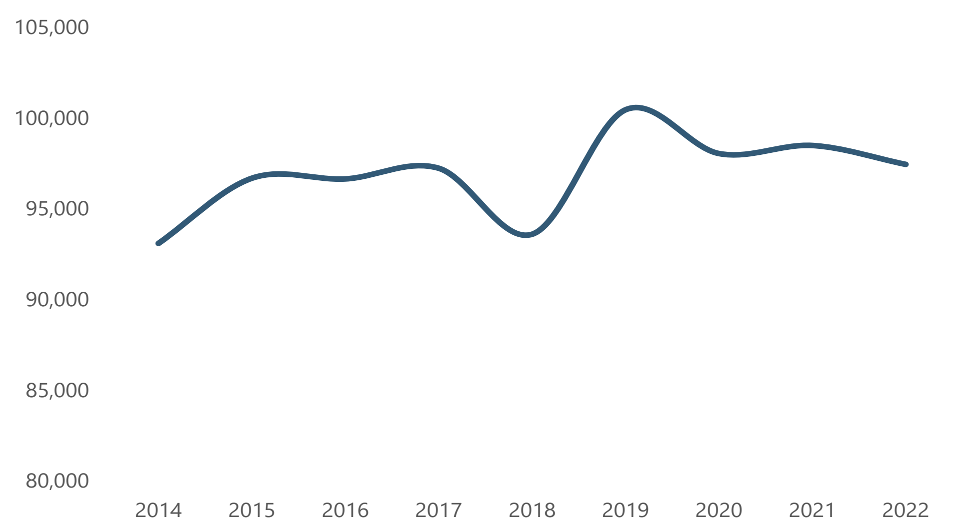
increasingly used by households from other LSGs in the watershed.

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

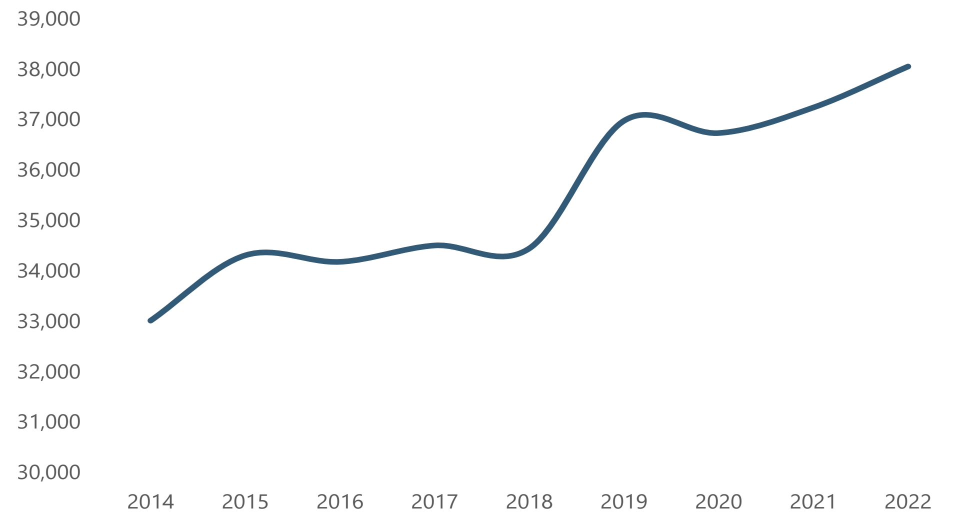
Analysis of longitudinal data from the Kadamjay district Department of Agriculture (Graphs 16-17) shows cattle and sheep & goat herds to have increased slightly over time, suggesting that pressures on pasture land in the both watersheds are likely to continue.
A noticeable dip in cattle ownership between 2020 and 2021is likely due to an overlap of drought conditions during this time which affected many households and their assets due to the dehydration and deaths of herds. However, 2021 to 2022 shows that cattle numbers have already started to recover in the last year showing trends are likely to continue to recover.

Furthermore analysis of available pasture land in each Ayil Aimak found that Masaliev and Maidan LSGs, despite having the smallest pasture area (about 5% each of the total pasture area in both watersheds), have the highest percentage of cattle and sheep&goats among the total number of livestock in relation to pasture area. On the other hand, the Maydan stands as the only LSG, that have the least number of livestock in relation to its pasture area. Although the LSGs has the highest number of livestock in percentage wise, after Uch-Korgon, among the other LSGs. According to KIs, the livestock of Masaliev and Maidan is kept in the remote pastures, while in Aiyrbaz the livestock grazes at the LSGs own pastures.

Graph 16: Number of cattle in Ak-Suu and Isfayramsay watersheds, 2019 - 2023[o]



Graph 17: Number of sheep & goats in Ak-Suu and Isfayramsay watersheds, 2019 - 2023[o]



o) Kadamjay District Department of Agriculture 2023.

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 Ak-Suu Watershed, although all LSGs except for Maidan showed high levels of degradation. As a restult, Kotormo and the Kadamajay town areas should be prioritised.

» Rainwater harvesting, less invasive livestock herding techniques, and tree nurseries to nourish soil can provide holistic solutions to restoring pasture lands.


Source: IMPACT, Ak-Suu River entering Uybekistan, Kadamjai Rayon, 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 Ak-Suu and Isfayramsay watersheds, 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.[56] Earthquakes are among the most destructive 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.[57]

Of an average of more than 23,000 earthquakes that occur annually in Central Asia, approximately 13,000 occur in Kyrgyzstan.[58] 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.

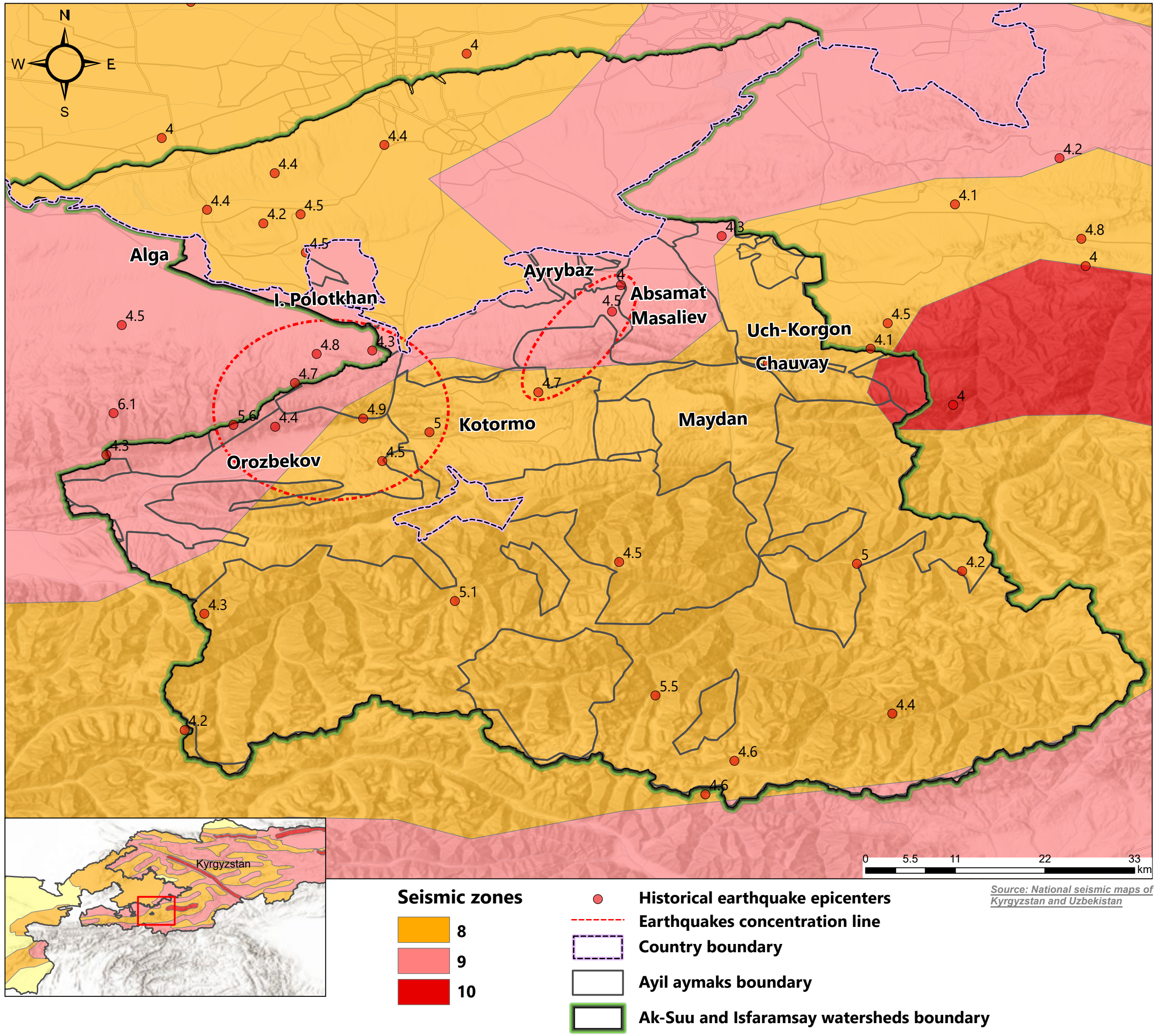
The most recent major earthquake to occur was the 2011 Fergana Valley earthquake, which occurred in central Batken Oblast and had a Maximum Mercalli Intensity (MMI) of 8 and a Richter Scale Magnitude of 6.1. Across all three countries, 14 people were killed and 86 were injured.

Map 16 illustrates the earthquake susceptibility of the watershed, indicating seismic zoning ranging from 7 to 9, showing significant susceptibility to earthquakes.

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

The Ak-Suu and Isfayram watershed areas ranges between MMI 8 and MMI 9+, some of the highest levels of susceptibility in the region. The areas with the highest susceptibility to earthquakes are also the more populated areas along the border with Uzbekistan. Map 16 further shows these areas to be a common location of previous earthquakes. Together, this suggests that future earthquakes in either watershed would likely be in locations where large numbers of people would be exposed to danger.

Map 16: Earthquake hazard susceptibility in Ak-Suu and Isfayram watersheds, June 2023[m]

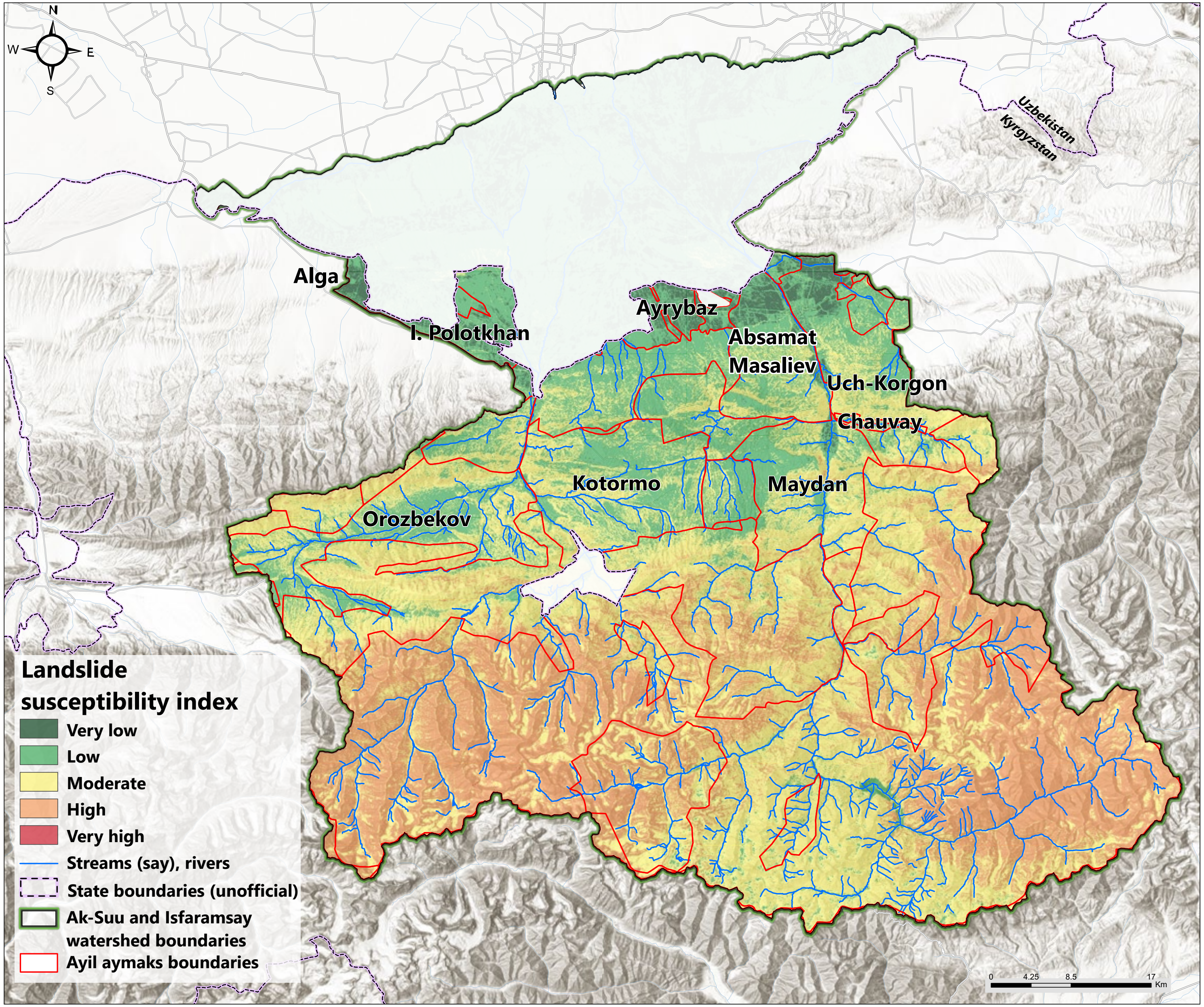


Landslides involve the downward movement

56. USGS, Earthquake Facts and Earthquake Fantasy
57. MOES, Information on Emergency Situations registered in the territory of Leylek District in the first quarter of 2023, 30 March 2023.
58. CABAR, Earthquakes in Central Asia: casualties and half a billion damages per year, June 2023.

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

Map 17: Landslide susceptibility in Ak-Suu and Isfayramsay watersheds, 2023



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.[59]

Due to its mountainous terrain, Kyrgyzstan is mostly prone to landslides.[60] 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. [61]

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 most of the LSGs, and therefore populated areas of the watershed, to have low susceptibility to landslides, making them a minor concern in the context of other natural hazards examined in this study.

However, there is some moderate risk to landslides in the elevated, upper pasture areas of the watershed, particularly in the southern mountainous areas of both watersheds. MoES hazards maps corroborated the findings from Map 16, showing mild risks to landslides faced by communities in villages in

59. USGS, What is a landslide and what causes once?.
60. F. Caleca, C. Scaini, W. Frodella, V. Tofani, Regional-scale landslide risk assessment in Central Asia, June 2023.
61. 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.

northern Kotormo LSG near Uzbekistan's Shakhimardan exclave and northern Maidan LSG.

In addition, the MOES notes that 48 houses and 16.5 km of road in Kadmjay city, 8 km of road in Maydan LSG, and 4 houses in Uch-Korgon are vulnerable to rockfalls (a similar natural hazard), suggesting that small, specific pockets of population are still at vulnerable.

In addition to higher slopes, a lack of overall vegetation in the mountains also increases the overall vulnerability of landslides, contributing to greater risk. Previous analysis found this to be a major issue in the elevated areas of both watersheds. 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.

Suggested watershed support

- Paving of roads will reduce their vulnerability to damage and length of closure due to landslides.
- Prepositioning of resources and assets in key villages known to be likely to be affected by landslides will improve response time and overall quality.
- Review and identification 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 Kadamjay district MoES department manages disaster preparedness for communities in both the Ak-Suu and Isfayram watersheds.

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.[62]

KIs noted that the main natural hazards in the watershed were mudflows, landslides/rockfalls, drought, and riverbank erosion. in addition, MoES documents and previous academic studies highlight the risk of Glacial Lake Outburst Flood (GLOF) in the district. GLOFs occur when glaciers, which can act as natural dams for lakes that form in glacial depressions, melt, allowing the water that has collected in the glacial lake to escape, causing a sudden flood that can cause destruction of lives and property in unprepared communities. Climate change has made GLOF events more likely, as glaciers melt away. MoES has noted 15 glacial lakes in Isfayram and 6 in Ak-Suu watersheds that could become GLOFs in the future. All 21 potential GLOFs are projected by the MoES to threaten most of the communities within each watershed should they activate, presenting a major hazard for entire watershed populations that requires significant preparation.

Other than earthquakes, at-risk populations tended to be small pockets of people, usually between 9-143 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 staff noted that while the district had done a lot to prepare for potential disasters, very little had been done from a preventative standpoint. The only project mentioned was a bank reinforcement project implemented by an international organisation in collaboration with the local government. The KIs reported that the MoES is also working on strengthening river banks with concrete to prevent erosion and other works to strengthen the banks, but this lacks the financial support to make a major difference in reducing the overall risk to the population.

The KI also mentioned that all the villages in the watersheds are accessible by road. Some of these roads are paved with asphalt and others with gravel. According to KI, certain villages face accessibility problems during natural disasters. In particular, villages in Kotormo AO and Maidan AO, such as Kara-Zhygach, Karol and Austan, located at the foot of the mountain, experience road closures due to rock falls. In addition, the village of Chauvai in Uch-Korgon AO is at risk of being blocked by landslides.[63]

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, lack of pre-deployed resources. Nevertheless, the disaster management committees established in LSGs developed preparedness plans for communities withing the watersheds to address potential hazards, working in close coordination with the MoES.

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

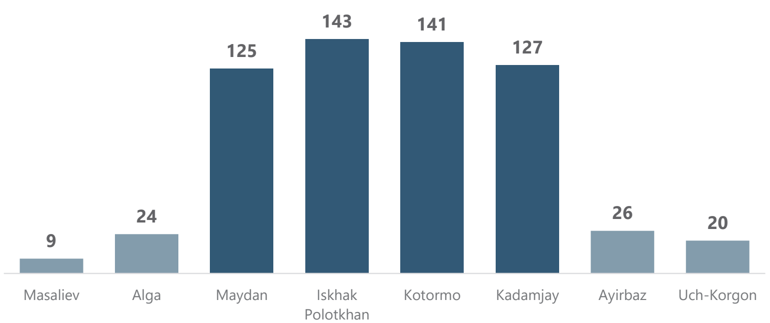
62. Republic of Kyrgyzstan, Ministry of Emergency Situations, Monitoring and Forcasting of Emergency Situations within the Regions and Districts of the Kyrgyz Republic, 2023.

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

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.
Uch-Korgon-Chauvai	6	7
Uch-Korgon - Maidan	17	23
Uch-Korgon - Teniz-bay	0	43
Osh - Isfana	0	78
Osh - Isfana	125	138
Osh - Isfana	149	190

Graph 18. Number of household shelters exposed to flooding and mudflows in Ak-Suu and Isfayram watersheds, 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 of the watersheds.

KIIs noted that gender dynamics in the Fergana Valley tend to enforce separate spheres of work and socialisation, 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.[64] These factors contribute to a situation where women are often excluded from WUAs and other NRM decision making bodies at local levels.[65]

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 worsened this trend.[66]

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.

64. CAWATERinfo, Empowering women in water resources management in Central Asia, 2012.
65. The World Bank, Promoting women's Participation in Water Resource Management in Central Asia, 20 January 2021.
66. 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

Ak-Suu & Isfayramsay Watersheds
Kadamjay District - Batken Region - Kyrgyzstan

Analysis of local dispute causes and resolution dynamics

Conducted by:

international alert

Source: Google Earth, 2023

Inter-Communal Tensions Over Water Management in Isfaramsay Watershed

The Kojo-Kaiyr and Lagan Canals: Vital Irrigation Arteries of the Kadamjay Region

The Kojo-Kaiyr and Lagan Canals, drawing from the Isfayram-Say river, supply irrigation water to the Masaliev, Maidan, and Airybaz Aiyl Aimaks (AA) in Kadamjay Rayon. Their water resources, including all related canals and aryks, are distributed by three Water User Associations (WUA). Combined, these associations irrigate 4,568 hectares: WUA "Kara-Dobo" (1,808 hectares), WUA "Isa-Mariyam" (560 hectares), and WUA "Kojo-Kaiyr" (2,200 hectares) .

Distinct from the Kojo-Kaiyr Canal, the Lagan Canal has its roots in Uzbekistan, specifically near the Masaliev AA. Its main intake is within Uzbekistan, but its course lies along the Kyrgyz-Uzbek state boundary, crossing Kyrgyz territory and then re-entering Uzbekistan. The Lagan Canal irrigates several villages and new residential settlements of Masaliev, Maidan, and Airybaz AA.

Until recently, the Lagan Canal was entirely owned by the Uzbekistan. However, in 2015, based on the CIS Agreement , 11.2 kilometers of the Lagan Canal were transferred to Kyrgyzstan's state ownership . Before this transfer, the canal, along with several other hydraulic structures built and operated during the Soviet era, was under the management of Uzbekistan.

Despite the aforementioned agreement and the primary infrastructure of Lagan Canal being located in Uzbek territory, periodic grievances continue to arise among water users in Kyrgyzstan, attributed to misunderstandings and perceptions of restricted water supply by Uzbekistan. This strain is particularly noticeable during the spring, a pivotal period for vegetation. The situation is exacerbated by insufficient communication regarding transboundary water-sharing and the impacts of climate change. Moreover, the aging infrastructure intensifies these tensions. Water losses, which result from worn-out infrastructure average around 30%.

Climate Change and Community Confrontations

Suggested watershed support

- Enhanced Communication and Engagement. A clear, factual initiative about transnational water-sharing practices and outlining legal procedures can alleviate misunderstandings. Investment in community engagement and awareness campaigns can foster trust and cooperation.
- Infrastructure Modernization. Upgrading existing water systems can curb water losses and promote efficient use and distribution, mitigating concerns of water scarcity and potential disputes.
- Exploration of Alternative Water Sources. Developing projects like the "Ismat-Kakyr" Canal can decrease reliance on singular water sources and minimize potential tension points, enhancing water security and independence.

Climate change leads to significant disruptions in the hydrological regime of the Isfayram-Say river, making forecasting increasingly challenging year by year. Due to the decrease in water volume and disruptions in the usual hydrological cycles, tension in the region is escalating. This often exacerbates the already complex situation of water distribution among communities reliant on the water resources of the two main canals, Lagan and Kojo-Kaiyr. Climate-induced changes alter the river's hydrological regime, complicating water resource management and forecasting, which are critical for regional stability. In July and August, the water discharge in the Isfayram-Say river reaches up to 70 m3/s, whereas in winter and early spring, this figure averages around 6 m3/s. Such tenfold fluctuations negatively impact the consistency and uninterrupted supply of irrigation water to farmers.

Tensions and conflicts over water sharing intensify in the spring, primarily when the Isfayram-Say river experiences a notable drop in water levels due to hydrological variations. Between March and mid-June, these tensions peak as water scarcity combines with the season's hydrological patterns. Each year sees increased confrontations between the users of downstream villages, like Dostuk, Kok-Talaa, and Airybaz, and those from the upstream villages in the Maidan and Masaliev Aiyl Aimaks. The downstream villages face severe water shortages while the upstream ones, prioritizing their needs, frequently extract excessive amounts, overlooking the rights and requirements of the downstream residents. This neglect tends to magnify minor misunderstandings into full-blown conflicts.

There's a noticeable lack of discipline in water distribution. The scheduled water distribution often gets bypassed, leading to verbal disputes that sometimes intensify to physical altercations, occasionally involving tools like the 'ketmen' (a type of hoe). Consequently, locals from villages like Kok-Talaa and Dostuk often find themselves standing guard at the "Kara-Dobo" section during nighttime. Yet, even these vigilant efforts face risks from potential vandalism or theft of the sluice gates. Thus, this standoff regarding water distribution frequently results in protests and appeals to district authorities demanding better regulation and control over water distribution.

Suggested watershed support

- Enhanced Community Engagement. Trust and cohesion among communities are paramount. Regular meetings, dialogue sessions, and community engagement exercises can mediate disagreements effectively.
- Infrastructure Modernization. Upgrading water infrastructure, including improved security measures to thwart unauthorized tampering with sluice gates, can ensure fair water distribution and lessen conflicts.
- Collaborative Management. Establishing joint committees with representatives from all involved villages can promote collective decision-making, ensuring equity and fairness.
- Education and Awareness. Spreading information and awareness about equitable water sharing, comprehending downstream requirements, and the broader environmental and societal implications of water misuse can shape community viewpoints.
- Reservoir and Daily Regulation Basin Construction: Building reservoirs and daily regulation basins designed to store water during winter and distribute it evenly during vegetation peaks in the spring would be beneficial. This is especially crucial when the Isfayram-Say river reaches its hydrological low and the demand for water for agricultural crops increases.

Inter-Communal Tensions Over Water Management in Isfayramsay Watershed

Water Scarcity Amidst Rising Population and Territorial Expansion

Airybaz AA is grappling with the escalating issue of water scarcity, a challenge further exacerbated by two dynamics: rising population and the development of new settlements. These factors exert pressure on water infrastructure that, being approximately six decades old, is now outdated and inadequate in addressing contemporary needs.

Constructed during the Soviet era, the canals serving Airybaz AA were designed for distinct demographic and consumption patterns. Since then, both the population and the number of settlements have significantly augmented, surpassing the original capacity of the canals. For instance, just within the last five years, Airybaz witnessed a 10.67% population surge from 2018 to 2022, escalating the total population to 17,040 .

Alongside population growth, water consumption patterns have evolved. The heightened demand in both agricultural and residential sectors has pushed the existing infrastructure to its limits. Once sufficient, the canals now struggle to meet modern-day demands, leading to water rationing, inter-village competition, a decline in agricultural productivity, and subsequent impacts on livelihoods.

The ongoing development of new residential areas, notably Dostuk-2 and Tashov in Airybaz AA, has imposed further demand on the already burdened water system. These emerging areas necessitate supplementary water infrastructure to meet their needs, applying additional strain on the aging system.

The amplified complexities due to population growth and territorial expansion are making water resource management more intricate than ever, necessitating urgent, multifaceted solutions. Such strategies must encompass the renovation of existing water infrastructure, enhancement of water use efficiency, and the formulation of comprehensive water management plans.

Crop Structure: The Upstream-Downstream Water Divide

Suggested watershed support

- Aging Infrastructure and Overburdened System. The current water infrastructure in Airybaz AA is struggling to meet present-day water demands due to the substantial growth in population and the formation of new settlements.
- Increased Demand with New Settlements. Newly formed settlements like Dostuk-2 and Tashov in Airybaz AA are intensifying water demand, stressing the already depleted water resources. The introduction of water-saving technologies and sustainable water practices is crucial in these areas.
- Administrative and Political Challenges. The expanding population and emerging settlements require a reassessment of water distribution plans and quotas. It is imperative to cultivate open dialogue involving all stakeholders, from local communities to administrative entities, to collaboratively formulate fair and transparent water distribution plans to mitigate potential disputes.

In the villages of Masaliev, Maidan, and Airybaz AA, local water consumption is significantly influenced by the crops they cultivate: onions, cucumbers, and fruit trees such as cherry and peach. Onions and peaches, both high-profit and water-intensive crops, are dominant in the region due to their appealing market prices and consistent demand. This is despite their cultivation often not aligning with sustainable water management practices.

A noteworthy feature of these crops is their early maturation. Timely and sufficient irrigation is crucial for their optimal growth and for ensuring the market standards of their fruits. The vegetation period for these crops coincides with spring and June, a time when the region experiences acute water shortages. Consequently, many farmers have reported poor and substandard harvests this year due to insufficient irrigation. This has led to lower quality produce in the market, and subsequently, reduced revenues. Drought and subsequent crop infections have further diminished yields, particularly this year.

The upstream villages of Masaliev AA, where these water-intensive crops are mainly grown, consume a significant portion of the available water resources. This results in a water imbalance between the upstream and downstream villages. While the upstream areas use water extensively for heavy irrigation, downstream villages grapple with reduced water availability. This imbalance causes increased competition and tension between the two communities, particularly during the peak growing seasons.

An interesting observation is that in the downstream villages of Kok-Talaa and Dostuk of Airybaz AA, peach is a popular crop requiring frequent irrigation. If its cultivation continues at the current rate, given the escalating water shortage, competition for water could intensify, heightening tensions further.

According to local self-government bodies of Airybaz, Maidan, and Masaliev AA, there have been no significant changes in the agricultural crop structure over the past five years. The proportion of water-loving crops hasn't shown a marked increase or decrease.

To address these water disparities, there is a clear need for crop diversification. Shifting to less water-intensive crops in upstream areas or implementing crop rotation practices that combine high and low water-consuming crops can lessen water demand. This not only conserves water but also benefits soil health and pest control.

Suggested watershed support

- Deteriorated Yields and Rising Tensions. Insufficient irrigation, exacerbated by droughts, results in poor harvests and reduced revenues. This situation, combined with the continued cultivation of high-water-demand crops, especially in downstream villages like Kok-Talaa and Dostuk, could escalate competition and heighten regional tensions.
- Cultivation Choices Intensify Tensions. The preference for water-intensive crops in upstream villages, particularly in Masaliev AA, results in pronounced water imbalances, increasing the potential for disputes between upstream and downstream communities over water resources.
- Crop Diversification as Conflict Mitigation. Addressing the water disparity through crop diversification, including the promotion of less water-intensive crops and rotation practices, emerges as a potential strategy to alleviate regional tensions. Collaborative approaches among stakeholders are essential to ensure peaceful coexistence and mutual benefit.

Research underscores that the Kojo-Kaiyr and Lagan Canals are integral assets to the Kadamjay Rayon. However, with the region confronting escalating challenges such as population growth, heightened water demand, the extensive cultivation of water-intensive crops, and water losses due to deteriorating infrastructure, tensions are inevitably heightening. These pressures are further amplified by the ramifications of climate change.

4. Recommendations

Ak-Suu & Isfayramsay Watersheds
Kadamjay District - Batken Region - 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 organisations 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 relevant Territorial 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 Organisations:

- 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 Ak-Suu and Isfayramsay watersheds, 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 measure-ment	2021	2022
Hard coal and lignite	thousand tons	654.9	765.2
Crude oil	thousand tons	12.1	11.8
Meat and edible offal 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	thousand tons	4.7	4.3
Shoes	thousand pairs	1.1	1.3
Construction bricks, floor blocks and similar prod-ucts, ceramic, non-fire-resistant	million units	10.2	21.2
Prefabricated concrete building structures	thousand tons	0.5	0.5
Furniture	million soms	103.3	112.9
Electricity	million kWh	1.4	

Table A3: 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 A2: 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
Agricultural in-dustry	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 and le-gumes	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 berry fields	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
others	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
raising livestock and 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
others	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[67] 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.

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.

67. UNDRR, 2023.

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

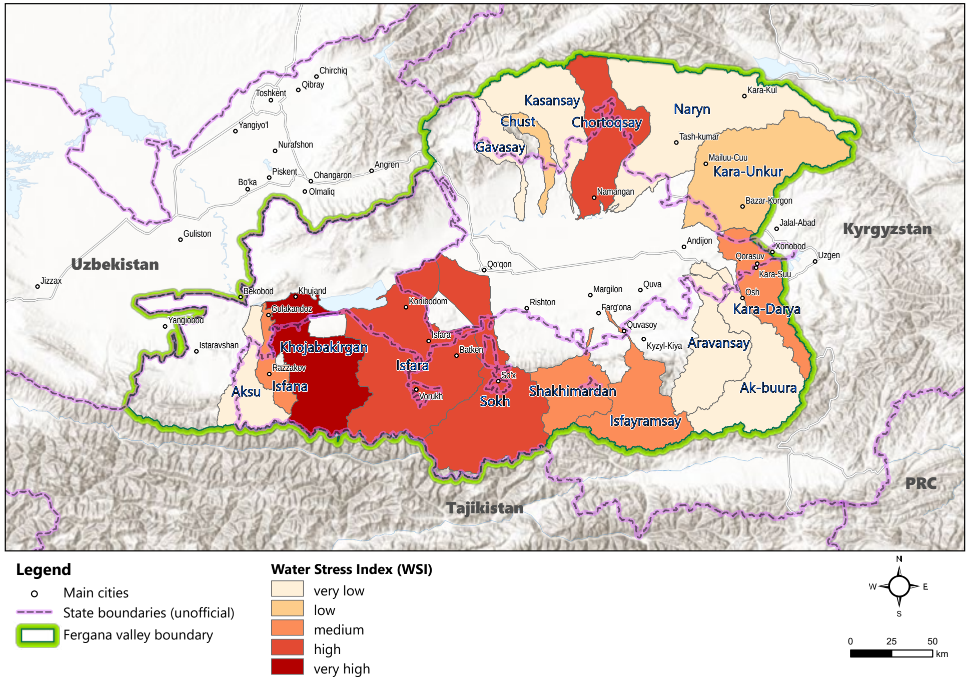


Table A1: Water Stress Index Indicators, hazard groupings, and weighting of indicators to create composite water Stress Index.

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[68] ; 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	

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


Source: Google Earth, 2023